Working Draft Project American National Standard

T13/2161-D

Revision 1b
October 17, 2011

Information technology - ATA/ATAPI Command Set - 3 (ACS-3)

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Reference number
ISO/IEC xxxx-xxx:200x
ANSI INCITS xxx-200x

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American National Standard
for Information Technology

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ABSTRACT

This standard specifies the AT Attachment command set used to communicate between host systems and storage devices. This provides a common command set for systems manufacturers, system integrators, software suppliers, and suppliers of storage devices. The AT Attachment command set includes the PACKET feature set implemented by devices commonly known as ATAPI devices. This standard maintains a high degree of compatibility with the ATA/ATAPI Command Set - 2 (ACS-2).

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American National Standards Institute
23 W. 43nd Street, New York, New York 10036

Document Status

Document f11107 is the issues list for this draft. f11107 contains a list of the issues associated with the document, an issue number that remains assigned to the issue for the life of document development, a resolution to the issue, an owner for the issue, and a disposition for the issue. All major changes associated with this draft are first documented in f11107 and given a number. This includes proposals which are targeted for inclusion into this draft.

Revision History (Sheet 1 of 2)

Rev	Date	Description
0	February 22, 2011	1) Initial revision created from ACS-2r6 2) Abstract updated to reflect ACS-3 3) Restarted revision history and integrated proposals list
1	August 13, 2011	1) Incorporated e09104r2 - defines a statistic for reallocation candidates. Fixed minor grammatical issues in the proposal during integration. Statistic data type was listed as DWord, but shown as 48 bits. Adjusted statistic to match the data type and reduced it to 32bits. 2) Incorporated e08116r2 - report non-volatile write cache. The bit description needed to be completely re-written to follow the form and style of ACS-3. 3) Incorporate e09151r6 - Report security compliance. The proposal was based on an early version of ACS-2. Since the current text does not match the text in the proposal, editorial changes were dropped. 4) Incorporate f10138r6 - LBA Status Log Page. **This proposal has a reference to an unknown table.** 5) Incorporate e09156r8 - New download microcode subcommands. This completely rewrites download microcode. ***Still need to rework the figure.*** 6) Incorporate e08156r4 - Adds a new IDENTIFY DEVICE data log. This proposal included material from e09143r2
1a	October 15, 2011	1) Incorporated f10203r1 Obsolete the HPA feature set. **Editor’s notes were added as follows to highlight material not specifically modified by this proposal:** **A) one in 3.1.53;** **B) one in table 16;** **C) one in A.11.5.2.16;** **D) one in A.11.5.2.23; and** **E) one in A.11.6.2.11.** 2) Incorporated f10205r0 Obsolete the NV Cache and NV Cache Power Management feature set. To eliminate unresolved cross references: A) the content of the LBA Range Entry subclause in the NV Cache Management model section was copied to the Output From the Host to the Device Data Structure subclause in the DATA SET MANAGEMENT command definition; and B) the LBA Range Entry table was copied out of the ADD LBA(S) TO NV CACHE PINNED SET command definition and into the DATA SET MANAGEMENT command definition. 3) Incorporated f10204r0 Obsolete the Device Configuration Overlay feature set. **An editor’s note was added in 7.41.2 to highlight an uncorrectable error in the proposal.** 4) IDENTIFY DEVICE data still shows SERVICE and RELEASE bits word 82. Change these to obsolete. (Issue 52 in f11107r6.) 5) Incorporated f11129r1 Obsolete the "Total time in seconds to complete off-line data collection activity" field returned by SMART READ DATA.

Revision History (Sheet 2 of 2)

Rev	Date	Description
1b	October 16, 2011	1) Incorporated f10146r0 Assign the same code assigned by T10 for the JEDEC UFS Security Protocol ID (note T10 assigned code ECh). 2) Incorporated f11122r0 - IDENTIFY DEVICE data word 206 bit 7 is assigned to SCT BIST in SATA but is still marked reserved in ACS-2. Note: the incorporation of e08156r4 or e09143r2 in r1 appears to have already corrected the second problem reported in f11122r0. The text cited as needing correction cannot be found, but the requested correction text is present in table A.27. 3) Incorporated f10122r5 Device Internal Log. **A possible bug in table A.65 was highlighted with an editor’s note.** 4) Incorporated f11128r1 - Clarify use of status bit 4. 5) Incorporated f11130r1 - Stream error logs in sleep. 6) Incorporated f11127r0 - Define IDENTIFY DEVICE word 91 bits 15:8. Because the text of 7.16.7.45 was moved to A.11.6.3.1 between r0 and r1, the changes made were not exactly what f11127r0 specified. Also, the reserved bytes specified by f11127r0 were added to the IDENTIFY DEVICE table (see table 46). 7) Incorporated e09142r0 Reporting expanded security erase times. Because the text of 7.16.7.43 was moved to A.11.8.5 and 7.16.7.44 was moved to A.11.8.4 between r0 and r1, the changes made were not exactly what e09142r0 specified. Also, changes to the IDENTIFY DEVICE table (see table 46) were heavily edited to improve readability. 8) Incorporated f11111r3 EPC clarifications. Although the proposal does not clearly identify the change, circumstantial evidence suggests that the list in 7.45.18.6.1 is intended to be changed from unordered to ordered, and that change has been made. 9) Incorporated f11120r1 - Synch with SPC-4. f11120r1 included black (supposedly unchanged) text which differed from the ACS-3 working draft, the most significant of which was the name of the descriptor “Security requirements for cryptographic modules”. Discrepancies of this type were resolved by making ACS-3 match SPC-4. 10) Incorporated f10123r4 Coordinating Device Maintenance. Updated the text layout to match the new log page presentation format. 11) Incorporate f11119r3 - Clarifications for DOWNLOAD MICROCODE. Added an editor’s notes in the DL3:DL4 and DL5a:DL1 transitions to highlight the absence of shall/should/may verbs from list items added/modified by the proposal. 12) Updated so that the FrameMaker spelling checker could be used by: A) disabling the “extra spaces” and “straight quotes” checking options; B) changing all instances of … to ellipses (i.e., Ctrl+Q I, not to be confused with Ctrl+Q i which is È); C) changing all instances of .. to a newly created variable names Range so that FrameMaker will not check them (i.e., FrameMaker never spelling checks the contents of variables, a blessing or curse depending on how it is used); and D) using the spelling checker “Allow in Document” option to “teach” FrameMaker a few ACS-3 terms.

New Capabilities added to ACS-3

Items indicated in bold are new functionality.

Integrated Proposal List		
#	**Doc**	**Description**
1	e09104r2	Defines a statistic for reallocation candidates.
2	e08116r2	Reports that the device has a non-volatile write cache.
3	e09151r6	Report security compliance
4	f10138r6	Adds the ability for the device to return a list of the LBAs that are currently trimmed.
5	e09156	Rewrites download microcode and adds new subcommands.
6	e08156	Expands IDENTIFY DEVICE data by creating a log.
7	e09143	Adds nominal buffer size to IDENTIFY DEVICE data log.
8	f10122r5	Adds two log addresses with many pages to report device internal state (e.g., for failures).
9	f10123r4	Adds three new timing values in the Current Settings log page to allow hosts to better coordinate with devices regarding device internal maintenance needs.

Contents

Tables

Figures

Foreword

(This foreword is not part of this standard.)

This standard is designed to maintain a high degree of compatibility with the ATA8-ACS standard.

Requests for interpretation, suggestions for improvement and addenda, or defect reports are welcome. They should be sent to the INCITS Secretariat, ITI, 1101 K Street NW, Suite 610, Washington, DC 20005.

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 Colegrove, Chair

Jim Hatfield, Vice-Chair

Mark Overby, Secretary

Table 1 — Membership and Participant list

Name	Company
TBD	

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 Normal and Error Output fields.
Clause 7 describes commands.
Clause 8 describes the SCT Command Transport.
Clause 9 describes command normal and error outputs.
Annex A describes logs.
Annex B provides command summaries.
Annex C describes considerations for using devices with non-512-byte sectors.
Annex D provides a tutorial on how to use SCT.
Annex E provides implementation guidelines for 1 024/4 096 byte sectors.

American National Standard
for Information Technology –

ATA/ATAPI Command Set - 3 (ACS-3)

1 Scope

The set of AT Attachment standards consists of this standard and the ATA implementation standards described in AT Attachment - 8 ATA/ATAPI Architecture Model (ATA8-AAM). The ATA/ATAPI Command Set - 2 (ACS-2) standard 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.

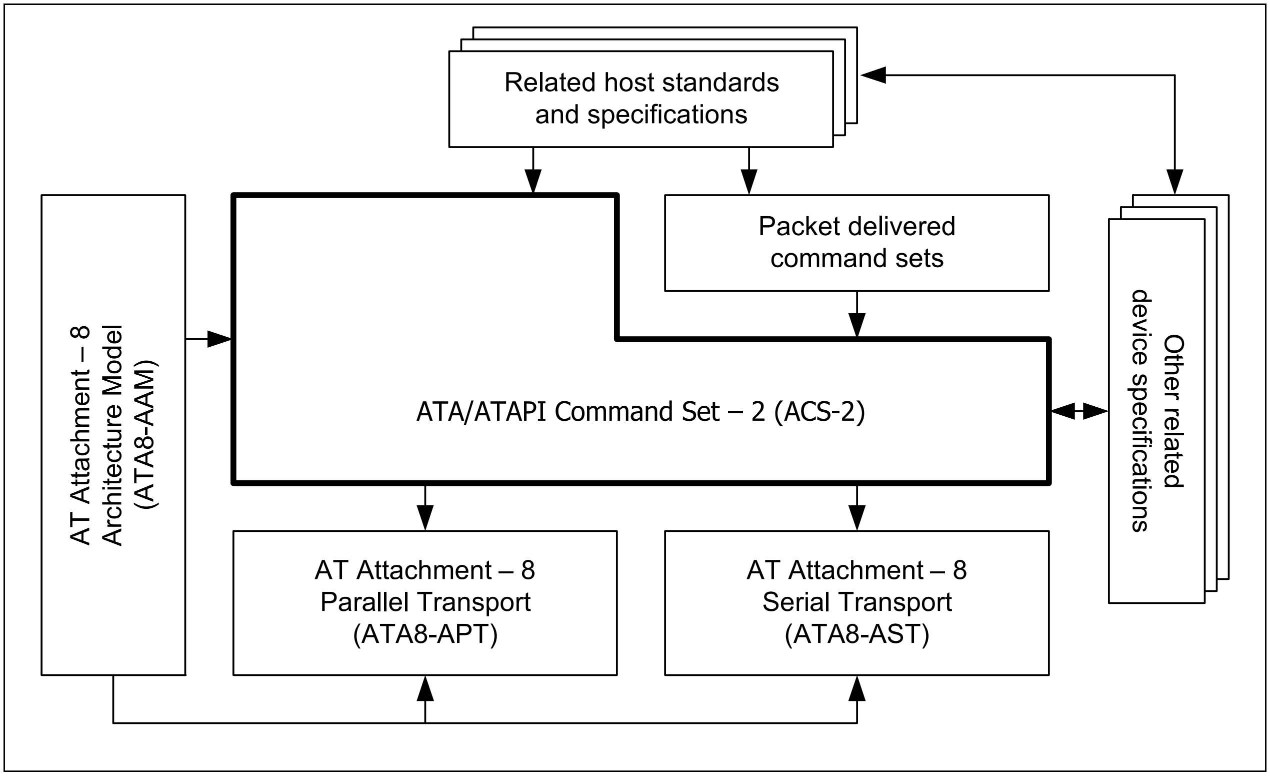

Figure 1 — ATA document relationships

This standard maintains compatibility with the ATA8-ACS standard, INCITS 452-2008, while providing additional functions.

2 Normative references

2.1 General

The standards listed in 2.2, 2.3, and 2.4 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 in 2.2, 2.3, and 2.4.

Copies of these standards may 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 as needed.

2.2 Approved references

Copies of the following documents may be obtained from ANSI, an ISO member organization:

a) Approved ANSI standards;
b) approved international and regional standards (ISO and IEC); and
c) approved foreign standards (including JIS and DIN).

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Table 2 lists approved ANSI standards, approved international and regional standards (ISO, IEC, CEN/CENELEC, ITUT). Additional information may be available at http://www.t10.org and http://www.t13.org.

Table 2 — Approved ANSI References

Name	Reference
Protected Area Run Time Interface Extensions (PARTIES)	ANSI INCITS 346-2001
AT Attachment with Packet Interface Extension - 5 (ATA/ATAPI-5)	ANSI INCITS 340-2000
AT Attachment with Packet Interface Extension - 6 (ATA/ATAPI-6)	ANSI INCITS 361-2002
AT Attachment with Packet Interface Extension - 7 (ATA/ATAPI-7)	ANSI INCITS 397-2005 ISO/IEC 14776-971
ATA/ATAPI-7 Amendment 1	ANSI INCITS 397-2005/AM 1-2006
AT Attachment – 8 ATA/ATAPI Command Set (ATA8-ACS)	ANSI INCITS 452-2008
AT Attachment-8 - ATA/ATAPI Architecture Model (ATA8-AAM)	ANSI INCITS 451-2008
Time Limited Commands (TLC)	ANSI INCITS TR37-2004
SMART Command Transport (SCT)	ANSI INCITS TR38-2005
Acoustics - Measurement of airborne noise emitted by information technology and telecommunications equipment	ISO/IEC 7779:1999(E)
Information Systems - Coded Character Sets - 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII)	ANSI INCITS 4-1986 (R2002)

2.3 References under development

At the time of publication, the 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 in table 3.

Table 3 — References Under Development

Name	Project Number
AT Attachment-8 - Parallel Transport (ATA8-APT)	INCITS 1698D ISO/IEC 14776-881
Method to Disable Data Transfer after Error Technical Report (DDT)	INCITS 1825DT INCITS/TR-43
AT Attachment-8 - ATA Serial Transport (ATA8-AST)	INCITS 1697D
Host Bus Adapter - 2 (HBA-2)	INCITS 2014D
SCSI Block Commands - 3 (SBC-3)	INCITS 1799D
SCSI Primary Commands - 4 (SPC-4)	INCITS 1731D

2.4 Other references

These standards and specifications are also referenced.

CompactFlash Association Specification, Revision 5.0
For the CompactFlash Association Specification published by the CompactFlash Association, contact the CompactFlash Association at http://www.compactflash.org.

RFC 3280, Internet X.509 Public Key Infrastructure: Certificate and Certificate Revocation List (CRL) Profile, IETF, 2002.
For RFC 3280 contact the Internet Engineering Task Force at http://www.ietf.org.

RFC 3281, An Internet Attribute Certificate: Profile for Authorization, IETF, 2002
For RFC 3281 contact the Internet Engineering Task Force at http://www.ietf.org

SDCard TrustedFlash Security Systems Specification 1.1.3
For the Security Systems Specification 1.1.3, contact the SD Card Association (SDA) at http://www.sdcard.org.

NOTE 1 — An SDA login is required to access the Trusted Flash specification. If you need an SDA login, please go to the “Contact Us” page for information on joining the SDA, and/or getting access to the Members Site/Workspace pages.SD-ATA Interface Specification (Part H2)

Serial ATA revision 2.6 (SATA 2.6)
For the SATA 2.6 specification published by SATA-IO, contact them at http://www.sata-io.org

CFast™, a CompactFlash™ Association Specification, Rev 1.0
For the CFast Specification published by the CompactFlash™ Association, contact the CompactFlash™ Association at http://www.compactflash.org.

IEEE 1667-2009 - Standard Protocol for Authentication in Host Attachments of Transient Storage Devices
For the IEEE 1667-2009 standard, contact the IEEE at http://ieeexplore.ieee.org/.

FIPS PUB 140-2, SECURITY REQUIREMENTS FOR CRYPTOGRAPHIC MODULES, May 25, 2001
For FIPS PUB 140-2, contact NIST at http://www.nist.gov

FIPS PUB 140-3 (Revised DRAFT 09/11/09), SECURITY REQUIREMENTS FOR CRYPTOGRAPHIC MODULES, 09/11/09
For FIPS PUB 140-3 (Revised DRAFT 09/11/09), contact NIST at http://www.nist.gov

3 Definitions, abbreviations, and conventions

3.1 Definitions and abbreviations

3.1.1 **28-bit command:** A command that uses Feature (7:0), Count (7:0), LBA (27:0), Device (15:8) and Command (7:0) to specify its arguments.

3.1.2 **48-bit command:** A command that uses Feature (15:0), Count (15:0), LBA (47:0), Device (15:8) and Command (7:0) to specify its arguments.

3.1.3 **Active mode:** The power condition specified by the PM0: Active state.

3.1.4 **application:** Software that is dependent on the services of an operating system.

3.1.5 **application client:** An object in the host that is the source of commands and device management functions (see ATA8-AAM).

3.1.6 **ASCII character:** A byte containing a 7-bit ASCII pattern in bits (6:0) with bit 7 cleared to zero.

3.1.7 **acoustics:** Measurement of airborne noise emitted by information technology and telecommunications equipment (see ISO 7779:1999(E)).

3.1.8 **ATA (AT Attachment) device:** A device implementing the General feature set (see 4.2).

3.1.9 **ATA string:** A set of ASCII characters (see 3.1.6) in the format specified in 3.3.10.

3.1.10 **ATAPI (AT Attachment Packet Interface) device:** A device implementing the PACKET feature set (see 4.3).

3.1.11 **AV (Audio-Video):** Audio-Video application data that is related to video images and/or audio (see 4.20).

3.1.12 **Background Activities:** Activities initiated by a command that occur after command completion has been reported.

3.1.13 **BIOS (Basic Input/Output System)**: An initial application client that is run when power is applied. The primary function of BIOS is to initialize various components (e.g. storage devices).

3.1.14 **block erase:** An internal media operation supported by some devices that sets a block of data to a vendor specific value (i.e., replacing previous data) and may precondition the media for write operations.

3.1.15 **byte:** A sequence of eight contiguous bits considered as a unit (see 3.3.9).

3.1.16 **cache:** A data storage area outside the area accessible by application clients that may contain a subset of the data stored in the non-volatile data storage area.

3.1.17 **CFA device:** A device implementing the CFA feature set (see 4.6). CFA Devices may implement the ATA8-APT transport or the ATA8-AST transport (see 3.1.19).

3.1.18 **CFA-APT device:** A CFA device that implements the ATA8-APT transport and not the ATA8-AST transport.

3.1.19 **CFast™ Device:** A CF form factor device that conforms to the SATA device requirements in this standard, implements the ATA8-AST transport and does not implement the ATA8-APT transport. CFast devices may support the CompactFlash™ feature set.

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

3.1.21 **circular buffer:** A buffer that is filled starting at the first byte continuing to the last byte and then wrapping to store data in the first byte of the buffer again.

3.1.22 **command aborted:** Command completion with the Error bit set to one in the Status field and the Abort bit set to one in the Error field.

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

3.1.24 **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.

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

3.1.26 **COMRESET:** A commanded hardware reset in the Serial ATA transport (see SATA 2.6).

3.1.27 **Data Set**: A set of LBA Ranges used by the device as a single group.

3.1.28 **device:** A data storage peripheral (e.g., a disk drive) (see 3.1.8 and 3.1.10).

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

3.1.30 **DRQ (Data Request) data block:** A number of logical sectors with available status when using either the PIO Data-In command protocol or the PIO Data-Out command protocol.

3.1.31 **DWord:** A sequence of four contiguous bytes considered as a unit. See 3.3.9.

3.1.32 **FIS:** The Frame Information Structure for the serial ATA interface (see ATA8-AST).

3.1.33 **free fall:** A vendor specific condition of acceleration.

3.1.34 **hardware reset:** The routine performed by a device after a hardware reset event as defined in ATA8-AAM.

3.1.35 **host:** An object that originates commands and device management functions (see ATA8-AAM).

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

3.1.37 **host interface:** The service delivery subsystem (see ATA8-AAM).

3.1.38 **Idle mode:** The power condition specified by the PM1: Idle state.

3.1.39 **Invalid LBA:** An LBA that is greater than or equal to the largest value reported in IDENTIFY DEVICE data words 60..61 (see 7.16.7.22), IDENTIFY DEVICE data words 100..103 (see 7.16.7.53), or IDENTIFY DEVICE data words 230..233 (see 7.16.7.88).

3.1.40 **Invalid LBA Range:** A range of LBAs that contains one or more invalid LBAs.

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

3.1.42 **logical block:** See logical sector (see 3.1.43).

3.1.43 **logical sector:** A set of logical words accessed and referenced as a unit (see IDENTIFY DEVICE data words 118:117 (see 7.16.7.61)). These units are referenced by LBA (see 3.1.41).

3.1.44 **log:** A named sequence of one or more log pages (see Annex A).

3.1.45 **log address:** A numeric value that a log command uses to identify a specific log.

3.1.46 **log command:** A SMART READ LOG command (see 7.48.7), SMART WRITE LOG command (see 7.48.9), or GPL feature set (see 4.9) command.

3.1.47 **log page:** A 512-byte block of data associated with a log (see Annex A).

3.1.48 **LSB (least significant bit):** In a binary code, the bit or bit position with the smallest numerical weighting in a group of bits that, when taken as a whole, represent a numerical value (e.g., in the number 0001b, the bit that is set to one).

3.1.49 **Master Password Capability:** Indicates if the Master password may be used to unlock the device.

3.1.50 **Media:** The material on which user data is stored.

3.1.51 **Media Access Command:** Any command that causes the device to access non-volatile media.

3.1.52 **MSB (most significant bit):** In a binary code, the bit or bit position with the largest numerical weighting in a group of bits that, when taken as a whole, represent a numerical value (e.g., in the number 1000b, the bit that is set to one).

3.1.53 **native max address:** The highest LBA that a device accepts as reported by DEVICE CONFIGURATION IDENTIFY data or as reduced by the DEVICE CONFIGURATION SET command (i.e., the highest LBA that is accepted by a device using the SET MAX ADDRESS command (see 7.50.2) or, if the 48-bit Address feature set is supported, then the highest value accepted by a device using the SET MAX ADDRESS EXT command (see 7.51)).

Editor's Note 1: f10203r0-Obsolete HPA appears to have missed the fact that this glossary entry needs to be updated.

3.1.54 **Non-Volatile cache:** Cache that retains data through all reset events (e.g. power-on reset). Non-volatile cache is a subset of the non-volatile media.

3.1.55 **Non-Volatile Media:** Physical storage media that retains data written to it through all reset events (e.g., power-on reset).

3.1.56 **Non-Volatile Write cache:** Write cache that retains data through all power and reset events.

3.1.57 **organizationally unique identifier (OUI):** A numeric identifier that is assigned by the IEEE such that no assigned identifiers are identical. OUI is equivalent to company_id or IEEE company_id. The numeric identifier is called an OUI when it is assigned by the IEEE. The IEEE maintains a tutorial describing the OUI at http://standards.ieee.org/regauth/oui/.

3.1.58 **partition:** A range of LBAs specified by an application client.

3.1.59 **Password Attempt Counter Exceeded:** IDENTIFY DEVICE, word 128, bit 4 (see 7.16.7.66).

3.1.60 **PATA (Parallel ATA) device:** A device implementing the parallel ATA transport (see ATA8-APT).

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

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

3.1.63 **power condition:** One of the following power management substates: Idle_a, Idle_b, Idle_c, Standby_y or Standby_z (see 4.7).

3.1.64 **power cycle:** the period from when power is removed from a host or device until the subsequent power-on event (see ATA8-AAM).

3.1.65 **power-on reset:** the host specific routine performed by the host or the routine performed by a device after detecting a power-on event (see ATA8-AAM).

3.1.66 **Queued Command:** A NCQ command that has reported command acceptance but not command completion.

3.1.67 **QWord:** A sequence of eight contiguous bytes considered as a unit. See 3.3.9.

3.1.68 **read command:** A command that causes the device to transfer data from the device to the host. The following commands are read commands: READ DMA, READ DMA EXT, READ DMA QUEUED, READ FPDMA QUEUED, READ MULTIPLE, READ MULTIPLE EXT, READ SECTOR(S), READ SECTOR(S) EXT, READ STREAM EXT, READ STREAM DMA EXT, READ VERIFY SECTOR(S), or READ VERIFY SECTOR(S) EXT.

3.1.69 **read stream command:** A command that causes the device to transfer data from the device to the host. The following commands are read stream commands: READ STREAM EXT and READ STREAM DMA EXT.

3.1.70 **SATA (Serial ATA) device:** A device implementing the serial ATA transport (see ATA8-AST).

3.1.71 **SCT Command:** A command that writes to the SCT command/status log (see clause 8).

3.1.72 **SCT Status:** A command that reads from the SCT command/status log (see clause 8).

3.1.73 **sector:** See logical sector (see 3.1.43).

3.1.74 **Security Level:** See Master Password Capability (see 3.1.49).

3.1.75 **Serial ATAPI device:** A device implementing the serial ATA transport (see ATA8-AST) and the PACKET feature set.

3.1.76 **signature:** A unique set of values placed in the return parameters used to distinguish device types (e.g., General, ATAPI device, Port Multiplier) (see table 184).

3.1.77 **signed:** A value that is encoded using two's compliment.

3.1.78 **Sleep mode:** The power condition specified by the PM3: Sleep state.

3.1.79 **software reset:** The routine performed by a device after a software reset event as defined in ATA8-AAM. The software reset routine includes the actions defined in ATA8-AAM, this standard, and the applicable transport standards.

3.1.80 **spin-down:** The process of bringing a rotating media device's media to a stop.

3.1.81 **spin-up:** The process of bringing a rotating media device's media to operational speed.

3.1.82 **Standby mode:** The power condition specified by the PM2: Standby state.

3.1.83 **Stream:** A set of operating parameters specified by a host using the CONFIGURE STREAM command (see 7.8) to be used for subsequent READ STREAM commands and WRITE STREAM commands.

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

3.1.85 **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.

3.1.86 **unrecoverable error:** When the device sets either the Error bit or the Device Fault bit to one in the Status field at command completion.

3.1.87 **user data:** Data that is transferred between the application client and the device using read commands and write commands.

3.1.88 **user data area:** Any area of the device's media that stores user data and is addressable by the host from LBA 0 to DEVICE CONFIGURATION IDENTIFY data words 3..6.

3.1.89 **Volatile Cache:** Cache that does not retain data through power cycles.

3.1.90 **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.

3.1.91 **word:** A sequence of two contiguous bytes considered as a unit. See 3.3.9.

3.1.92 **write command:** A command that causes the device to transfer data from the host to the device. The following commands are write commands: SCT Write Same, WRITE DMA, WRITE DMA EXT, WRITE DMA FUA EXT, WRITE FPDMA QUEUED, WRITE MULTIPLE, WRITE MULTIPLE EXT, WRITE MULTIPLE FUA EXT, WRITE SECTOR(S), WRITE SECTOR(S) EXT, WRITE STREAM DMA EXT, or WRITE STREAM EXT.

3.1.93 **write stream command:** A command that causes the device to transfer data from the host to the device. The following commands are write stream commands: WRITE STREAM DMA EXT and WRITE STREAM EXT

3.1.94 **WWN (world wide name):** A 64-bit worldwide unique name based upon a company's IEEE OUI, reported in IDENTIFY DEVICE data words 108..111 (see 7.16.7.58) and IDENTIFY PACKET DEVICE data words 108..111 (see 7.17.6.44).

3.2 Symbols and abbreviations

Abbreviation	Meaning
*	multiplied by
/	divided by
<	less than
>	greater than
ACS	ATA/ATAPI Command Set
APM	Advanced Power Management
ASC	Additional Sense Code
ASCII	American Standard Code for Information Interchange
ASCQ	Additional Sense Code Qualifier
ASR	Asynchronous Signal Recovery
ATA	AT Attachment
ATAPI	AT Attachment with Packet Interface
ATA/ATAPI-5	AT Attachment with Packet Interface Extension - 5 (see 2.2)
ATA/ATAPI-6	AT Attachment with Packet Interface Extension - 6 (see 2.2)
ATA/ATAPI-7	AT Attachment with Packet Interface Extension - 7 (see 2.2)
ATA8-AAM	AT Attachment-8 - ATA/ATAPI Architecture Model (see 2.2)
ATA8-ACS	AT Attachment – 8 ATA/ATAPI Command Set (see 2.2)
ATA8-APT	AT Attachment-8 - Parallel Transport (see 2.3)
ATA8-AST	AT Attachment-8 - Serial Transport (see 2.3)
AV	Audio/Visual
BIOS	Basic I/O System
CDB	Command Descriptor Block (see SPC-4)
CFA	Compact Flash Association
CFast	Compact Flash ATA Serial Transport
CRC	Cyclic Redundancy Check
DDT	Method to Disable Data Transfer after Error Technical Report (see 2.3)
DMA	Direct Memory Access
DRQ	Data ReQuest
EPC	Extended Power Conditions
EXT	Command used the extended (48-bit LBA) format parameters
FIS	Frame Information Structure
FUA	Forced Unit Access
GPL	General Purpose Logging
HBA	Host Bus Adapter
HBA-2	Host Bus Adapter - 2 (see 2.3)
INCITS	InterNational Committee for Information Technology Standards (see www.incits.org)
ISO	Organization for International Standards
LBA	Logical Block Address
LLS	Long Logical Sector
LPS	Long Physical Sector

Abbreviation	Meaning
LSB	Least Significant Bit
ms	milliseconds
MSB	Most Significant Bit
NCQ	Native Command Queueing
ns	nanoseconds
NV	Non-volatile
OUI	Organizationally Unique Identifier
PARTIES	Protected Area Run Time Interface Extensions (see 2.2)
PATA	Parallel ATA
PIO	Programmed Input/Output
PUIS	Power-Up In Standby
RMW	Read-Modify-Write
SATA	Serial ATA
SATA-IO	Serial ATA International Organization (see www.sata-io.org)
SCT	SMART Command Transport (see 2.2)
SMART	Self-Monitoring Analysis and Reporting Technology
SPC-4	SCSI Primary Commands - 4 (see 2.3)
SSP	Software Settings Preservation
T10	INCTIS Technical Committee T10
TCG	Trusted Computing Group (see www.trustedcomputinggroup.org)
TLC	Time Limited Commands (see 2.2)
µs	microseconds
VS	Vendor Specific
WWN	World Wide Name

3.3 Conventions

3.3.1 Overview

Lowercase is used for words having the normal English language meaning. Certain words and terms used in this standard have a specific meaning beyond the normal English language 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 3.3.6 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 the content of bit n.

3.3.2 Precedence

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

3.3.3 Lists

3.3.3.1 Lists overview

Lists shall be introduced by a complete grammatical proposition followed by a colon and completed by the items in the list.

Each item in a list shall be preceded by an identification with the style of the identification being determined by whether the list is intended to be an ordered list or an unordered list.

If the item in a list is not a complete sentence, then the first word in the item shall not be capitalized. If the item in a list is a complete sentence, then the first word in the item shall be capitalized,

Each item in a list shall end with a semicolon, except the last item, which shall end in a period. The next to the last entry in the list shall end with a semicolon followed by an “and” or an “or” (i.e., “…; and”, or “…; or”). The “and” is used if all the items in the list are required. The “or” is used if only one or more items in the list are required.

3.3.3.2 Unordered lists

An unordered list is one in which the order of the listed items is unimportant (i.e., it does not matter where in the list an item occurs as all items have equal importance). Each list item shall start with a lower case letter followed by a close parenthesis. If it is necessary to subdivide a list item further with an additional unordered list (i.e., have a nested unordered list), then the nested unordered list shall be indented and each item in the nested unordered list shall start with an upper case letter followed by a close parenthesis.

The following is an example of an unordered list with a nested unordered list:

The following are the items for the assembly:

a) a box containing:
   A) a bolt;
   B) a nut; and
   C) a washer;
b) a screwdriver; and
c) a wrench.

3.3.3.3 Ordered lists

An ordered list is one in which the order of the listed items is important (i.e., item n is required before item n+1). Each listed item starts with an Western-Arabic numeral followed by a close parenthesis. If it is necessary to subdivide a list item further with an additional unordered list (i.e., have a nested unordered list), then the nested unordered list shall be indented and each item in the nested unordered list shall start with an upper case letter followed by a close parenthesis.

The following is an example of an ordered list with a nested unordered list:

The following are the instructions for the assembly:

1) remove the contents from the box;
2) assemble the item;
   A) use a screwdriver to tighten the screws; and
   B) use a wrench to tighten the bolts;
   and
3) take a break.

3.3.4 Keywords

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

3.3.4.1 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.

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

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

3.3.4.4 N/A: A keyword that indicates a field is not applicable and has no defined value and should not be checked by the host or device.

3.3.4.5 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 return command aborted by devices conforming to this standard. However, if a device does not return command aborted for an obsolete command, then the device shall return command completion for the command.

3.3.4.6 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.

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

3.3.4.8 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 considered a command parameter error and reported by returning command aborted.

3.3.4.9 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.

3.3.4.10 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.

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

3.3.5 Numbering

A binary number is represented in this standard by any sequence of digits consisting of only the Western-Arabic numerals 0 and 1 immediately followed by a lower-case b (e.g., 0101b). Underscores or spaces may be included between characters in binary number representations to increase readability or delineate field boundaries (e.g., 0 0101 1010b or 0_0101_1010b).

A hexadecimal number is represented in this standard by any sequence of digits consisting of only the Western-Arabic numerals 0 through 9 and/or the upper-case English letters A through F immediately followed by a lower-case h (e.g., FA23h). Underscores or spaces may be included between characters in hexadecimal number representations to increase readability or delineate field boundaries (e.g., B FD8C FA23h or B_FD8C_FA23h).

A decimal number is represented in this standard by any sequence of digits consisting of only the Arabic numerals 0 through 9 not immediately followed by a lower-case b or lower-case h (e.g., 25). This standard uses the following conventions for representing decimal numbers:

a) the decimal separator (i.e., separating the integer and fractional portions of the number) is a period;
b) the thousands separator (i.e., separating groups of three digits in a portion of the number) is a space; and
c) the thousands separator is used in both the integer portion and the fraction portion of a number.

Table 4 shows some examples of decimal numbers using various numbering conventions.

Table 4 — Numbering conventions

French	English	This standard
0,6	0.6	0.6
3,141 592 65	3.14159265	3.141 592 65
1 000	1,000	1 000
1 323 462,95	1,323,462.95	1 323 462.95

A decimal number represented in this standard with an overline over one or more digits following the decimal point is a number where the overlined digits are infinitely repeating (e.g., $666.\overline{6}$ means 666.666 666… or 666 2/3, and $12.\overline{142\ 857}$ means 12.142 857 142 857… or 12 1/7).

3.3.6 Bit conventions

Name (n:m), where n shall be greater than m, denotes a set of bits (e.g., Feature (7:0)). n:m where n shall be greater than m denotes a bit range in a table.

3.3.7 Number range convention

p..q, where p is less than q, represents a range of numbers (e.g., words 100..103 represents words 100, 101, 102, and 103).

3.3.8 State diagram conventions

All state diagrams use the notation shown in Figure 2.

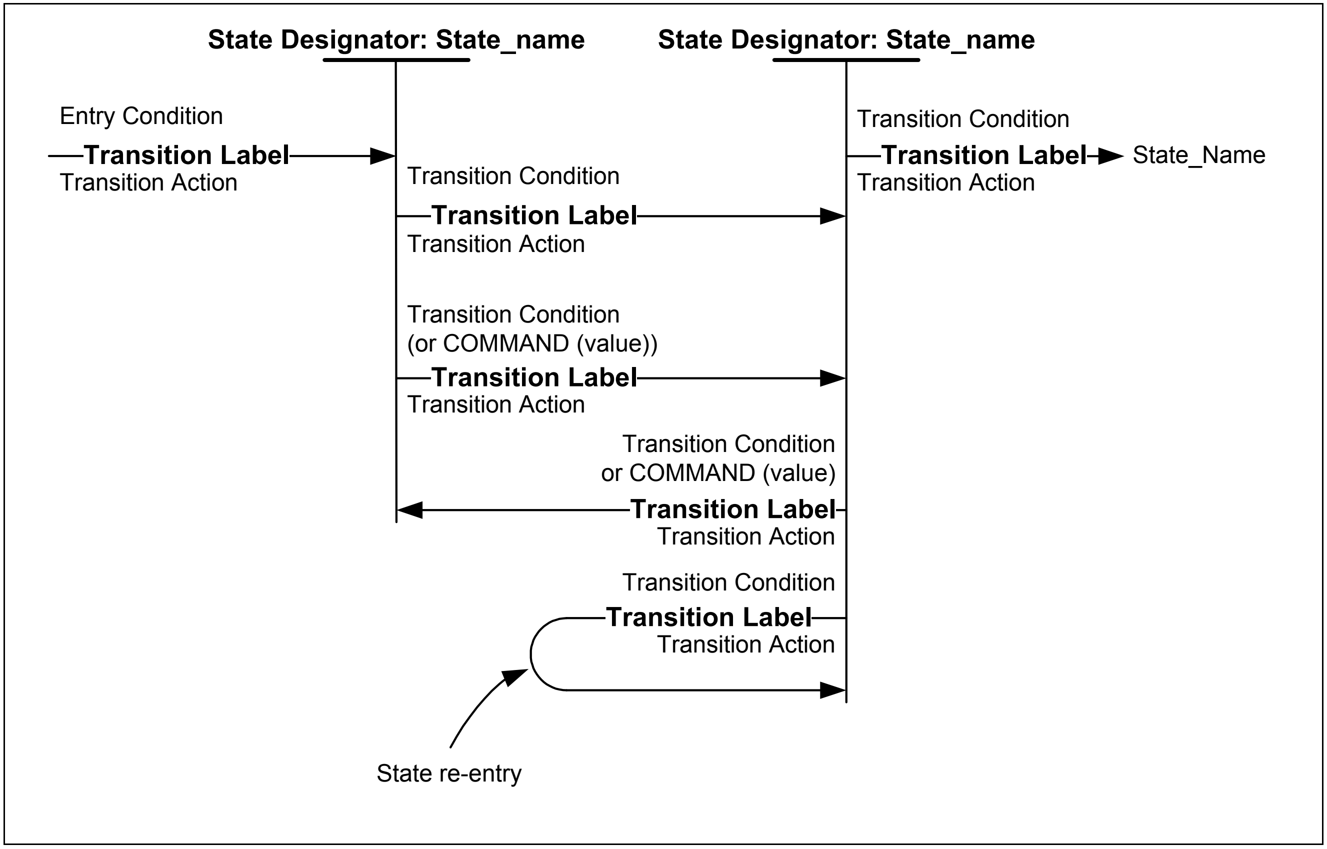

Figure 2 — State diagram convention

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 standard. 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, then the primary functions 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.

Each transition is identified by a transition label, a transition condition, and optionally by a transition action. 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. 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 processed. In this case, the state designator is labeled State_name. The transition condition is a brief description of the event or condition that causes the transition to occur. A transition action may be included, indicated in italics, that is taken when the transition occurs. This action is described in the transition description text.

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

Each state machine is instantiated based on the Entry Conditions. An Entry Condition is a transition based on an action occurring outside of the state machine.

All transitions shall be instantaneous.

The notation COMMAND (value), as a transition condition, refers to the device receiving the command with a specific value or values. For example:

a) SET MAX ADDRESS (volatile) means the device successfully processes a volatile SET MAX ADDRESS command (i.e., a SET MAX ADDRESS with the V_V field set to zero); or
b) SET MAX ADDRESS (non-volatile) means the device successfully processes a non-volatile SET MAX ADDRESS command (i.e., a SET MAX ADDRESS with the V_V field set to one).

If a state has a transition condition that specifies native max, then any other set max conditions imply a value less than the native max value. If a state has a transition condition that specifies neither volatile nor non-volatile, then both are implied.

If the (value) notation is not present on a transition, then the transition occurs for any parameter combination of the command.

3.3.9 Byte, word, DWord, and QWord Relationships

Figure 3 illustrates the relationship between bytes, words, DWords, and QWords.

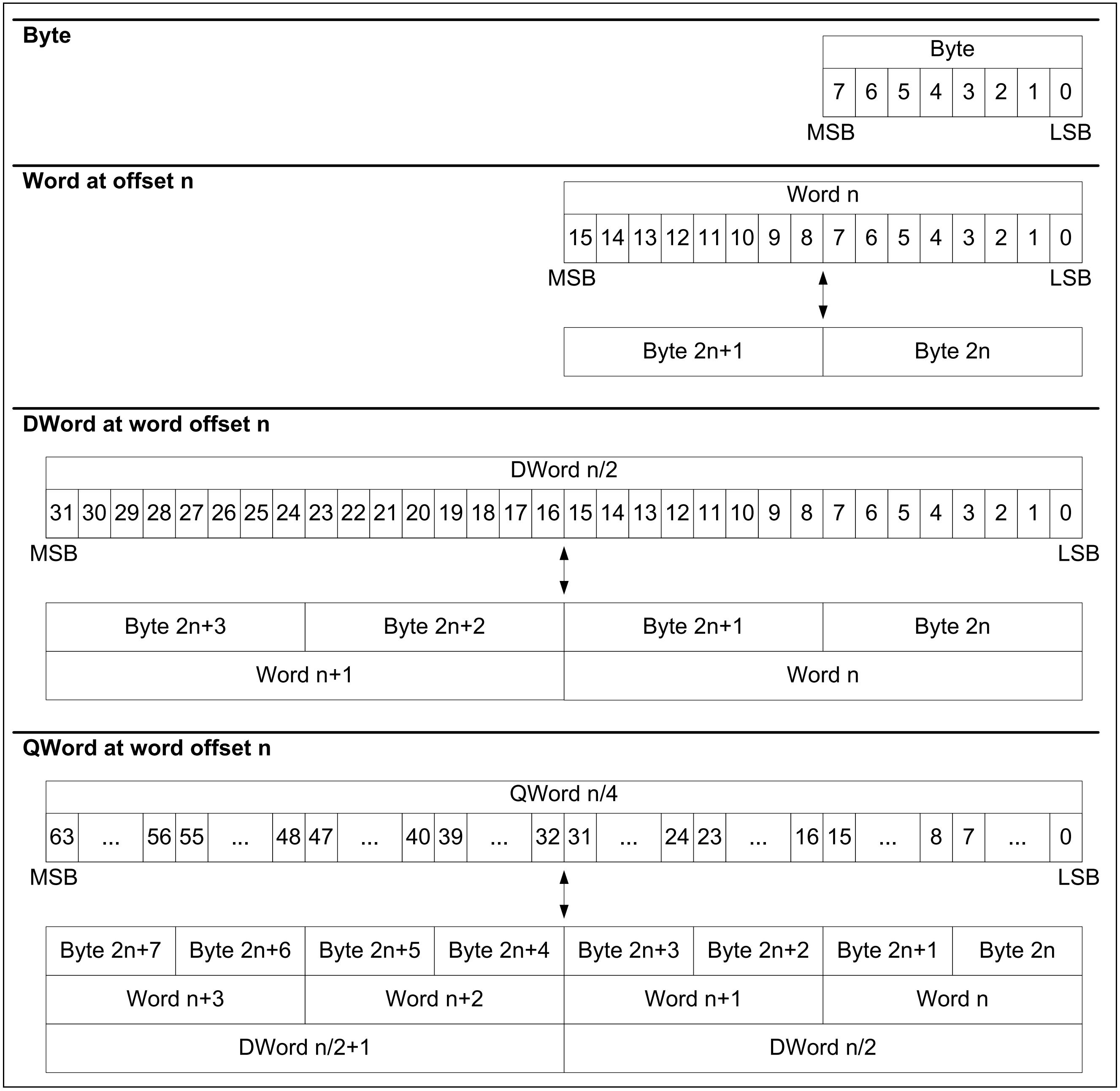

Figure 3 — Byte, word, DWord and QWord relationships

Unless stated or defined otherwise, in a field containing a multi-byte value (e.g., a word, DWord, or QWord), the byte containing the LSB is stored at the lowest offset and the byte containing the MSB is stored at the highest offset. For example:

a) if the two-byte field (i.e., word) in SCT command (see table 164) word 0 contains 0007h, then:
   A) byte 0 contains 07h; and
   B) byte 1 contains 00h;
b) if the four-byte field (i.e., DWord) at IDENTIFY DEVICE data words 60..61 (see table 46) contains 8001_0203h (i.e., 2 147 549 699), then:
   A) byte 120 contains 03h;
   B) byte 121 contains 02h;
   C) byte 122 contains 01h; and

   - D) byte 123 contains 80h;

   and

- c) if an eight-byte field (i.e., QWord) in the WRITE SAME command words 2..5 (see table 166) contains 0000_0504_0302_0100h), then:
   - A) byte 4 contains 00h;
   - B) byte 5 contains 01h;
   - C) byte 6 contains 02h;
   - D) byte 7 contains 03h;
   - E) byte 8 contains 04h;
   - F) byte 9 contains 05h;
   - G) byte 10 contains 00h; and
   - H) byte 11 contains 00h.

Exceptions to this convention include:

- a) each field containing an ATA string (e.g., the IDENTIFY DEVICE data and IDENTIFY PACKET DEVICE data Serial number, Firmware revision, and Model number fields) is considered to be an array of bytes, not a multi-byte value, and is handled as described in 3.3.10;
- b) the IDENTIFY DEVICE data and IDENTIFY PACKET DEVICE data World Wide Name field consists of four word fields rather than one QWord field and is handled as described in 7.16.7.58;
- c) the CFA TRANSLATE SECTOR data LBA and logical sector write cycles count fields (see table 28);
- d) the command packet in the PACKET command (see 7.21) is formatted as defined by the applicable command standard); and
- e) parameter data in the TRUSTED RECEIVE command (see 7.52), TRUSTED RECEIVE DMA command (see 7.53), TRUSTED SEND command (see 7.54), and TRUSTED SEND DMA command (see 7.55) is formatted as defined in those sections or in the standard defining the security protocol.

3.3.10 ATA string convention

ATA strings are sequences of bytes containing ASCII graphic characters in the range of 20h-7Eh. ATA strings shall not contain values in the range of 00h-1Fh or 7Fh-FFh.

The following fields in IDENTIFY DEVICE data (see 7.16.7) and IDENTIFY PACKET DEVICE data (see 7.17.6) contain ATA strings:

- a) Serial number (words 10..19) (see 7.16.7.10);
- b) Firmware revision (words 23..26) (see 7.16.7.13);
- c) Model number (words 27..46) (see 7.16.7.14); and
- d) Current media serial number (words 176..205) (see 7.16.7.74).

Each pair of bytes in an ATA string is swapped as shown in table 5.

Table 5 — ATA string byte swapping

Word	Offset	Character in string
0	0	Second character
	1	First character
1	2	Fourth character
	3	Third character
…	…	…
n	2n	Last character
	2n+1	Second-to-last character

If the Firmware revision field (i.e., words 23..26) contains the string “abcdefg ”, including one padding space character at the end, then the word and byte representations for the field are shown in table 6.

Table 6 — ATA firmware revision example

Word	Value	Offset	Value
23	6162h (i.e., “ba”)	46	62h (i.e., “b”)
		47	61h (i.e., “a”)
24	6364h (i.e., “dc”)	48	64h (i.e., “d”)
		49	63h (i.e., “c”)
25	6566h (i.e., “fe”)	50	66h (i.e., “f”)
		51	65h (i.e., “e”)
26	6720h (i.e., “ g”)	52	20h (i.e., “ “, the space character)
		53	67h (i.e., “g”)

3.3.11 Offset Convention

An offset is a byte value used as an index into a larger data structure.

4 Feature set definitions

4.1 Overview

Table 7 lists the feature sets in alphabetical order and shows whether a feature set is mandatory, optional, prohibited, or not defined for ATA devices and ATAPI devices.

Table 7 — Feature Set Summary

Feature Set	ATA Devices	ATAPI Devices
48-Bit Address feature set (see 4.4)	O	P
Advanced Power Management (APM) feature set (see 4.5)	O	O
CompactFlash Association (CFA) feature set (see 4.6)	O	P
Extended Power Conditions (EPC) feature set (see 4.7)	O	P
Free-fall Control feature set (see 4.8)	O	P
General feature set (see 4.2)	M	P
General Purpose Logging (GPL) feature set (see 4.9)	O	O
Long Logical Sector (LLS) feature set (see 4.10)	O	P
Long Physical Sector (LPS) feature set (see 4.11)	O	P
Native Command Queuing (NCQ) feature set (see 4.12)	O	P
PACKET feature set (see 4.3)	P	M
Power Management feature set (see 4.13)	M	O
Power-Up In Standby (PUIS) feature set (see 4.14)	O	O
Sanitize Device feature set (see 4.15)	O	P
Security feature set (see 4.16)	O	O
Self-Monitoring, Analysis, and Reporting Technology (SMART) feature set (see 4.17)	O	P
Sense Data Reporting feature set (see 4.18)	O	P
Software Settings Preservation (SSP) feature set (see 4.19)	O	P
Streaming feature set (see 4.20)	O	P
Trusted Computing feature set (see 4.21)	O	P
Write-Read-Verify feature set (see 4.22)	O	P
Key: M – Mandatory, O – Optional, P – Prohibited, N – Not defined		

The following rules are used for setting IDENTIFY DEVICE data:

a) if the 48-bit Address feature set (see 4.4) is not supported, then words 60..61 (see 7.16.7.22) shall contain the total number of user addressable logical sectors, words 100..103 (see 7.16.7.53) shall be reserved, and word 69 bit 3 (see 7.16.7.30) shall be cleared to zero;
b) if the 48-bit Address feature set (see 4.4) is supported and the total number of user addressable logical sectors is less than or equal to 0FFF_FFFFh, then
    A) words 60..61 (see 7.16.7.22) and words 100..103 (see 7.16.7.53) shall contain the total number of user addressable logical sectors; and
    B) if word 69 bit 3 (see 7.16.7.30) is set to one, then words 230..233 (see 7.16.7.88) shall contain the total number of user addressable sectors;

    and

c) if the 48-bit Address feature set is supported and the total number of user addressable logical sectors is greater than 0FFF_FFFFh, then words 60..61 (see 7.16.7.22) shall contain 0FFF_FFFFh and:

A) if word 69 bit 3 (see 7.16.7.30) is cleared to zero, then words 100..103 (see 7.16.7.53) shall contain the total number of user addressable logical sectors; and
B) If word 69 bit 3 (see 7.16.7.30) is set to one, then
   a) words 230..233 (see 7.16.7.88) shall contain the total number of user addressable sectors; and
   b) words 100.103 (see 7.16.7.53) shall contain a value
      A) less than or equal to the total number of user addressable sectors; and
      B) greater than 0000_0000_0FFF_FFFFh

NOTE 2 — IDENTIFY DEVICE data words 100..103 (see 7.16.7.53) may be limited to 0000_0000_FFFF_FFFFh and the full capacity reported in IDENTIFY DEVICE data words 230..233 (see 7.16.7.88)).

4.2 General feature set

The following General feature set commands are mandatory:

a) EXECUTE DEVICE DIAGNOSTIC (see 7.13);
b) IDENTIFY DEVICE (see 7.16); and
c) SET FEATURES (see 7.45).

The following General feature set commands are optional:

a) DOWNLOAD MICROCODE (see 7.12);
b) DOWNLOAD MICROCODE DMA (see 7.12)
c) NOP (see 7.20);
d) FLUSH CACHE (see 7.14);
e) READ BUFFER (see 7.22);
f) READ BUFFER DMA (see 7.23);
g) READ DMA (see 7.24);
h) READ MULTIPLE (see 7.29);
i) READ SECTOR(S) (see 7.31);
j) READ VERIFY SECTOR(S) (see 7.35);
k) SET MULTIPLE MODE (see 7.46);
l) WRITE BUFFER (see 7.56);
m) WRITE BUFFER DMA (see 7.57);
n) WRITE DMA (see 7.58);
o) WRITE MULTIPLE (see 7.64);
p) WRITE SECTOR(S) (see 7.67); and
q) WRITE UNCORRECTABLE EXT (see 7.71).

The DEVICE RESET command, PACKET command, and IDENTIFY PACKET DEVICE command shall not be implemented by ATA devices.

4.3 The PACKET feature set

4.3.1 Overview

ATAPI devices use DEVICE RESET commands and PACKET commands as well as a subset of the General feature set to control the device.

The content of command packets delivered during processing of the PACKET command are defined in the standard indicated by IDENTIFY PACKET DEVICE data word 0 bits (12:8) (see 7.17.6.2) and are not described in this standard.

Devices implementing the PACKET feature set exhibit responses different from those exhibited by devices not implementing this feature set.

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

a) DEVICE RESET (see 7.10);
b) EXECUTE DEVICE DIAGNOSTIC (see 7.13);
c) IDENTIFY DEVICE (see 7.16);
d) IDENTIFY PACKET DEVICE (see 7.17);

e) NOP (see 7.20);
f) PACKET (see 7.21);
g) READ SECTOR(S) (see 7.31); and
h) SET FEATURES (see 7.45).

For ATAPI devices, the IDENTIFY DEVICE command (see 7.16) and the READ SECTOR(S) command (see 7.31) are command aborted and return the ATAPI device signature (see table 184).

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

a) FLUSH CACHE (see 7.14);
b) READ LOG DMA EXT (see 7.28);
c) READ LOG EXT (see 7.27);
d) WRITE LOG DMA EXT (see 7.63); and
e) WRITE LOG EXT (see 7.62).

All commands that are not specified as mandatory or optional in this subclause and that are defined in the General feature set shall not be implemented.

4.3.2 Identification of PACKET feature set devices

The IDENTIFY PACKET DEVICE command is used by the host to get identifying parameter information for a device implementing the PACKET feature set (see 7.16.5 and 7.17).

4.3.3 Signature for ATAPI devices

ATAPI devices return a signature in the Normal Outputs that differentiate them from other device types (see table 184).

4.3.4 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 process (see clause 1).

The protocol for handling the transmission of the PACKET command and associated data is transport specific.

4.4 48-bit Address feature set

The 48-bit Address feature set allows devices:

a) with capacities up to 281 474 976 710 655 logical sectors (i.e., up to 144 115 188 075 855 360 bytes for a 512-byte logical block device); and
b) to transfer up to 65 536 logical sectors in a single command.

The following commands are mandatory for devices that implement the 48-bit address feature set:

c) FLUSH CACHE EXT (see 7.15);
d) READ DMA EXT (see 7.25);
e) READ MULTIPLE EXT (see 7.30);
f) READ SECTOR(S) EXT (see 7.32);
g) READ VERIFY SECTOR(S) EXT (see 7.36);
h) WRITE DMA EXT (see 7.59);
i) WRITE DMA FUA EXT (see 7.60);
j) WRITE MULTIPLE EXT (see 7.65);
k) WRITE MULTIPLE FUA EXT (see 7.66); and
l) WRITE SECTOR(S) EXT (see 7.68).

Devices implementing the 48-bit Address feature set may also implement commands that use 28-bit addressing. 28-bit commands and 48-bit commands may be intermixed (see 7.1.3).

Devices that implement the 48-bit feature set shall indicate support of the 48-bit Address feature set in IDENTIFY DEVICE data word 83 bit 10 (see 7.16.7.40).

4.5 Advanced Power Management (APM) feature set

The Advanced Power Management feature set is an optional feature set that allows the host to select a power management level in a device. The power management level is specified using a scale from the lowest power consumption setting of 01h to the highest power consumption of FEh (i.e., maximum performance level), see table 93. Device performance may increase with increasing power management levels. Device power consumption may increase as the power management setting numerically increases. A device may implement one APM method for two or more contiguous power management levels (e.g., a device may implement one APM method from level 80h to A0h and a higher performance, higher power consumption method from level A1h to FEh). APM levels 80h and greater do not permit a device with rotating media to spin down as a result of an APM method.

The APM feature set uses the following subcommands:

a) a SET FEATURES subcommand to enable APM (see 7.45.6); and
b) an optional SET FEATURES subcommand to disable APM.

APM is independent of the Standby timer (see 4.13.3). If both APM and the Standby timer are set, then the device shall go to the Standby state when the timer expires or the device's APM algorithm indicates that the Standby state should be entered.

The device shall indicate:

a) feature set support in IDENTIFY DEVICE data word 83 bit 3 (see 7.16.7.40) and IDENTIFY PACKET DEVICE data word 83 bit 3 (see 7.17.6.34);
b) feature set enabled in IDENTIFY DEVICE data word 86 bit 3 (see 7.16.7.41) and IDENTIFY PACKET DEVICE data word 86 bit 3 (see 7.17.6.35); and
c) APM level in IDENTIFY DEVICE data word 91 (see 7.16.7.45) and IDENTIFY PACKET DEVICE data word 91 (see 7.17.6.39).

4.6 CompactFlash Association (CFA) feature set

The CompactFlash Association (CFA) feature set provides support for devices that implement the CFA specifications. The following commands are mandatory for devices implementing the CFA feature set:

a) CFA ERASE SECTORS (see 7.2);
a) CFA REQUEST EXTENDED ERROR CODE (see 7.3);
b) CFA TRANSLATE SECTOR (see 7.4);
c) CFA WRITE MULTIPLE WITHOUT ERASE (see 7.5);
d) CFA WRITE SECTORS WITHOUT ERASE (see 7.6); and
e) SET FEATURES Enable/Disable 8-bit PIO data transfer (see 7.45.3).

Devices reporting the value 848Ah in IDENTIFY DEVICE data word 0 (see 7.16.7.2) or devices having IDENTIFY DEVICE data word 83 bit 2 (see 7.17.6.34) set to one shall support the CFA feature set. If the CFA feature set is implemented, then all CFA commands and the SET FEATIURES Enable/Disable 8-bit PIO data transfer subcommand shall be implemented.

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

NOTE 3 — CFast devices do not support 8-bit PIO data transfers. CFast devices may support the CompactFlash feature set. CFast devices follow the requirements for SATA devices.

4.7 Extended Power Conditions (EPC) feature set

4.7.1 Overview

The Extended Power Conditions feature set provides a host with additional methods to control the power condition of a device. These methods include:

a) defining power conditions within the PM1:Idle power management state (i.e., Idle_a, Idle_b and Idle_c);
b) defining power conditions within the PM2:Standby power management state (i.e., Standby_y and Standby_z);

c) enabling and initializing any of the power condition timers to specify that the device wait for a period of inactivity before transitioning to a specified power condition; and
d) allowing the host to determine the power condition settings of the device.

The following command-related device properties are mandatory if this feature set is supported:

a) the SET FEATURES Extended Power Conditions subcommand (see 7.45.18);
b) the Power Conditions log (see A.8);
c) additional status values returned by the CHECK POWER MODE command (see 7.7); and
d) IDENTIFY DEVICE data fields.

The IDENTIFY DEVICE command indicates if this feature set is supported and if the feature set is enabled.

4.7.2 Power conditions

Idle_a, Idle_b, and Idle_c are power conditions within the PM1:Idle power management state. Standby_y and Standby_z are power conditions within the PM2:Standby power management state. The power conditions shall be ordered from highest power consumption to lowest power consumption as follows:

Idle_a power >= Idle_b power >= Idle_c power >= Standby_y power >= Standby_z power

The Standby timer is controlled using:

a) EPC subcommands;
b) the IDLE command; and
c) the STANDBY command.

The EPC feature set also defines a default Standby timer value that is controlled in the same manner as the other EPC power conditions (e.g., enabled, disabled, or queried).

Each of these power conditions has a set of current, saved and default settings (see A.8). Default settings are not modifiable. Default and saved settings shall persist across power cycles. The current settings shall not persist across power cycles.

4.7.3 Power condition timers

The device shall have manufacturer specified power-on default settings for the power condition timers. Power condition timers are changeable with the SET FEATURES Extended Power Conditions subcommand (see 7.45.18). Configured settings for the timers shall be readable in the Power Conditions log (see A.8).

A power condition timer set to zero indicates that the associated power condition is disabled.

If the power condition is enabled, then the value of each timer specifies the time after command completion that the device shall wait before transitioning to the power condition. All enabled power condition timers run concurrently.

If a command is accepted that requires a transition to PM0:Active, then the timers shall be stopped. If a command is accepted that does not require a transition to PM0:Active (e.g., a CHECK POWER MODE command), then the timers shall continue to run.

On command completion all timers that were stopped shall be initialized with the Current Timer (see A.8) settings values and started.

As a result of processing any command, the device may change to a different power condition.

If an enabled timer associated with a power condition lower than the power condition that the device is currently in expires, then the device shall transition to the power condition associated with that timer (e.g., if the Standby_z timer is set to a smaller interval than the Idle_b timer, and the device is currently in the Standby_z power condition, then the device shall remain in the Standby_z power condition when the Idle_b timer expires). If the timer expiration qualifies the device to transition to more than one enabled power condition, then the device shall transition to the power condition with the least power consumption.

Prior to entering into any power condition that prevents accessing the media (e.g., before a hard drive stops its spindle motor during transition to the Standby_z power condition) and if volatile write cache is enabled, then the device shall write all cached data to the medium for the device (e.g., as a device does in response to a flush command).

4.7.4 Interaction with resets, commands and other features if the EPC feature set is enabled

If the device processes a power-on reset or the EPC enable subcommand, then the device shall:

1) stop all EPC timers;
2) copy the Saved Timer Enabled field to the Current Timer Enabled field, for all supported power conditions;
3) copy the Saved Timer Settings field to the Current Timer Settings field, for all supported power conditions; and
4) initialize and restart all enabled EPC timers with Current values.

If the device processes a hardware reset, a software reset, or a DEVICE RESET command, then the device shall:

1) stop all EPC timers;
2) remain in the current power condition; and
3) initialize and restart all enabled EPC timers with Current values.

If the device processes an IDLE command without error, then:

1) in the Standby_z section of the Power Conditions log, if the specified Standby timer value in the IDLE command is:
    A) non-zero, then the device shall set the Current Timer Enabled field to one, convert the specified timer value to units of 100 milliseconds, and set the converted value as the Current Standby_z timer; or
    B) zero, then the device shall clear the Current Timer Enabled field to zero and clear the Current Standby_z timer field to zero;
2) the device shall transition to the PM1:Idle state; and
3) the device shall enter the Idle_a power condition.

If the device processes an IDLE IMMEDIATE command without error, then:

1) if the unload feature was selected, then:
    A) the device shall protect itself (see 7.19.2.2); and
    B) if volatile write cache is enabled, then 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 command with unload feature;
2) the device shall transition to the PM1:Idle state; and
3) the device shall enter the Idle_a power condition.

If the device processes a STANDBY command without error, then:

1) in the Standby_z section of the Power Conditions log, if the specified Standby timer value in the STANDBY command is:
    A) non-zero, then the device shall set the Current Timer Enabled field to one, convert the specified timer value to units of 100 milliseconds, and set the converted value as the Current Standby_z timer; or
    B) zero, then the device shall clear the Current Timer Enabled field to zero and clear the Current Standby_z timer field to zero;
2) the device shall transition to the PM2:Standby state; and
3) the device shall enter the Standby_z power condition.

If the device processes a STANDBY IMMEDIATE command without error, then the device shall:

1) write all cached data to the medium, if volatile write cache is enabled;
2) transition to the PM2:Standby state; and
3) enter the Standby_z power condition.

The Extended Power Conditions feature set and the Advanced Power Management feature set are mutually exclusive. All EPC subcommands, except Enable the EPC feature set (see 7.45.18.6), shall return command aborted if the EPC feature set is disabled.

If the device processes a SET FEATURES Enable APM subcommand without error and IDENTIFY DEVICE data word 120 bit 7 (see 7.16.7.41) is set to one, then the device shall disable the EPC feature set.

During background activities, all EPC timers may be stopped. On completion of the activity, any stopped EPC timers shall be restarted from where they were stopped.

4.8 Free-fall Control feature set

The Free-fall Control feature set allows the device to attempt to protect itself in the event of free-fall detection. When this feature is enabled, upon detecting a free-fall event the device should protect the user data from damage. The implementation of free-fall detection and protection is vendor specific.

The following SET FEATURES subcommands are mandatory for devices implementing the Free-fall Control feature set:

a) SET FEATURES subcommand to Enable the Free-fall Control feature set (see 7.45.14); and
b) SET FEATURES subcommand to Disable the Free-fall Control feature set.

The Enable/Disable Free-fall Control subcommands shall be non-volatile. After the Free-fall Control feature set is enabled, the device shall keep this feature enabled until changed by the Enable/Disable Free-fall Control subcommands.

IDENTIFY DEVICE data word 120 bit 5 (see 7.16.7.41) or IDENTIFY PACKET DEVICE data word 120 bit 5 (see 7.17.6.35) indicates when the Free-fall Control feature set is enabled.

4.9 General Purpose Logging (GPL) feature set

The General Purpose Logging (GPL) feature set provides access to the logs in a device. These logs are associated with specific feature sets (e.g., SMART (see 4.17) and Streaming (see 4.20)). Support of the individual logs (see table A.2) 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 GPL feature set shall not be disabled by disabling SMART. If the feature set associated with a requested log is disabled, the device shall return command aborted.

If the GPL feature set is implemented, the following commands shall be supported:

a) READ LOG EXT (see 7.27); and
b) WRITE LOG EXT (see 7.62).

The following commands are optional:

a) READ LOG DMA EXT (see 7.28); and
b) WRITE LOG DMA EXT (see 7.63).

If the GPL feature set is supported, all Host Specific logs shall be supported (see A.10).

4.10 Long Logical Sector (LLS) feature set

The Long Logical Sector (LLS) feature set provides a method for a device to indicate that it has more than 256 words per logical sector (e.g., sectors with 520 or 528 bytes). Devices with logical sectors longer than 256 words shall set IDENTIFY DEVICE data word 106 bit 12 to 1 (see 7.16.7.56). The logical sector size is described by IDENTIFY DEVICE data words 117..118 (see 7.16.7.61).

Table 8 describes the command behavior of ATA devices that support the LLS feature set. Data transfer commands transfer either the long logical sector length or 256 words depending on the command (e.g., the READ DMA EXT command and the WRITE DMA EXT command transfer data in long logical sectors while the READ LOG EXT command and the WRITE LOG EXT command transfer 256 word blocks of data, regardless of the logical sector length). Figure 4 example 2 shows a diagram of a device formatted with long logical sectors.

The Long Physical Sector (LPS) feature set (see 4.11) and the LLS feature set are not mutually exclusive. Figure 4 example 4 illustrates a device implementing both the LPS and LLS feature sets.

Table 8 — Block Size By Command (Sheet 1 of 2)

Command	Words transferred per block
CFA TRANSLATE SECTOR	256
CFA WRITE MULTIPLE WITHOUT ERASE	IDENTIFY DEVICE data words (118:117)
CFA WRITE SECTORS WITHOUT ERASE	IDENTIFY DEVICE data words (118:117)
DATA SET MANAGEMENT	256
DOWNLOAD MICROCODE	256
DOWNLOAD MICROCODE DMA	256
IDENTIFY DEVICE	256
IDENTIFY PACKET DEVICE	256
READ BUFFER	256
READ BUFFER DMA	256
READ DMA	IDENTIFY DEVICE data words (118:117)
READ DMA EXT	IDENTIFY DEVICE data words (118:117)
READ FPDMA QUEUED	IDENTIFY DEVICE data words (118:117)
READ LOG EXT	256
READ LOG DMA EXT	256
READ MULTIPLE	IDENTIFY DEVICE data words (118:117)
READ MULTIPLE EXT	IDENTIFY DEVICE data words (118:117)
READ SECTOR(S)	IDENTIFY DEVICE data words (118:117)
READ SECTOR(S) EXT	IDENTIFY DEVICE data words (118:117)
READ STREAM DMA EXT	IDENTIFY DEVICE data words (118:117)
READ STREAM EXT	IDENTIFY DEVICE data words (118:117)
READ VERIFY SECTOR(S)	IDENTIFY DEVICE data words (118:117)
SECURITY DISABLE PASSWORD	256
SECURITY ERASE UNIT	256
SECURITY SET PASSWORD	256
SECURITY UNLOCK	256
SET MAX SET PASSWORD	256
SET MAX SET PASSWORD DMA	256
SET MAX UNLOCK	256
SET MAX UNLOCK DMA	256
SMART READ DATA	256
SMART READ LOG	256
SMART WRITE LOG	256
TRUSTED RECEIVE	256
TRUSTED RECEIVE DMA	256
TRUSTED SEND	256
TRUSTED SEND DMA	256
WRITE BUFFER	256
WRITE BUFFER DMA	256
WRITE DMA	IDENTIFY DEVICE data words (118:117)

Table 8 — Block Size By Command (Sheet 2 of 2)

Command	Words transferred per block
WRITE DMA EXT	IDENTIFY DEVICE data words (118:117)
WRITE DMA FUA EXT	IDENTIFY DEVICE data words (118:117)
WRITE FPDMA QUEUED	IDENTIFY DEVICE data words (118:117)
WRITE LOG EXT	256
WRITE LOG DMA EXT	256
WRITE MULTIPLE	IDENTIFY DEVICE data words (118:117)
WRITE MULTIPLE EXT	IDENTIFY DEVICE data words (118:117)
WRITE MULTIPLE FUA EXT	IDENTIFY DEVICE data words (118:117)
WRITE SECTOR(S)	IDENTIFY DEVICE data words (118:117)
WRITE SECTOR(S) EXT	IDENTIFY DEVICE data words (118:117)
WRITE STREAM DMA EXT	IDENTIFY DEVICE data words (118:117)
WRITE STREAM EXT	IDENTIFY DEVICE data words (118:117)

4.11 Long Physical Sector (LPS) feature set

The Long Physical Sector (LPS) feature set allows a device to indicate that there are multiple logical sectors per physical sector as shown in figure 4.

Long Physical Sector Alignment Error Reporting Control (see 7.45.17) and the LPS Mis-alignment log (see A.13) are optional for devices implementing the LPS feature set.

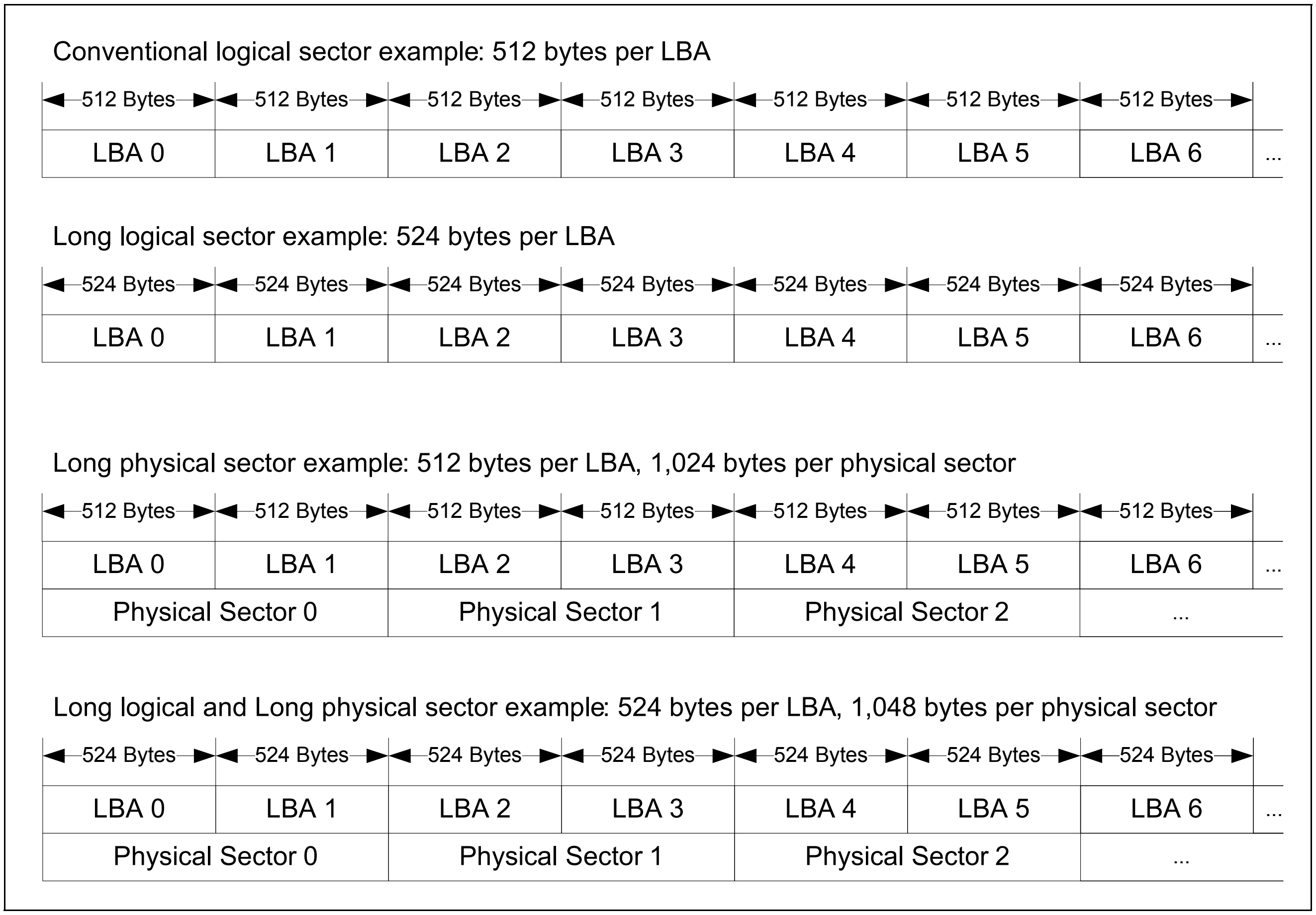

Figure 4 — LLS and LPS Example

If the device reports a LPS and a smaller logical sector, the device may report the alignment of the first logical sector (LBA 0) within the first physical sector. Example 1, example 2, and example 3 give examples of logical/physical sector alignments.

Example 1:

In Figure 5 there are 2 logical sectors within one physical sector, and the first logical sector is in the first half.

The offset is: 0, and the value in IDENTIFY DEVICE data word 209 is 4000h.

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

Figure 5 — Alignment 0

Example 2:

In Figure 6 there are 2 logical sectors within one physical sector, and the first logical sector is in the second half. The offset is: 1, and the value in word 209 is 4001h.

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

Figure 6 — Alignment 1

Example 3:

In Figure 7 there are 4 logical sectors within one physical sector, and the first logical sector is in the second half. The offset is: 3, and the value in word 209 is 4003h.

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

Figure 7 — Alignment 3

4.12 Native Command Queuing (NCQ) feature set

4.12.1 Overview

The NCQ feature set provides support for devices that implement the Serial Transport (see ATA8-AST). The NCQ feature set allows commands within this feature set to be accepted even though the device has not reported command completion for one or more previously accepted commands in the NCQ feature set. A device reports command completion for commands in the NCQ feature set by returning a transport dependent indicator (see ATA8-AST). The following commands are mandatory for devices implementing the NCQ feature set:

a) READ FPDMA QUEUED (see 7.26); and
b) WRITE FPDMA QUEUED (see 7.61).

Devices that report support for the NCQ feature set shall also report support for the GPL feature set (see 4.9), the General Purpose Log Directory log and the NCQ Command Error log.

If the device receives a command that is not an NCQ command while NCQ commands are in the queue, then the device shall return command aborted for the new command and for all of the NCQ commands that are in the queue.

All the commands in the NCQ feature set shall include a NCQ Tag. If the value of the NCQ Tag exceeds the value returned in IDENTIFY DEVICE data word 75 (see 7.16.7.33), then the device shall return command aborted for the new command and for all NCQ commands that are in the queue. If the device receives an NCQ command with a NCQ Tag value that is identical to the NCQ Tag value for another NCQ command in the queue, then the device shall return command aborted for the new command and for all the NCQ commands that are in the queue.

NOTE 4 — The NCQ Tag identifies return information (i.e., error status, data transfer and command completion).

If an error occurs while the device is processing an NCQ command, then the device shall return command aborted for all NCQ commands that are in the queue and shall return command aborted for any new commands, except a READ LOG EXT command requesting log address 10h, until the device completes a READ LOG EXT command requesting log address 10h (i.e., reading the NCQ Command Error log) without error.

> NOTE 5 — The NCQ feature set uses 48-bit addresses and is intentionally not included in the 48-bit address feature set.

4.12.2 Priority

Host knowledge of I/O priority may be transmitted to the device as part of the command. There are two priority values for NCQ commands, normal and high. When the host marks an NCQ command as high priority, the host is requesting a better quality of service for that command than commands issued with normal priority.

The device may choose to complete a normal priority command before an outstanding high priority command, although preference should be given to the high priority commands. One example where a normal priority command may be completed before a high priority command is when the normal priority command is a cache hit, whereas the high priority command requires access of the device media.

The priority is specified in the PRIO bit for NCQ commands (i.e., the READ FPDMA QUEUED command and the WRITE FPDMA QUEUED command). This bit specifies either a normal priority or a high priority value. If a command is marked by the host as high priority, the device should attempt to provide better quality of service for the command.

4.12.3 Unload

When NCQ commands are outstanding, the device may accept the IDLE IMMEDIATE command with the Unload feature. Upon acceptance of this command with the Unload feature specified, the device shall:

1) move the heads to a safe position; and
2) return command aborted.

When the host receives the error indication, it should proceed to do a READ LOG EXT command for the NCQ Command Error log. In the log, the device shall indicate whether the error was due to accepting an IDLE IMMEDIATE command with the Unload feature and whether the Unload was processed. The device shall not load the heads to the media when processing the READ LOG EXT command for the NCQ Command Error log.

The READ LOG EXT command for the NCQ Command Error log indicates whether the device has accepted the Unload and if it is in the process of moving the heads to a safe position. For a indication of a successful Unload, the IDLE IMMEDIATE command with the Unload feature should be reissued after the READ LOG EXT command for the NCQ Command Error log is processed. After the READ LOG EXT command for the NCQ Command Error log is processed:

a) there are no NCQ commands outstanding; and
b) the NCQ error is cleared,

such that if the unload process completes successfully, then:

a) the IDLE IMMEDIATE command with the Unload Feature should be processed normally; and
b) a successful status should be returned.

There may be a delay in issuing the IDLE IMMEDIATE command with the Unload feature to the device if the device is currently performing a data transfer for a previously issued NCQ command.

4.12.4 Command Phases

4.12.4.1 Command Acceptance

The device receives a command in the NCQ feature set and returns command acceptance. Once the device reports command acceptance, it may then accept additional commands in the NCQ feature set.

4.12.4.2 Data transmission

Data transfer should occur after acceptance of the command.

4.12.4.3 Command completion

When the transfer of all of the data requested by one or more NCQ commands occurred without error, the device returns a transport dependent indicator (see ATA8-AST) that informs the host of completion for one or more NCQ commands.

If an error occurs while processing an NCQ command, then the device shall return command aborted for the command in error and for all other NCQ commands that are in the queue. The condition of the data for any NCQ command for which a device reports command aborted is indeterminate.

4.13 Power Management feature set

4.13.1 Overview

An ATA device shall implement the Power Management feature set. An ATAPI device may implement power management as defined by the command set transported by the PACKET command. Otherwise, an ATAPI device shall implement the Power Management feature set as defined in this standard.

The Power Management feature set allows an application client 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. An ATA device that implements the Power Management feature set shall implement the following (see also 4.5 and 4.14):

a) the Standby timer;
b) CHECK POWER MODE command;
c) IDLE command;
d) IDLE IMMEDIATE command;
e) SLEEP command;
f) STANDBY command; and
g) STANDBY IMMEDIATE command.

An ATAPI device that implements the Power Management feature set shall implement the following:

a) CHECK POWER MODE command;
b) IDLE IMMEDIATE command;
c) SLEEP command; and
d) STANDBY IMMEDIATE command.

4.13.2 Power management commands

The CHECK POWER MODE command allows a host to determine if a device is 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 command and IDLE IMMEDIATE command move a device to Idle mode immediately from the Active mode or Standby mode. The IDLE command also sets the Standby timer count and enables or disables the Standby timer.

The STANDBY command and STANDBY IMMEDIATE command move a device to Standby mode immediately from the Active mode or Idle mode. 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 after the device reports command completion for the SLEEP command. A device only transitions from Sleep mode after processing a hardware reset, a software reset, or a DEVICE RESET command.

4.13.3 Standby timer

The Standby timer provides a method for the device to enter Standby mode from either Active mode or Idle mode following a host programmed period of inactivity. If:

a) the Standby timer is enabled;
b) the device is in the Active mode or the Idle mode; and
c) the standby timer expires,

then the device enters the Standby mode if no media access command is received.

If a media access command is received and the standby timer is enabled, then the standby timer is reinitialized and started from the previously specified time period.

If the Standby timer is disabled, the device may automatically enter Standby mode after a vendor specific time has expired.

4.13.4 Power modes

Figure 8 shows the set of state transitions that shall be implemented.

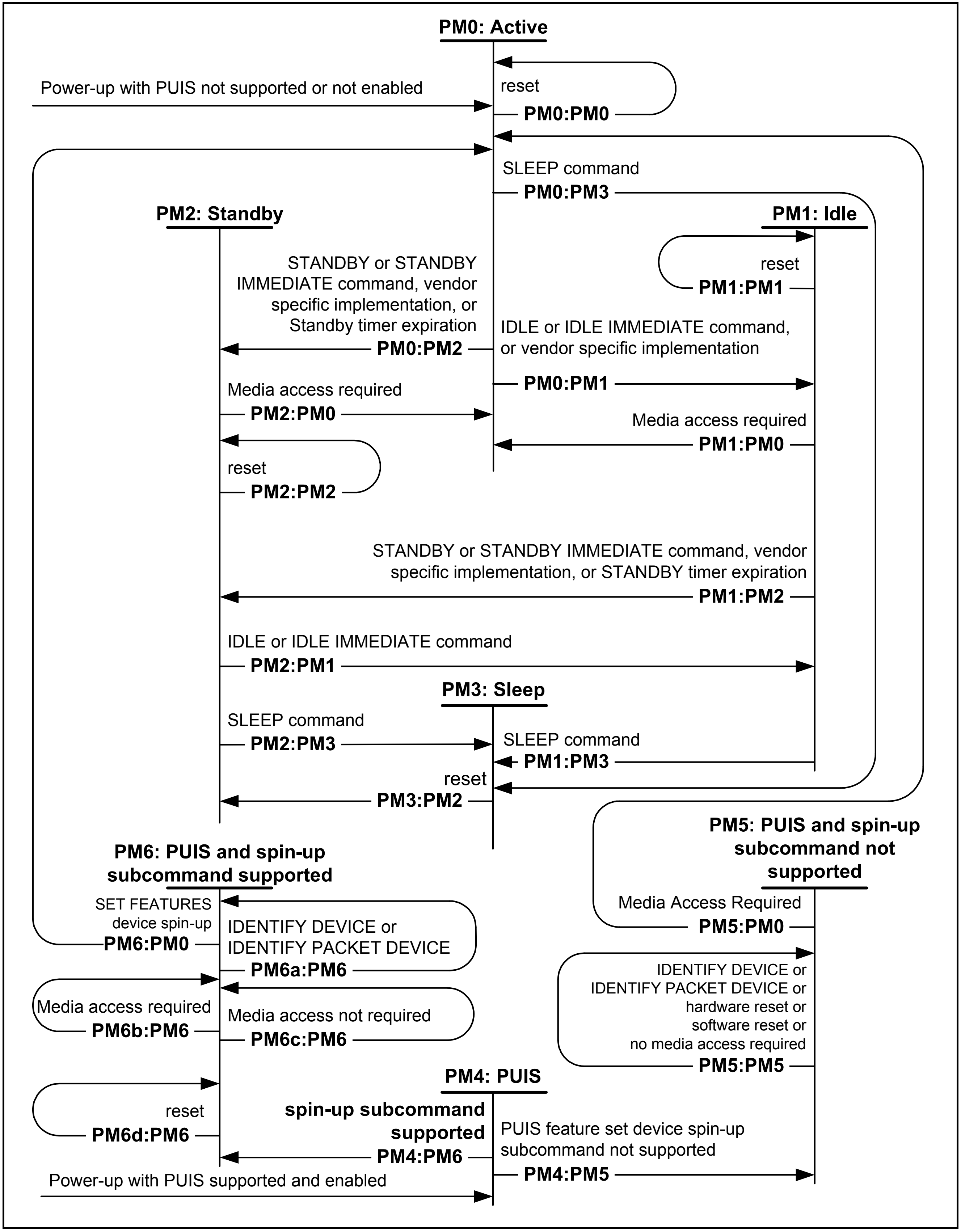

Figure 8 — Power management state diagram

PM0: Active: This state shall be entered when the device receives a media access command while in Idle mode or Standby mode. This state shall also be entered after processing a power-on reset if the Power-Up In Standby feature is not supported or is not enabled (see 4.14).

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

Transition PM0:PM0: The device shall transition to the PM0: Active state after processing a hardware reset, software reset, or DEVICE RESET command.

Transition PM0:PM1: If an IDLE command or IDLE IMMEDIATE command is received or a vendor specific implementation determines this transition is required, then the device shall transition to the PM1: Idle state.

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

Transition PM0:PM3: If a SLEEP command is received, then the device shall transition to the PM3: Sleep state.

PM1: Idle: This state shall be entered when the device receives an IDLE command or IDLE IMMEDIATE command. Some devices may perform vendor specific internal power management and 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: If a media access is required, then the device shall transition to the PM0: Active state.

Transition PM1:PM1: The device shall transition to the PM1: Idle state after processing a hardware reset, software reset, or DEVICE RESET command.

Transition PM1:PM2: The device shall transition to the PM2: Standby state if:

a) a STANDBY command is processed;
b) a STANDBY IMMEDIATE command is processed;
c) the Standby timer expires; or

Transition PM1:PM3: If a SLEEP command is received, then the device shall transition to the PM3: Sleep state.

PM2: Standby: This state shall be entered when:

d) the device successfully processes a STANDBY command;
e) the device successfully processes a STANDBY IMMEDIATE command;
f) the Standby timer expires;
g) a device performs a vendor specific power management function; or
h) the device successfully processes a hardware reset, a software reset, or a DEVICE RESET command while in PM2: Standby or PM3: Sleep.

In Standby mode the device is capable of responding to commands but the device may take longer (e.g., 30 seconds) to complete commands than in the Idle mode. Power consumption may be reduced from that of Idle mode.

Transition PM2:PM0: If a media access is required, then the device shall transition to the PM0: Active state.

Transition PM2:PM1: If an IDLE command or IDLE IMMEDIATE command is received, then the device shall transition to the PM1: Idle state.

Transition PM2:PM2: The device shall transition to the PM2: Standby state after processing a hardware reset, software reset, or DEVICE RESET command.

Transition PM2:PM3: If a SLEEP command is received, then the device shall transition to the PM3: Sleep state.

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

A device transitions from Sleep mode only after processing a hardware reset, a software reset, or a DEVICE RESET command. Processing a hardware reset, a software reset, or a DEIVCE RESET command may take a long time (e.g., 30 seconds). Sleep state provides the lowest power consumption of any state.

In Sleep state, the device interface behavior is defined in the applicable transport standard.

Transition PM3:PM2:, A device shall transition to the PM2: Standby state after processing a hardware reset, software reset, or DEVICE RESET command.

PM4: PUIS: This state shall be entered after processing a power-on reset if the PUIS feature set (see 4.14) is supported and is enabled.

Transition PM4:PM5: A device shall transition to the PM5: PUIS and spin-up subcommand not supported state if the device does not implement the PUIS feature set device spin-up command (see 7.45.8).

Transition PM4:PM6: A device shall transition to the PM6: PUIS and spin-up subcommand supported state if the device implements the PUIS feature set device spin-up command.

PM5: PUIS and spin-up subcommand not supported: This state shall be entered after processing a power-on reset if the PUIS feature set is supported and is enabled and the device does not implement the PUIS feature set device spin-up subcommand.

In this state, the device is capable of responding to commands but the device may take longer (e.g., 30 seconds) to complete commands than in the Idle mode. Power consumption may be reduced from that of Idle mode.

Transition PM5:PM0: If the device receives a media access command, then the device shall transition to the PM0: Active state.

Transition PM5:PM5: A device shall transition to the PM5: PUIS and spin-up subcommand not supported state after processing an IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command, any hardware or software reset, or any command that does not require media access.

PM6: PUIS and spin-up subcommand supported: This state shall be entered after processing a power-on reset if the PUIS feature set is supported and is enabled and the device implements the PUIS feature set device spin-up command.

In this state, the device is capable of responding to commands but the device may take longer (e.g., 30 seconds) to complete commands than in the Idle mode. Power consumption may be reduced from that of Idle mode.

Transition PM6:PM0: A device shall transition to the PM0: Active state after processing a SET FEATURES device spin-up subcommand.

Transition PM6a:PM6: A device shall transition to the PM6: PUIS and spin-up subcommand supported state after processing IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command.

Transition PM6b:PM6: The device shall transition to the PM6: PUIS and spin-up subcommand supported state after returning command aborted in response to a command, other than IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command, that requires media access.

Transition PM6c:PM6: A device shall transition to the PM6: PUIS and spin-up subcommand supported state after processing a command, other than IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command, that does not require media access.

Transition PM6d:PM6: A device shall transition to the PM6: PUIS and spin-up subcommand supported state after processing a hardware reset, software reset, or DEVICE RESET command.

4.14 Power-Up In Standby (PUIS) feature set

The PUIS feature set allows devices to be powered-up into the PM4: PUIS state to minimize inrush current at power-up and to allow the host to sequence the spin-up of devices. This feature set may be enabled or disabled by use of:

a) the SET FEATURES command; or
b) a jumper or similar means.

When enabled by a jumper, this feature set shall not be disabled via the SET FEATURES command. The IDENTIFY DEVICE data or IDENTIFY PACKET DEVICE data indicates whether this feature set is implemented and/or enabled.

Once this feature is enabled in a device, the device shall not disable the feature as a result of processing a power-on reset, a hardware reset, or a software reset.

A device may implement a SET FEATURES subcommand (see 7.45.8) 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 the PM4: PUIS state 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 data or IDENTIFY PACKET DEVICE data.

If the device:

c) implements the Enable/disable Power-up in Standby subcommand;
d) has the PUIS feature set enabled; and
e) receives an IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command while the device is in the Standby power mode as a result of powering up in that mode,

then the device shall respond to the IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command without spinning up the media. If the device is unable to return a complete response without accessing the media, then the device shall set IDENITFY DEVICE data word 0 bit 2 (see 7.16.7.2) to one to indicate that the response is incomplete. At a minimum, IDENITFY DEVICE data word 0 and IDENITFY DEVICE data word 2 (see 7.16.7.4) shall be correctly reported. Those fields that are not provided shall be filled with zeros. Once a device is able to return all data for an IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command, the device shall return all data for those commands until after processing the next power-on reset.

If the device does not implement the SET FEATURES subcommand to spin-up the device after power-up and PUIS is enabled, the device shall spin-up upon receipt of the first command that requires the device to access the media, except the IDENTIFY DEVICE command or the IDENTIFY PACKET DEVICE command.

4.15 Sanitize Device feature set

The Sanitize Device feature set allows hosts to request that devices modify the content of all user data areas in the device using Sanitize Device operations. Sanitize Device operations shall use one of the methods defined in this subclause to make all previously written content in the user data area of the device unable to be read. Sanitize Device operations shall only affect the following:

a) user data areas;
b) user data areas that are not currently allocated (e.g., previously allocated areas and physical sectors that have become inaccessible); and
c) user data caches.

If the Sanitize feature set is implemented, the following commands shall be supported:

a) SANITIZE STATUS EXT (see 7.38.6); and
b) SANITIZE FREEZE LOCK EXT (see 7.38.5).

At least one of the following commands shall be implemented:

a) CRYPTO SCRAMBLE EXT (see 7.38.3);
b) BLOCK ERASE EXT (see 7.38.2); or
c) OVERWRITE EXT (see 7.38.4).

Sanitize Device operations should not return an error if physical sectors that have become inaccessible were not successfully sanitized.

Sanitize Device operations shall not affect non-user data areas (e.g., logs (see Annex A), and Device SMART data structure (see table 115)).

Automatic sector reallocation is permitted during the operation of this function. After completion of a Sanitize Device operation, the device shall:

a) return an error if physical sectors that are available to be allocated for user data (e.g. allocated physical sectors or unallocated physical sectors allowed by vendor-specific means to be usable for user data) were not successfully sanitized; or

b) set the Sanitize Operation Complete Without Error bit if:
    A) all physical sectors that are available to be allocated for user data have been successfully sanitized; and
    B) any physical areas that were not successfully sanitized were removed from use.

To perform a Sanitize Device operation the host issues:

a) CRYPTO SCRAMBLE EXT command (see 7.38.3);
b) BLOCK ERASE EXT command (see 7.38.2); or
c) OVERWRITE EXT command (see 7.38.4),

followed by a SANITIZE STATUS EXT command (see 7.38.6) to check for completion.

After a device has started processing a Sanitize Device operation, and until the device transitions to the Sanitize Idle state, the device shall abort all commands other than IDENTIFY DEVICE command, REQUEST SENSE DATA EXT command, SANITIZE STATUS EXT command, and the SET FEATURES PUIS feature set device spin-up subcommand. If a Sanitize Device operation is interrupted by a power-on reset, the Sanitize Device operation shall continue to completion. If the device processes a power-on reset and enters the PM5: PUIS and spin-up subcommand not supported state, then the device shall resume processing the Sanitize Device operation after receiving a media access command.

NOTE 6 — the media access command reports failure because the Sanitize operation does not allow media access commands. However, since the device has received a media access command, the device is allowed to spin-up.

The SANITIZE STATUS EXT command returns information about the current Sanitize Device operation, if any, and a percentage of completion if a Sanitize Device operation is in progress.

An accepted CRYPTO SCRAMBLE EXT command, BLOCK ERASE EXT command, or OVERWRITE EXT command shall transition the device into the Sanitize Operation state. The device shall remain in this state until the device has completed the Sanitize Device operation (see figure 9).

The SANITIZE FREEZE LOCK EXT command (see 7.38.5) shall cause the device to transition to the Sanitize Frozen state and shall cause any subsequent CRYPTO SCRAMBLE EXT command, BLOCK ERASE EXT command, or OVERWRITE EXT command to be aborted. If the device processes a power-on reset or a hardware reset, then the device shall transition from the Sanitize Frozen state to the Sanitize Idle state.

A device implementing this feature set shall implement one or more of the following sanitization methods:

a) cryptographic scramble;
b) block erase; or
c) overwrite.

The cryptographic scramble method and block erase method make previously written contents in the user data area unretrievable.

The overwrite method fills all user data with a four byte pattern passed within the LBA field of the command. Parameters for this method include a count for multiple overwrites and the option to invert the four byte pattern between consecutive overwrite passes.

A software reset shall not cause the Sanitize operation state to change.

Figure 9 describes the operation of the Sanitize Device feature set.

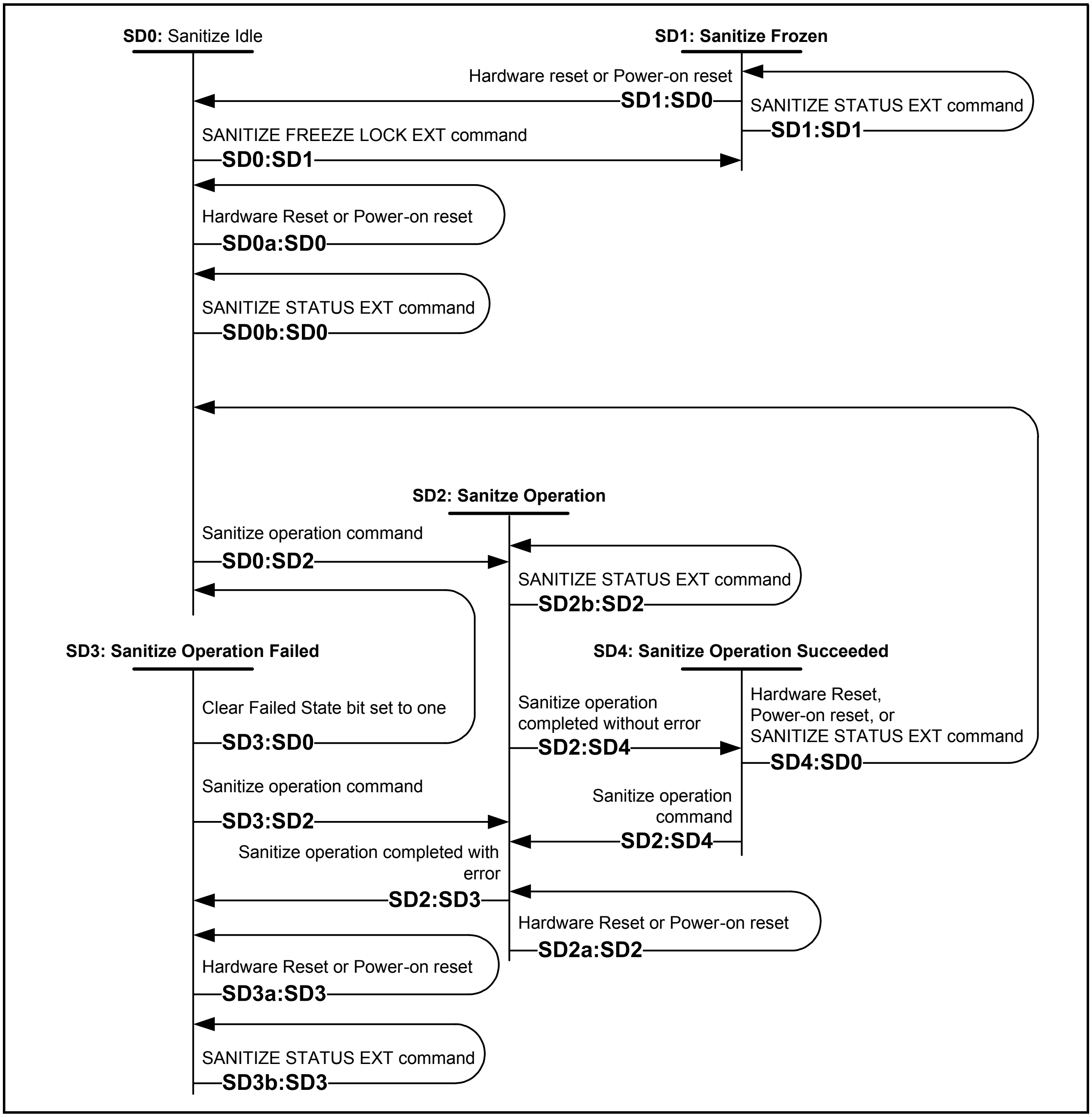

Figure 9 — Sanitize Device state machine

SD0: Sanitize Idle State: This state is entered when the device processes a power-on reset from SD0, SD1, or SD4.

Transition SD0a:SD0: If the device is:

a) in the Sanitize Idle state; and
b) processes a hardware reset or power-on reset,

then the device shall remain in the SD0: Sanitize Idle state.

Transition SD0b:SD0: If the device is in the Sanitize Idle state and it processes a SANITIZE STATUS EXT command, then the device shall complete the command and remain in the SD0: Sanitize Idle state.

Transition SD0:SD1: If the device is in the Sanitize Idle state and it processes a SANITIZE FREEZE LOCK EXT command, then the device shall transition to the SD1: Sanitize Frozen state.

Transition SD0:SD2: If the device is in the Sanitize Idle state and it processes a supported Sanitize operation command, then the device shall transition to the SD2: Sanitize Operation state.

SD1: Sanitize Frozen State: This state is entered from the SD0: Sanitize Idle state when the device processes a SANITIZE FREEZE LOCK EXT command.

Transition SD1:SD0: If the device is in the Sanitize Frozen state and it processes a hardware reset or a power-on reset, then the device shall transition to the SD0: Sanitize Idle state.

Transition SD1:SD1: If the device is in the Sanitize Frozen state and it processes a SANITIZE STATUS EXT command, then the device shall complete the command and remain in the SD1: Sanitize Frozen state.

SD2: Sanitize Operation State: This state is entered if:

a) the device processes a power-on reset from SD2; or
b) the device is in the SD0 Sanitize Idle state and a supported Sanitize operation command is received.

Transition SD2a:SD2: If the device is in the Sanitize Operation state and processes a hardware reset or power-on reset, then the device shall remain in the SD2: Sanitize Operation state.

Transition SD2b:SD2: If the device is in the Sanitize Operation state and it processes a SANITIZE STATUS EXT command, then the device shall remain in the SD2: Sanitize Operation state.

Transition SD2:SD3: If the device is in the Sanitize Operation state and a Sanitize operation completes with an error, then the device shall transition to the SD3: Sanitize Operation Failed state.

Transition SD2:SD4: If the device is in the Sanitize Operation state and a Sanitize operation completes without an error, then the device shall transition to the SD4: Sanitize Operation Succeeded state.

SD3: Sanitize Operation Failed State: This state is entered when:

a) the device processes a power-on reset from SD3; or
b) the device is in the SD2: Sanitize Operation state and a Sanitize operation completes with an error.

Transition SD3:SD0: If the device is in the Sanitize Operation Failed state and:

a) the Sanitize operation was initiated by a Sanitize operation command with the Failure Mode bit set to one; and
b) the SANITIZE STATUS EXT command has been successfully processed with the Clear Sanitize Operation Failed bit set to one,

then the device shall transition to the Sanitize Idle state.

Transition SD3:SD2: If the device is in the Sanitize Operation Failed state and it processes a supported Sanitize operation command, then the device shall transition to the SD2: Sanitize Operation state.

Transition SD3a:SD3: If the device is in the Sanitize Operation Failed state and it processes a hardware reset or power-on reset, then the device shall remain in the SD3: Sanitize Operation Failed state.

Transition SD3b:SD3: If the device is in the Sanitize Operation Failed state, and it processes a SANITIZE STATUS EXT command with the Clear Sanitize Operation Failed bit cleared to zero, then the device shall remain in the SD3: Sanitize Operation Failed state.

SD4: Sanitize Operation Succeeded State: This state is entered when the device is in the SD2 Sanitize Operation state and a Sanitize operation completes without an error.

Transition SD4:SD0: If the device is in the Sanitize Operation state and it processes:

a) a hardware reset;
b) a power-on reset; or
c) a SANITIZE STATUS EXT command,

then the device shall transition to the SD0: Sanitize Idle state.

Transition SD4:SD2: If the device is in the Sanitize Operation state and it processes a supported Sanitize operation command, then the device shall transition to the SD2: Sanitize Operation state.

4.16 Security feature set

4.16.1 Overview

The Security feature set is a password system that restricts access to user data stored on a device. Access to some configuration capabilities are limited.

The Master Password Identifier feature (see 4.16.11) is an optional enhancement to the Security feature set.

4.16.2 Passwords

4.16.2.1 Overview

The system has two types of passwords:

a) User; and
b) Master.

4.16.2.2 User Password

The User password creates a lock to block processing of some commands, including preventing access to all user data on the device. The User password may be used to unlock the device to allow access.

Security is enabled by setting a User password with the SECURITY SET PASSWORD command. If security is enabled, then the device is Locked (i.e., access to user data on the device is denied) after a power-on reset is processed until a SECURITY UNLOCK command completes without error.

4.16.2.3 Master Password

The Master password is a password that may be used to unlock the device if the User password is lost or if an administrator requires access (e.g., to repurpose a device).

A factory-installed Master password may be valid before an initial SECURITY SET PASSWORD command has been completed without error. A device may contain both a valid Master password and a valid User password. Setting the Master password does not enable security (i.e., does not Lock the device after the next power-on reset has been processed).

4.16.3 Master Password Capability

A device with security enabled has two ways of using the Master password. This capability has values of High or Maximum. The capability value is set when the User password is set (see 7.43).

When the Master Password Capability is set to High, either the User password or Master password may be used interchangeably.

When the Master Password Capability is set to Maximum, the Master password is not used with the SECURITY DISABLE PASSWORD command and SECURITY UNLOCK command. The SECURITY ERASE UNIT command, however, does accept either a valid User or Master password.

4.16.4 Frozen Mode

The SECURITY FREEZE LOCK command prevents changes to all Security states until a subsequent power-on reset or hardware reset. The purpose of the SECURITY FREEZE LOCK command is to prevent password setting attacks on the security system.

4.16.5 Commands

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

a) SECURITY SET PASSWORD (see 7.43);
b) SECURITY UNLOCK (see 7.44);
c) SECURITY ERASE PREPARE (see 7.40);
d) SECURITY ERASE UNIT (see 7.41);
e) SECURITY FREEZE LOCK (see 7.42); and
f) SECURITY DISABLE PASSWORD (see 7.39).

4.16.6 IDENTIFY DEVICE data

Support of the Security feature set is indicated in IDENTIFY DEVICE data words 82 and 128 (see 7.16.7.40 and 7.16.7.66) and IDENTIFY PACKET DEVICE data words 82 and 128 (see 7.17.6.34 and 7.17.6.51).

Security information in IDENTIFY DEVICE data words 82, 89 and 90 (see table 46) and IDENTIFY PACKET DEVICE data words 82, 89 and 90 (see table 51) is fixed until the next power-on reset.

Security information in IDENTIFY DEVICE data words 85, 92 and 128 and IDENTIFY DEVICE data words 85, 92 and 128 are variable and may change.

If the Security feature set is not supported, then IDENTIFY DEVICE data words 89, 90, 92 and 128 and IDENTIFY PACKET DEVICE data words 89, 90, 92 and 128 are N/A.

4.16.7 Security initial setting

When the device is shipped by the manufacturer, security shall be disabled (e.g., is not Locked). The initial Master password value is not defined by this standard.

4.16.8 Password Rules

This subclause applies to any security command that accepts a password, and for which there exists a valid password. This subclause does not apply after the drive has processed a SECURITY FREEZE LOCK command without error.

The SECURITY ERASE UNIT command ignores the Master Password Capability value when comparing passwords, and shall accept either a valid Master password or User password.

If the User password sent to the device does not match the User password previously set with the SECURITY SET PASSWORD command, then the device shall return command aborted.

If the Master Password Capability was set to High during the last SECURITY SET PASSWORD command setting the User password, then the device shall accept the Master password and complete the command without error.

If the Master Password Capability was set to Maximum during the last SECURITY SET PASSWORD command setting the User password, then the device shall return command aborted for a SECURITY UNLOCK command or a SECURITY DISABLE PASSWORD command if the Master password is supplied.

4.16.9 Password attempt counter

The device shall have a password attempt counter. The counter shall be decremented while in SEC4 state (see figure 10), whenever the SECURITY UNLOCK command fails because of an invalid User password or Master password.

When the password attempt counter reaches zero, the device shall:

a) not decrement the counter;
b) set the Password Attempt Counter Exceeded bit (i.e., bit 4 of word 128 in the IDENTIFY DEVICE data) to one; and
c) return command aborted for all SECURITY UNLOCK commands and SECURITY ERASE UNIT commands until after the device processes a power-on reset or hardware reset.

The Password Attempt Counter Exceeded bit shall be cleared to zero after processing a power-on reset or a hardware reset.

The password attempt counter shall be set to five after a power-on reset or hardware reset.

4.16.10 Security states

Figure 10 describes security states and state transitions, table 9 is a summary of the security states, and table 10 describes the effect of security on commands. When the power is off, the security characteristics are as in table 9, but are not reportable.

Table 9 — Summary of Security States and Security Characteristics

Security State	Security Characteristics				
	Power	Enabled[a]	Locked[b]	Frozen[c]	Password Attempts Exceeded[d]
SEC0	off	0	N/A	N/A	N/A
SEC1	on	0	0	0	0
SEC2	on	0	0	1	Varies
SEC3	off	1	N/A	N/A	N/A
SEC4	on	1	1	0	Varies
SEC5	on	1	0	0	Varies
SEC6	on	1	0	1	Varies

[a] IDENTIFY DEVICE data word 85 bit 1 (see 7.16.7.41)
[b] IDENTIFY DEVICE data word 128 bit 2 (see 7.16.7.66)
[c] IDENTIFY DEVICE data word 128 bit 3 (see 7.16.7.66)
[d] IDENTIFY DEVICE data word 128 bit 4 (see 7.16.7.66)

Table 10 — Security Command Actions (Sheet 1 of 3)

Command	Locked [a]	Unlocked or Disabled [b]	Frozen [c]
BLOCK ERASE EXT	Command aborted	Executable	Executable
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 POWER MODE	Executable	Executable	Executable
CONFIGURE STREAM	Command aborted	Executable	Executable
CRYPTO SCRAMBLE EXT	Command aborted	Executable	Executable
DATA SET MANAGEMENT	Command aborted	Executable	Executable
DEVICE RESET	Executable	Executable	Executable
DOWNLOAD MICROCODE	Vendor Specific	Vendor Specific	Vendor Specific
DOWNLOAD MICROCODE DMA	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
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
OVERWRITE EXT	Command aborted	Executable	Executable
PACKET	Command aborted	Executable	Executable
READ BUFFER	Executable	Executable	Executable
READ BUFFER DMA	Executable	Executable	Executable
READ DMA	Command aborted	Executable	Executable
READ DMA EXT	Command aborted	Executable	Executable
READ FPDMA QUEUED	Command aborted	Executable	Executable
READ LOG DMA EXT	Executable	Executable	Executable
READ LOG EXT	Executable	Executable	Executable

Note - all commands not listed in this table are not addressed by the Security feature set.

[a] State SEC4

[b] States SEC1 or SEC5

[c] States SEC2 or SEC6

Table 10 — Security Command Actions (Sheet 2 of 3)

Command	Locked [a]	Unlocked or Disabled [b]	Frozen [c]
READ MULTIPLE	Command aborted	Executable	Executable
READ MULTIPLE EXT	Command aborted	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
REQUEST SENSE DATA EXT	Executable	Executable	Executable
SANITIZE FREEZE LOCK EXT	Command aborted	Executable	Executable
SANITIZE STATUS EXT	Command aborted	Executable	Executable
SCT WRITE SAME	Command aborted	Executable	Executable
SCT ERROR RECOVERY CONTROL	Command aborted	Executable	Executable
SCT FEATURE CONTROL	Command aborted	Executable	Executable
SCT DATA TABLES	Command aborted	Executable	Executable
SCT READ STATUS	Executable	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 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
SMART READ LOG	Executable	Executable	Executable
SMART RETURN STATUS	Executable	Executable	Executable
SMART WRITE LOG	Executable	Executable	Executable

Note - all commands not listed in this table are not addressed by the Security feature set.

[a] State SEC4
[b] States SEC1 or SEC5
[c] States SEC2 or SEC6

Table 10 — Security Command Actions (Sheet 3 of 3)

Command	Locked [a]	Unlocked or Disabled [b]	Frozen [c]
STANDBY	Executable	Executable	Executable
STANDBY IMMEDIATE	Executable	Executable	Executable
TRUSTED NON-DATA	Command aborted	Executable	Executable
TRUSTED RECEIVE	Command aborted	Executable	Executable
TRUSTED RECEIVE DMA	Command aborted	Executable	Executable
TRUSTED SEND	Command aborted	Executable	Executable
TRUSTED SEND DMA	Command aborted	Executable	Executable
WRITE BUFFER	Executable	Executable	Executable
WRITE BUFFER DMA	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 FPDMA QUEUED	Command aborted	Executable	Executable
WRITE LOG DMA 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
WRITE UNCORRECTABLE EXT	Command aborted	Executable	Executable

Note - all commands not listed in this table are not addressed by the Security feature set.

[a] State SEC4
[b] States SEC1 or SEC5
[c] States SEC2 or SEC6

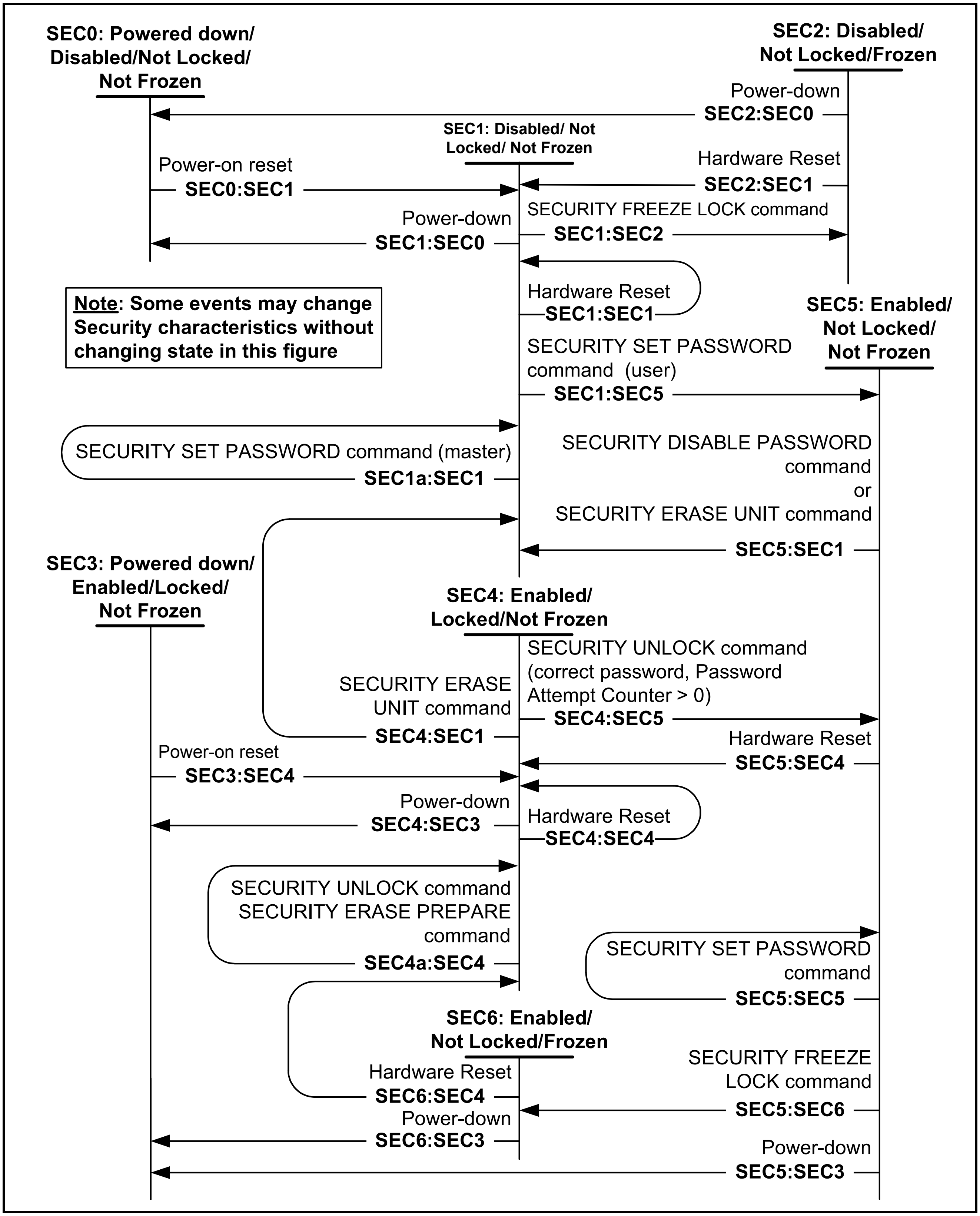

Figure 10 — Security state diagram

State SEC0: Powered down/Security Disabled/Not Locked/ Not Frozen: This state shall be entered when the device is powered-down with the Security feature set disabled.

Transition SEC0:SEC1: After the device processes a power-on reset, the device shall transition to the SEC1 state.

State SEC1: Security Disabled/Not Locked/Not Frozen: This state shall be entered when the device processes a power-on reset or a hardware reset with the Security feature set disabled or when the Security feature set is disabled by a SECURITY DISABLE PASSWORD command or SECURITY ERASE UNIT command.

When entering this state after processing a power-on reset or hardware reset, the device shall set the password attempt counter to a value of five and clear the Password Attempt Counter Exceeded flag.

In this state, the device shall respond to all commands as specified in the Disabled column of table 10. With the exception of the SECURITY commands, processing of these commands shall not cause a transition from state SEC1.

The device shall report IDENTIFY DEVICE command and IDENTIFY PACKET DEVICE command data words as described in table 11.

Table 11 — IDENTIFY settings for Security state SEC1

Word	Bit Position	Value	Description
82	1	1	Security feature set is supported
85	1	0	There is no active User password
128	0	copy of word 82 bit 1	Security feature set is supported
128	1	copy of word 85 bit 1	Security feature set is disabled
128	2	0	device is not locked
128	3	0	device is not frozen
128	4	Varies	Password Attempt Counter Exceeded 1= counter exceeded 0= counter not exceeded
128	8	0	Master Password Capability is not maximum

Transition SEC1:SEC0: When the device is powered-down, the device shall transition to the SEC0 state.

Transition SEC1:SEC1: When the device processes a hardware reset, the device shall remain in the SEC1 state.

Transition SEC1a:SEC1: When a SECURITY SET (master) PASSWORD command completes without error, the device shall:

a) save the Master password and the optional Master Password Identifier;
b) remain in the SEC1 state; and
c) not change the Master Password Capability.

Transition SEC1:SEC2: When a SECURITY FREEZE LOCK command completes without error, the device shall transition to the SEC2 state.

Transition SEC1:SEC5: When a SECURITY SET (user) PASSWORD command completes without error, the device shall:

a) save the User password;
b) update the Master Password Capability; and
c) transition to the SEC5 state.

State SEC2: Security Disabled/Not Locked/Frozen: This state shall be entered when the device receives a SECURITY FREEZE LOCK command while in state SEC1.

In this state, the device shall respond to all commands as specified in the Frozen column of table 10. Processing of any of these commands shall not cause a transition from state SEC2.

The device shall report IDENTIFY DEVICE data words and IDENTIFY PACKET DEVICE data words as described in table 12.

Table 12 — IDENTIFY settings for Security state SEC2

Word	Bit Position	Value	Description
82	1	1	Security feature set is supported
85	1	0	There is no active User password
128	0	copy of word 82 bit 1	Security feature set is supported
128	1	copy of word 85 bit 1	Security feature set is disabled
128	2	0	device is not locked
128	3	1	device is frozen
128	4	Varies	Password Attempt Counter Exceeded 1= counter exceeded 0= counter not exceeded
128	8	Varies	Master Password Capability 0=high/User password disabled 1=Maximum/User password disabled

Transition SEC2:SEC0: When the device is powered-down, the device shall transition to the SEC0 state.

Transition SEC2:SEC1: When the device receives a hardware reset, the device shall transition to the SEC1 state.

State SEC3: Powered down/Security Enabled/ Locked/ Not Frozen: This state shall be entered when the device is powered-down with the Security feature set enabled.

Transition SEC3:SEC4: If the device processes a power-on reset, then the device shall transition to the SEC4 state.

State SEC4: Security Enabled/ Locked/ Not Frozen: This state shall be entered if the device processes a power-on reset or hardware reset with the Security feature set enabled.

In this state, the device shall respond to all commands as specified in the Locked column of table 10. With the exception of the SECURITY commands, processing of these commands shall not cause a transition from state SEC4.

When entering this state from power-on reset or hardware reset, the device shall set the password attempt counter to a value of 5 and clear the Password Attempt Counter Exceeded flag.

The device shall report IDENTIFY DEVICE data words and the IDENTIFY PACKET DEVICE data words as described in table 13.

Table 13 — IDENTIFY settings for Security state SEC4

Word	Bit Position	Value	Description
82	1	1	Security feature set is supported
85	1	1	There is an active User password
128	0	copy of word 82 bit 1	Security feature set is supported
128	1	copy of word 85 bit 1	Security feature set is enabled
128	2	1	device is locked
128	3	0	device is not frozen
128	4	Varies	Password Attempt Counter Exceeded 1= counter exceeded 0= counter not exceeded
128	8	Varies	Master Password Capability 0=high 1=Maximum

Transition SEC4:SEC1: When a SECURITY ERASE UNIT command completes without error, then the device shall transition to the SEC1 state.

Transition SEC4:SEC3: When the device is powered-down, the device shall transition to the SEC3 state.

Transition SEC4:SEC4: When the device receives a hardware reset, the device shall remain in the SEC4 state.

Transition SEC4a:SEC4: When a SECURITY UNLOCK command is received with an incorrect password, the password attempt counter shall be decremented by one, and remain in the SEC4 state.

If the password attempt counter reaches zero, then the Password Attempt Counter Exceeded bit shall be set to one.

After processing of the SECURITY ERASE PREPARE command, the device remains in the SEC4 state.

Transition SEC4:SEC5: When a SECURITY UNLOCK command is successful, the device shall transition to the SEC5 state.

State SEC5: Security Enabled/ Not Locked/ Not Frozen: This state shall be entered when either a SECURITY SET (user) PASSWORD command or a SECURITY UNLOCK command completes without error.

In this state, the device shall respond to all commands as specified in the Unlocked column of table 10. With the exception of the SECURITY commands, processing of these commands shall not cause a transition from state SEC5.

The device shall report IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command data words as described in table 14.

Table 14 — IDENTIFY settings for Security state SEC5

Word	Bit Position	Value	Description
82	1	1	Security feature set is supported
85	1	1	There is an active User password
128	0	copy of word 82 bit 1	Security feature set is supported
128	1	copy of word 85 bit 1	Security feature set is enabled
128	2	0	device is not locked
128	3	0	device is not frozen
128	4	Varies	Password Attempt Counter Exceeded 1= counter exceeded 0= counter not exceeded
128	8	Varies	Master Password Capability 0=high 1=Maximum

Transition SEC5:SEC1: If a SECURITY DISABLE PASSWORD command or a SECURITY ERASE UNIT command is successful, then the device shall transition to the SEC1 state.

Transition SEC5:SEC3: When the device is powered-down, the device shall transition to the SEC3 state.

Transition SEC5:SEC4: When the device receives a hardware reset, the device shall transition to the SEC4 state.

Transition SEC5:SEC5: When a SECURITY SET (master) PASSWORD command completes without error, the device shall:

a) save the Master password and the optional Master Password Identifier;
b) not change the Master Password Capability; and
c) remain in the SEC5 state.

When a SECURITY SET (user) PASSWORD command completes without error, the device shall:

a) save the User password;
b) update the Master Password Capability; and
c) remain in the SEC5 state.

If a SECURITY ERASE PREPARE command completes without error, then the device shall remain in the SEC5 state.

Transition SEC5:SEC6: When a SECURITY FREEZE LOCK command is successful, the device shall transition to the SEC6 state.

State SEC6: Security Enabled/ Not Locked/ Frozen: This state shall be entered when the device receives a SECURITY FREEZE LOCK command while in the SEC5 state.

In this state, the device shall respond to all commands as specified in the Frozen column of table 10. With the exception of the SECURITY commands, processing of these commands shall not cause a transition from state SEC6.

The device shall report IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command data words as described in table 15.

Table 15 — IDENTIFY settings for Security state SEC6

Word	Bit Position	Value	Description
82	1	1	Security feature set is supported
85	1	1	There is an active User password
128	0	copy of word 82 bit 1	Security feature set is supported
128	1	copy of word 85 bit 1	Security feature set is enabled
128	2	0	device is not locked
128	3	1	device is frozen
128	4	Varies	Password Attempt Counter Exceeded 1= counter exceeded 0= counter not exceeded
128	8	Varies	Master Password Capability 0=high 1=Maximum

Transition SEC6:SEC4: When the device receives a hardware reset, the device shall transition to the SEC4 state.

Transition SEC6:SEC3: When the device is powered-down, the device shall transition to the SEC3 state.

4.16.11 Master Password Identifier feature

4.16.11.1 Overview

The Master Password Identifier is an optional feature in the Security feature set.

4.16.11.2 Example use case

This feature allows an administrator to use several sets of Master passwords (e.g., for use in different deployments of devices). The administrator may maintain a mapping of actual Master passwords and a corresponding Identifier. When an administrator sets a Master password, the corresponding Master Password Identifier may also be set.

If a User password had been set and lost, an administrator may obtain a hint as to which Master password was previously set from the Master Password Identifier.

4.16.11.3 Requirements

The device shall maintain a value associated with the Master Password that may be specified by the host.

The Master Password Identifier does not indicate whether a Master Password exists or is valid.

Support for this feature is reported in the IDENTIFY DEVICE data or IDENTIFY PACKET DEVICE data in word 92. Valid identifiers are 0001h through FFFEh. A value of 0000h or FFFFh indicates that this feature is not supported.

If the device supports the Security feature set, then:

a) the device shall store a non-volatile identifier field with the stored Master password;
b) the identifier is maintained for the benefit of the host and shall not be modified by the device; and
c) prior to first use, the Master Password Identifier shall be set to FFFEh by the manufacturer.

4.17 Self-Monitoring, Analysis, and Reporting Technology (SMART) feature set

4.17.1 Overview

The Self-Monitoring, Analysis, and Reporting Technology (SMART) feature set allows for the protection of user data and minimizes the likelihood of unscheduled system downtime that may be caused by predictable degradation and/or fault of the device. SMART feature set devices attempt to predict the likelihood of near-term degradation or fault condition. The SMART feature set provides the host with the knowledge of a negative reliability condition. Support of this feature set is indicated in the IDENTIFY DEVICE data.

4.17.2 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 in the SMART data structure may be useful to the host if the SMART EXECUTE OFF-LINE IMMEDIATE command is implemented (see 7.48.5).

4.17.3 Background data collection

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

4.17.4 Off-line/Captive mode data collection

If the device is required to respond to commands from the host while performing data collection, then the device shall use the off-line mode or captive mode for data collection and self-test routines that have an impact on performance. 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 background data collection mode for any particular device and may vary from one device to another.

4.17.5 Threshold exceeded condition

This condition occurs when the device’s SMART reliability status indicates an impending degrading or fault condition (see 7.48.8).

4.17.6 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 7.48).

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

a) SMART DISABLE OPERATIONS (see 7.48.2);
b) SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE (see 7.48.3);
c) SMART ENABLE OPERATIONS (see 7.48.4); and
d) SMART RETURN STATUS (see 7.48.8).

If the SMART feature set is implemented, the following commands are optional:

a) SMART EXECUTE OFF-LINE IMMEDIATE (see 7.48.5);
b) SMART READ DATA (see 7.48.6);
c) SMART READ LOG (see 7.48.7); and
d) SMART WRITE LOG (see 7.48.9).

4.17.7 SMART operation with power management modes

When the SMART feature set is enabled a device should save the device accumulated SMART data upon receipt of an IDLE IMMEDIATE command, STANDBY IMMEDIATE command, or SLEEP command or upon return to an Active state or Idle state from a Standby state (see 7.48.6).

If a SMART feature set enabled device has been set to use the Standby timer (see 4.13.3), the device should save the device accumulated SMART data prior to going from an Idle state to the Standby state or upon return to an Active state or Idle state from a Standby state.

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

4.17.8 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 (see table 115) and IDENTIFY DEVICE DATA word 84 bit 0 (see 7.16.7.40). 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 7.48.7). 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.

The SMART error logs are: the Summary Error Log, the Comprehensive Error Log and the Extended Comprehensive Error Log.

4.18 Sense Data Reporting feature set

The Sense Data Reporting feature set allows devices to report that additional error or non-error informational status is available from the device and may be retrieved by the host. This feature set is prohibited for devices implementing the PACKET command feature set.

The REQUEST SENSE DATA EXT command (see 7.37) and the SET FEATURES subcommand Enable/Disable the Sense Data Reporting feature set (see 7.45.16) are mandatory for this feature set.

This feature is enabled by issuing a SET FEATURES subcommand Enable/Disable the Sense Data Reporting feature set (see 7.45.16), to the device. The host may disable this capability by issuing a SET FEATURES subcommand Enable/Disable the Sense Data Reporting feature set (see 7.45.16), to the device.

If the Sense Data Reporting feature set has been enabled (see 7.45.16), then the device notifies the host of additional information by setting the Sense Data Available bit in the Status field to one. The Error field shall comply with the requirements in clause 6. The host retrieves this additional information by issuing a REQUEST SENSE DATA EXT command to the device. The device may set the Sense Data Available bit to one in the Status field and clear the Error bit to zero in the Status field to indicate that the command was successfully processed and there is additional information about the command (e.g., a correctable error occurred).

If the Sense Data Reporting feature set is not enabled, the device may make this information available through the REQUEST SENSE DATA EXT command.

The device maintains only the most recent sense data. If more than one reportable event has occurred before the host issues a REQUEST SENSE DATA EXT command, then the device shall return the most recent sense data.

The sense data shall be cleared after:

a) receiving any reset;
b) acceptance of a command other than REQUEST SENSE DATA EXT command that does not read the NCQ Command Error log; or
c) completion of a REQUEST SENSE DATA EXT command.

This feature set shall be disabled upon completion of a power-on reset (see ATA8-AAM).

4.19 Software Settings Preservation (SSP) feature set

The Software Settings Preservation (SSP) feature set provides a method for an application client to cause a SATA device to retain the settings of some features that are enabled or disabled using a SET FEATURES command after the device has received a COMRESET. If a device supports the SSP feature set, then the SSP feature set shall be enabled by default.

The software settings that shall be preserved across COMRESET are listed in table 16. The device is only required to preserve the indicated software setting if it supports the particular feature/command with which the setting is associated.

Table 16 — Preserved Feature Sets and Settings

Capability	Preserved Setting
INITIALIZE DEVICE PARAMETERS	Obsolete
Security Mode	Preserve the Current Security State as defined in the security state transition diagram (see 4.16.10)
Standby Timer	Preserve the setting for the Standby timer (see 4.13.3)
Read/Write Stream Error Logs	Preserve the contents of these logs (see A.15 and A.20)
Password Attempt Counter	Preserve the value of the Password Attempt Counter (see 4.16.9)
SET MAX ADDRESS (EXT)	Current maximum LBA (see 7.50.2 and 7.51) Editor’s Note 2: f10203r0-Obsolete HPA appears to have missed the fact that this row needs to be deleted.
Write Cache enable/disable	Enabled or disabled (see 7.45.4)
Transfer Mode	Preserve the PIO, DMA and UDMA transfer mode settings (see 7.45.5)
Advanced Power Mode	Enabled or disabled (see 7.45.6)
Read look-ahead	Enabled or disabled (see 7.45.12)
Release Interrupt	Obsolete
Service Interrupt	Obsolete
Reverting to Power-On Defaults	Enabled or disabled (see 7.45.13)
Multiple Mode	Preserve the block size from the last set multiple mode (see 7.46)
SANITIZE FREEZE LOCK EXT	The Sanitize Frozen state established by the SANITIZE FREEZE LOCK EXT command (see 4.15)
Write-Read-Verify	Preserve the settings of the Write-Read-Verify feature set

4.20 Streaming feature set

4.20.1 Streaming feature set overview

The Streaming feature set 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. While processing commands in the Streaming feature set, devices may process background tasks if the specified command processing time limits for the commands are met. The Streaming feature set only defines commands that use 48-bit addressing.

Devices that implement the Streaming feature set shall implement the GPL feature set and the following commands:

a) CONFIGURE STREAM (see 7.8);
b) READ STREAM EXT (see 7.34);
c) WRITE STREAM EXT (see 7.70);
d) READ STREAM DMA EXT (see 7.33); and
e) WRITE STREAM DMA EXT (see 7.69).

SET FEATURES Set Maximum Host Interface Sector Times (see 7.45.11) is an optional feature of the Streaming feature set.

Support of the Streaming feature set is indicated in IDENTIFY DEVICE data word 84 bit 4 (see 7.16.7.40).

4.20.2 Streaming commands

4.20.2.1 Streaming command overview

The CONFIGURE STREAM command (see 7.8) 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 commands and write stream commands to access any stream.

The CONFIGURE STREAM command Default Command Completion Time Limit (Default CCTL) (see 7.8.3.4) provides a method for a host to set the time limit for a device to process read stream commands and write stream commands. If the host does not use a CONFIGURE STREAM command to set Default CCTL, the host may specify the time limit for command processing with the Command Completion Time Limit (CCTL) in each read stream command or write stream command, where the time limit is effective for that command only (see 7.33.3.2). Each stream may be configured with different command completion time limits.

The read stream commands and write stream commands may access all the user data 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 commands and 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.

The host should send read stream commands and write stream commands specifying a transfer length that is a multiple of the Stream Minimum Request Size indicated in IDENTIFY DEVICE data word 95 (see 7.16.7.49).

4.20.2.2 Flush bit

The Flush bit (Flush) in the write stream commands (see 7.69.3.3) specifies that the device flushes all volatile cache 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 (see 7.8.3.5), streaming performance may be degraded. The SET FEATURES command to enable and disable caching (see 7.45.4) may affect caching for commands in the Streaming feature set.

4.20.2.3 Not Sequential bit

The Not Sequential bit (NS) in the read stream commands (see 7.33.3.4) specifies that the next READ STREAM command with the same Stream ID may not start with the next LBA following the last LBA of the previous read stream command.

NOTE 7 — The NS bit provides information for the device to optimize pre-fetching decisions.

4.20.2.4 Read Continuous bit

The Read Continuous bit (RC) in the read stream commands (see 7.33.3.3) 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.

4.20.2.5 Write Continuous bit

The Write Continuous bit (WC) in the write stream commands (see 7.69.3.2) specifies that the device shall transfer the requested amount of data from the host within the time specified by Default CCTL or CCTL even if an error occurs. If the device is unable to resolve an error 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 an error, even though the data is erroneous.

4.20.2.6 Streaming Logs

A device implementing the Streaming feature set shall implement the Read Stream Error Log (see A.15) and the Write Stream Error Log (see A.20). These logs are accessed by a host via the READ LOG EXT command (see 7.27).

4.21 Trusted Computing feature set

The Trusted Computing feature set provides an interface between a security component embedded in a device and an application client.

The following commands are mandatory for devices implementing the Trusted Computing feature set:

a) TRUSTED NON-DATA (see 7.51);
b) TRUSTED SEND (see 7.54);
c) TRUSTED SEND DMA (see 7.55);
d) TRUSTED RECEIVE (see 7.52); and
e) TRUSTED RECEIVE DMA (see 7.53).

The TRUSTED SEND command and the TRUSTED SEND DMA command may be may be used interchangeably. The two commands only differ by the type of data transport protocol used (i.e., PIO Data-Out Command or DMA Command). Similarly, the TRUSTED RECEIVE command and the TRUSTED RECEIVE DMA command are interchangeable (i.e., PIO Data-In Command or DMA Command).

IDENTIFY DEVICE data word 48 bit 0 (see 7.16.7.16) indicates whether or not this feature set is supported.

The data streams and subsequent actions resulting from these commands are defined by the security protocol identified in the command parameters. The definition of Security Protocols, other than Security Protocol 00h, are outside the scope of this standard (see table 126 and table 136).

4.22 Write-Read-Verify feature set

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

To enable or disable the feature of Write/Read/Verify, the host may issue a SET FEATURES command (see 7.45.10).

A device may experience a performance degradation when the Write-Read-Verify feature set is enabled.

These commands are affected by this feature:

a) WRITE DMA (see 7.58);
b) WRITE DMA EXT (see 7.59);
c) WRITE DMA FUA EXT (see 7.60);
d) WRITE FPDMA QUEUED (see 7.61);
e) WRITE MULTIPLE (see 7.64);
f) WRITE MULITIPLE EXT (see 7.65);
g) WRITE MULTIPLE FUA EXT (see 7.66);
h) WRITE SECTOR(S) (see 7.67); and
i) WRITE SECTOR(S) EXT (see 7.68).

See 7.45.10 for a description of device behavior when this feature set is supported and enabled.

The IDENTIFY DEVICE data shall reflect the supported and enabled or disabled state of this feature set.

When the device’s volatile write cache is enabled, the device may report command completion with no error to the host even if the user data is in the device’s volatile write cache and not written and verified to the non-volatile media.

If:

a) the volatile write cache is disabled and any write command is processed by the device;
b) a forced unit access write command is processed by the device; or
c) a flush cache command is processed by the device,

then the device shall only report command completion after the user data has been verified.

If the Write-Read-Verify feature set is enabled and the device has not already verified the maximum number of logical sectors configured for this feature set, then after the device has written the logical sectors to the non-volatile media, the device shall read the data from the non-volatile media and verify that there are no errors.

A read from the non-volatile media shall be performed before verification. The verification of logical sectors is defined as vendor specific.

If the Write-Read-Verify feature set is disabled, or if the device has already verified the maximum number of logical sectors configured for this feature set, then no verification by this feature set shall be performed after the device has written the sectors to the non-volatile media.

If an unrecoverable error condition is encountered by the device during the write operation, read operation, or verify operation, the device shall set the Device Fault bit (see 6.2.7) to one.

5 ATA protocols

ATA Protocols are described in the transport standards (e.g., ATA8-APT and ATA8-AST). The protocols listed here shall be implemented by all transports that use ATA8-ACS commands. The following list of protocols are described in ATA8-AAM and the implementation of each protocol is described in the transport standards:

a) Non-Data Command Protocol;
b) PIO Data-In Command Protocol;
c) PIO Data-Out Command Protocol;
d) DMA Command Protocol;
e) PACKET command Protocol;
f) DMA Queued Command Protocol;
g) Execute Device Diagnostic Command Protocol; and
h) Device Reset Command Protocol.

6 Normal and Error Output field descriptions

6.1 Overview

Clause 6 describes requirements for all commands. Individual commands may describe additional requirements. The normal outputs (see 9.2) and error outputs (see 9.3) for each command shall include:

a) a one byte Status field (see 6.2);
b) a one byte Error field (see 6.3);
c) a one byte Interrupt Reason field (see 6.4), if required, for certain commands (e.g., PACKET, READ DMA QUEUED, READ DMA QUEUED EXT, WRITE DMA QUEUED, and WRITE DMA QUEUED EXT); and
d) the Count (see 6.5), SATA Status (see 6.7), and SActive (see 6.6) fields, if required, for certain commands (e.g., the READ FPDMA QUEUED command, Sanitize Device commands, and WRITE FPDMA QUEUED command).

6.2 Status field

6.2.1 Overview

The Status field is one byte, is conveyed as an output from the device to the host. Each bit, when valid, is defined in table 17. Details about individual normal outputs are defined in 9.2. Details about individual error outputs are defined in 9.3.

Table 17 — Status field

Bit	Description
7	Busy (see 6.2.3)
6	Device Ready (see 6.2.8)
5	Device Fault (see 6.2.7) or Stream Error (see 6.2.11)
4	Deferred Write Error (see 6.2.6)
3	Data Request (see 6.2.5)
2	Alignment Error (see 6.2.2)
1	Sense Data Available (see 6.2.10)
0	Check Condition (see 6.2.4) or Error (see 6.2.9)

6.2.2 Alignment Error

The Alignment Error bit shall be set to one if:

a) IDENTIFY DEVICE data word 106 bit 13 (see 7.16.7.56) is set to one;
b) IDENTIFY DEVICE data word 69 bit 13 (see 7.16.7.30) is set to one;
c) IDENTIFY DEVICE data word 49 bits (1:0) (see 7.16.7.17) are 01b or 10b; and
d) the device successfully processes a write command where:
   A) the first byte of data transfer does not begin at the first byte of a physical sector (see IDENTIFY DEVICE data word 209 bits (13:0) (see 7.16.7.76)); or
   B) the last byte of data transfer does not end at the last byte of a physical sector (see IDENTIFY DEVICE data word 209 bits (13:0)).

If an Alignment Error and another error occur during the processing of a write command, then the error is retuned and the Alignment Error is not reported in the Status field. If an Alignment Error occurs, even if it is not reported in the Status field and there is space remaining in the LPS Mis-alignment log, then an entry shall be made in the log.

6.2.3 Busy bit

The Busy bit is transport dependent (see 6.2.12). Refer to the applicable transport standard for the usage of the Busy bit.

6.2.4 Check Condition bit

The Check Condition bit shall be set to one if the Sense Key field value of the Error field is greater than zero or any Error bit is set to one (see 6.3).

6.2.5 Data Request bit

The Data Request bit is transport dependent (see 6.2.12). Refer to the appropriate transport standard for the usage of the Data Request bit.

6.2.6 Deferred Write Error bit

The Deferred Write Error bit shall be set to one if an error was detected in a deferred write to the media for a previous WRITE STREAM DMA EXT command (see 7.69) or WRITE STREAM EXT command (see 7.70). If the Deferred Write Error bit is set to one, then the location of the deferred error is only reported in the Write Stream Error Log (see A.20).

6.2.7 Device Fault bit

If the device enters a condition where continued operation may affect user data integrity (e.g., failure to spin-up without error, or no spares remaining for reallocation), then the device shall set the Device Fault bit to one and no longer accept commands. This condition is only cleared by power cycling the device. Once the Device Fault bit has been cleared to zero it may remain clear until a command that affects user data integrity is received by the device.

6.2.8 Device Ready bit

The Device Ready bit is transport dependent (see 6.2.12). Refer to the applicable transport standard for the usage of the Device Ready bit.

6.2.9 Error bit

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

6.2.10 Sense Data Available

The Sense Data Available bit shall be set to one if:

a) IDENTIFY DEVICE data word 119 bit 6 (see 7.16.7.40) is set to one;
b) IDENTIFY DEVICE data word 120 bit 6 (see 7.16.7.41) is set to one; and
c) the device has sense data to report after processing any command.

The Error bit and the Sense Data Available may both be set to one.

Bit 1 of the Status field is obsolete if:

a) IDENTIFY DEVICE data word 119 bit 6 (see 7.16.7.40) is cleared to zero; or
b) IDENTIFY DEVICE data word 120 bit 6 (see 7.16.7.41) is cleared to zero.

6.2.11 Stream Error bit

The Stream Error bit shall be set to one if an error occurred during the processing of a command in the Streaming feature set (see 4.20) and either the Read Continuous (RC) bit is set to one in a READ STREAM command (see 7.33.3.3) or the Write Continuous (WC) bit is set to one in a WRITE STREAM command (see 7.69.3.2). When the Stream Error bit is set to one, the value returned in the LBA bits (47:0) contains the address of the first logical sector in error, and the Count field contains the number of consecutive logical sectors that may contain errors. If the RC bit is set to one in a READ STREAM command or the WC bit is set to one in a WRITE STREAM command, and the Interface CRC bit, the Uncorrectable Error bit, the ID Not Found bit, the Abort bit, or the Command Completion Time Out bit is set to one in the Error field (see 6.3), then:

a) the Stream Error bit shall be set to one;
b) the Error bit shall be cleared to zero; and

c) the error information (e.g., bits set in the Error field) shall be saved in the appropriate Read Stream Error Log (see A.15) or Write Stream Error log (see A.20).

6.2.12 Transport Dependent (TD)

All bits and fields that are labelled transport dependent are defined in the transport standards.

6.3 Error field

6.3.1 Overview

The Error field is one byte, is conveyed as an output from the device to the host, and is defined in table 18.

Table 18 — Error field

Bit	Description
7:4	Sense Key (see 6.3.9)
7	Interface CRC (see 6.3.7)
6	Uncorrectable Error (see 6.3.10)
5	Obsolete
4	ID Not Found (see 6.3.5)
3	Obsolete
2	Abort (see 6.3.2)
1	End of Media (see 6.3.4)
0	Illegal Length Indicator (see 6.3.6) or Command Completion Time Out (see 6.3.3) or Media Error (see 6.3.8) or

6.3.2 Abort bit

The Abort bit shall be set to one if the device aborted the command. The Abort bit shall be cleared to zero if the device did not abort the command.

The Abort bit is set to one when the device does not set the ID Not Found bit to one when a a user addressable address was not found or the host request an address outside of the range of user addressable addresses (see 6.3.5).

6.3.3 Command Completion Time Out bit

The Command Completion Time Out bit shall be set to one if a Command Completion Time Out error has occurred (see 4.20).

6.3.4 End of Media bit

The operation of the End of Media bit is specific to the SCSI command set implemented by ATAPI devices.

6.3.5 ID Not Found bit

The ID Not Found bit shall be set to one if:

a) a user-addressable address was not found; or
b) an address outside of the range of user-addressable addresses is requested, and the Abort bit is not set to one (see 6.3.2).

6.3.6 Illegal Length Indicator bit

The operation of the Illegal Length Indicator bit is specific to the SCSI command set implemented by ATAPI devices.

6.3.7 Interface CRC bit

The Interface CRC bit shall be set to one if an interface CRC error has occurred during an Ultra DMA data transfer. The content of the Interface CRC bit may be applicable to Multiword DMA and PIO data transfers. If the Interface CRC is set to one, the Abort bit shall be set to one.

6.3.8 Media Error bit

The Media Error bit shall be set to one if a media error is detected.

6.3.9 Sense Key field

The operation of this four bit field is specific to the SCSI command set implemented by ATAPI devices.

6.3.10 Uncorrectable Error bit

The Uncorrectable Error bit shall be set to one if the data contains an uncorrectable error.

6.4 Interrupt Reason field

6.4.1 Overview

The Interrupt Reason field is one byte, is conveyed as an output from the device to the host for commands in the PACKET feature set and NCQ feature set, and is defined in table 19.

Table 19 — Interrupt Reason field

Bit	Description
7:2	Obsolete
1	Input/Output (see 6.4.3)
0	Command/Data (see 6.4.2)

6.4.2 Command/Data bit

The Command/Data bit shall be cleared to zero if the transfer is data, otherwise the Command/Data bit shall be set to one.

6.4.3 Input/Output (I/O) bit

The Input/Output bit shall be cleared to zero if the transfer is to the device. The Input/Output bit shall be set to one if the transfer is to the host.

6.5 Count field

6.5.1 overview

The Count field is one byte, is conveyed as an output from the device to the host, and is defined in table 20.

Table 20 — Count field

Bit	Description
7:3	NCQ Tag (see 6.5.2)
2:0	Reserved

6.5.2 NCQ Tag field

The NCQ Tag field shall contain the NCQ Tag value for an NCQ command. An NCQ Tag value may be any value that does not exceed the value in word 75 in the IDENTIFY DEVICE data (see 7.16.7.33).

6.6 SActive field

See SATA Rev 2.6 for a description of the SActive field.

6.7 SATA Status

See SATA Rev 2.6 for a description of word 0 of the Set Device Bits FIS.

7 Command descriptions

7.1 Command description introduction

7.1.1 Overview

ATA commands are delivered using the following fields:

a) Feature;
b) Count;
c) LBA;
d) Device; and
e) Command.

Field lengths change based on the type of command (see 7.1.3).

This standard describes the ATA command set in a transport independent fashion. Each command is defined by a series of subclauses as described in 7.1.2 through 7.1.8.

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

The heading for each command starts with the name of the command. The name is followed by "-" and then the command code, subcommand code if applicable, and protocol used to process the command.

An example heading reads:

READ SECTOR(S) - 20h, PIO Data-In

In this example heading the name of the command is READ SECTOR(S). The command code is 20h. The protocol used to transfer the data is PIO Data-In.

Protocols are defined in ATA8-AAM. The transport protocol standards define the implementation of each protocol.

7.1.3 Feature Set

The feature set subclause for each command lists the feature set (see clause 4) along with a statement that indicates if the command uses 28-bit field formatting or 48-bit field formatting. If a command uses 28-bit formatting, then:

a) the Feature field, Count field, Device field, Error field, Status field, and Command field are 8 bits in length; and
b) the LBA field is 28-bits in length.

If a command uses 48-bit formatting, then:

a) the Device field, Error field, Status field, and Command field is 8 bits in length;
b) the Feature field and Count field is 16 bits in length; and
c) the LBA field is 48-bits in length.

An example feature set subclause reads:

Feature Set

This 28-bit command is for all ATA devices.

7.1.4 Inputs

7.1.4.1 Overview

The Inputs subclause contains a table showing the inputs for the command. An example command structure is shown in table 21.

Table 21 — Example Command Structure

Name	Description
Feature	Each transport standard shows how the Feature field is mapped for proper functionality. Each transport standard also shows how 28-bit commands are mapped differently from 48-bit commands.
Count	Each transport standard shows how the Count field is mapped for proper functionality. Each transport standard also shows how 28-bit commands are mapped differently from 48-bit commands.
LBA	For many commands this is the LBA of the first logical sector to be transferred. Each transport standard defines how these bits are mapped to the appropriate fields or registers.
Device	Each transport standard shows how the Device field bits (7:4) are mapped. Bits (3:0) are marked reserved in every reference to the Device field.
Command	The command number goes here.

7.1.5 Normal Outputs

This is an example Normal Output. A command with Normal Outputs does not return an error. Therefore, the Error field in the Normal Outputs is reserved in every command. The Count field and LBA field may be reserved. In some commands these fields have return parameters on successful command completion. The Status field shows the Device Fault bit and the Error bit. Bit 7, bit 6, and bit 3 are marked Transport Dependent in many of the Normal Outputs.

Table 22 — Example Normal Output

Name	Description
Error	Reserved
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3:0 Reserved

7.1.6 Error Outputs

The Error Outputs subclause shows the Error field, Count field, LBA field, and Status field. An Error Output occurs when a bit in the Status field (e.g., the Error bit, the Device Fault bit, or the Stream Error bit) is set to one, indicating that an error occurred. If the Error bit is set to one, the Error field indicates the type of Error that occurred.

Table 23 — Example Error Output

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.7 6 Uncorrectable Error - See 6.3.10 5 Obsolete 4 ID Not Found - See 6.3.5 3 Obsolete 2 Abort - See 6.3.2 1 Obsolete 0 Obsolete
Count	Reserved
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2:1 N/A 0 Error - See 6.2.9

7.1.7 Input From the Device to the Host Data Structure

Some commands (e.g., IDENTIFY DEVICE command) 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 subclause.

7.1.8 Output From the Host to the Device Data Structure

Some commands, (e.g., SECURITY SET PASSWORD command) 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 subclause.

7.1.9 Unsupported commands

The host should not issue commands that are indicated as not supported. If the device receives an unsupported command, then the device shall respond with command aborted as described in table 194.

7.2 CFA ERASE SECTORS - C0h, Non-Data

7.2.1 Feature Set

This 28-bit command is for devices implementing the CFA feature set (see 4.6).

7.2.2 Description

The CFA ERASE SECTORS command causes the device to pre-erase and condition 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 command or a CFA WRITE MULTIPLE WITHOUT ERASE command to increase the processing speed of the write operation.

7.2.3 Inputs

See table 24 for the CFA ERASE SECTORS command inputs.

Table 24 — CFA ERASE SECTORS command inputs

Name	Description
Feature	N/A
Count	Number of logical sectors to be erased. A value of 00h specifies that 256 logical sectors are to be erased
LBA	LBA of first logical sector to be erased
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 C0h

7.2.4 Normal Outputs

See table 177.

7.2.5 Error Outputs

See table 195.

7.3 CFA REQUEST EXTENDED ERROR CODE - 03h, Non-Data

7.3.1 Feature Set

This 28-bit command is for devices implementing the CFA feature set (see 4.6).

7.3.2 Description

The CFA REQUEST EXTENDED ERROR CODE command returns the extended error code from a previously processed command that identifies the cause of an error condition in more detail than is available with Status field and Error field values. If the previous command completed with an error, then the CFA REQUEST EXTENDED ERROR CODE command shall return an extended error code (see table 26). If the previous command completed without an error, then the CFA REQUEST EXTENDED ERROR CODE command shall return the No error detected Extended error code (see table 26).

7.3.3 Inputs

See table 25 for the CFA REQUEST EXTENDED ERROR CODE command inputs.

Table 25 — CFA REQUEST EXTENDED ERROR CODE command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 03h

7.3.4 Normal Outputs

See table 178.

Table 26 — Extended error codes (Sheet 1 of 2)

Extended error code	Description
00h	No error detected / no additional information
01h	Self-test passed
02h	Reserved
03h	Write / Erase failed
04h	Reserved
05h	Self-test or diagnostic failed
06h-08h	Reserved
09h	Miscellaneous error
0Ah	Reserved
0Bh	Vendor specific
0Ch	Corrupted media format

Table 26 — Extended error codes (Sheet 2 of 2)

Extended error code	Description
0Dh-0Fh	Vendor specific
10h	ID Not Found / ID Error
11h	Uncorrectable ECC error
12h-13h	Reserved
14h	ID Not Found
15h-17h	Reserved
18h	Corrected ECC error
19h-1Ch	Reserved
1Dh-1Eh	Vendor specific
1Fh	Data transfer error / command aborted
20h	Invalid command
21h	Invalid LBA
22h-23h	Vendor specific
24h-26h	Reserved
27h	Write protect violation
28h-2Eh	Reserved
2Fh	LBA overflow (i.e., address too large)
30h-34h	Self-test or diagnostic failed
35h-36h	Supply or generated voltage out of tolerance
37h	Self-test or diagnostic failed
38h	Corrupted media format
39h	Vendor specific
3Ah	Spare sectors exhausted
3Bh-3Ch	Corrupted media format
3Dh	Vendor specific
3Eh	Self-test or diagnostic failed
3Fh	Corrupted media format
40h-FFh	Reserved

7.3.5 Error Outputs

See table 197.

7.4 CFA TRANSLATE SECTOR - 87h, PIO Data-In

7.4.1 Feature Set

This 28-bit command is mandatory for devices implementing the CFA feature set (see 4.6).

7.4.2 Description

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

7.4.3 Inputs

See table 27 for the CFA TRANSLATE SECTOR command inputs.

Table 27 — CFA TRANSLATE SECTOR command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	LBA of Logical Sector
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 87h

7.4.4 Normal Outputs

See table 181.

7.4.5 Input From the Device to the Host Data Structure

512 bytes of data are transferred to the host (see table 28).

Table 28 — CFA TRANSLATE SECTOR data

Offset	Description
0..3	Obsolete
4	LBA (23:16)
5	LBA (15:8)
6	LBA (7:0)
7..18	Reserved
19	Logical sector erased flag (FFh = erased; 00h = not erased)
20..23	Reserved
24	Logical sector write cycles count (23:16)
25	Logical sector write cycles count (15:8)
26	Logical sector write cycles count (7:0)
27..511	Reserved

7.4.6 Error Outputs

See table 197.

7.5 CFA WRITE MULTIPLE WITHOUT ERASE - CDh, PIO Data-Out

7.5.1 Feature Set

This 28-bit command is for devices implementing the CFA feature set (see 4.6).

7.5.2 Description

The CFA WRITE MULTIPLE WITHOUT ERASE command is the same as the WRITE MULTIPLE command (see 7.64) 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 (see 7.16.7.21) is cleared to zero, and a CFA WRITE MULTIPLE WITHOUT ERASE command is received by the device, and no successful SET MULTIPLE MODE command has been processed by the device, then the device shall return command aborted. A successful SET MULTIPLE MODE command should precede this command.

7.5.3 Inputs

See table 29 for the CFA WRITE MULTIPLE WITHOUT ERASE command inputs.

Table 29 — CFA WRITE MULTIPLE WITHOUT ERASE command inputs

Name	Description
Feature	N/A
Count	Number of logical sectors to be transferred. A value of 00h specifies that 256 logical sectors are to be transferred
LBA	Starting LBA
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 CDh

7.5.4 Normal Outputs

See table 181.

7.5.5 Error Outputs

An unrecoverable error encountered during processing of this command results in command completion with the device returning the LBA of the logical sector where the first unrecovered error occurred. The amount of data transferred is indeterminate. See table 196.

7.6 CFA WRITE SECTORS WITHOUT ERASE - 38h, PIO Data-Out

7.6.1 Feature Set

This 28-bit command is for devices implementing the CFA feature set (see 4.6).

7.6.2 Description

The CFA WRITE SECTORS WITHOUT ERASE command is the same as the WRITE SECTOR(S) command (see 7.67) 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 the sector is not pre-erased with the CFA ERASE SECTORS command, then a normal write sector operation occurs.

7.6.3 Inputs

See table 30 for the CFA WRITE SECTORS WITHOUT ERASE command inputs.

Table 30 — CFA WRITE SECTORS WITHOUT ERASE command inputs

Name	Description
Feature	N/A
Count	Number of logical sectors to be transferred. A value of 00h specifies that 256 logical sectors are to be transferred
LBA	Starting LBA
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 38h

7.6.4 Normal Outputs

See table 181.

7.6.5 Error Outputs

An unrecoverable error encountered during processing of this command results in command completion with the device returning the LBA of the logical sector where the first unrecovered error occurred. The amount of data transferred is indeterminate. See table 196.

7.7 CHECK POWER MODE - E5h, Non-Data

7.7.1 Feature Set

This 28-bit command is for ATA devices that implement the Power Management feature set (see 4.13). This command is mandatory for ATAPI devices when the Power Management feature set is not implemented in the command set transmitted via the PACKET command.

7.7.2 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 its power management state or affect the operation of the Standby timer.

NOTE 8 — The device may be in transition to the reported state.

7.7.3 Inputs

See table 31 for the CHECK POWER MODE command inputs.

Table 31 — CHECK POWER MODE command inputs.

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E5h

7.7.4 Normal Outputs

See table 182.

7.7.5 Error Outputs

See table 197.

7.8 CONFIGURE STREAM - 51h, Non-Data

7.8.1 Feature Set

This 48-bit command is for devices that implement the Streaming feature set (see 4.20).

7.8.2 Description

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.

7.8.3 Inputs

7.8.3.1 Overview

See table 32 for the CONFIGURE STREAM command inputs.

Table 32 — CONFIGURE STREAM command inputs

Name	Description
Feature	**Bit Description** 15:8 Default Command Completion Time Limit (Default CCTL) - See 7.8.3.4. 7 Add/Remove Stream (A/R) – See 7.8.3.2. 6 Obsolete 5:3 Reserved 2:0 Stream ID - See 7.8.3.3.
Count	Allocation Unit – See 7.8.3.5
LBA	Reserved
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 51h

7.8.3.2 Add/Remove Stream (A/R)

If A/R is set to one (i.e., the application client is adding a stream), then the device shall set the operating parameters for the stream as specified by this command. If 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.

If A/R is cleared to zero (i.e., the application client is removing a stream), then the device shall clear the operating characteristics for the Stream ID specified by this command and the Default Command Completion Time Limit field is Reserved.

7.8.3.3 Stream Identifier (Stream ID)

The Stream ID specifies the stream to which the operating parameters apply.

7.8.3.4 Default Command Completion Time Limit (Default CCTL)

The Default CCTL field indicates the time in which the device shall report command completion for a read stream command or a write stream command for this stream with the CCTL field cleared to zero (see 7.33.3.2) according to the following formula:

maximum command completion time = (Default CCTL * (IDENTIFY DEVICE data words (99:98)) microseconds

The device shall measure the time from command acceptance to command completion.

7.8.3.5 Allocation Unit

The Allocation Unit specifies the number of logical blocks that the device should use for read look-ahead and write cache operations for the stream being configured.

NOTE 9 — Setting the Allocation Unit does not restrict or change command behavior.

7.8.4 Normal Outputs

See table 183.

7.8.5 Error Outputs

The Abort bit 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; or
c) The device does not support the requested Default CCTL.

If the Abort bit is set to one, then the last parameters specified for the Stream ID shall remain in effect. See table 201 for the definition of Error Outputs.

7.9 DATA SET MANAGEMENT - 06h, DMA

7.9.1 Feature Set

This 48-bit command is optional for ATA devices and prohibited for ATAPI devices. The DATA SET MANAGEMENT command is not part of any feature set.

7.9.2 Description

The DATA SET MANAGEMENT command provides information for device optimization (e.g., file system information).

7.9.3 Inputs

7.9.3.1 Overview

See table 33 for the DATA SET MANAGEMENT command inputs.

Table 33 — DATA SET MANAGEMENT command inputs

Name	Description
Feature	**Bit Description** 15:1 Reserved. 0 Trim - See 7.9.3.2.
Count	Number of 512-byte blocks to be transferred (see 7.9.6). The value of zero is reserved.
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 06h

7.9.3.2 Trim

If the Trim bit is set to one, then a trim operation is being requested on the LBAs addressed by the DATA SET MANAGEMENT command's output data (see 7.9.6). For a logical block that has been trimmed, if a subsequent write of that logical block has not successfully completed and the data from that logical block is read, then the data is returned as described in table 34.

Table 34 shows the interactions of IDENTIFY DEVICE data word 169 bit 0 (see 7.16.7.71), IDENTIFY DEVICE data word 69 bit 14 (see 7.16.7.30), and IDENTIFY DEVICE data word 69 bit 5 (see 7.16.7.30).

Table 34 — Trim related interactions

Word 169 bit 0	Word 69 bit 14	Word 69 bit 5	Description
0	Reserved	Reserved	The Trim function of the DATA SET MANAGEMENT command (see 7.9.3.2) is not supported. The data is unaffected by the DATA SET MANAGEMENT command.
1	0	Reserved	The Trim function of the DATA SET MANAGEMENT command (see 7.9.3.2) causes non-deterministic read after trim behavior [a].
1	1	0	The Trim function of the DATA SET MANAGEMENT command (see 7.9.3.2) shall cause deterministic read after trim behavior [b] with data set to any value.
1	1	1	The Trim function of the DATA SET MANAGEMENT command (see 7.9.3.2) shall cause deterministic read after trim behavior [b] with data set to zero.

[a] Non-deterministic read after trim behavior: each read command to the logical block may return different data.

[b] Deterministic read after trim behavior: after a read command has completed processing, the data in that logical block becomes determinate (i.e., all read commands to the logical block shall return the same data).

The data read from an LBA that has been trimmed shall not be retrieved from data that was previously received from an application client addressed to any other LBA.

Once a trimmed LBA has been written (e.g., a write command or a SECURITY ERASE UNIT command), the data in that logical block becomes determinate (i.e., the logical block contains the written data).

7.9.4 Normal Outputs

See table 189.

7.9.5 Error Outputs

If the Trim bit is set to one and:

a) the device detects an invalid LBA Range Entry; or
b) count is greater than IDENTIFY DEVICE data word 105 (see 7.16.7.55),

then the device shall return command aborted.

A device may trim one or more LBA Range Entries before it returns command aborted. See table 209.

7.9.6 Output From the Host to the Device Data Structure

DATA SET MANAGEMENT Request Data is a list of one or more LBA Range Entries. If the Trim bit is set to one, then LBA Range Entries may overlap and are not required to be sorted. See table 35.

Table 35 — LBA Range Entries

Offset	Type	Description
0..7	QWord	Entry #0 63:48 Range Length 47:0 LBA Value
8..15	QWord	Entry #1 63:48 Range Length 47:0 LBA Value
…		…
496..511	QWord	Entry #63 63:48 Range Length 47:0 LBA Value

An individual LBA range is called an LBA Range Entry and is represented by eight bytes. The LBA is expressed by the LBA Range Entry's first six bytes and the Range Length is a zero based number (e.g., 0=0 and 1=1) represented by the remaining two bytes. If the two byte range length is zero, then the LBA Range Entry shall be discarded as padding.

The following are two examples:

1) If logical blocks 11, 12, 13, 14, 15, 16, 17, and 18 were in the NV Cache Pinned Set and logical blocks 10 and 19 were not, then logical blocks 11 through 18 make one LBA Range Entry that has LBA 11 as its first 48 bits and the value of 8 as its next 16 bits (i.e., 0000_0000_000B_0008h).
2) If only LBA 20 was represented in an LBA Range Entry, then the range value is one (i.e., 0000_0000_0014_0001h).

The largest range that may be specified in a LBA Range Entry is 65 535. Multiple LBA Range Entries shall be used to specify larger range values.

7.10 DEVICE RESET - 08h, Device Reset

7.10.1 Feature Set

This 28-bit command is for ATAPI devices (see 4.3).

7.10.2 Description

The DEVICE RESET command resets the device.

7.10.3 Inputs

See table 36 for the DEVICE RESET command inputs.

Table 36 — DEVICE RESET command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 08h

7.10.4 Normal Outputs

See table 184.

7.10.5 Error Outputs

ATAPI devices shall not report an error. If the device is able to complete the DEVICE RESET and maintain the device setting, then DEVICE RESET shall complete with Check Condition cleared to zero. If the device reverts to its default state, then the device shall report an exception by setting the Check Condition bit to one in the Status field.

7.11 DOWNLOAD MICROCODE - 92h, PIO Data-Out/Non-Data

7.11.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.11.2 Description

7.11.2.1 Overview

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

There are several microcode data conditions:

a) active: the microcode data that the device is currently running;
b) updated: the microcode data that the device is in the process of receiving from the host;
c) saved: updated microcode data that has been completely downloaded, validated, and saved to non-volatile storage; and
d) deferred: saved microcode data that is not automatically activated.

Downloading and activating microcode involves the following steps:

1) Download: the host transfers updated microcode data to the device in one or more DOWNLOAD MICROCODE commands or DOWNLOAD MICROCODE DMA commands;
2) Save: after receiving the complete updated microcode data, if specified by the download microcode mode, the device shall save the updated microcode data to nonvolatile storage; and
3) Activate: the device begins using the saved or deferred microcode data for the first time after an event specified by the download microcode mode and the saved or deferred microcode data becomes the active microcode data.

The Block Count is the number of 512-byte data blocks that shall be transferred. The Block Count is specified in the Count field and the LBA field (see table 38).

Activation may change device feature configuration (e.g., DCO, IDENTIFY DEVICE, SET FEATURES settings or the contents of any logs). If the Security feature set is supported, then activation shall not change the following Security feature set items:

a) User Password;
b) Master Password; and
c) Master Password Capability.

Table 37 lists the DOWNLOAD MICROCODE subcommands.

The state machine (see 7.11.2.6) for the DOWNLOAD MICROCODE subcommands describes additional requirements.

Table 37 — DOWNLOAD MICROCODE subcommands

Subcommand Code	Subcommand Name	Phases Included		
		Download	Save	Activate
01h	Obsolete			
03h	Download with offsets and save microcode for immediate and future use (see 7.11.2.2)	one or more segments	Yes	Yes [a]
07h	Download and save microcode for immediate and future use (see 7.11.2.3)	one segment only	Yes	Yes
0Eh	Download with offsets and save microcode for future use (see 7.11.2.4)	one or more segments	Yes	No [b]
0Fh	Activate downloaded microcode (see 7.11.2.5)	No	No	Yes
all others	Reserved			

[a] Activation occurs after the complete updated microcode data has been downloaded.

[b] Activation does not occur as part of the processing of the command, but is triggered by events that occur after command completion (e.g., power cycle or Activate downloaded microcode subcommand).

7.11.2.2 Download with offsets and save microcode for immediate and future use subcommand (i.e., 03h)

The Download with offsets and save microcode for immediate and future use subcommand transfers the updated microcode data in one or more DOWNLOAD MICROCODE commands or DOWNLOAD MICROCODE DMA commands. This subcommand downloads data containing a segment of the updated microcode data. On normal command completion, the Count field may contain additional indicators (see 7.11.4).

When the final segment has been downloaded, the device validates the downloaded updated microcode. If the validation is successful, the downloaded updated microcode is saved to non-volatile storage and is activated.

After transferring a segment where the value of the Buffer Offset field is set to zero, if the device begins to process a command that is not a DOWNLOAD MICROCODE command and is not a DOWNLOAD MICROCODE DMA command, then the device:

1) may discard any updated microcode data that has not been saved; and
2) shall continue to process the new command.

7.11.2.3 Download and save microcode for immediate and future use subcommand (i.e., 07h)

The Download and save microcode for immediate and future use subcommand transfers the updated microcode data in one DOWNLOAD MICROCODE command or in one DOWNLOAD MICROCODE DMA command.

After the updated microcode data has been downloaded, the device shall:

1) save the updated microcode data;
2) activate the updated microcode data; and
3) if command completion has not previously been returned, then the device shall return command completion.

7.11.2.4 Download with offsets and save microcode for future use subcommand (i.e., 0Eh)

The Download and save microcode for future use subcommand transfers the updated microcode data in one or more DOWNLOAD MICROCODE commands or DOWNLOAD MICROCODE DMA commands. On normal command completion, the Count field may contain additional indicators (see 7.11.4).

When the final segment has been downloaded, the device validates the downloaded updated microcode. If the validation is successful, the downloaded updated microcode is saved to non-volatile storage and becomes the deferred microcode. The deferred microcode data is activated as a result of processing the next power on reset or processing an Activate downloaded microcode subcommand (see 7.11.2.5).

After transferring a segment where the value of the Buffer Offset field is set to zero, if the device begins to process a command that is not a DOWNLOAD MICROCODE command and is not a DOWNLOAD MICROCODE DMA command, then the device:

1) shall retain any updated microcode data that has not been saved; and
2) shall continue to process the new command.

7.11.2.5 Activate downloaded microcode subcommand (i.e., 0Fh)

The Activate downloaded microcode subcommand shall activate deferred microcode data that had been previously downloaded and saved by the Download with offsets and save microcode for future use subcommand (see 7.11.2.4).

If there is no deferred microcode data that has been saved using the Download with offsets and save microcode for future use subcommand then the device shall return command aborted.

If the activation attempt fails, then the device shall return command aborted.

7.11.2.6 DOWNLOAD MICROCODE state machine

Figure 11 and this subclause describe the DOWNLOAD MICROCODE state machine for all subcommands of the DOWNLOAD MICROCODE command and the DOWNLOAD MICROCODE DMA command.

Editor’s Note 3: Figure 1 is in this subclause… Is this redundant.

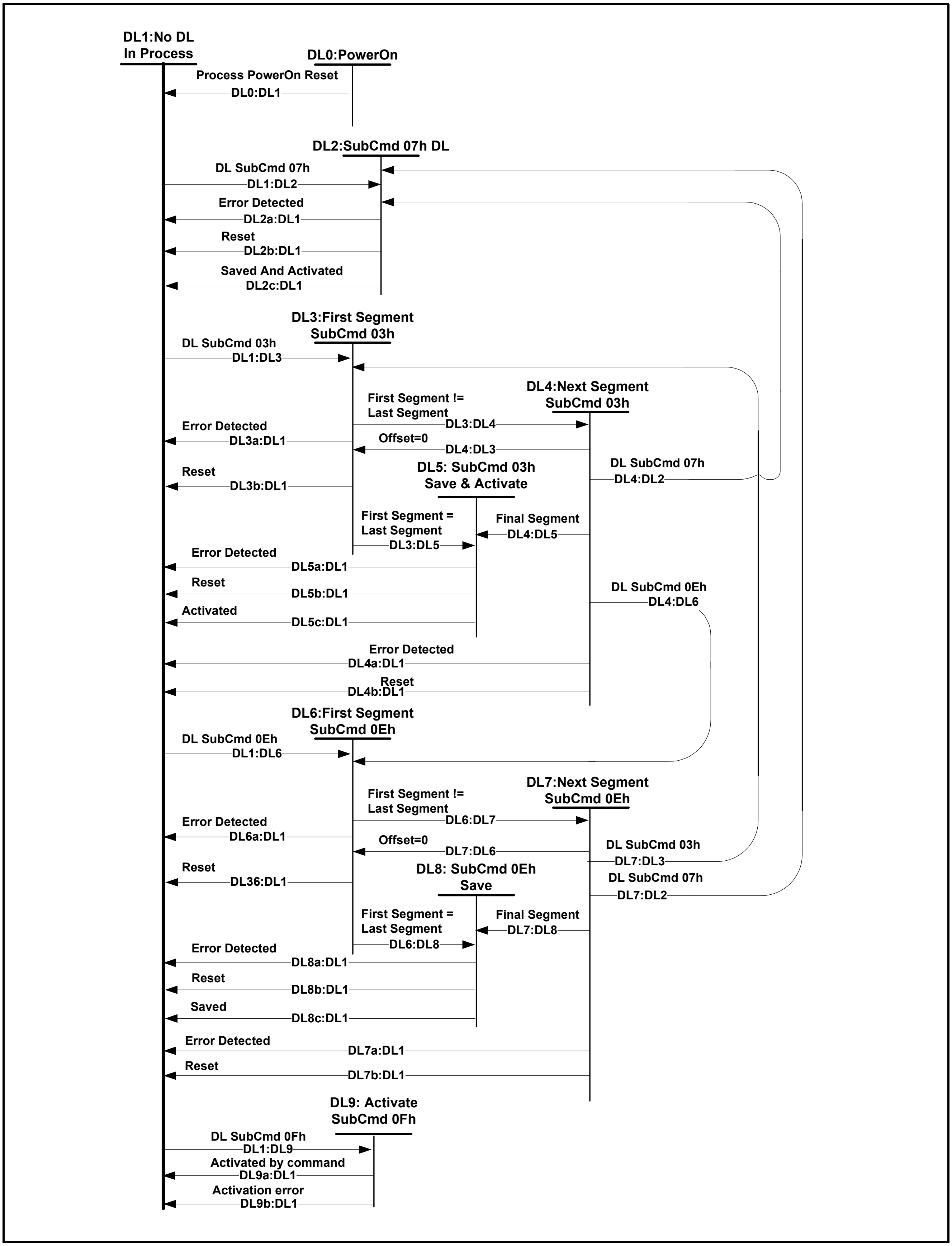

Figure 11 — DOWNLOAD MICROCODE State Machine

State DL0: In state DL0, the device processes a power-on reset. If there is any deferred microcode data, then the device shall activate the deferred microcode data.

The device shall discard all updated microcode data that has not been saved.

Transition DL0:DL1: After deferred microcode data, if any, has been activated, then the device shall transition to state DL1.

State DL1: In state DL1, there is no download command sequence in process. In state DL1, any ATA command for which command acceptance occurs shall be processed.

If a download command is processed and the value of the Block Count field is set to zero, then the Non-Data transfer protocol shall be used. This condition shall not be considered as an error.

If a download command is processed and:

a) the subcommand is not supported;
b) the Download with offsets and save microcode for immediate and future use subcommand is processed and the value of the Buffer Offset field is non-zero; or
c) the Download with offsets and save microcode for future use subcommand is processed and the value of the Buffer Offset field is non-zero.then the device shall return command aborted.

Transition DL1:DL2: If the device processes a Download and save microcode for immediate and future use subcommand, then the device shall transition to the DL2 state.

Transition DL1:DL3: If the device processes a Download with offsets and save microcode for immediate and future use subcommand and the value of the Buffer Offset field is set to zero, then the device shall transition to the DL3 state.

Transition DL1:DL6: If the device processes a Download with offsets and save microcode for future use subcommand and the value of the Buffer Offset field is set to zero, then the device shall transition to the DL6 state.

Transition DL1:DL9: If the device processes an Activate downloaded microcode subcommand, then the device shall transition to the DL9 state.

State DL2: In state DL2, the device processes a Download and save microcode for immediate and future use subcommand. The device shall download updated microcode data from the host. After the data transfer is complete and there is no error, the device shall save the updated microcode data in a non-volatile location.

Transition DL2a:DL1: If the device detects an error, then the device shall:

1) discard all updated microcode data that has not been saved;
2) return command aborted; and
3) transition to the DL1 state.

Transition DL2b:DL1: If the device processes a hardware reset or a software reset prior to activating the updated microcode data, then the device shall:

1) discard the updated microcode data; and
2) transition to the DL1 state.

Transition DL2c:DL1: If the device does not detect an error, then the device:

1) should activate the updated microcode data before the device returns command completion;
2) shall activate the updated microcode data if the device returned command completion first;
3) shall return command completion if the device has not previously returned command completion; and
4) shall transition to the DL1 state.

State DL3: In state DL3, the device processes a Download with offsets and save microcode for immediate and future use subcommand and the value of the Buffer Offset field is set to zero. The device shall transfer the first segment of updated microcode data from the host.

If a Download with offsets and save microcode for immediate and future use subcommand is processed and the value of the Block Count field is set to zero, then the Non-Data transfer protocol shall be used. This condition shall not be considered as an error.

Transition DL3a:DL1: If the device detects an error, then the device shall:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data;
3) return command aborted; and
4) transition to the DL1 state.

Transition DL3b:DL1: If the device processes a hardware reset or a software reset, then the device shall:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data; and
3) transition to the DL1 state.

Transition DL3:DL4: If the data transfer is complete and not all of the updated microcode data has been received by the device (e.g., the first segment is not the last segment), then the device:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data;
3) shall return command completion with no error;
4) may set the Count field to 01h (see 7.11.4); and
5) shall transition to the DL4 state.

Editor's Note 4: Items 1 and 2 in the list above lack verbs. This appears to be due to a cut and paste error from the DL3b:DL1 transition. However, adding any normative verb is not an editorial change (i.e., George would ring my neck for doing it).

Transition DL3:DL5: If the data transfer is complete and all of the updated microcode data has been received by the device, then the device shall:

1) not return command completion; and
2) transition to the DL5 state.

State DL4: In state DL4, the device waits for and processes additional Download with offsets and save microcode for immediate and future use subcommands. In state DL4, any ATA command for which command acceptance occurs between segments may be processed.

If a Download with offsets and save microcode for immediate and future use subcommand is processed and the value of the Block Count field is set to zero, then the Non-Data transfer protocol shall be used. This condition shall not be considered as an error.

If the device processes a Download with offsets and save microcode for immediate and future use subcommand and the value of the Block Count field is set to zero, then the device shall:

1) ignore the Buffer Offset field; and
2) return command completion with no error

If the device processes a Download with offsets and save microcode for immediate and future use subcommand in which:

a) the segment is not the last segment;
b) the value of the Block Count field is non-zero; and
c) the value of the Buffer Offset field is non-zero and is equal to the sum of:
    A) the value of the Buffer Offset field of the previous Download with offsets and save microcode for immediate and future use subcommand; and
    B) the value of the Block Count field of the previous Download with offsets and save microcode for immediate and future use subcommand,

then the device:

1) shall retain all deferred microcode data;
2) may set the Count field to 01h (see 7.11.4); and
3) shall return command completion with no error.

If the device processes a command that is not a download command and the device retains updated microcode data that has not been saved, then the device shall process the new command.

Transition DL4a:DL1: If the device processes a Download with offsets and save microcode for immediate and future use subcommand in which:

a) the value of the Block Count field is non-zero; and
b) the value of the Buffer Offset field is not equal to the sum of:
    A) the value of the Buffer Offset field of the previous Download with offsets and save microcode for immediate and future use subcommand; and
    B) the value of the Block Count field of the previous Download with offsets and save microcode for immediate and future use subcommand,

then the device shall:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data; and
3) transition to the DL1 state.

Transition DL4b:DL1: If the device processes a hardware reset or a software reset, then the device shall:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data; and
3) transition to the DL1 state.

Transition DL4c:DL1: If the device processes a command that is not a download command and the device discards unsaved updated microcode data, then the device shall:

1) retain all deferred microcode data;
2) transition to the DL1 state; and
3) process the new command.

Transition DL4:DL2: If the device processes a Download and save microcode for immediate and future use subcommand, then the device shall:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data; and
3) transition to the DL2 state.

Transition DL4:DL3: If the device processes a Download with offsets and save microcode for immediate and future use subcommand and the value of the Buffer Offset field is set to zero, then the device shall:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data; and
3) transition to the DL3 state.

Transition DL4:DL5: If the device determines that all segments of the updated microcode data have been downloaded, then the device shall transition to the DL5 state.

Transition DL4:DL6: If the device processes a Download with offsets and save microcode for future use subcommand and the value of the Buffer Offset field is set to zero, then the device shall:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data; and
3) transition to the DL6 state.

State DL5: In state DL5, the device has received all of the updated microcode data. The device shall perform any verification required by the device. After the data transfer is complete and there is no error, the device shall save the updated microcode data in a non-volatile location.

Transition DL5a:DL1: If the device detects an error, then the device:

1) shall discard all updated microcode data that has not been saved;
2) retain all deferred microcode data;
3) shall return command aborted; and
4) shall transition to the DL1 state.

Editor’s Note 5: Item 2 in the list above lacks a verb. This appears to be due to a cut and paste error. However, adding any normative verb is not an editorial change.

Transition DL5b:DL1: If the device processes a hardware reset or a software reset prior to saving the updated microcode data, then the device shall:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data; and
3) transition to the DL1 state.

Transition DL5c:DL1: If the device does not detect an error, then the device:

1) may change the feature configuration (e.g., SET FEATURES settings);
2) should activate the updated microcode data;
3) may set the Count field to 02h (see 7.11.4);
4) shall return command completion with no error; and
5) shall transition to state DL1.

State DL6: In state DL6, the device processes a Download with offsets and save microcode for future use subcommand if the value of the Buffer Offset field is equal to zero. The device shall transfer the first segment of updated microcode data from the host.

If a Download with offsets and save microcode for future use subcommand is processed and the value of the Block Count field is set to zero, then the Non-Data transfer protocol shall be used. This condition shall not be considered as an error.

Transition DL6a:DL1: If the device detects an error, then the device shall:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data;
3) return command aborted; and
4) transition to the DL1 state.

Transition DL6b:DL1: If the device processes a hardware reset or a software reset, then the device shall:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data; and
3) transition to the DL1 state.

Transition DL6:DL7: If the data transfer is complete and not all of the updated microcode data have been received by the device (e.g., the first segment is not the last segment), then the device:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data;
3) shall return command completion with no error;
4) shall set the Count field to 01h (see 7.11.4); and
5) shall transition to the DL7 state.

Transition DL6:DL8: If the data transfer is complete and all of the updated microcode data has been received by the device, then the device shall:

1) not return command completion; and
2) transition to the DL8 state.

State DL7: In state DL7, the device waits for additional Download with offsets and save microcode for future use subcommands. The device shall transfer all remaining segments of updated microcode data from the host. In state DL7, any ATA command for which command acceptance occurs between segments shall be processed.

If a Download with offsets and save microcode for future use subcommand is processed and the value of the Block Count field is set to zero, then the Non-Data transfer protocol shall be used. This condition shall not be considered as an error.

If the device processes a Download with offsets and save microcode for future use subcommand in which:

a) the segment is not the last segment;
b) the value of the Block Count field is non-zero; and
c) the value of the Buffer Offset field is non-zero and is equal to the sum of:
    A) the value of the Buffer Offset field of the previous download command; and
    B) the value of the Block Count field of the previous download command,

then the device:

1) shall set the Count field to 01h (see 7.11.4); and
2) shall return command completion with no error.

If the device processes a command that is not a download command, then the device shall:

1) retain all updated microcode data that has not been saved; and
2) process the new command.

Transition DL7a:DL1: If the device processes a Download with offsets and save microcode for immediate and future use subcommand in which:

a) the value of the Block Count field is non-zero;
b) the value of the Buffer Offset field is not equal to the sum of:
    A) the value of the Buffer Offset field of the previous download command; and
    B) the value of the Block Count field of the previous download command,

then the device shall discard all updated microcode data that has not been saved.

Transition DL7b:DL1: If the device processes a hardware reset or a software reset, then the device shall:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data; and
3) transition to the DL1 state.

Transition DL7:DL2: If the device processes a Download and save microcode for immediate and future use subcommand, then the device shall:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data; and
3) transition to the DL2 state.

Transition DL7:DL3: If the device processes a Download with offsets and save microcode for immediate and future use subcommand and the value of the Buffer Offset field is set to zero, then the device shall:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data; and
3) transition to the DL3 state.

Transition DL7:DL6: If the device processes a Download with offsets and save microcode for future use subcommand and the value of the Buffer Offset field is set to zero, then the device shall:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data; and
3) transition to the DL6 state.

Transition DL7:DL8: If the device determines that all segments of the updated microcode data have been downloaded, then the device shall transition to the DL8 state.

State DL8: In state DL8, the device shall:

1) perform any verification required by the device; and
2) save the updated microcode data in a non-volatile location, replacing any deferred microcode data.

Transition DL8a:DL1: If the device detects an error, then the device shall:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data;

3) return command aborted; and
4) transition to the DL1 state.

Transition DL8b:DL1: If the device processes a hardware reset or a software reset prior to saving the updated microcode data, then the device shall:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data; and
3) transition to the DL1 state.

Transition DL8c:DL1: If the device does not detect an error, then the device:

1) shall set the Count field to 03h (see 7.11.4);
2) shall return command completion with no error; and
3) shall transition to state DL1.

State DL9: In state DL9, the deferred microcode data is activated.

Transition DL9a:DL1: If the device has deferred microcode data, then the device shall:

1) activate the deferred microcode data;
2) discard the deferred microcode data;
3) set the Count field to 03h (see 7.11.4);
4) return command completion with no error; and
5) transition to state DL1.

Transition DL9b:DL1: If the device:

a) has updated microcode data that has not been saved;
b) does not have deferred microcode data; or
c) is unable to activate the deferred microcode data,

then the device shall:

1) discard all updated microcode data that has not been saved;
2) discard all deferred microcode data;
3) return command aborted; and
4) transition to state DL1.

7.11.3 Inputs

7.11.3.1 Overview

See table 38 for the DOWNLOAD MICROCODE command inputs.

Table 38 — DOWNLOAD MICROCODE command inputs

Name	Description
Feature	Subcommand (see 7.11.3.2)
Count	Block count (7:0) (see 7.11.3.3)
LBA	**Bit** **Description** 27:24 Reserved 23:8 Buffer offset (see 7.11.3.4) 7:0 Block count (15:8) (see 7.11.3.3)
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 92h

7.11.3.2 Subcommand

See table 37.

7.11.3.3 Block Count

The Block Count field contains the number of 512-byte data blocks that shall be transferred. The Block Count is specified in the Count field and the LBA field. The Block Count field is only valid if the subcommand field is 03h or 0Eh, and is reserved for all other subcommands.

7.11.3.4 Buffer Offset

The Buffer Offset field is only valid if the subcommand field is 03h or 0Eh, and is reserved for all other subcommands.

7.11.4 Normal Outputs

If the subcommand is Download with offsets and save microcode for future use, then table 3 describes the indicator returned in the Count field.

If the subcommand is Download with offsets and save microcode for immediate and future use, then if:

a) IDENTIFY DEVICE data word 234 (see 7.16.7.89) has a value other than 0000h or FFFFh; or
b) b) IDENTIFY DEVICE data word 235 (see 7.16.7.90) has a value other than 0000h or FFFFh,

then table 39 describes the indicator returned in the Count field.

Table 39 — Count field output for DOWNLOAD MICROCODE requesting the offset transfer method

Value	Valid for Subcommands	Description
00h	03h	No indication of download microcode status.
01h	03h and 0Eh	Indicates the ATA device is expecting more download microcode commands to follow.
02h	03h and 0Fh	Indicates that the ATA device has applied the new microcode.
03h	0Eh	All segments of the updated microcode data have been received and saved, and the device is waiting for activation of the updated microcode data.
04h-FFh		Reserved

For additional returns see table 180.

7.11.5 Error Outputs

The device shall return command aborted if the device did not accept part or all of the microcode data. The device shall return command aborted if the subcommand code is not a supported value. See table 199.

7.12 DOWNLOAD MICROCODE DMA - 93h, DMA

7.12.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.12.2 Description

See 7.11.2.

7.12.3 Inputs

See table 40 for the DOWNLOAD MICROCODE DMA command inputs.

Table 40 — DOWNLOAD MICROCODE DMA command inputs

Name	Description
Feature	See the Feature field in 7.11.3.
Count	See the Count field in 7.11.3.
LBA	See the LBA field in 7.11.3.
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 93h

7.12.4 Normal Outputs

See 7.11.4.

7.12.5 Error Outputs

See 7.11.5.

7.13 EXECUTE DEVICE DIAGNOSTIC - 90h, Execute Device Diagnostic

7.13.1 Feature Set

This 28-bit command is for all devices (see 4.2 and 4.3).

7.13.2 Description

The EXECUTE DEVICE DIAGNOSTIC command shall cause the device to perform internal diagnostic tests.

> NOTE 10 — There are transport and Host Adapter implications for this command (i.e., see ATA8-APT and HBA2).

If the host issues an EXECUTE DEVICE DIAGNOSTIC command while a device is in, or transitioning to, a power management state other than the PM3:Sleep state (see figure 8), then the device shall process the diagnostic sequence.

7.13.3 Inputs

See table 41 for the EXECUTE DEVICE DIAGNOSTIC command inputs.

Table 41 — EXECUTE DEVICE DIAGNOSTIC command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 90h

7.13.4 Normal Outputs

The diagnostic code written into the Error field is an 8-bit code defined in table 42. See table 184.

Table 42 — Diagnostic codes

Code [a]	Description
When this code is in the Device 0 [c] Error field	
01h	Device 0 [c] passed, Device 1 [c] passed or not present
00h, 02h-7Fh	Device 0 [c] failed, Device 1 [c] passed or not present
81h	Device 0 [c] passed, Device 1 [c] failed
80h, 82h-FFh	Device 0 [c] failed, Device 1 [c] failed
When this code is in the Device 1 [c] Error field	
01h	Device 1 [c] passed [b]
00h, 02h-7Fh	Device 1 [c] failed [b]
80h-FFh	Reserved

[a] Codes other than 01h and 81h may indicate additional information about the failure(s).

[b] If Device 1 is not present, the host may see the information from Device 0 even though Device 1 is selected.

[c] See the appropriate transport standard for the definition of device 0 and device 1.

7.13.5 Error Outputs

This command shall complete without setting the Error bit to one (see 7.13.4).

7.14 FLUSH CACHE - E7h, Non-Data

7.14.1 Feature Set

This 28-bit command is for ATA devices (see 4.2) and ATAPI devices (see 4.3).

7.14.2 Description

The FLUSH CACHE command requests the device to flush the volatile write cache. If there is data in the volatile write cache, that data shall be written to the non-volatile media. This command shall not indicate completion until the data is flushed to the non-volatile media or an error occurs. If the device supports more than 28 bits of addressing this command shall attempt to flush all the data in the volatile cache. If the volatile write cache is disabled or no volatile write cache is present, the device shall indicate command completion without error.

NOTE 11 — This command may take longer than 30 seconds to complete.

7.14.3 Inputs

See table 43 for the FLUSH CACHE command inputs.

Table 43 — FLUSH CACHE command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E7h

7.14.4 Normal Outputs

See table 179.

7.14.5 Error Outputs

If an unrecoverable error occurs while the device is writing data to its media, then the device shall terminate processing the command and report the error, including the LBA of the first sector where an unrecoverable error occurred. Subsequent FLUSH CACHE commands continue the process of flushing the cache. See table 202.

If an error occurs during the flush process and the LBA of the data in error is outside the 28-bit address range, then the LBA of the logical sector in error is incorrectly reported. For correct error reporting in a device that has more than a 28-bit address range, use the FLUSH CACHE EXT command (see 7.15).

7.15 FLUSH CACHE EXT - EAh, Non-Data

7.15.1 Feature Set

This 48-bit command is mandatory for devices implementing the 48-bit Address feature set (see 4.4).

7.15.2 Description

The FLUSH CACHE EXT command requests the device to flush the volatile write cache. If there is data in the volatile write cache, that data shall be written to the non-volatile media. This command shall not indicate completion until the data is flushed to the non-volatile media or an error occurs. If the volatile write cache is disabled or no volatile write cache is present, the device shall indicate command completion without error.

NOTE 12 — This command may take longer than 30 seconds to complete.

7.15.3 Inputs

See table 43 for the FLUSH CACHE EXT command inputs.

Table 44 — FLUSH CACHE EXT command inputs

Name	Description
Feature	Reserved
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 EAh

7.15.4 Normal Outputs

See table 189.

7.15.5 Error Outputs

If an unrecoverable error occurs while the device is writing data to its media, then the device shall terminate processing the command and report the error, including the LBA of the first sector where an unrecoverable error occurred. If a device receives a subsequent FLUSH CACHE EXT command, then the device shall continue the process of flushing its cache. See table 203.

7.16 IDENTIFY DEVICE - ECh, PIO Data-In

7.16.1 Feature Set

This 28-bit command is mandatory for all devices (see 4.2 and 4.3).

7.16.2 Description

The IDENTIFY DEVICE command specifies that the device shall send a 512-byte block of data to the host. See 7.16.7 for a description of the return data.

Devices may read the non-volatile media in order to complete this command.

The IDENTIFY DEVICE data contains information regarding optional feature or command support. If the host issues a command that is indicated as not supported in the IDENTIFY DEVICE data, the device shall return command aborted for the command.

7.16.3 Inputs

See table 45 for the IDENTIFY DEVICE command inputs.

Table 45 — IDENTIFY DEVICE command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 ECh

7.16.4 Normal Outputs for ATA devices

See table 179.

7.16.5 Normal Outputs for ATAPI devices

In response to this command, ATAPI devices shall return command aborted and place the PACKET feature set signature in the appropriate fields (see table 184).

7.16.6 Error Outputs

ATA devices shall not report an error, except after a NCQ Feature Set command error and before the NCQ Command Error Log is read (see table 199).

7.16.7 Input From the Device to the Host Data Structure

7.16.7.1 Overview

Table 46 specifies the format of the IDENTIFY DEVICE data.

Table 46 — IDENTIFY DEVICE data (Sheet 1 of 19)

Word	O M	S P	F V	Description
0	M	B		General configuration (see 7.16.7.2)
			F	15 0 = ATA device
			X	14:8 Retired
			X	7:6 Obsolete
			X	5:3 Retired
			V	2 Response incomplete
			X	1 Retired
				0 Reserved
1			X	Obsolete
2	O	B	V	Specific configuration (see 7.16.7.4)
3			X	Obsolete
4..5			X	Retired
6			X	Obsolete
7..8		N		Reserved for the CompactFlash Association
9			X	Retired
10..19	M	B	F	Serial number (ATA string) (see 7.16.7.10)
20..21			X	Retired
22			X	Obsolete
23..26	M	B	F	Firmware revision (ATA string) (see 7.16.7.13)
27..46	M	B	F	Model number (ATA string) (see 7.16.7.14)
47	M			See 7.16.7.15
		B	F	15:8 80h
		B	F	7:0 00h = Reserved
				01h-FFh = Maximum number of logical sectors that shall be transferred per DRQ data block on READ/WRITE MULTIPLE commands

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 46 — IDENTIFY DEVICE data (Sheet 2 of 19)

Word	O M	S P	F V	Description
48	O	B		Trusted Computing feature set options (see 7.16.7.16)
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
				13:1 Reserved for the Trusted Computing Group
			F	0 1=Trusted Computing feature set is supported
49	M			Capabilities (see 7.16.7.17)
				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
				12 Reserved for the IDENTIFY PACKET DEVICE command.
		P	F	11 1 = IORDY (see ATA8-APT) supported 0 = IORDY (see ATA8-APT) may be supported
		P	F	10 1 = IORDY (see ATA8-APT) may be disabled
		B	F	9 Shall be set to one to indicate that LBA is supported.
		P	F	8 1 = DMA supported
			X	7:2 Reserved
				1:0 Current Long Physical Sector Alignment setting
50	M			Capabilities (see 7.16.7.17)
		B	F	15 Shall be cleared to zero
		B	F	14 Shall be set to one
				13:2 Reserved
			X	1 Obsolete
		B	F	0 Shall be set to one to indicate a vendor specific Standby timer value minimum
51..52			X	Obsolete

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 46 — IDENTIFY DEVICE data (Sheet 3 of 19)

Word	O M	S P	F V	Description
53				See 7.16.7.19
	M	B	F	15:8 Free-fall Control Sensitivity
				00h = Vendor's recommended setting
				01h-FFh = Sensitivity level. A larger number is a more sensitive setting.
				7:3 Reserved
		B	F	2 1 = the fields reported in word 88 are valid
				0 = the fields reported in word 88 are not valid
		B	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..58			X	Obsolete
59				See 7.16.7.21
	M			15 1 = The BLOCK ERASE EXT command is supported (see 7.38.2)
				14 1= The OVERWRITE EXT command is supported (see 7.38.4)
				13 1 = The CRYPTO SCRAMBLE EXT command is supported (see 7.38.3)
				12 1 = The Sanitize feature set is supported (see 4.15)
				11:9 Reserved
		B	V	8 1 = Multiple logical sector setting is valid
		B	V	7:0 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 for 28-bit commands (DWord) (see 7.16.7.22)
62			X	Obsolete

Key:

F/V – Fixed/variable content

F – The content of the field is fixed and does not change.

V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.

X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.

M – Support of the word is mandatory.

O – Support of the word is optional.

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 46 — IDENTIFY DEVICE data (Sheet 4 of 19)

Word	O M	S P	F V	Description
63				See 7.16.7.24
	M			15:11 Reserved
		P	V	10 1 = Multiword DMA mode 2 is selected
				0 = Multiword DMA mode 2 is not selected
		P	V	9 1 = Multiword DMA mode 1 is selected
				0 = Multiword DMA mode 1 is not selected
		P	V	8 1 = Multiword DMA mode 0 is selected
				0 = Multiword DMA mode 0 is not selected
				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				See 7.16.7.25
	M			15:2 Reserved
				Editor's Note 6: Changed this to make text match
		P	F	1:0 PIO modes supported
65	M			Minimum Multiword DMA transfer cycle time per word (see 7.16.7.26)
		P	F	15:0 Cycle time in nanoseconds
66	M			Manufacturer's recommended Multiword DMA transfer cycle time (see 7.16.7.27)
		P	F	15:0 Cycle time in nanoseconds
67	M			Minimum PIO transfer cycle time without flow control (see 7.16.7.28)
		P	F	15:0 Cycle time in nanoseconds
68	M			Minimum PIO transfer cycle time with IORDY (see ATA8-APT) flow control (see 7.16.7.29)
		P	F	15:0 Cycle time in nanoseconds

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 46 — IDENTIFY DEVICE data (Sheet 5 of 19)

Word	O M	S P	F V	Description
69				Additional Supported (see 7.16.7.30)
	O	S	F	15 1 = CFast Specification Support
	O	B	F	14 1 = Deterministic data in trimmed LBA range(s) is supported
	O	B	F	13 1 = Long Physical Sector Alignment Error Reporting Control is supported
	O	B	F	12 Obsolete
	O	B	F	11 1 = READ BUFFER DMA is supported
	O	B	F	10 1 = WRITE BUFFER DMA is supported
	O	B	F	9 1 = SET MAX SET PASSWORD DMA and SET MAX UNLOCK DMA are supported
	O	B	F	8 1 = DOWNLOAD MICROCODE DMA is supported
				7 Reserved for IEEE 1667
	M	B	F	6 0 = Optional ATA device 28-bit commands supported
				5 1 = Trimmed LBA range(s) returning zeroed data is supported
				4 1 = Device Encrypts All User Data
				3 1 = Extended Number of User Addressable Sectors is supported
				2 1 = All write cache is non-volatile
				1:0 Reserved
70				Reserved
71..74				Reserved for the IDENTIFY PACKET DEVICE command
75	O			Queue depth (see 7.16.7.33)
				15:5 Reserved
		B	F	4:0 Maximum queue depth - 1

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 46 — IDENTIFY DEVICE data (Sheet 6 of 19)

Word	O M	S P	F V	Description
76	O	S		Serial ATA Capabilities (see 7.16.7.34)
				15:13 Reserved for Serial ATA
				12 1 = Supports NCQ priority information
				11 1 = Supports Unload while NCQ commands are outstanding
			F	10 1 = Supports the SATA Phy Event Counters log
			F	9 1 = Supports receipt of host initiated power management requests
			F	8 1 = Supports the NCQ feature set
				7:3 Reserved for Serial ATA
			F	2 1 = Supports SATA Gen2 Signaling Speed (3.0Gb/s)
			F	1 1 = Supports SATA Gen1 Signaling Speed (1.5Gb/s)
			F	0 Shall be cleared to zero
77		S		Reserved for Serial ATA
78	O	S		Serial ATA features supported (see 7.16.7.36)
				15:7 Reserved for Serial ATA
			F	6 1 = Device supports Software Settings Preservation
				5 Reserved for Serial ATA
			F	4 1 = Device supports in-order data delivery
			F	3 1 = Device supports initiating power management
			F	2 1 = Device supports DMA Setup auto-activation
			F	1 1 = Device supports non-zero buffer offsets
			F	0 Shall be cleared to zero
79	O	S		Serial ATA features enabled (see 7.16.7.37)
				15:7 Reserved for Serial ATA
			V	6 1 = Software Settings Preservation enabled
				5 Reserved for Serial ATA
			V	4 1 = In-order data delivery enabled
			V	3 1 = Device initiated power management enabled
			V	2 1 = DMA Setup auto-activation enabled
			V	1 1 = Non-zero buffer offsets enabled
			F	0 Shall be cleared to zero

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 46 — IDENTIFY DEVICE data (Sheet 7 of 19)

Word	O M	S P	F V	Description
80	M			Major version number (see 7.16.7.38)
				15:10 Reserved
				9 1 = supports ACS-2
		B	F	8 1 = supports ATA8-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 Obsolete
			X	3 Obsolete
			X	2 Obsolete
			X	1 Obsolete
				0 Reserved
81	M	B	F	Minor version number (see 7.16.7.39)
82	M			Commands and feature sets supported (see 7.16.7.40)
			X	15 Obsolete
		B	F	14 1 = The NOP command is supported
		B	F	13 1 = The READ BUFFER command is supported
		B	F	12 1 = The WRITE BUFFER command is supported
			X	11 Obsolete
		B	F	10 Obsolete
		B	F	9 Shall be cleared to zero to indicate that the DEVICE RESET command is not supported
		B	F	8:7 Obsolete
		B	F	6 1 = Read look-ahead is supported
		B	F	5 1 = The volatile write cache is supported
		B	F	4 Shall be cleared to zero to indicate that the PACKET feature set is not supported
		B	F	3 Shall be set to one to indicate that the mandatory Power Management feature set is supported
			X	2 Obsolete
		B	F	1 1 = The Security feature set is supported
		B	F	0 1 = The SMART feature set is supported

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 46 — IDENTIFY DEVICE data (Sheet 8 of 19)

Word	O M	S P	F V	Description	
83	M			Commands and feature sets supported (see 7.16.7.40)	
			F	15	Shall be cleared to zero
			F	14	Shall be set to one
		B	F	13	1 = The FLUSH CACHE EXT command is supported
		B	F	12	Shall be set to one to indicate that the mandatory FLUSH CACHE command is supported
		B	F	11	Obsolete
		B	F	10	1 = The 48-bit Address feature set is supported
		B	F	9:8	Obsolete
				7	Reserved for the Address Offset Reserved Area Boot Method
		B	F	6	1 = SET FEATURES subcommand is required to spin-up after power-up
		B	F	5	1 = The PUIS feature set is supported
			X	4	Obsolete
		B	F	3	1 = The APM feature set is supported
		N	F	2	1 = The CFA feature set is supported
			X	1	Obsolete
		B	F	0	1 = The DOWNLOAD MICROCODE command is supported

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 46 — IDENTIFY DEVICE data (Sheet 9 of 19)

Word	O M	S P	F V	Description
84	M			Commands and feature sets supported (see 7.16.7.40)
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
		B	F	13 1 = The IDLE IMMEDIATE command with UNLOAD feature is supported
				12 Reserved for TLC
				11 Reserved for TLC
			X	10:9 Obsolete
		B	F	8 1 = The 64-bit World wide name is supported
			X	7 Obsolete
		B	F	6 1 = The WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported
		B	F	5 1 = The GPL feature set is supported
		B	F	4 1 = The Streaming feature set is supported
		N	F	3 Obsolete
		B	F	2 1 = Media serial number is supported
		B	F	1 1 = The SMART self-test is supported
		B	F	0 1 = SMART error logging is supported

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 46 — IDENTIFY DEVICE data (Sheet 10 of 19)

Word	O M	S P	F V	Description
85	M			Commands and feature sets supported or enabled (see 7.16.7.41)
			X	15 Obsolete
		B	F	14 1 = The NOP command is supported
		B	F	13 1 = The READ BUFFER command is supported
		B	F	12 1 = The WRITE BUFFER command is supported
			X	11 Obsolete
		B	V	10 Obsolete
		B	F	9 Shall be cleared to zero to indicate that the DEVICE RESET command is not supported
		B	V	8 1 = The SERVICE interrupt is enabled
		B	V	7 1 = The release interrupt is enabled
		B	V	6 1 = Read look-ahead is enabled
		B	V	5 1 = The volatile write cache is enabled
		B	F	4 Shall be cleared to zero to indicate that the PACKET feature set is not supported
		B	F	3 Shall be set to one to indicate that the mandatory Power Management feature set is supported
			X	2 Obsolete
		B	V	1 1 = The Security feature set is enabled
		B	V	0 1 = The SMART feature set is enabled

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 46 — IDENTIFY DEVICE data (Sheet 11 of 19)

Word	O M	S P	F V	Description
86	M			Commands and feature sets supported or enabled(see 7.16.7.41)
		B	F	15 1 = Words 119..120 are valid
				14 Reserved
		B	F	13 1 = FLUSH CACHE EXT command supported
		B	F	12 1 = FLUSH CACHE command supported
		B	F	11 Obsolete
		B	F	10 1 = The 48-bit Address features set is supported
		B	V	9:8 Obsolete
				7 Reserved for Address Offset Reserved Area Boot Method
		B	F	6 1 = SET FEATURES subcommand is required to spin-up after power-up
		B	V	5 1 = The PUIS feature set is enabled
			X	4 Obsolete
		B	V	3 1 = The APM feature set is enabled
		N	F	2 1 = The CFA feature set is supported
			X	1 Obsolete
		B	F	0 1 = The DOWNLOAD MICROCODE command is supported

Key:
F/V – Fixed/variable content
F – The content of the field is fixed and does not change.
V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
M – Support of the word is mandatory.
O – Support of the word is optional.
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 46 — IDENTIFY DEVICE data (Sheet 12 of 19)

Word	O M	S P	F V	Description
87	M			Commands and feature sets supported or enabled(see 7.16.7.41)
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
		B	F	13 1 = The IDLE IMMEDIATE command with UNLOAD FEATURE is supported
				12 Reserved for TLC
				11 Reserved for TLC
			X	10:9 Obsolete
		B	F	8 1 = The 64-bit World wide name is supported
			X	7 Obsolete
		B	F	6 1 = The WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported
		B	F	5 1 = The GPL feature set is supported
			X	4 Obsolete
		N	V	3 Obsolete
		B	V	2 1 = Media serial number is valid
		B	F	1 1 = SMART self-test supported
		B	F	0 1 = SMART error logging is supported

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 46 — IDENTIFY DEVICE data (Sheet 13 of 19)

Word	O M	S P	F V	Description
88	O			Ultra DMA modes (see 7.16.7.42)
				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
				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	See 7.16.7.43
				15 1=Extended Time is reported in bits 14:0 0=Time is reported in bits 7:0 and bits 14:8 are reserved
				14:8 Extended Time required for Normal Erase mode SECURITY ERASE UNIT command (i.e., bit 15 is set to one)
				7:0 Extended Time required for Normal Erase mode SECURITY ERASE UNIT command, and Time required for Normal Erase mode SECURITY ERASE UNIT command (i.e., bit 15 is set to zero or bit 15 is set to one)

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 46 — IDENTIFY DEVICE data (Sheet 14 of 19)

Word	O M	S P	F V	Description
90	O	B	F	See 7.16.7.44
				15 1=Extended Time is reported in bits 14:0 0=Time is reported in bits 7:0 and bits 14:8 are reserved
				14:8 Extended Time required for Enhanced Erase mode SECURITY ERASE UNIT command (i.e., bit 15 is set to one)
				7:0 Extended Time required for Enhanced Erase mode SECURITY ERASE UNIT command, and Time required for Enhanced Erase mode SECURITY ERASE UNIT command (i.e., bit 15 is set to zero or bit 15 is set to one)
91				15:8 Reserved
	O	B	V	7:0 Current APM level value (see 7.16.7.45)
92	O	B	V	Master Password Identifier (see 7.16.7.46)
93	M			Hardware reset result (see 7.16.7.47)
			F	15 Shall be cleared to zero.
			F	14 Shall be set to one.
		P	V	13 1 = device detected the CBLID- above V_{iHB} (see ATA8-APT)
				0 = device detected the CBLID- below V_{iL} (see ATA8-APT)
		P		12:8 Device 1 hardware reset result. Device 0 shall clear these bits to zero. Device 1 shall set these bits as follows:
				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.
				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:
				7 Reserved.
			F	6 0 = Device 0 does not respond when Device 1 is selected.
				1 = Device 0 responds when Device 1 is selected.

Key:

F/V – Fixed/variable content
  F – The content of the field is fixed and does not change.
  V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
  X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
  M – Support of the word is mandatory.
  O – Support of the word is optional.

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 46 — IDENTIFY DEVICE data (Sheet 15 of 19)

Word	O M	S P	F V	Description
			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.
			V	2:1 These bits indicate how Device 0 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	0 Shall be set to one.
94				Obsolete
95	O	B	F	Stream Minimum Request Size (see 7.16.7.49)
96	O	B	V	Streaming Transfer Time - DMA (see 7.16.7.50)
97	O	B	V	Streaming Access Latency - DMA and PIO (see 7.16.7.51)
98..99	O	B	F	Streaming Performance Granularity (DWord) (see 7.16.7.52)
100..103	O	B	V	Number of User Addressable Logical Sectors (QWord) (see 7.16.7.53)
104	O	B	V	Streaming Transfer Time - PIO (see 7.16.7.54)
105				Maximum number of 512-byte blocks per DATA SET MANAGEMENT command (see 7.9)
106	O			Physical sector size / logical sector size (see 7.16.7.56)
		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	F	12 1 = Device Logical Sector longer than 256 Words
				11:4 Reserved
		B	F	3:0 2^X logical sectors per physical sector
107	O	B	F	Inter-seek delay for ISO 7779 standard acoustic testing (see 7.16.7.57)
108..111	M	B	F	World wide name (see 7.16.7.58)
112..115				Reserved
116				Reserved for TLC

Key:

F/V – Fixed/variable content

F – The content of the field is fixed and does not change.

V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.

X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.

M – Support of the word is mandatory.

O – Support of the word is optional.

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 46 — IDENTIFY DEVICE data (Sheet 16 of 19)

Word	O M	S P	F V	Description
117..118	O	B	F	Logical sector size (DWord) (see 7.16.7.61)
119	M			Commands and feature sets supported (Continued from words 82..84) (see 7.16.7.40)
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
				13:8 Reserved
				7 1 = Extended Power Conditions feature set is supported
	O	B	F	6 1 = Sense Data Reporting feature set is supported
		B	F	5 1 = The Free-fall Control feature set is supported
		B	F	4 1 = Download Microcode mode 3 is supported
		B	F	3 1 = The READ LOG DMA EXT and WRITE LOG DMA EXT commands are supported
		B	F	2 1 = The WRITE UNCORRECTABLE EXT command is supported
		B	F	1 1 = The Write-Read-Verify feature set is supported
				0 Reserved for DDT
120	M			Commands and feature sets supported or enabled (Continued from words 85..87) (see 7.16.7.41)
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
				13:8 Reserved
				7 1 = Extended Power Conditions feature set is enabled
	O	B	V	6 1 = Sense Data Reporting feature set is enabled
		B	V	5 1 = The Free-fall Control feature set is enabled
		B	F	4 1 = Download Microcode mode 3 is supported
		B	F	3 1 = The READ LOG DMA EXT and WRITE LOG DMA EXT commands are supported
		B	F	2 1 = The WRITE UNCORRECTABLE EXT command is supported
		B	V	1 1 = The Write-Read-Verify feature set is enabled
				0 Reserved for DDT
121..126				Reserved for expanded supported and enabled settings
127			X	Obsolete

Key:

F/V – Fixed/variable content
  F – The content of the field is fixed and does not change.
  V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
  X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
  M – Support of the word is mandatory.
  O – Support of the word is optional.

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 46 — IDENTIFY DEVICE data (Sheet 17 of 19)

Word	O M	S P	F V	Description
128	O			Security status (see 7.16.7.66)
				15:9 Reserved
		B	V	8 Master Password Capability: 0 = High, 1 = Maximum
				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
160	O	N		CFA power mode (see 7.16.7.68)
			F	15 Word 160 supported
				14 Reserved
			F	13 CFA power mode 1 is required for one or more commands implemented by the device
			V	12 CFA power mode 1 disabled
			F	11:0 Maximum current in ma
161..167				Reserved for the CompactFlash Association
168				See 7.16.7.70
				15:4 Reserved
	O	B	F	3:0 Device Nominal Form Factor
169				DATA SET MANAGEMENT command is supported (see 7.16.7.71)
				15:1 Reserved
	O	B	F	0 1 = the Trim bit in the DATA SET MANAGEMENT command is supported
170..173	O	B	F	Additional Product Identifier (ATA String) (see 7.16.7.72)
174..175				Reserved
176..205	O	B	V	Current media serial number (ATA string) (see 7.16.7.74)

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 46 — IDENTIFY DEVICE data (Sheet 18 of 19)

Word	O M	S P	F V	Description
206	O	B		SCT Command Transport(see 7.16.7.75)
			X	15:12 Vendor Specific
				11:8 Reserved
			F	7 Reserved for Serial ATA
				6 Reserved
			F	5 The SCT Data Tables command is supported
			F	4 The SCT Feature Control command is supported
			F	3 The SCT Error Recovery Control command is supported
			F	2 The SCT Write Same command is supported
			F	1 Obsolete
			F	0 The SCT Command Transport is supported
207..208		N		Reserved
209	O		F	Alignment of logical blocks within a physical block (see 7.16.7.76)
				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 (DWord) (see 7.16.7.77)
212..213	O	B	F	Write-Read-Verify Sector Count Mode 2 (DWord) (see 7.16.7.78)
214..216				Obsolete
217	M	B	F	Nominal media rotation rate (see 7.16.7.80)
218				Reserved
219				Obsolete
220				See 7.16.7.83
	O	B		15:8 Reserved
			V	7:0 Write-Read-Verify feature set current mode
221				Reserved

Key:

F/V – Fixed/variable content

F – The content of the field is fixed and does not change.

V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.

X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.

M – Support of the word is mandatory.

O – Support of the word is optional.

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 46 — IDENTIFY DEVICE data (Sheet 19 of 19)

Word	O M	S P	F V	Description		
222	M	B		Transport major version number (see 7.16.7.85) 0000h or FFFFh = device does not report version		
			F	15:12	Transport Type 0h = Parallel 1h = Serial 2h-Fh = Reserved	
					Parallel	**Serial**
				11:6	Reserved	Reserved
				5	Reserved	SATA Rev 3.0
			F	4	Reserved	SATA Rev 2.6
			F	3	Reserved	SATA Rev 2.5
			F	2	Reserved	SATA II: Extensions
			F	1	ATA/ATAPI-7	SATA 1.0a
			F	0	ATA8-APT	ATA8-AST
223	M	B	F	Transport minor version number (see 7.16.7.86)		
224..229		N		Reserved		
230..233				Extended Number of User Addressable Sectors (QWord) (see 7.16.7.88)		
234	O	B	F	Minimum number of 512-byte data blocks per Download Microcode mode 03h operation (see 7.16.7.89)		
235	O	B	F	Maximum number of 512-byte data blocks per Download Microcode mode 03h operation (see 7.16.7.90)		
236..254				Reserved		
255	M		V	Integrity word (see 7.16.7.92)		
		B		15:8	Checksum	
		B		7:0	Checksum Validity Indicator	

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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

7.16.7.2 Word 0: General configuration

If the device is an ATA device, then bit 15 shall be cleared to zero.

Bits (7:6) are obsolete.

If bit 2 of word 0 is set to one, then the content of the IDENTIFY DEVICE data is incomplete. This may occur if the device supports the Power-up in Standby feature set and required data is contained on the device media. The content of IDENTIFY DEVICE data 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.

7.16.7.3 Word 1: Obsolete

7.16.7.4 Word 2: Specific configuration

Word 2 shall be set as defined in table 47.

Table 47 — Specific configuration

Value	Description
37C8h	Device requires SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is incomplete (see 4.14).
738Ch	Device requires SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is complete (see 4.14).
8C73h	Device does not require SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is incomplete (see 4.14).
C837h	Device does not require SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is complete (see 4.14).
All other values	Reserved.

7.16.7.5 Word 3: Obsolete

7.16.7.6 Words 4..5: Retired

7.16.7.7 Word 6: Obsolete

7.16.7.8 Words 7..8: Reserved for assignment by the CompactFlash Association

7.16.7.9 Word 9: Retired

7.16.7.10 Words 10..19: Serial number

Words 10..19 are a copy of Serial number (see A.11.7.2).

7.16.7.11 Words 20..21: Retired

7.16.7.12 Word 22: Obsolete

7.16.7.13 Words 23..26: Firmware revision

Words 23..26 are a copy of Firmware revision (see A.11.7.3).

7.16.7.14 Words 27..46: Model number

Words 27..46 are a copy of Model number (see A.11.7.4).

7.16.7.15 Word 47

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.

For SATA devices, bits (7:0) shall be set to 16 or less.

7.16.7.16 Word 48: Trusted Computing feature set options

Bit 0 of word 48 is a copy of Trusted Computing feature set (see A.11.8.6).

7.16.7.17 Words 49..50: Capabilities

Bits (15:14) of word 49 are reserved for use in IDENTIFY PACKET DEVICE data (see table 50).

Editor's Note 7: Not sure if this is relevant today

If bit 13 of word 49 is set to one, then table 53 shall define the Standby timer values used by the device. If bit 13 of word 49 is cleared to zero, then the timer values used by the device shall be vendor specific.

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

Bit 11 of word 49 is a copy of IORDY supported (see A.11.9.2.1).

Bit 10 of word 49 is a copy of IORDY may be disabled (see A.11.9.2.2).

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

Bit 8 of word 49 is a copy of DMA supported (see A.11.9.2.3).

Bits (7:2) of word 49 are reserved.

Bits (1:0) of word 49 are a copy of Alignment Error Reporting (see A.11.4.3.3).

Bit 15 of word 50 shall be cleared to zero.

Bit 14 of word 50 shall be set to one.

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

Bit 1 of word 50 is obsolete.

If bit 0 of word 50 is set to one, then the device has a minimum Standby timer value that is vendor specific.

7.16.7.18 Words 51..52: Obsolete

7.16.7.19 Word 53

Bit 0 of word 53 is obsolete.

For PATA devices when bit 1 of word 53 is set to one, the values reported in words 64..70 are valid. If this bit is cleared to zero, the values reported in words 64..70 are not valid. All devices except CFA-APT 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 64..70.

For SATA devices, bit 1 of word 53 shall be set to one.

For PATA devices, 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 shall be cleared to zero.

For SATA devices, bit 2 of word 53 shall be set to one.

Editor's Note 8: There seems to be no documentation for bits 15:8… Free Fall Sensitivity.

7.16.7.20 Words 54..58: Obsolete

7.16.7.21 Word 59

Bit 15 of word 59 is a copy of BLOCK ERASE EXT command is supported (see A.11.8.7.1).

Bit 14 of word 59 is a copy of OVERWRITE EXT command is supported (see A.11.8.7.2).

Bit 13 of word 59 is a copy of CRYPTO SCRAMBLE EXT command is supported (see A.11.8.7.3).

Bit 12 of word 59 is a copy of Sanitize Device feature set is supported (see A.11.8.7.4).

If bit 8 of word 59 is set to one, then bits (7:0) indicate the number of logical sectors that shall be transferred per DRQ data block for a READ MULTIPLE command or a WRITE MULTIPLE command. This default setting of this field is the optimum value for the device or zero (see 7.46).

7.16.7.22 Words 60..61: Total number of user addressable logical sectors for 28-bit commands

This field contains a value that is one greater than the maximum user addressable LBA. The maximum value that shall be placed in this field is 0FFF_FFFFh. If this field contains 0FFF_FFFFh and the device has user addressable LBAs greater than or equal to 0FFF_FFFFh, then words 100..103 contain the total number of user addressable LBAs (see 4.1).

7.16.7.23 Word 62: Obsolete

7.16.7.24 Word 63

See A.11.9.2.4.1

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

If bit 10 of word 63 is a copy of Multiword DMA mode 2 is selected (see A.11.9.2.4.2).

If bit 9 of word 63 is a copy of Multiword DMA mode 1 is selected (see A.11.9.2.4.3).

If bit 8 of word 63 is a copy of Multiword DMA mode 1 is selected (see A.11.9.2.4.4).

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

Bit 2 of word 63 is a copy of Multiword DMA mode 2 and below are supported (see A.11.9.2.4.5).

bit 1 of word 63 is a copy of Multiword DMA mode 1 and below are supported (see A.11.9.2.4.6).

Bit 0 of word 63 is a copy of Multiword DMA mode 0 is supported (see A.11.9.2.4.7).

7.16.7.25 Word 64

Word 64 is a copy of PIO Modes Supported (see A.11.9.3).

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

Word 65 is a copy of Minimum Multiword DMA transfer cycle time (see A.11.9.4.2).

7.16.7.27 Word 66: Device recommended Multiword DMA transfer cycle time

Word 66 is a copy of Manufacturer’s recommended Multiword DMA transfer cycle time (see A.11.9.4.1).

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

Word 67 is a copy of Minimum PIO transfer cycle time without IORDY flow control (see A.11.9.5.2).

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

Word 68 is a copy of Minimum PIO transfer cycle time with IORDY flow control (see A.11.9.5.1).

7.16.7.30 Word 69: Additional Supported

Word 69 shall indicate features and command sets supported. If a defined bit is cleared to zero, the indicated features and command set is not supported. These features and command sets are enabled and there is no disable mechanism.

Bit 15 of word 69 is a copy of CFast Specification Support (see A.11.5.2.2).

Bit 14 of word 69 is a copy of Deterministic read after TRIM is supported (see A.11.5.2.3).

Bit 13 of word 69 is a copy of Long Physical Sector Alignment Error Reporting Control is supported (see A.11.5.2.4).

Bit 12 of word 69 is obsolete.

Bit 11 of word 69 is a copy of READ BUFFER DMA is supported (see A.11.5.2.6).

Bit 10 of word 69 is a copy of WRITE BUFFER DMA is supported (see A.11.5.2.7).

Bit 9 of word 69 is a copy of SET MAX SET PASSWORD DMA and SET MAX UNLOCK DMA are supported (see A.11.5.2.8).

Bit 8 of word 69 is a copy of DOWNLOAD MICROCODE DMA is supported (see A.11.5.2.9).

Bit 7 is reserved for IEEE 1667.

Bit 6 of word 69 is a copy of Optional ATA device 28-bit commands supported (see A.11.5.2.10).

Bit 5 of word 69 is a copy of Trimmed LBA range(s) returning zeroed data is supported (see A.11.5.2.11).

word 69 bit 4 is a copy of Device Encrypts All User Data (see A.11.8.7.5).

If word 69 bit 3 is set to one, then words 230..233 (see 7.16.7.88) are valid. If word 69 bit 3 is cleared to zero, then words 230..233 (see 7.16.7.88) are reserved.

Bit 2 of word 69 is a copy of All write cache is non-volatile (see A.11.5.2.12).

Bits (2:0) of word 69 are reserved.

7.16.7.31 Word 70: Reserved

7.16.7.32 Words 71..74: Reserved for ATAPI

7.16.7.33 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 shall be set to one less than the maximum queue depth (e.g., a value of zero in this field indicates a queue depth of one, and a value of 31 in this field indicates a queue depth of 32). If bit 6 of word 76 is cleared to zero indicating that the device does not support NCQ feature set commands, then the value in this field shall be zero. Support of this word is mandatory if the NCQ feature set is supported.

7.16.7.34 Word 76: Serial ATA Capabilities

Word 76 indicates the capabilities of a SATA device. A PATA device shall set word 76 to 0000h or FFFFh. If word 76 is set to 0000h or FFFFh, then the device does not claim compliance with the Serial ATA specification and words 76 through 79 are not valid and shall be ignored.

If word 76 is not set to 0000h or FFFFh, then the device claims compliance with the Serial ATA specification, and words 77 through 79 shall be valid.

Bits (15:13) of word 76 are reserved for Serial ATA.

If bit 12 of word 76 is set to one, then the device supports the Priority field in the READ FPDMA QUEUED command and WRITE FPDMA QUEUED command and optimization based on this information. This bit shall only be set to one if the device supports NCQ as shown in bit 8 of Word 76.

If bit 11 of word 76 is set to one, then the device supports moving the heads to a safe position upon reception of the IDLE IMMEDIATE command with the Unload Feature specified while NCQ commands are outstanding. This bit shall only be set to one if the device supports NCQ as shown in bit 8 of Word 76.

If bit 10 of word 76 is set to one, then the device supports the SATA Phy Event Counters log (see A.16).

If bit 9 of word 76 is set to one, then the device supports Partial and Slumber interface power management states when initiated by the host (see SATA 2.6).

If bit 8 of word 76 is set to one, then the device supports the NCQ feature set.

Bits (7:3) of word 76 are reserved for Serial ATA.

If bit 2 of word 76 is set to one, then the device supports the Gen2 signaling rate of 3.0 Gb/s (see SATA 2.6).

If bit 1 of word 76 is set to one, then the device supports the Gen1 signaling rate of 1.5 Gb/s (see SATA 2.6).

Bit 0 of word 76 shall be cleared to zero.

7.16.7.35 Word 77: Reserved for Serial ATA

Word 77 is reserved for Serial ATA.

7.16.7.36 Word 78: Serial ATA features supported

If Word 76 is not 0000h or FFFFh, Word 78 reports the optional features supported by the device. If this word is not supported the word shall be cleared to zero.

Bits (15:7) are reserved for Serial ATA.

If bit 6 is set to one, then the device supports the SSP feature set (see 4.19).

Bit 5 is reserved for Serial ATA.

If bit 4 is set to one the device supports guaranteed in-order data delivery when non-zero buffer offsets are used for commands in the NCQ feature set. See SATA 2.6 for more information.

If bit 3 is set to one the device supports device initiated power management requests. If bit 3 is cleared to zero the device does not support device initiated power management requests. A device may support reception of power management requests initiated by the host as described in the definition of bit 9 of Word 76 without supporting initiating such power management requests as indicated by this bit.

If bit 2 is set to one the device supports the use of the DMA Setup FIS Auto-Activate optimization. See SATA 2.6 for more information.

If bit 1 is set to one the device supports the use of non-zero buffer offsets for commands in the NCQ feature set. See SATA 2.6 for more information.

Bit 0 shall be cleared to zero.

7.16.7.37 Word 79: Serial ATA features enabled

If Word 76 is not 0000h or FFFFh, Word 79 reports which optional features supported by the device are enabled. This word shall be supported if Word 78 is supported and shall not be supported if Word 78 is not supported.

Bits (15:7) are reserved for Serial ATA.

If bit 6 is set to one, then the SSP feature set is enabled. If the device supports the SSP feature set, then this field shall be one after a power on reset has been processed. If the device does not support the SSP feature set, then this field shall be zero by default.

Bit 5 is reserved for Serial ATA.

If bit 4 is set to one, then device support for guaranteed in-order data delivery when non-zero buffer offsets are used for commands in the NCQ feature set is enabled. See SATA 2.6 for more information.

If bit 3 is set to one, then device support for initiating power management requests to the host is enabled. When set to one the device may initiate power management transition requests. When cleared to zero the device shall not initiate interface power management requests to the host. This field shall be zero by default.

If bit 2 is set to one, then the device support for use of the DMA Setup FIS Auto-Activate optimization is enabled. See SATA 2.6 for more information.

If bit 1 is set to one, then device support for the use of non-zero buffer offsets for commands in the NCQ feature set is enabled. See SATA 2.6 for more information.

Bit 0 shall be cleared to zero.

7.16.7.38 Word 80: Major version number

If word 80 is not set to 0000h or FFFFh, then the device claims compliance with the major version(s) as indicated by bits (8:4) being set to one. Values other than 0000h and FFFFh are bit significant. A device may set more than one bit.

7.16.7.39 Word 81: Minor version number

Table 48 defines the value that shall be reported in word 81 to indicate the version of the standard that guided the implementation.

Table 48 — Minor version number (Sheet 1 of 2)

Value	Minor Version
0000h	Minor version is not reported
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	Obsolete
000Eh	Obsolete
000Fh	Obsolete
0010h	Obsolete
0011h	Obsolete
0012h	Obsolete
0013h	ATA/ATAPI-5 T13 1321D version 3
0014h	Obsolete
0015h	ATA/ATAPI-5 T13 1321D version 1
0016h	ATA/ATAPI-5 published, ANSI INCITS 340-2000
0017h	Obsolete
0018h	ATA/ATAPI-6 T13 1410D version 0
0019h	ATA/ATAPI-6 T13 1410D version 3a
001Ah	ATA/ATAPI-7 T13 1532D version 1
001Bh	ATA/ATAPI-6 T13 1410D version 2
001Ch	ATA/ATAPI-6 T13 1410D version 1
001Dh	ATA/ATAPI-7 published ANSI INCITS 397-2005.
001Eh	ATA/ATAPI-7 T13 1532D version 0
001Fh	Reserved
0020h	Reserved
0021h	ATA/ATAPI-7 T13 1532D version 4a
0022h	ATA/ATAPI-6 published, ANSI INCITS 361-2002

Table 48 — Minor version number (Sheet 2 of 2)

Value	Minor Version
0023h..0026h	Reserved
0027h	ATA8-ACS version 3c
0028h	ATA8-ACS version 6
0029h	ATA8-ACS version 4
0030h	Reserved
0031h	ASC-2 Revision 2
0032h	Reserved
0033h	ATA8-ACS version 3e
0034h..0038h	Reserved
0039h	ATA8-ACS version 4c
0040h..0041h	Reserved
0042h	ATA8-ACS version 3f
0043h..0051h	Reserved
0052h	ATA8-ACS version 3b
0053h..0106h	Reserved
0107h	ATA8-ACS version 2d
0108h..010Fh	Reserved
0110h	ACS-2 Revision 3
0111h..FFFEh	Reserved
FFFFh	Minor version is not reported

7.16.7.40 Words 82..84, 119: Commands and feature sets supported

Words 82..84 and 119 shall indicate features and command sets supported. If a defined bit is cleared to zero, the indicated features and 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, then the contents of words 82..83 contain valid support information. Otherwise, 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, then the contents of word 84 contains valid support information. Otherwise, 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, then the contents of word 119 contains valid support information. Otherwise, support information is not valid in word 119.

Bit 15 of word 82 is obsolete.

Bit 14 of word 82 is a copy of The NOP command is supported (see A.11.5.2.13).

Bit 13 of word 82 is a copy of The READ BUFFER command is supported (see A.11.5.2.14).

Bit 12 of word 82 is a copy of The WRITE BUFFER command is supported (see A.11.5.2.15).

Bits 11:10 of word 82 are obsolete.

Bit 9 shall be cleared to zero to indicate that the DEVICE RESET command is not supported.

Bits 8:7 of word 82 are obsolete

Bit 6 of word 82 is a copy of Read look-ahead is supported (see A.11.5.2.17).

Bit 5 of word 82 is a copy of The volatile write cache is supported (see A.11.5.2.18).

Bit 4 of word 82 shall be cleared to zero to indicate that this is not an ATAPI device.

Editor’s Note 9: The power management feature set is mandatory, this bit was not moved. This wording should probably change to “shall be set to one”

If bit 3 of word 82 is set to one, then the Power Management feature set is supported.

Bit 2 of word 82 is obsolete.

Bit 1 of word 82 is a copy of The Security feature set is supported (see A.11.8.3.1).

Bit 0 of word 82 is a copy of The SMART feature set is supported (see A.11.5.2.19).

Bit 13 of word 83 is a copy of The FLUSH CACHE EXT command is supported (see A.11.5.2.20).

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

Bit 11 of word 83 is obsolete.

Bit 10 of word 83 is a copy of The 48-bit Address feature set is supported (see A.11.5.2.22).

Bits 9:8 of word 83 are obsolete.

Bit 7 of word 83 is reserved for Address Offset Reserved Area Boot Method.

Bit 6 of word 83 is a copy of SET FEATURES subcommand is required to spin-up after power-up (see A.11.5.2.24).

Bit 5 of word 83 is a copy of The PUIS feature set is supported (see A.11.5.2.25).

Bit 4 of word 83 is obsolete.

Bit 3 of word 83 is a copy of The APM feature set is supported (see A.11.5.2.26).

Bit 2 of word 83 is a copy of The CFA feature set is supported (see A.11.5.2.27).

Bit 1 of word 83 is obsolete.

Bit 0 of word 83 is a copy of The DOWNLOAD MICROCODE command is supported (see A.11.5.2.28).

Bit 13 of word 84 is a copy of The IDLE IMMEDIATE command with UNLOAD feature is supported (see A.11.5.2.29).

Bit 12 of word 84 is reserved for TLC.

Bit 11 of word 84 is reserved for TLC.

Bits (10:9) are Obsolete

Bit 8 of word 84 shall be set to one indicating the mandatory World Wide Name in words 108..111 is supported.

Bit 7 of word 84 is obsolete.

Bit 6 of word 84 is a copy of The WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported (see A.11.5.2.30).

Bit 5 of word 84 is a copy of The GPL feature set is supported (see A.11.5.2.31).

Bit 4 of word 84 is a copy of The Streaming feature set is supported (see A.11.5.2.32).

If bit 3 of word 84 is obsolete.

Bit 2 of word 84 is a copy of Media serial number is supported (see A.11.5.2.33).

Bit 1 of word 84 is a copy of The SMART self-test is supported (see A.11.5.2.34).

Bit 0 of word 84 is a copy of SMART error logging is supported (see A.11.5.2.35).

Bits (13:8) of word 119 are reserved.

Bit 7 of word 119 is a copy of Extended Power Conditions feature set is supported (see A.11.5.2.36).

Bit 6 of word 119 is a copy of Sense Data Reporting feature set is supported (see A.11.5.2.37).

Bit 5 of word 119 is a copy of The Free-fall Control feature set is supported (see A.11.5.2.38).

Bit 4 of word 119 is a copy of The DOWNLOAD MICROCODE command with mode 3 is supported (see A.11.5.2.39).

Bit 3 of word 119 is a copy of The READ LOG DMA EXT and WRITE LOG DMA EXT commands are supported (see A.11.5.2.40).

Bit 2 of word 119 is a copy of The WRITE UNCORRECTABLE EXT command is supported (see A.11.5.2.41).

Bit 1 of word 119 is a copy of The Write-Read-Verify feature set is supported (see A.11.5.2.42).

Bit 0 of word 119 is reserved for DDT.

7.16.7.41 Words 85..87, 120: Commands and feature sets supported or enabled

Words 85..87 and 120 shall indicate features and command sets enabled. If a defined bit is cleared to zero, the indicated features and command set is not enabled. If a supported feature or feature set is supported and there is no defined method to disable the feature or feature set, then 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, then the contents of words 85..87 contain valid information. If bit 14 of word 120 is set to one and bit 15 of word 120 is cleared to zero, then the contents of word 120 contain valid information. Otherwise, information is not valid in these words.

> NOTE 13 — Some features do not have a method to be disabled. These features are marked as supported in this subclause for symmetry.

Bit 14 of word 85 is a copy of bit 14 of word 82.

Bit 13 of word 85 is a copy of bit 13 of word 82.

Bit 12 of word 85 is a copy of bit 12 of word 82.

Bit 10 of word 85 is a copy of bit 10 of word 82.

Bit 9 of word 85 shall be cleared to zero to indicate that the DEVICE RESET command is not supported.

Bits 8:7 of word 85 are obsolete.

bit 6 of word 85 is a copy of Read look-ahead is enabled (see A.11.6.2.9).

bit 5 of word 85 is a copy of Volatile write cache is enabled (see A.11.6.2.4).

Bit 4 of word 85 is a copy of bit 4 of word 82.

Bit 3 of word 85 is a copy of bit 3 of word 82.

Bit 1 of word 85 is a copy of Security enabled (see A.11.8.3.7).

Bit 0 of word 85 is a copy of The SMART feature set is enabled (see A.11.6.2.10).

If bit 15 of word 86 is set to one, then words 119 and 120 are valid.

Bit 14 of word 86 is reserved.

Bit 13 of word 86 is a copy of bit 13 of word 83.

Bit 12 of word 86 is a copy of bit 12 of word 83.

Bit 11 of word 86 is obsolete.

Bit 10 of word 86 is a copy of bit 10 of word 83.

Bits 9:8 of word 86 are obsolete.

Bit 7 of word 86 is reserved for Address Offset Reserved Area Boot Method.

Bit 6 of word 86 is a copy of bit 6 of word 83.

Bit 8 of word 86 is a copy of The PUIS feature set is enabled (see A.11.6.2.12).

Bit 3 of word 86 is a copy of The APM feature set is enabled (see A.11.6.2.13)

Bit 2 of word 86 is a copy of bit 2 of word 83.

Bit 1 of word 86 is obsolete.

Bit 0 of word 86 is a copy of bit 0 of word 83.

Bit 13 of word 87 is a copy of bit 13 of word 84.

Bit 12 of word 87 is reserved for TLC.

Bit 11 of word 87 is reserved for TLC.

Bit 8 of word 87 is a copy of word 84 bit 8.

Bit 7 of word 87 is obsolete.

Bit 6 of word 87 is a copy of bit 6 of word 84.

Bit 5 of word 87 is a copy of bit 5 of word 84.

If bit 3 of word 87 is obsolete

If bit 2 of word 87 is set to one, then the media serial number field in words 176..205 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. This bit is valid if bit 2 of word 84 is set to one indicating Media serial number is supported.

Bit 1 of word 87 is a copy of bit 1 of word 84.

Bit 0 of word 87 is a copy of bit 0 of word 84.

Bits (13:8) of word 120 are reserved.

Bit 7 of word 120 is a copy of The EPC feature set is enabled (see A.11.6.2.2).

Bit 6 of word 120 is a copy of Sense Data Reporting is enabled (see A.11.6.2.7).

Bit 5 of word 120 is a copy of The Free-fall Control feature set is enabled (see A.11.6.2.14).

Bit 4 of word 120 is a copy of bit 4 of word 119.

Bit 3 of word 120 is a copy of bit 3 of word 119.

Bit 2 of word 120 is a copy of bit 2 of word 119.

Bit 1 of word 120 is a copy of The Write-Read-Verify feature set is enabled (see A.11.6.2.15).

Bit 0 of word 120 is reserved for DDT.

7.16.7.42 Word 88: Ultra DMA modes

See A.11.9.2.5.1.

Bit 15 of word 88 is reserved.

Bit 14 of word 88 is a copy of Ultra DMA mode 6 is selected (see A.11.9.2.5.2).

Bit 13 of word 88 is a copy of Ultra DMA mode 5 is selected (see A.11.9.2.5.3).

Bit 12 of word 88 is a copy of Ultra DMA mode 4 is selected (see A.11.9.2.5.4).

Bit 11 of word 88 is a copy of Ultra DMA mode 3 is selected (see A.11.9.2.5.5).

Bit 10 of word 88 is a copy of Ultra DMA mode 2 is selected (see A.11.9.2.5.6).

Bit 9 of word 88 is a copy of Ultra DMA mode 1 is selected (see A.11.9.2.5.7).

Bit 8 of word 88 is a copy of Ultra DMA mode 0 is selected (see A.11.9.2.5.8).

Bit 7 of word 88 is reserved.

Bit 6 of word 88 is a copy of Ultra DMA mode 6 and below are supported (see A.11.9.2.5.9).

Bit 5 of word 88 is a copy of Ultra DMA mode 5 and below are supported (see A.11.9.2.5.10).

Bit 4 of word 88 is a copy of Ultra DMA mode 4 and below are supported (see A.11.9.2.5.11).

Bit 3 of word 88 is a copy of Ultra DMA mode 3 and below are supported (see A.11.9.2.5.12).

Bit 2 of word 88 is a copy of Ultra DMA mode 2 and below are supported (see A.11.9.2.5.13).

Bit 1 of word 88 is a copy of Ultra DMA mode 1 and below are supported (see A.11.9.2.5.14).

Bit 0 of word 88 is a copy of Ultra DMA mode 0 is supported (see A.11.9.2.5.15).

7.16.7.43 Word 89

Word 89 is a copy of Extended Time and Time required for a Normal Erase mode SECURITY ERASE UNIT command (see A.11.8.5).

7.16.7.44 Word 90

Word 90 is a copy of Extended Time and Time required for an Enhanced Erase mode SECURITY ERASE UNIT command (see A.11.8.4).

7.16.7.45 Word 91: Current advanced power management level value

Bits 7:0 of word 91 is a copy of APM Level (see A.11.6.3.1). Bits 15:8 of word 91 are reserved.

7.16.7.46 Word 92: Master Password Identifier

Word 92 is a copy of Master Password Identifier (see A.11.8.2).

7.16.7.47 Word 93: Hardware reset results

For PATA devices, when 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 processing of a hardware reset, Device 0 shall set bits (12:8) of this word to zero and shall set bits (7:0) of this word to show the result of the hardware reset. During processing of a hardware reset, Device 1 shall clear bits (7:0) of this word to zero and shall set bits (12:8) of the word to show the result of the hardware reset. The contents of bits (12:0) of this word shall change only during the processing of a hardware reset.

Bit 13 shall be set or cleared by the selected device to indicate whether the device detected the CBLID- signal (see ATA8-APT) above V_{IH} or the CBLID- signal below V_{IL} at any time during the processing of each IDENTIFY DEVICE command after receiving the command from the host but before returning data to the host. This test may be repeated by the device during command processing (see ATA8-APT).

For SATA devices, word 93 shall be set to the value 0000h.

7.16.7.48 Word 94: Obsolete

7.16.7.49 Word 95: Stream Minimum Request Size

Word 95 is a copy of Streaming minimum request size (see A.11.6.6).

7.16.7.50 Word 96: Streaming Transfer Time - DMA

Word 96 is a copy of DMA Host Interface Sector Times (see A.11.6.4).

7.16.7.51 Word 97: Streaming Access Latency - DMA and PIO

Word 97 is a copy of Streaming access latency (see A.11.6.7).

7.16.7.52 Words 98..99: Streaming Performance Granularity

Words 98..99 are a copy of Streaming Performance Granularity (see A.11.6.8).

7.16.7.53 Words 100..103: Number of User Addressable Logical Sectors

Words 100..103 contain a value that is one greater than the maximum LBA in the user data area when the 48-bit Addressing feature set is supported. The maximum value that shall be placed in this field is 0000_FFFF_FFFF_FFFFh. Support of these words is mandatory if the 48-bit Address feature set is supported.

7.16.7.54 Word 104: Streaming Transfer Time - PIO

Word 104 is a copy of PIO Host Interface Sector Times

7.16.7.55 Word 105: Maximum number of 512-byte blocks of LBA Range Entries per DATA SET MANAGEMENT command

Word 105 contains the maximum number of 512-byte blocks of LBA Range Entries per DATA SET MANAGEMENT command that the ATA device shall accept. A value of 0000_0000h indicates that the maximum number of 512-byte blocks of LBA Range Entries is not specified.

If bit 0 of word 169 (see 7.16.7.71) is cleared to zero, then word 105 is reserved.

7.16.7.56 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, then the contents of word 106 contain valid information. Otherwise, information is not valid in this word.

Bit 13 of word 106 is a copy of Device has multiple logical sectors per physical sector (see A.11.4.3.1).

Bit 12 of word 106 is a copy of Device has a logical sector size greater than 256 words (see A.11.4.3.2).

Bits (11:4) of word 106 are reserved.

7.16.7.57 Bits (3:0) of word 106 are a copy of 2x logical sectors per physical sectors (see A.11.4.3.4).**Word 107: Inter-seek delay for ISO 7779 standard acoustic testing**

Word 107 is the manufacturer’s recommended time delay between seeks in microseconds during ISO 7779 standard acoustic testing (i.e., ISO 7779 value t_D (see ISO 7779:1999 (E))).

7.16.7.58 Words 108..111: World wide name

Words 108..111 are a copy of World Wide Name (see A.11.5.8)

7.16.7.59 Words 112..115: Reserved for a 128-bit world wide name

7.16.7.60 Word 116: Reserved for TLC

7.16.7.61 Words 117..118: Logical sector size

Words 117..118 are a copy of Logical Sector Size (see A.11.4.4).

7.16.7.62 Word 119: See 7.16.7.40

7.16.7.63 Word 120: See 7.16.7.41

7.16.7.64 Words 121..126: Reserved for expanded supported and enabled settings

7.16.7.65 Word 127: Obsolete

7.16.7.66 Word 128: Security status

Support of this word is mandatory if the Security feature set is supported. If the Security feature set is not supported, this word shall be cleared to zero.

Bit 8 of word 128 is a copy of Master Password Capability (see A.11.8.3.2).

Bit 5 of word 128 is a copy of Enhanced security erase supported (see A.11.8.3.3).

Bit 4 of word 128 is a copy of Security count expired (see A.11.8.3.4).

Bit 3 of word 128 is a copy of Security frozen (see A.11.8.3.5).

Bit 2 of word 128 is a copy of Security locked (see A.11.8.3.6).

Bit 1 of word 128 is a copy of Security enabled (see A.11.8.3.7).

Bit 0 of word 128 is a copy of word 82, bit 1.

7.16.7.67 Words 129..159: Vendor specific

7.16.7.68 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 is 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, then the device is in CFA Power Mode 0 (see 7.45.9).

Bits (11:0) indicate the maximum average RMS current in Milliamperes required during 3.3V or 5V device operation in CFA Power Mode 1.

7.16.7.69 Words 161..167: Reserved for assignment by the CompactFlash Association

7.16.7.70 Word 168: Device Nominal Form Factor

Word 168 is a copy of Nominal Form Factor (see A.11.5.5).

7.16.7.71 Word 169: DATA SET MANAGEMENT is supported

Word 169 bits 15:1 are reserved.

Bit 0 of word 169 is a copy of Trim (see A.11.5.9.1).

7.16.7.72 Words 170..173: Additional Product Identifier

Words 170..173 are a copy of Additional Product Identifier (see A.11.7.5).

7.16.7.73 Words 174..175: Reserved

7.16.7.74 Words 176..205: Current media serial number

Words 176..205 are a copy of Current media serial number (see A.11.7.6).

7.16.7.75 Word 206: SCT Command Transport

Bits (15:12) indicate support for vendor specific action codes.

Bits (11:6) of word 206 are reserved.

If bit 5 of word 206 is set to one, then the device supports SCT Data Tables (see 8.3.5).

If bit 4 of word 206 is set to one, then the device supports SCT Feature Control (see 8.3.4).

If bit 3 of word 206 is set to one, then the device supports SCT Error Recovery Control (see 8.3.3).

If bit 2 of word 206 is set to one, then the device supports SCT Write Same (see 8.3.2).

Bit 1 of word 206 is obsolete.

If bit 0 of word 206 is set to one, then the device supports the SCT Command Transport including SCT Read Status (see clause 8).

7.16.7.76 Word 209: Alignment of logical blocks within a physical block

Word 209 shall report the location of logical sector zero within the first physical sector of the media. See Annex E for more information. This word is valid if bit 13 of word 106 is set to one.

Bit 15 of word 209 shall be cleared to zero.

Bit 14 of word 209 shall be set to one.

Bits 13:0 of word 209 is a copy of Logical sector offset within the first physical sector where the first logical sector is placed (see A.11.4.3.5).

7.16.7.77 Words 210..211: Write-Read-Verify Sector Count Mode 3

Words 210..211 are a copy of Write-Read-Verify Sector Count Mode 3 (see A.11.5.6).

7.16.7.78 Words 212..213: Write-Read-Verify Sector Count Mode 2

Words 212..213 are a copy of Write-Read-Verify Sector Count Mode 2 (see A.11.5.7).

7.16.7.79 Words 214..216: Obsolete

7.16.7.80 Word 217: Nominal media rotation rate

Word 217 is a copy of Nominal Media Rotation Rate (see A.11.5.4).

7.16.7.81 Word 218: Reserved

7.16.7.82 Word 219: Obsolete

7.16.7.83 Word 220

Bits (15:8) of word 220 are reserved.

Bits (7:0) of Word 220 are a copy of Current mode of the Write-Read-Verify feature set (see A.11.6.3.2).

7.16.7.84 Word 221: Reserved

7.16.7.85 Word 222: Transport major version number

If word 222 is not set to FFFFh or 0000h, then the device claims compliance with one or more of the ATA transport standard major versions as indicated by bits (11:0). Bits (15:12) indicate the transport type. Values other than 0000h and FFFFh are bit significant. A device may set more than one bit to one.

7.16.7.86 Word 223: Transport minor version number

Table 49 defines the value that shall be reported in word 223 to indicate the version of the standard that guided the implementation.

Table 49 — Transport minor version number

Value	Minor Version
0000h	Minor version not reported
0001h-0020h	Reserved
0021h	ATA8-AST T13 Project D1697 Version 0b
0022h-0050h	Reserved
0051h	ATA-AST T13 Project D1697 Version 1
0052h-FFFEh	Reserved
FFFFh	Minor version not reported

7.16.7.87 Words 224..229: Reserved

7.16.7.88 Words 230..233: Extended Number of User Addressable Sectors

If word 69 bit 3 (see 7.16.7.30) is set to one, then words 230..233 contain a value that is one greater than the maximum LBA in user accessible space. The maximum value that shall be placed in this field is 0000_FFFF_FFFF_FFFFh.

7.16.7.89 Word 234: Minimum number of 512-byte data blocks per Download Microcode mode 03h operation

Word 234 is a copy of Maximum number of 512-byte data blocks per DOWNLOAD MICROCODE command mode 03h (see A.11.5.3.4).

7.16.7.90 Word 235: Maximum number of 512-byte data blocks per Download Microcode mode 03h operation

Word 235 is a copy of Minimum number of 512-byte data blocks per DOWNLOAD MICROCODE command mode 03h (see A.11.5.3.5).

7.16.7.91 Words 236..254: Reserved

7.16.7.92 Word 255: Integrity word

If bits (7:0) of this word contain the Checksum Validity Indicator A5h, then 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 0..254 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.

7.17 IDENTIFY PACKET DEVICE - A1h, PIO Data-In

7.17.1 Feature Set

This 28-bit command is mandatory for devices implementing the PACKET feature set (see 4.3).

7.17.2 Description

The IDENTIFY PACKET DEVICE command enables the host to receive parameter information from a device that implements the PACKET feature set. See table 51 for a description of the return data.

Devices may read the non-volatile media in order to complete this command.

The IDENTIFY PACKET DEVICE data contains information regarding feature or command support. If the host issues a command that is indicated as not supported in the IDENTIFY PACKET DEVICE data, the device shall return command aborted for the command.

7.17.3 Inputs

See table 50 for the IDENTIFY PACKET DEVICE command inputs.

Table 50 — IDENTIFY PACKET DEVICE command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 A1h

7.17.4 Normal Outputs

See table 179.

7.17.5 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 199. The device may return command completion with the Error bit set to one if an Interface CRC error has occurred.

NOTE 14 — There is no defined mechanism for a device to return an Interface CRC 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 may verify that an Interface CRC error occurred in these cases.

7.17.6 Input From the Device to the Host Data Structure

7.17.6.1 Overview

Table 51 specifies the format of IDENTIFY PACKET DEVICE data.

Table 51 — IDENTIFY PACKET DEVICE data (Sheet 1 of 13)

Word	O M	S P	F V		Description
0	M	B			General configuration
			F	15:14	10b = ATAPI device
			F		11b = Reserved
				13	Reserved
			F	12:8	Indicates command set used by the device
			X	7	Obsolete
			F	6:5	00b = Device shall set DRQ to one within 3 ms of receiving PACKET command.
					01b = Obsolete.
					10b = Device shall set DRQ to one within 50 μs of receiving PACKET command.
					11b = Reserved
				4:3	Reserved
			V	2	Incomplete response
			F	1:0	00b = 12 byte command packet
					01b = 16 byte command packet
					1xb = Reserved
1					Reserved
2		B	V		Specific configuration
3..9					Reserved
10..19	M	B	F		Serial number (ATA String)
20..22					Reserved
23..26	M	B	F		Firmware revision (ATA String)
27..46	M	B	F		Model number (ATA String)
47..48					Reserved

Key:
F/V – Fixed/variable content
F – The content of the field is fixed and does not change.
V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
M – Support of the word is mandatory.
O – Support of the word is optional.
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 51 — IDENTIFY PACKET DEVICE data (Sheet 2 of 13)

Word	O M	S P	F V	Description
49	M			Capabilities
			X	15:12 Obsolete
		P	F	11 1 = IORDY supported
		P	F	10 1 = IORDY may be disabled
			F	9 Shall be set to one.
		P	F	8 1 = DMA supported. Devices that 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.
				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			15:3 Reserved
		B	F	2 1 = the fields reported in word 88 are valid
		B	F	1 1 = the fields reported in words 64..70 are valid
			X	0 Obsolete
54..61				Reserved

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 51 — IDENTIFY PACKET DEVICE data (Sheet 3 of 13)

Word	O M	S P	F V	Description
62	M			DMADIR (see 7.17.6.17)
		S	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.
				14:11 Reserved
		P	F	10 1 = DMA is supported
		P	F	9 1 = Multiword DMA mode 2 is supported
		P	F	8 1 = Multiword DMA mode 1 is supported
		P	F	7 1 = Multiword DMA mode 0 is supported
		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
63	M			15:11 Reserved
		P	V	10 1 = Multiword DMA mode 2 is selected
		P	V	9 1 = Multiword DMA mode 1 is selected
		P	V	8 1 = Multiword DMA mode 0 is selected
				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 Multiword DMA mode selected.
64	M			15:8 Reserved
		P	F	7:0 PIO transfer 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 (see ATA8-APT) flow control

Key:

F/V – Fixed/variable content

- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.

- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 51 — IDENTIFY PACKET DEVICE data (Sheet 4 of 13)

Word	O M	S P	F V	Description
		P	F	15:0 Cycle time in nanoseconds
69..70				Reserved
71..72			X	Obsolete
73..74				Reserved
75			X	Obsolete
76	O	S		Serial ATA Capabilities
				15:11 Reserved for Serial ATA
			F	10 1 = The SATA Phy Event Counters log is supported
			F	9 1 = Receipt of host initiated power management requests are supported
				8:3 Reserved for Serial ATA
			F	2 1 = The SATA Gen2 Signaling Speed (3.0Gb/s) is supported
			F	1 1 = The SATA Gen1 Signaling Speed (1.5Gb/s) is supported
			F	0 Shall be cleared to zero
77				Reserved for Serial ATA
78	O	S		Serial ATA features supported
				15:7 Reserved for Serial ATA
			F	6 1 = The SSP feature set is supported
				5 1 = Asynchronous notification supported
			F	4 Reserved for Serial ATA
			F	3 1 = Device initiated power management is supported
			F	2:1 Reserved for Serial ATA
			F	0 Shall be cleared to zero
79	O	S		Serial ATA features enabled
				15:7 Reserved for Serial ATA
			V	6 1 = The SSP feature set is enabled
				5 1 = Asynchronous notification enabled
			V	4 Reserved for Serial ATA
			V	3 1 = Device initiated power management is enabled
			V	2:1 Reserved for Serial ATA
			F	0 Shall be cleared to zero

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 51 — IDENTIFY PACKET DEVICE data (Sheet 5 of 13)

Word	O M	S P	F V	Description
80	M	B		Major version number 0000h or FFFFh = device does not report version
				15:9 Reserved
			F	8 1 = ATA8-ACS is supported
			F	7 1 = ATA/ATAPI-7 is supported
			F	6 1 = ATA/ATAPI-6 is supported
			F	5 1 = ATA/ATAPI-5 is supported
			F	4 Obsolete
			X	3 Obsolete
			X	2 Obsolete
			X	1 Obsolete
				0 Reserved
81	M	B	F	Minor version number

Key:

F/V – Fixed/variable content

F – The content of the field is fixed and does not change.

V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.

X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.

M – Support of the word is mandatory.

O – Support of the word is optional.

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 51 — IDENTIFY PACKET DEVICE data (Sheet 6 of 13)

Word	O M	S P	F V	Description
82	M	B		Commands and feature sets supported
			X	15 Obsolete
			F	14 Shall be set to one to indicate that the NOP command is supported
			F	13 Shall be cleared to zero to indicate that the READ BUFFER command is not supported
			F	12 Shall be cleared to zero to indicate that the WRITE BUFFER command is not supported
			X	11 Obsolete
			F	10 Obsolete
			F	9 Shall be set to one to indicate that the DEVICE RESET command is supported
			X	8 Obsolete
			X	7 Obsolete
			F	6 1 = Read look-ahead supported
			F	5 1 = The volatile write cache is supported
			F	4 Shall be set to one indicating the PACKET feature set is supported.
			F	3 1 = The Power Management feature set supported
			X	2 Obsolete
			F	1 1 = The Security feature set is supported
			F	0 Shall be cleared to zero to indicate that the SMART feature set is not supported

Key:

F/V – Fixed/variable content

F – The content of the field is fixed and does not change.

V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.

X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.

M – Support of the word is mandatory.

O – Support of the word is optional.

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 51 — IDENTIFY PACKET DEVICE data (Sheet 7 of 13)

Word	O M	S P	F V	Description
83	M	B		Commands and feature sets supported
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
				13 Reserved
			F	12 1 = The FLUSH CACHE command is supported
			F	11 Obsolete
				10 Reserved
			F	9:8 Obsolete
				7 Reserved for Address Offset Reserved Area Boot Method
			F	6 1 = The SET FEATURES subcommand is required to spin-up after power-up
			F	5 1 = The PUIS feature set is supported
			X	4 Obsolete
			F	3 1 = The APM feature set is supported
				2:1 Reserved
			F	0 Shall be cleared to zero to indicate that the DOWNLOAD MICROCODE command is not supported
84	M	B		Commands and feature sets supported
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
				13:9 Reserved
			F	8 shall be set to one to indicate that the mandator WWN is supported
				7:6 Reserved
			F	5 1 = The GPL feature set is supported
				4:0 Reserved

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 51 — IDENTIFY PACKET DEVICE data (Sheet 8 of 13)

Word	O M	S P	F V	Description
85	M	B		Commands and feature sets supported or enabled
			X	15 Obsolete
			F	14 Shall be set to one to indicate that the NOP command is supported
			F	13 Shall be cleared to zero to indicate that the READ BUFFER command is not supported
			F	12 Shall be cleared to zero to indicate that the WRITE BUFFER command is not supported
			X	11 Obsolete
			V	10 Obsolete
			F	9 Shall be set to one to indicate that the DEVICE RESET command is supported
			X	8 Obsolete
			X	7 Obsolete
			V	6 1 = Read look-ahead is enabled
			V	5 1 = The volatile write cache is enabled
			F	4 Shall be set to one indicating the PACKET feature set is supported.
			F	3 1 = Power Management feature set is enabled
			X	2 Obsolete
			V	1 1 = The Security feature set is enabled
			F	0 Shall be cleared to zero to indicate that the SMART feature set is not supported

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 51 — IDENTIFY PACKET DEVICE data (Sheet 9 of 13)

Word	O M	S P	F V	Description
86	M	B		Commands and feature sets supported or enabled
				15:13 Reserved
			V	12 1 = The FLUSH CACHE command is supported
			F	11 Obsolete
				10 Reserved
			V	9:8 Obsolete
				7 Reserved for Address Offset Reserved Area Boot Method
			F	6 1 = SET FEATURES subcommand required to spin-up after power-up
			V	5 1 = The PUIS feature set is enabled
			X	4 Obsolete
			V	3 1 = The APM feature set is enabled
				2:1 Reserved
			F	0 Shall be cleared to zero to indicate that the DOWNLOAD MICROCODE command is not supported
87	M			Commands and feature sets supported or enabled
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
				13:9 Reserved
			F	8 Shall be set to one to indicate that the mandator WWN is supported
				7:6 Reserved
			F	5 This bit is a copy of word 84 bit 5
				4:0 Reserved

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 51 — IDENTIFY PACKET DEVICE data (Sheet 10 of 13)

Word	O M	S P	F V	Description
88	M	B		Ultra DMA modes
				15 Reserved
			V	14 1 = Ultra DMA mode 6 is selected
			V	13 1 = Ultra DMA mode 5 is selected
			V	12 1 = Ultra DMA mode 4 is selected
			V	11 1 = Ultra DMA mode 3 is selected
			V	10 1 = Ultra DMA mode 2 is selected
			V	9 1 = Ultra DMA mode 1 is selected
			V	8 1 = Ultra DMA mode 0 is selected
				7 Reserved
			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.
89	O	B	F	Time required for Normal Erase mode SECURITY ERASE UNIT command
90	O	B	F	Time required for an Enhanced Erase mode SECURITY ERASE UNIT command
91	O	B	V	Current APM level value (see 7.17.6.39)
92	O	B	V	Master Password Identifier
93	M	B		Hardware reset result. The contents of bits (12:0) of this word shall change only during the processing of a hardware reset.
			F	15 Shall be cleared to zero.
			F	14 Shall be set to one.
			V	13 1 = device detected CBLID- (see ATA8-APT) above V_{iH}.
				0 = device detected CBLID- (see ATA8-APT) 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:
				12 Reserved.
			V	11 0 = Device 1 did not assert PDIAG-.

Key:

F/V – Fixed/variable content

F – The content of the field is fixed and does not change.

V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.

X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.

M – Support of the word is mandatory.

O – Support of the word is optional.

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 51 — IDENTIFY PACKET DEVICE data (Sheet 11 of 13)

Word	O M	S P	F V	Description
				1 = Device 1 asserted PDIAG-.
			V	10:9 These bits indicate how Device 1 determined the device number:
				00b = Reserved.
				01b = a jumper was used.
				10b = the CSEL signal was used.
				11b = 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:
				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.
			V	2:1 These bits indicate how Device 0 determined the device number:
				00b = Reserved.
				01b = a jumper was used.
				10b = the CSEL signal was used.
				11b = some other method was used or the method is unknown.
			F	0 Shall be set to one.
94				Obsolete
95..107				Reserved
108..111	M	B	F	World wide name
112..115				Reserved for world wide name extension to 128 bits
116..118				Reserved
119				Commands and feature sets supported 15:0 Reserved
120				Commands and feature sets supported or enabled

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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 51 — IDENTIFY PACKET DEVICE data (Sheet 12 of 13)

Word	O M	S P	F V	Description
				15:0 Reserved
121..125				Reserved
125	M	B	F	ATAPI byte count = 0 behavior
126..127			X	Obsolete
128	O			Security status
				15:9 Reserved
			V	8 Master Password Capability: 0 = High, 1 = Maximum
				7:6 Reserved
			F	5 1 = The enhanced security erase mode is supported
			V	4 1 = The Security count is expired
			V	3 1 = Security is frozen
			V	2 1 = Security is locked
			V	1 1 = Security is enabled
			F	0 1 = Security is supported
129..159			X	Vendor specific

Key:

F/V – Fixed/variable content

F – The content of the field is fixed and does not change.

V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.

X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.

M – Support of the word is mandatory.

O – Support of the word is optional.

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 51 — IDENTIFY PACKET DEVICE data (Sheet 13 of 13)

Word	O M	S P	F V	Description
160..175		N		Reserved for assignment by the CompactFlash Association
176..221				Reserved
222	M	B		Transport Major version number. 0000h or FFFFh = device does not report version
			F	15:12 Transport Type
				0h = Parallel
				1h = Serial
				2h-Fh = Reserved
				Parallel **Serial**
				11:5 Reserved Reserved
			F	4 Reserved SATA Rev 2.6
			F	3 Reserved SATA Rev 2.5
			F	2 Reserved SATA II: Extensions
			F	1 ATA/ATAPI-7 SATA 1.0a
			F	0 ATA8-APT ATA8-AST
223	M	B	F	Transport Minor version number
224..254				Reserved
255	O		V	Integrity word
		B		15:8 Checksum
		B		7:0 Checksum Validity Indicator

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change.
- V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.
- X – The fixed or variable type of this field is not defined in this standard.

O/M – Mandatory/optional requirement.
- M – Support of the word is mandatory.
- O – Support of the word is optional.

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

7.17.6.2 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 zero to indicate the device is an ATAPI device.

Bits (12:8) of word 0 indicate the command set used by the device. This value follows the peripheral device type as defined in SPC-4 (e.g., 05h indicates a CD/DVD device).

Bit 7 of word 0 is Obsolete.

For PATA devices, bits (6:5) of word 0 indicate the DRQ response time when a PACKET command is received. A value of 00b indicates that the maximum time for a device to set DRQ to one after receiving a PACKET command is 3 ms. The value 01b is obsolete. A value of 10b indicates that the maximum time for a device to set DRQ to one after receiving a PACKET command is 50 μs. The value 11b is reserved.

If bit 2 of word 0 is set to one, then the content of the IDENTIFY PACKET DEVICE data is incomplete. This may occur if the device supports the PUIS feature set and required data is contained on the device media. The content of IDENTIFY DEVICE data 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 and a value of 01b indicates a 16 byte packet. The values 10b and 11b are reserved.

7.17.6.3 Word 1: Reserved

7.17.6.4 Word 2: Specific configuration

Word 2 shall have the same content described for IDENTIFY DEVICE data word 2 (see 7.16.7.4).

7.17.6.5 Words 3..9: Reserved

7.17.6.6 Words 10..19: Serial number

If the ATAPI device does not report the serial number, then the content shall be 0000h in each word. Otherwise, the content shall be as described for IDENTIFY DEVICE data words 10..19 (see 7.16.7).

7.17.6.7 Words 20..22: Reserved

7.17.6.8 Words 23..26: Firmware revision

Words 23..26 shall have the content described for IDENTIFY DEVICE data words 23..26 (see 7.16.7.13).

7.17.6.9 Words 27..46: Model number

Words 27..46 shall have the content described for IDENTIFY DEVICE data words 27..46 (see 7.16.7.14).

7.17.6.10 Words 47..48: Reserved

7.17.6.11 Word 49: Capabilities

Bits (15:12) of word 49 are obsolete.

Bit 11 of word 49 indicates whether a device supports IORDY (see ATA8-APT). If this bit is set to one, then the device supports IORDY (see ATA8-APT) operation. If this bit is cleared to zero, the device may support IORDY (see ATA8-APT). If a device supports PIO mode 3 or higher, then this bit shall be set to one. For SATA devices, this bit shall be set to one.

Bit 10 of word 49 indicates a device's ability to enable or disable the use of IORDY (see ATA8-APT). If this bit is set to one, then the device supports the disabling of IORDY (see ATA8-APT). Disabling and enabling of IORDY (see ATA8-APT) is accomplished using the SET FEATURES command. For SATA devices, 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 that require the DMADIR bit in the PACKET command shall clear this bit to 0

7.17.6.12 Word 50: Capabilities

Word 50 shall have the content described for IDENTIFY DEVICE data word 50 (see 7.16.7.17). Support of this word is mandatory if the STANDBY command is supported.

7.17.6.13 Word 51: Obsolete

7.17.6.14 Word 52: Obsolete

7.17.6.15 Word 53

Word 53 bits (2:0) shall have the content described for IDENTIFY DEVICE data word 53 bits (2:0). Bits (15:3) are reserved.

7.17.6.16 Words 54..61: Reserved

7.17.6.17 Word 62: DMADIR

ATAPI devices may require use of the DMADIR bit to indicate transfer direction for PACKET commands using the DMA data transfer protocol. Word 62 indicates if such support is required.

If word 62 bit 15 is set to one, then the DMADIR bit in the PACKET command is required by the device for PACKET commands using the DMA data transfer protocol and:

a) word 63 bits (2:0);
b) word 49 bit 15;
c) word 49 bit 8; and
d) word 88 bits (6:0),

shall be cleared to zero.

If word 62 bit 15 is cleared to zero, then:

a) the DMADIR bit in the PACKET command is not required; and
b) word 62 shall be cleared to zero.

Bits (14:11) of word 62 are reserved.

If word 62 bit 15 is set to one and word 62 bit:

a) 10 is set to one, then DMA is supported;
b) 10 is cleared to zero, then DMA is not supported;
c) 9 is set to one, then Multiword DMA mode 2 is supported;
d) 9 is cleared to zero, then Multiword DMA mode 2 is not supported;
e) 8 is set to one, then Multiword DMA mode 1 is supported;
f) 8 is cleared to zero, then Multiword DMA mode 1 is not supported;
g) 7 is set to one, then Multiword DMA mode 0 is supported;
h) 7 is cleared to zero, then Multiword DMA mode 0 is not supported;
i) 6 is set to one, then Ultra DMA mode 6 and below are supported;
j) 6 is cleared to zero, then Ultra DMA mode 6 and below are not supported;
k) 5 is set to one, then Ultra DMA mode 5 and below are supported;
l) 5 is cleared to zero, then Ultra DMA mode 5 and below are not supported;
m) 4 is set to one, then Ultra DMA mode 4 and below are supported;
n) 4 is cleared to zero, then Ultra DMA mode 4 and below are not supported;
o) 3 is set to one, then Ultra DMA mode 3 and below are supported;
p) 3 is cleared to zero, then Ultra DMA mode 3 and below are not supported;
q) 2 is set to one, then Ultra DMA mode 2 and below are supported;
r) 2 is cleared to zero, then Ultra DMA mode 2 and below are not supported;
s) 1 is set to one, then Ultra DMA mode 1 and below are supported;
t) 1 is cleared to zero, then Ultra DMA mode 1 and below are not supported;
u) 0 is set to one, then Ultra DMA mode 0 is supported; and
v) 0 is cleared to zero, then Ultra DMA mode 0 is not supported.

7.17.6.18 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.

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

Bits (10:8) of word 63 shall have the content described for IDENTIFY DEVICE data word 63. (see 7.16.7.24)

Bits (7:3) of word 63 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.

For SATA devices:

a) if bit 15 of IDENTIFY PACKET DEVICE data word 62 (see 7.17.6.17) is set to one, then bit 2 of IDENTIFY PACKET DEVICE data word 63 shall be cleared to zero; and

b) if bit 15 of IDENTIFY PACKET DEVICE data word 62 is cleared to zero, then bit 2 of IDENTIFY PACKET DEVICE data word 63 shall be set to one.

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.

For SATA devices:

a) if bit 15 of IDENTIFY PACKET DEVICE data word 62 (see 7.17.6.17) is set to one, then bit 1 of IDENTIFY PACKET DEVICE data word 63 shall be cleared to zero; and
b) if bit 15 of IDENTIFY PACKET DEVICE data word 62 is cleared to zero, then bit 2 of IDENTIFY PACKET DEVICE data word 63 shall be set to one.

If bit 0 of word 63 is set to one, then Multiword DMA mode 0 is supported.

For SATA devices:

a) if bit 15 of IDENTIFY PACKET DEVICE data word 62 (see 7.17.6.17) is set to one, then bit 0 of IDENTIFY PACKET DEVICE data word 63 shall be cleared to zero; and
b) if bit 15 of IDENTIFY PACKET DEVICE data word 62 is cleared to zero, then bit 0 of IDENTIFY PACKET DEVICE data word 63 shall be set to one.

7.17.6.19 Word 64: PIO transfer modes supported

Word 64 shall have the content described for IDENTIFY DEVICE data word 64 (see 7.16.7.25).

7.17.6.20 Word 65: Minimum multiword DMA transfer cycle time per word

Word 65 shall have the content described for IDENTIFY DEVICE data word 65 (see 7.16.7.26).

7.17.6.21 Word 66: Device recommended multiword DMA transfer cycle time

Word 66 shall have the content described for IDENTIFY DEVICE data word 66 (see 7.16.7.27).

7.17.6.22 Word 67: Minimum PIO transfer cycle time without flow control

Word 67 shall have the content described for IDENTIFY DEVICE data word 67 (see 7.16.7.28).

7.17.6.23 Word 68: Minimum PIO transfer cycle time with IORDY

Word 68 shall have the content described for IDENTIFY DEVICE data word 68 (see 7.16.7.29).

7.17.6.24 Words 69..70: Reserved

7.17.6.25 Words 71..72: Obsolete

7.17.6.26 Words 73..74: Reserved

7.17.6.27 Word 75: Obsolete

7.17.6.28 Word 76: Serial ATA Capabilities

Bits (15:11) of word 76 are reserved for SATA.

bits (10:9) of word 76 shall have the content described for IDENTIFY DEVICE data word 76 bits (10:9) (see 7.16.7.34).

Bits (8:3) of word 76 are reserved for SATA.

Bits (2:0) of word 76 shall have the content described for IDENTIFY DEVICE data word 76 bits (2:0) (see 7.16.7.34).

7.17.6.29 Word 77: Reserved for Serial ATA

7.17.6.30 Word 78: Serial ATA features supported

Bits 15:7 of word 78 are reserved for Serial ATA.

Bit 6 of word 78 shall have the content described for IDENTIFY DEVICE data word 78 bit 6 (see 7.16.7.36).

If bit 5 of word 78 is set to one, then the device shall support initiating notification events. If bit 5 of word 78 is cleared to zero, then the device shall not support initiating notification events (See SATA 3.0).

Bit 4 is reserved for Serial ATA.

Bit 3 or word 78 shall have the content described for IDENTIFY DEVICE data word 78 bit 3 (see 7.16.7.36).

Bits 2:1 of word 78 are reserved for Serial ATA.

Bit 0 of word 78 shall be cleared to zero.

7.17.6.31 Word 79: Serial ATA features enabled

Bits 15:7 of word 79 are reserved for Serial ATA.

Bit 6 of word 79 shall have the content described for IDENTIFY DEVICE data word 79 bit 6 (see 7.16.7.37).

If bit 5 of word 79 is set to one, then the device shall support initiating notification events. If bit 5 of word 79 is cleared to zero, then the device shall not support initiating notification events (See SATA 3.0).

Bit 4 of word 79 is reserved for Serial ATA.

Bit 3 of word 79 shall have the content described for IDENTIFY DEVICE data word 79 bit 3 (see 7.16.7.37).

Bits 2:1 of word 79 are reserved for Serial ATA.

Bit 0 of word 79 shall be cleared to zero.

7.17.6.32 Word 80: Major version number

Word 80 shall have the content described for IDENTIFY DEVICE data word 80 (see 7.16.7.38).

7.17.6.33 Word 81: Minor version number

Word 81 shall have the content described for IDENTIFY DEVICE data word 81 (see 7.16.7.39).

7.17.6.34 Words 82..84, 119: Commands and feature sets supported

Words 82..84 and 119 shall have the content described for IDENTIFY DEVICE data words 82..84 and 119 (see 7.16.7.40) except as specified in table 51.

7.17.6.35 Words 85..87, 120: Commands and feature sets supported or enabled

Words 85..87 and 120 shall have the content described for IDENTIFY DEVICE data words 85..87 and 120 (see 7.16.7.41) except as specified in table 51.

7.17.6.36 Word 88:Ultra DMA modes

Word 88 bits (15:7) shall have the content described for IDENTIFY DEVICE data word 88 (see 7.16.7.42). If word 62 bit 15 is cleared to zero then word 88 bits (6:0) shall be the content described for IDENTIFY DEVICE data word 88 (see 7.16.7.42). If word 62 bit 15 is set to one then:

a) word 88 bit 6 may be set to one; and
b) word 88 bits (5:0) shall be cleared to zero.

7.17.6.37 Word 89: Time required for Normal Erase mode SECURITY ERASE UNIT command

Word 89 shall have the content described for IDENTIFY DEVICE data word 89 (see 7.16.7.43).

7.17.6.38 Word 90: Time required for an Enhanced Erase mode SECURITY ERASE UNIT command

Word 90 shall have the content described for IDENTIFY DEVICE data word 90 (see 7.16.7.44).

7.17.6.39 Word 91: Current APM level value

Word 91 shall have the content described for IDENTIFY DEVICE data word 91 (see 7.16.7.45)

7.17.6.40 Word 92: Master Password Identifier

Word 92 shall have the content described for IDENTIFY DEVICE data word 92 (see 7.16.7.46).

7.17.6.41 Word 93: Hardware reset results

Word 93 shall have the content described for IDENTIFY DEVICE data word 93 (see 7.16.7.47).

7.17.6.42 Word 94: Current automatic acoustic management value

Word 94 shall have the content described for IDENTIFY DEVICE data word 94 (see 7.16.7.48).

7.17.6.43 Word 95..107: Reserved

7.17.6.44 Words 108..111: World wide name

Words 108..111 shall have the content described for IDENTIFY DEVICE data words 108..111 (see 7.16.7.58).

7.17.6.45 Words 112..115: Reserved for a 128-bit world wide name

7.17.6.46 Words 116..118: Reserved

7.17.6.47 Words 119..120: See words 82..84 and words 85..87

7.17.6.48 Words 121..124: Reserved

7.17.6.49 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, then 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, then 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 power-on reset or hardware reset.

7.17.6.50 Word 126..127: Obsolete

7.17.6.51 Word 128: Security status

Word 128 shall have the content described for IDENTIFY DEVICE data word 128 (see 7.16.7.66).

7.17.6.52 Words 129..159: Reserved

7.17.6.53 Words 160..167: Reserved for assignment by the CompactFlash Association

7.17.6.54 Words 168..221: Reserved

7.17.6.55 Word 222: Transport major version number

Word 222 shall have the content described for IDENTIFY DEVICE data word 222 (see 7.16.7.85).

7.17.6.56 Word 223: Transport minor version number

Word 223 shall have the content described for IDENTIFY DEVICE data word 223 (see 7.16.7.86).

7.17.6.57 Words 224..254: Reserved

7.17.6.58 Word 255: Integrity word

Word 255 shall have the content described for IDENTIFY DEVICE data word 255 (see 7.16.7.92).

7.18 IDLE - E3h, Non-Data

7.18.1 Feature Set

This 28-bit command is for devices implementing the Power Management feature set (see 4.13).

7.18.2 Description

The IDLE command places the device in the Idle mode and sets the Standby timer. Command completion may occur even though the device has not fully transitioned into the Idle mode.

If the host sets the Count field to 00h, then the device shall disable its Standby timer (see 4.13). If the host sets the Count field to a value > 00h, then table 53 defines the Standby timer value.

See 4.7.4 for interactions with the EPC feature set.

7.18.3 Inputs

See table 52 for the IDLE command inputs.

Table 52 — IDLE command inputs

Name	Description
Feature	Reserved
Count	This value shall determine the time period programmed into the Standby timer. Table 53 defines these values
LBA	Reserved
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E3h

Table 53 — Standby timer periods

Count field	Description
00h	Standby timer disabled
01h-F0h	(value * 5) seconds (i.e., 5 seconds to 1 200 seconds (i.e., 20 minutes))
F1h-FBh	((value - 240) * 30) minutes (i.e., 30 minutes to 330 minutes (i.e., 5.5 hours))
FCh	21 minutes
FDh	Between 8 hours and 12 hours
FEh	Reserved
FFh	21 minutes 15 seconds
Note - Times are approximate.	

7.18.4 Normal Outputs

See table 179.

7.18.5 Error Outputs

See table 198.

7.19 IDLE IMMEDIATE - E1h, Non-Data

7.19.1 Feature Set

This 28-bit command is for devices implementing the Power Management feature set (see 4.13).

7.19.2 Description

7.19.2.1 Default Function

The IDLE IMMEDIATE command places the device in the Idle mode. Command completion may occur even though the device has not fully transitioned into the Idle mode.

See 4.7.4 for interactions with the EPC feature set.

7.19.2.2 Unload feature

The unload feature of the IDLE IMMEDIATE command causes a device that has movable read/write heads to move them to a safe position.

Upon receiving an IDLE IMMEDIATE command with the unload feature, a device shall:

a) stop read look-ahead if that operation is in process;
b) stop writing cached data to the media if that operation is in process;
c) the device shall retract the head(s) onto the ramp if the device implements unloading its head(s) onto a ramp;
d) the device shall park its head(s) in the landing zone if the device implements parking its head(s) in a landing zone on the media; and
e) transition to the Idle mode.

The device shall retain any data in any 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 command with unload feature.

A device shall report command completion after the head(s) have been unloaded or parked.

7.19.3 Inputs (Default Function)

See table 54 for the IDLE IMMEDIATE command inputs.

Table 54 — IDLE IMMEDIATE command inputs

Name	Description
Feature	N/A except when the unload feature is requested, see 7.19.4
Count	N/A except when the unload feature is requested, see 7.19.4
LBA	N/A except when the unload feature is requested, see 7.19.4
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E1h

7.19.4 Inputs (Unload Feature)

See table 55 for the IDLE IMMEDIATE with Unload command inputs.

Table 55 — IDLE IMMEDIATE with Unload command inputs

Name	Description
Feature	44h
Count	00h
LBA	055_4E4Ch
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E1h

7.19.5 Normal Outputs (default)

See table 179.

7.19.6 Normal Outputs (unload feature)

See table 185.

7.19.7 Error Outputs

See table 198.

7.20 NOP - 00h, Non-Data

7.20.1 Feature Set

This 28-bit command is for ATA devices (see 4.2) and ATAPI devices (see 4.3).

7.20.2 Description

The NOP command shall complete with an error.

7.20.3 Inputs

See table 56 for the NOP command inputs.

Table 56 — NOP command inputs

Name	Description
Feature	Subcommand Code (see table 57)
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 00h

Table 57 — NOP Subcommand Code

Subcommand Code	Description	Action
00h	NOP	Return command aborted.
01h-FFh	Obsolete	

7.20.4 Normal Outputs

When processed by a device, this command always fails with an error (see table 57).

The Count and LBA fields retain the values that were present when the NOP command was accepted.

7.20.5 Error Outputs

See table 213.

7.21 PACKET - A0h, Packet

7.21.1 Feature Set

This 28-bit command is for devices implementing the PACKET feature set (see 4.3).

7.21.2 Description

The PACKET command transfers a SCSI CDB (see SPC-4) via a command packet. If the native form of the encapsulated command is shorter than the packet size reported in IDENTIFY PACKET DEVICE data word 0 bits (1:0) (see 7.17.6.2), then the encapsulated command shall begin at byte 0 of the packet. Packet bytes beyond the end of the encapsulated command are reserved.

7.21.3 Inputs

See table 58 for the PACKET command inputs.

Table 58 — PACKET command inputs

Name	Description
Feature	**Bit** **Description** 7:3 Reserved 2 DMADIR - See 7.21.4 1 Obsolete 0 DMA - This bit is set to one to inform the device that the data transfer (i.e., not the command packet transfer) associated with this command is via Multiword DMA or Ultra DMA mode.
Count	**Bit** **Description** 7:3 Obsolete 2:0 N/A
LBA	**Bit** **Description** 27:24 Reserved 23:8 Byte Count Limit - See 7.21.5 7:0 Reserved
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 A0h

7.21.4 DMADIR

The DMADIR bit indicates the direction of the DMA data transfer for the PACKET command and is used only for ATAPI devices that require direction indication from the host. If IDENTIFY PACKET DEVICE data word 62 bit 15 (see 7.17.6.17) is set to one, then the device requires the use of the DMADIR bit for DMA data transfer for PACKET commands.

If the device requires the DMADIR bit to be set to one for a DMA data transfer for a PACKET command (i.e., bit 0, the DMA bit, is set to one), then this bit indicates the direction of data transfer (i.e., 0 = transfer to the device, and 1 = transfer to the host). If the device requires the DMADIR bit to be set for a DMA data transfer for a PACKET command, but the current operation is a PIO data transfer (i.e., bit 0, the DMA bit, is cleared to zero), then this bit is ignored.

Since the data transfer direction is 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 to be set for a DMA data transfer for a PACKET command, then this bit should be cleared to zero.

A device that does not support the DMADIR feature may return command aborted for a command if the DMADIR bit is set to one.

7.21.5 Byte Count Limit

The Byte Count Limit is the maximum byte count that is to be transferred in any single DRQ data block for PIO transfers. The Byte Count Limit does not apply to the command packet transfer. If the PACKET command does not transfer data, the Byte Count Limit is ignored.

NOTE 15 — The amount of data transferred by this command is specified in the CDB (see SBC-3).

If the PACKET command results in a data transfer, then:

a) the host should not set the Byte Count Limit to zero (see 7.17.6.49);
b) if the total requested data transfer length is greater than the Byte Count Limit, then the value set into the Byte Count Limit shall be even;
c) if the total requested data transfer length is equal to or less than the Byte Count Limit, then the value set into the Byte Count Limit may be odd; and
d) the value FFFFh shall be interpreted by the device as though the value were FFFEh.

7.21.6 Normal Outputs

7.21.6.1 Awaiting command

When the device is ready to accept the command packet from the host the return structure shall be set according to table 186. The Input/Output bit shall be cleared to zero, and the Command/Data bit shall be set to one. The Byte Count Limit shall reflect the value set by the host when the command was issued.

7.21.6.2 Data transmission

Data transfer shall occur after the receipt of the command packet. See table 186 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.

If the transfer is to be in PIO mode, then the byte count of the data to be transferred for this DRQ data block shall be:

a) not equal to zero;
b) less than or equal to the byte count limit value received from the host;
c) less than or equal to FFFEh; and
d) even if this is not the last transfer of a command.

If this is the last transfer for a command in PIO mode, then the byte count for the DRQ data block may be odd. If the byte count for the DRQ data block is odd, then the last byte transferred shall be a pad byte (i.e., to make the total number of bytes transferred be even). The value of the pad byte is undefined.

7.21.6.3 Successful command completion

When the device has command completion without error, the device returns the data structure found in table 186. Input/Output shall be set to one, Command/Data shall be set to one. Byte Count is reserved at command completion.

7.21.7 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 table 214.

7.22 READ BUFFER - E4h, PIO Data-In

7.22.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.22.2 Description

The READ BUFFER command enables the host to read a 512-byte block of data.

The READ BUFFER command and WRITE BUFFER command shall be synchronized such that sequential WRITE BUFFER command and READ BUFFER command access the same data.

The command prior to a READ BUFFER command should be a WRITE BUFFER command. If the READ BUFFER command is not preceded by a WRITE BUFFER command, the data returned by READ BUFFER command may be indeterminate.

7.22.3 Inputs

See table 59 for the READ BUFFER command inputs.

Table 59 — READ BUFFER command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E4h

7.22.4 Normal Outputs

See table 179.

7.22.5 Error Outputs

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 199.

NOTE 16 — There is no defined mechanism for a device to return an Interface CRC 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 may verify that an Interface CRC error occurred in these cases.

7.23 READ BUFFER DMA - E9h, DMA

7.23.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.23.2 Description

See 7.22.2.

7.23.3 Inputs

See table 60 for the READ BUFFER DMA command inputs.

Table 60 — READ BUFFER DMA command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E9h

7.23.4 Normal Outputs

See 7.22.4.

7.23.5 Error Outputs

See 7.22.5.

7.24 READ DMA - C8h, DMA

7.24.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.24.2 Description

The READ DMA command allows the host to read data using the DMA data transfer protocol.

7.24.3 Inputs

See table 61 for the READ DMA command inputs.

Table 61 — READ DMA command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 C8h

7.24.4 Normal Outputs

See table 179.

7.24.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred. The validity of the data transferred is indeterminate. See table 206.

7.25 READ DMA EXT - 25h, DMA

7.25.1 Feature Set

This 48-bit command is for devices implementing the 48-bit Address feature set (see 4.4).

7.25.2 Description

The READ DMA EXT command allows the host to read data using the DMA data transfer protocol.

7.25.3 Inputs

See table 62 for the READ DMA EXT command inputs.

Table 62 — READ DMA EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 25h

7.25.4 Normal Outputs

See table 189.

7.25.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred. The validity of the data transferred is indeterminate. See table 204.

7.26 READ FPDMA QUEUED - 60h, DMA Queued

7.26.1 Feature Set

This 48-bit command is for devices implementing the NCQ feature set (see 4.12).

7.26.2 Description

The READ FPDMA QUEUED command requests data to be transferred from the device to the host.

7.26.3 Inputs

7.26.3.1 Overview

See table 63 for the READ FPDMA QUEUED command inputs.

Table 63 — READ FPDMA QUEUED command inputs

Name	Description
Feature	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred
Count	**Bit Description** 15 PRIO - See 7.26.3.2 14:8 Reserved 7:3 NCQ Tag - See 6.5.2 2:0 N/A
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 FUA - See 7.26.3.3 6 Shall be set to one 5 Reserved 4 Shall be set to zero 3:0 Reserved
Command	7:0 60h

7.26.3.2 Priority (PRIO)

The Priority (PRIO) value shall be assigned by the host based on the priority of the command issued. If PRIO is set to one, then the command shall be high priority. If PRIO is cleared to zero, then the command shall be normal priority. The device shall make a best effort to complete high priority requests in a more timely fashion than normal priority requests.

7.26.3.3 Forced Unit Access (FUA)

When the FUA bit is set to one the device shall retrieve the data from the non-volatile media regardless of whether the device holds the requested information in its volatile cache. If the device holds a modified copy of the requested data as a result of having volatile cached writes, the modified data shall be written to the non-volatile media before being retrieved from the non-volatile media as part of this operation. When the FUA bit is cleared to zero the data shall be retrieved either from the device's non-volatile media or cache.

7.26.4 Command Acceptance Outputs

See table 190.

7.26.5 Normal Outputs

See table 191.

7.26.6 Error Outputs

This return indicates that the command was aborted due to LBA out of range, a duplicate tag number, an invalid tag number, or an Interface CRC error, see table 219 for more information.

Errors that occur during the processing of this command are reported by returning a transport dependent indicator with additional information available in the NCQ Command Error log. The validity of the data transferred is indeterminate. See table 221.

7.27 READ LOG EXT - 2Fh, PIO Data-In

7.27.1 Feature Set

This 48-bit command is for devices implementing the GPL feature set (see 4.9).

7.27.2 Description

The READ LOG EXT command returns the specified log to the host. See table A.2 for the list of logs.

7.27.3 Inputs

7.27.3.1 Overview

All the logs in this standard reserve the Feature field unless otherwise specified. See table 64 for the READ LOG EXT command inputs.

Table 64 — READ LOG EXT command inputs

Name	Description
Feature	Log Specific
Count	Block Count - See 7.27.3.2
LBA	**Bit** **Description** 47:40 Reserved 39:32 Page # (15:8) - See 7.27.3.4. 31:16 Reserved 15:8 Page # (7:0) - See 7.27.3.4. 7:0 Log Address - See 7.27.3.3.
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 2Fh

7.27.3.2 Block Count

Specifies the number of 512-byte blocks of data to be read from the specified log. The log transferred by the device shall start at the block of data in the specified log at the specified offset, regardless of the block count requested. A value of zero is illegal and shall result in command aborted.

7.27.3.3 Log Address

Specifies the log to be read as described in table A.2. 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.

7.27.3.4 Page

Specifies the first log page (see 3.1.47) to be read from the specified log address. The first page number shall be zero.

7.27.4 Normal Outputs

See table 189.

7.27.5 Error Outputs

A device shall return command aborted if:

a) the feature set associated with the log specified in the LBA field (7:0) is not supported or not enabled;
b) the values in other fields are invalid (e.g., the Count field is cleared to zero); or
c) the value in the Page # field plus the value in the Count field is larger than the log size reported in the General Purpose Log Directory.

A device may return command aborted if an Interface CRC error has occurred. The validity of the data transferred is indeterminate.

See table 205.

NOTE 17 — There is no defined mechanism for a device to return an Interface CRC 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 may verify that an Interface CRC error occurred in these cases.

7.28 READ LOG DMA EXT - 47h, DMA

7.28.1 Feature Set

This 48-bit command is for devices implementing the General Purpose Logging feature set (see 4.9).

7.28.2 Description

See 7.27.2.

7.28.3 Inputs

All the logs in this standard reserve the Feature field unless otherwise specified. See table 65 for the READ LOG DMA EXT command inputs.

Table 65 — READ LOG DMA EXT command inputs

Name	Description
Feature	Log Specific
Count	Block Count - See 7.27.3.2
LBA	**Bit Description** 47:40 Reserved 39:32 Page # (15:8) - See 7.27.3.4. 31:16 Reserved 15:8 Page # (7:0) - See 7.27.3.4. 7:0 Log Address - See 7.27.3.3.
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 47h

7.28.4 Normal Outputs

See 7.27.4.

7.28.5 Error Outputs

See 7.27.5.

7.29 READ MULTIPLE - C4h, PIO Data-In

7.29.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.29.2 Description

The READ MULTIPLE 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 IDENTIFY DEVICE data word 59 (see 7.16.7.21). The device shall interrupt (See ATA8-APT and ATA8-AST) for each DRQ data block transferred.

If the number of requested logical sectors is not evenly divisible by the DRQ data block count (see 7.46), as many full DRQ data blocks as possible are transferred, followed by a final, partial DRQ data block transfer.

Device errors encountered during READ MULTIPLE commands are returned at the beginning of the DRQ data block or partial DRQ data block transfer.

If a READ MULTIPLE command is received by the device and:

a) IDENTIFY DEVICE data word 59 bit 8 (see 7.16.7.21) is cleared to zero; or
b) IDENTIFY DEVICE data word 59 bit 8 (see 7.16.7.21) is set to one and IDENTIFY DEVICE data word 59 bits 7:0 are set to zero,

then the device shall return command aborted. A successful SET MULTIPLE MODE command should precede a READ MULTIPLE command.

7.29.3 Inputs

See table 66 for the READ MULTIPLE command inputs.

Table 66 — READ MULTIPLE command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 C4h

7.29.4 Normal Outputs

See table 179.

7.29.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred. The validity of the data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 206.

NOTE 18 — There is no defined mechanism for a device to return an Interface CRC 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 may verify that an Interface CRC error occurred in these cases.

7.30 READ MULTIPLE EXT - 29h, PIO Data-In

7.30.1 Feature Set

This 48-bit command is for all devices implementing the 48-bit Address feature set (see 4.4).

7.30.2 Description

The READ MULTIPLE EXT 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 IDENTIFY DEVICE data word 59 (see 7.16.7.21). The device shall interrupt for each DRQ data block transferred.

If the number of requested logical sectors is not evenly divisible by the DRQ data block count (see 7.46), as many full DRQ data blocks as possible are transferred, followed by a final, partial DRQ data block transfer.

Device errors encountered during READ MULTIPLE EXT commands are returned at the beginning of the DRQ data block or partial DRQ data block transfer.

If IDENTIFY DEVICE data word 59 bit 8 (see 7.16.7.21) is cleared to zero, and a READ MULTIPLE EXT command is received by the device, and no successful SET MULTIPLE MODE command has been processed by the device, the device shall return command aborted. A successful SET MULTIPLE MODE command should precede a READ MULTIPLE EXT command.

7.30.3 Inputs

See table 67 for the READ MULTIPLE EXT command inputs.

Table 67 — READ MULTIPLE EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 29h

7.30.4 Normal Outputs

See table 189.

7.30.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred. The validity of the data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 216.

NOTE 19 — There is no defined mechanism for a device to return an Interface CRC 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 may verify that an Interface CRC error occurred in these cases.

7.31 READ SECTOR(S) - 20h, PIO Data-In

7.31.1 Feature Set

This 28-bit command is for ATA devices (see 4.2) and ATAPI devices (see 4.3).

7.31.2 Description

The READ SECTOR(S) command reads a maximum of 256 logical sectors as specified in the Count field. The transfer shall begin at the logical sector specified in the LBA field.

7.31.3 Inputs

See table 68 for the READ SECTOR(S) command inputs.

Table 68 — READ SECTOR(S) command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 20h

7.31.4 Outputs

7.31.5 Normal Outputs

See table 179.

7.31.6 Outputs for PACKET feature set devices

In response to this command, ATAPI shall report command aborted and place the ATAPI device signature in the LBA field (23:8), see table 184 for the list of signatures.

7.31.7 Error Outputs

The validity of the data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 206.

NOTE 20 — There is no defined mechanism for a device to return an Interface CRC 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 may verify that an Interface CRC error occurred in these cases.

7.32 READ SECTOR(S) EXT - 24h, PIO Data-In

7.32.1 Feature Set

This 48-bit command is for devices implementing the 48-bit Address feature set (see 4.4).

7.32.2 Description

The READ SECTOR(S) EXT command reads a maximum of 65 536 logical sectors as specified in the Count field. The transfer shall begin at the logical sector specified in the LBA field.

7.32.3 Inputs

See table 69 for the READ SECTOR(S) EXT command inputs.

Table 69 — READ SECTOR(S) EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit** **Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 24h

7.32.4 Normal Outputs

See table 189.

7.32.5 Error Outputs

The validity of the data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 216.

NOTE 21 — There is no defined mechanism for a device to return an Interface CRC 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 may verify that an Interface CRC error occurred in these cases.

7.33 READ STREAM DMA EXT - 2Ah, DMA

7.33.1 Feature Set

This 48-bit command is for devices that implement the Streaming feature set (see 4.20).

7.33.2 Description

The READ STREAM DMA EXT command provides a method for a host to read data within an allotted time. This command allows the host to specify that additional actions are to be performed by the device prior to the completion of the command.

7.33.3 Inputs

7.33.3.1 Inputs Overview

See table 70 for the READ STREAM DMA EXT command inputs.

Table 70 — READ STREAM DMA EXT command inputs

Name	Description
Feature	**Bit Description** 15:8 Command Completion Time Limit (CCTL) - See 7.33.3.2 7 Obsolete 6 Read Continuous (RC) - See 7.33.3.3 5 Not Sequential (NS) – See 7.33.3.4 4 Obsolete 3 Reserved 2:0 Stream ID – See 7.33.3.5
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 2Ah

7.33.3.2 Command Completion Time Limit (CCTL)

the CCTL field specifies the time allowed for the device to process the command before reporting command completion.

If the CCTL field is not cleared to zero, then the device shall report command completion within (CCTL * (IDENTIFY DEVICE data words 98..99 (see 7.16.7.52)) microseconds. The device shall measure the time before reporting command completion from command acceptance.

If the CCTL field is cleared to zero, and the Default CCTL field was not set to zero in the most recent CONFIGURE STREAM command (see 7.8) for the Stream ID, then the device shall report command completion within the time specified by the Default CCTL field (see 7.8.3.4).

If the CCTL field is cleared to zero, and the Default CCTL field was set to zero in the most recent CONFIGURE STREAM command (see 7.8) for the Stream ID, or the CCTL field is set 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.

7.33.3.3 Read Continuous (RC)

If the RC bit is set to one, then:

a) the device shall not stop processing the command due to errors associated with reading the media;
b) if an error occurs during data transfer, while reading data from the media before command completion, before the amount of time allowed for command completion based on the setting of the CCTL field (see 7.33.3.2), or the Default CCTL field (see 7.8.3) 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 the CCTL field (see 7.33.3.2) or the Default CCTL field (see 7.8.3) is reached, then the device:
    1) shall stop processing the command;
    2) shall report command completion; and
    3) shall set the Command Completion Time Out bit in the Read Streaming Error log to one.

If the RC bit 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.

7.33.3.4 Not Sequential (NS)

If the NS bit 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.

7.33.3.5 Stream ID

The Stream ID field 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.

7.33.4 Normal Outputs

See table 183 for the definition of Normal Outputs.

7.33.5 Error Outputs

If:

a) the RC bit was set to one in the READ STREAM DMA EXT command, and
b) the device is able to return the amount of data requested for the READ STREAM DMA EXT command (e.g., an error occurred while reading from the media),

then the device shall set the Stream Error bit to one and clear the Error bit to zero.

If:

a) the RC bit was set to one in the READ STREAM DMA EXT command, and
b) the device is not able to return the amount of data requested for the READ STREAM DMA EXT command (e.g., an Interface CRC error is reported at command completion),

then the device shall clear Stream Error bit to zero and set the Error bit to one.

If:

a) the RC bit was cleared to zero;

b) the CCTL field was not set to zero, or the CCTL field was cleared to zero and the Default CCTL field specified in the most recent CONFIGURE STREAM command for the Stream ID (see 7.8) was not cleared to zero; and
c) the time specified for command completion by the CCTL field (see 7.33.3.2) or the Default CCTL field (see 7.8.3) has been reached,

in the READ STREAM EXT command, then the device shall clear the Stream Error bit to zero, set the Error bit to one, and set:

a) the Command Completion Timeout bit to one; or
b) the Abort bit to one.

If:

a) the RC bit was cleared to zero;
b) the CCTL field was cleared to zero; and
c) the Default CCTL field was cleared to zero in the most recent CONFIGURE STREAM command for the Stream ID (see 7.8),

in the READ STREAM EXT command, then the device shall clear the Stream Error bit to zero, set the Error bit to one, Interface CRC bit to one, ID Not Found bit to one, and/or Abort bit to one (i.e., indicating the error type).

The validity of the data transferred is indeterminate. See table 207.

7.34 READ STREAM EXT - 2Bh, PIO Data-In

7.34.1 Feature Set

This 48-bit command is for devices that implement the Streaming feature set (see 4.20).

7.34.2 Description

See 7.33.2.

7.34.3 Inputs

See table 71 for the READ STREAM EXT command inputs.

Table 71 — READ STREAM EXT command inputs

Name	Description
Feature	**Bit Description** 15:8 Command Completion Time Limit (CCTL) - See 7.33.3.2 7 Obsolete 6 Read Continuous (RC) - See 7.33.3.3 5 Not Sequential (NS) – See 7.33.3.4 4 Obsolete 3 Reserved 2:0 Stream ID – See 7.33.3.5
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 2Bh

7.34.4 Normal Outputs

See 7.33.4.

7.34.5 Error Outputs

See 7.33.5.

7.35 READ VERIFY SECTOR(S) - 40h, Non-Data

7.35.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.35.2 Description

The READ VERIFY SECTOR(S) command verifies a maximum of 256 logical sectors as specified in the Count field, without transferring data to the application client. The device shall begin verifying at the logical sector specified in the LBA field. The device shall read the data from the non-volatile media and verify that there are no errors.

7.35.3 Inputs

See table 72 for the READ VERIFY SECTOR(S) command inputs.

Table 72 — READ VERIFY SECTOR(S) command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be verified. A value of 00h indicates that 256 logical sectors are to be verified
LBA	LBA of first logical sector to be verified
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 40h

7.35.4 Normal Outputs

See table 179.

7.35.5 Error Outputs

See table 206.

7.36 READ VERIFY SECTOR(S) EXT - 42h, Non-Data

7.36.1 Feature Set

This 48-bit command is for devices implementing the 48-bit Address feature set (see 4.4).

7.36.2 Description

The READ VERIFY SECTOR(S) EXT command verifies a maximum of 65 536 logical sectors as specified in the Count field, without transferring data to the application client. The device shall begin verifying at the logical sector specified in the LBA field. The device shall read the data from the non-volatile media and verify that there are no errors.

7.36.3 Inputs

See table 73 for the READ VERIFY SECTOR(S) EXT command inputs.

Table 73 — READ VERIFY SECTOR(S) EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be verified. A value of 0000h indicates that 65 536 logical sectors are to be verified
LBA	LBA of first logical sector to be verified
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 42h

7.36.4 Normal Outputs

See table 189.

7.36.5 Error Outputs

See table 216.

7.37 REQUEST SENSE DATA EXT - 0Bh, Non-Data

7.37.1 Feature Set

This 48-bit command is for devices implementing the Sense Data Reporting feature set (see 4.18).

7.37.2 Description

The REQUEST SENSE DATA EXT command allows the reporting of the most recent sense data from the device.

7.37.3 Inputs

See table 74 for the REQUEST SENSE DATA EXT command inputs.

Table 74 — REQUEST SENSE DATA EXT command inputs

Name	Description
Feature	Reserved
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 0Bh

7.37.4 Normal Outputs

When sense data is available, the sense key, additional sense code, and additional sense code qualifier fields shall be set to values that are defined in the SPC-4 standard. Otherwise, the sense key, additional sense code, and additional sense code qualifier shall be cleared to zero.

See table 192.

7.37.5 Error Outputs

See table 198.

7.38 Sanitize Device

7.38.1 Sanitize Device Overview

Individual Sanitize Device commands are identified by the value placed in the Feature field. Table 75 shows these Feature field values.

Table 75 — Sanitize Device Feature Field Values

Value	Command
0000h	SANITIZE STATUS EXT (see 7.38.6)
0001h..0010h	Reserved
0011h	CRYPTO SCRAMBLE EXT (see 7.38.3)
0012h	BLOCK ERASE EXT (see 7.38.2)
0013h	Reserved
0014h	OVERWRITE EXT (see 7.38.4)
0015h..001Fh	Reserved
0020h	SANITIZE FREEZE LOCK EXT (see 7.38.5)
0021h..FFFFh	

7.38.2 BLOCK ERASE EXT – B4h/0012h, Non-Data

7.38.2.1 Feature Set

This 48-bit command is for devices that implement the Sanitize Device feature set (see 4.15).

7.38.2.2 Description

The BLOCK ERASE EXT command shall start a sanitize operation that shall cause block erase operations on the internal media that stores user data. The BLOCK ERASE EXT command shall render data held in caches unreadable.

The BLOCK ERASE EXT command shall only be reported as supported if the internal media supports block erase operations.

After the block erase method has been successfully applied, the contents of the user data area are indeterminate.

The BLOCK ERASE EXT command shall only be processed if:

a) the Sanitize Device feature set is supported;
b) the BLOCK ERASE EXT command is supported; and
c) the device is in the Sanitize Idle state, the Sanitize Operation Failed state, or the Sanitize Operation Succeeded state.

7.38.2.3 Inputs

7.38.2.3.1 Overview

See table 76 for the BLOCK ERASE EXT command inputs.

Table 76 — BLOCK ERASE EXT command inputs

Name	Description
Feature	0012h
Count	**Bit Description** 15:5 Reserved 4 Failure Mode (see 7.38.2.3.2) 3:0 Reserved
LBA	**Bit Description** 47:32 Reserved 31:0 426B_4572h
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B4h

7.38.2.3.2 Failure Mode

If the Failure Mode bit is set to one, then the device may exit the Sanitize Operation Failed state with successful processing of a SANITIZE STATUS EXT command. If the Failure Mode bit is cleared to zero, then the Sanitize Operation Failed state shall only allow additional Sanitize operations (see figure 9).

7.38.2.4 Normal Outputs

See table 193.

7.38.2.5 Error Output

The Abort bit shall be set to one if a SANITIZE DEVICE FREEZE LOCK EXT command has successfully completed since the last power-on reset. See table 222.

7.38.3 CRYPTO SCRAMBLE EXT – B4h/0011h, Non-Data

7.38.3.1 Feature Set

This 48-bit command is for devices that implement the Sanitize Device feature set (see 4.15).

7.38.3.2 Description

The CRYPTO SCRAMBLE EXT command shall start a sanitize operation which shall change the internal encryption keys that are used for user data. The CRYPTO SCRAMBLE EXT command shall render data held in caches unreadable.

The CRYPTO SCRAMBLE EXT command shall only be reported as supported if all user data is affected by changing internal encryption keys.

After a successful cryptographic scramble, the contents of the user data area may be indeterminate.

The CRYPTO SCRAMBLE EXT command shall only be processed if:

a) the Sanitize Device feature set is supported; and
b) the device is in the Sanitize Idle state, the Sanitize Operation Failed state, or the Sanitize Operation Succeeded state.

7.38.3.3 Inputs

See table 77 for the CRYPTO SCRAMBLE EXT command inputs.

Table 77 — CRYPTO SCRAMBLE EXT command inputs

Name	Description
Feature	0011h
Count	**Bit Description** 15:5 Reserved 4 Failure Mode (see 7.38.2.3.2) 3:0 Reserved
LBA	**Bit Description** 47:32 Reserved 31:0 4372_7970h
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B4h

7.38.3.4 Normal Outputs

See table 193.

7.38.3.5 Error Output

The Abort bit shall be set to one if a SANITIZE DEVICE FREEZE LOCK EXT command has successfully completed since the last power-on reset. See table 222.

7.38.4 OVERWRITE EXT – B4h/0014h, Non-Data

7.38.4.1 Feature Set

This 48-bit command is for devices that implement the Sanitize Device feature set (see 4.15).

7.38.4.2 Description

The OVERWRITE EXT command shall start a sanitize operation which fills the user data area with a four byte pattern passed in the LBA field of the command. Parameters for the OVERWRITE EXT command include a count for multiple overwrites and the option to invert the four byte pattern between consecutive overwrite passes. The OVERWRITE EXT command shall render data held in caches unreadable.

After the overwrite method has been successfully applied, affected data blocks shall be readable without error.

The OVERWRITE EXT command shall only be processed if:

a) the Sanitize Device feature set is supported; and
b) the device is in the Sanitize Idle state, the Sanitize Operation Failed state, or the Sanitize Operation Succeeded state.

7.38.4.3 Inputs

See table 78 for the OVERWRITE EXT command inputs.

Table 78 — OVERWRITE EXT command inputs

Name	Description
Feature	0014h
Count	**Bit Description** 15:8 Reserved 7 Invert pattern between overwrite operations 6:5 Reserved 4 Failure Mode (see 7.38.2.3.2) 3:0 Count of OVERWRITE operations, a count of zero requests sixteen overwrites
LBA	**Bit Description** 47:32 4F57h 31:0 Overwrite pattern (DWord)
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B4h

7.38.4.4 Normal Outputs

See table 193.

7.38.4.5 Error Output

The Abort bit shall be set to one if a SANITIZE DEVICE FREEZE LOCK EXT command has successfully completed since the last power-on reset. See table 222.

7.38.5 SANITIZE FREEZE LOCK EXT – B4h/0020h, Non-Data

7.38.5.1 Feature Set

This 48-bit command is for devices that implement the Sanitize Device feature set (see 4.15).

7.38.5.2 Description

The SANITIZE FREEZE LOCK EXT command shall set the device to the Sanitize Frozen state. After command completion all Sanitize commands other than SANITIZE STATUS EXT command shall return command aborted. Sanitize Frozen state shall be disabled by power-off or hardware reset.

7.38.5.3 Inputs

See table 79 for the SANITIZE FREEZE LOCK EXT command inputs.

Table 79 — SANITIZE FREEZE LOCK EXT command inputs

Name	Description
Feature	0020h
Count	Reserved
LBA	**Bit** **Description** 47:32 Reserved 31:0 4672_4C6Bh
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B4h

7.38.5.4 Normal Outputs

See table 193.

7.38.5.5 Error Output

See table 222.

7.38.6 SANITIZE STATUS EXT – B4h/0000h, Non-Data

7.38.6.1 Feature Set

This 48-bit command is for devices that implement the Sanitize Device feature set (see 4.15).

7.38.6.2 Description

The SANITIZE STATUS EXT command returns information about current or previously completed Sanitize operations. This includes:

a) progress indication on a current Sanitize operation;
b) whether a previous Sanitize operation completed successfully or unsuccessfully; and
c) if an unsupported sanitize device command was received.

The SANITIZE STATUS EXT command may be processed at any phase in the Sanitize Device sequence.

7.38.6.3 Inputs

7.38.6.3.1 Overview

See table 80 for the SANITIZE STATUS EXT command inputs.

Table 80 — SANITIZE STATUS EXT command inputs

Name	Description
Feature	0000h
Count	**Bit Description** 15:1 Reserved 0 Clear Sanitize Operation Failed
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B4h

7.38.6.3.2 Clear Sanitize Operation Failed

If in a Sanitize operation:

a) the Failure Mode bit was set to one in the Sanitize Device command that caused the Sanitize operation;
b) the Sanitize operation failed; and
c) the Clear Sanitize Operation Failed bit is set to one in the SANITIZE STATUS EXT command,

then the Sanitize state machine shall transition from the Sanitize Failed state to the Sanitize Idle state.

If Clear Sanitize Operation Failed bit is set to one in the SANITIZE STATUS EXT command, and the Failure Mode bit was set to zero in the Sanitize Device command that caused the Sanitize operation, the SANITIZE STATUS EXT command shall return command aborted.

7.38.6.4 Normal Outputs

See table 193.

7.38.6.5 Error Output

After the Sanitize operation has completed, if any physical sector that is available to be allocated for user data was not successfully sanitized, then this command shall return the Abort bit set to one. See table 222.

7.39 SECURITY DISABLE PASSWORD - F6h, PIO Data-Out

7.39.1 Feature Set

This 28-bit command is for devices that implement the Security feature set (see 4.16).

7.39.2 Description

The SECURITY DISABLE PASSWORD command transfers 512 bytes of data from the host. Table 82 defines the content of this information.

If the password selected by word 0 (see table 82) matches the password previously saved by the device, then the device shall disable the User password, and return the device to the SEC1 state (see figure 10).

This command shall not change the Master password or the Master Password Identifier (see 4.16.11).

If security is disabled, then:

a) if the Identifier bit is cleared to zero (i.e., compare User password), then the device shall return command aborted; or
b) if the Identifier bit is set to one (i.e., compare Master password), then the device may compare the password supplied with the stored Master password.

If security is enabled and the Master Password Capability bit (see 4.16.3) is cleared to zero (i.e., High), then:

a) if the Identifier bit is set to one (i.e., compare Master password), then the password supplied shall be compared with the stored Master password; or
b) if the Identifier bit is cleared to zero (i.e., compare User password), then the password supplied shall be compared with the stored User password.

If security is enabled and the Master Password Capability bit (see 4.16.3) is set to one (i.e., Maximum), then:

a) if the Identifier bit is set to one (i.e., compare Master password), then the device shall return command aborted, even if the supplied Master password is valid; or
b) if the Identifier bit is cleared to zero (i.e., compare User password), then the password supplied shall be compared with the stored User password.

Upon successful completion of this command, fields in IDENTIFY DEVICE data or the IDENTIFY PACKET DEVICE data shall be updated as follows:

a) word 85, bit 1 (see 7.16.7.41) shall be cleared to zero (i.e., there is no active User password);
b) word 128, bit 1 (see 7.16.7.66) shall be equal to word 85, bit 1 (see 7.16.7.41); and
c) word 128, bit 8 (see 7.16.7.66) shall be cleared to zero (i.e., the Master Password Capability is not Maximum).

7.39.3 Inputs

See table 81 for the SECURITY DISABLE PASSWORD command inputs.

Table 81 — SECURITY DISABLE PASSWORD command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 F6h

7.39.4 Normal Outputs

See table 179.

7.39.5 Error Outputs

The device shall return command aborted if:

a) the Security feature set is not supported;
b) security is Locked (i.e., the device is in SEC4 state (see figure 10));
c) security is Frozen (i.e., the device is in SEC2 state or SEC6 state (see figure 10)); or
d) the password received in the data for the command does not match the password previously saved by the device.

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 199.

7.39.6 Output From the Host to the Device Data Structure

Table 82 — SECURITY DISABLE PASSWORD data content

Word	Description
0	Control word **Bit** **Field Name** **Description** 15:1 Reserved 0 Identifier 0=compare User password 1=compare Master password
1..16	Password (32 bytes)
17..255	Reserved

7.40 SECURITY ERASE PREPARE - F3h, Non-Data

7.40.1 Feature Set

This 28-bit command is for devices that implement the Security feature set (see 4.16).

7.40.2 Description

The SECURITY ERASE PREPARE command shall be issued immediately before the SECURITY ERASE UNIT command.

7.40.3 Inputs

See table 83 for the SECURITY ERASE PREPARE command inputs.

Table 83 — SECURITY ERASE PREPARE command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 F3h

7.40.4 Normal Outputs

See table 179.

7.40.5 Error Outputs

The Abort bit shall be set to one if the device is in Frozen mode. See table 198.

7.41 SECURITY ERASE UNIT - F4h, PIO Data-Out

7.41.1 Feature Set

This 28-bit command is for devices that implement the Security feature set (see 4.16).

7.41.2 Description

The SECURITY ERASE UNIT command transfers 512-bytes of data from the host. Table 85 defines the content of this information.

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 and the previous command was not a successful SECURITY ERASE PREPARE command, the device shall return command aborted for the SECURITY ERASE UNIT command.

When security is disabled and the Identifier bit (see table 85) is cleared to zero (i.e.,compare User password), then the device shall return command aborted.

When security is enabled:

a) Identifier bit (see table 85) is set to one (i.e.,compare Master password), then the password supplied shall be compared with the stored Master password; or
b) Identifier bit (see table 85) is cleared to zero (i.e.,compare User password), then the password supplied shall be compared with the stored User password.

When Normal Erase mode (see table 85) is specified, the SECURITY ERASE UNIT command shall replace the contents of LBA 0 to the LBA reported by:

a) If DCO is supported, then the value reported in DEVICE CONFIGURATION IDENTIFY; or
b) If DCO is not supported, then the value reported in 4.1.

IDENTIFY DEVICE data word 89 (see 7.16.7.43) or IDENTIFY PACKET DEVICE data word 89 (see 7.17.6.37) gives an estimate of the time required to complete the erasure.

IDENTIFY DEVICE data word 128 bit 5 (see 7.16.7.66) or IDENTIFY PACKET DEVICE data word 128 bit 5 (see 7.17.6.51) indicates whether the mode is supported. When Enhanced Erase mode is specified, the device shall write vendor specific data patterns from LBA 0 to the Maximum LBA reported in 4.12.4. In Enhanced Erase mode, all previously written user data shall be overwritten, including sectors that are no longer in use due to reallocation. IDENTIFY DEVICE data word 90 (see 7.16.7.44) or IDENTIFY PACKET DEVICE data word 90 (see 7.17.6.38) gives an estimate of the time required to complete the erasure.

> Editor's Note 10: The 4.12.4 in the paragraph above is bogus, but it is what f10204r0 said to put there and this editor cannot determine a correct replacement.

On successful completion, this command shall disable Security (e.g., returns the device to SEC1 state (see figure 10)), and invalidate any existing User password. Any previously valid Master password and Master Password Identifier remains valid.

Upon successful completion, the fields in the IDENTIFY DEVICE data (see table 46) or the IDENTIFY PACKET DEVICE data (see table 51) shall be updated as follows:

a) word 85, bit 1 shall be cleared to zero (i.e., there is no active User password);
b) word 128, bit 1 shall be cleared to zero (i.e., there is no active User password); and
c) word 128, bit 8 shall be cleared to zero (i.e., the Master Password Capability is set to High).

7.41.3 Inputs

See table 84 for the SECURITY ERASE UNIT command inputs.

Table 84 — SECURITY ERASE UNIT command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 F4h

7.41.4 Normal Outputs

See table 179.

7.41.5 Error Outputs

The device shall return command aborted if:

a) this command was not immediately preceded by a SECURITY ERASE PREPARE command;
b) Enhanced mode was requested but the device does not support that mode;
c) the password received in the data for the command does not match the password previously saved by the device;
d) an invalid password was specified; or
e) if the data area is not successfully overwritten.

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 199.

7.41.6 Output From the Host to the Device Data Structure

Table 85 — SECURITY ERASE UNIT data content

Word	Description
0	Control word **Bit Field Name Description** 15:2 Reserved 1 Erase mode 0=Normal Erase 1=Enhanced Erase 0 Identifier 0=Compare User password 1=Compare Master password
1..16	Password (32 bytes)
17..255	Reserved

7.42 SECURITY FREEZE LOCK - F5h, Non-Data

7.42.1 Feature Set

This 28-bit command is for devices that implement the Security feature set (see 4.16).

7.42.2 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 return command aborted. Frozen mode shall be disabled by power-off or hardware reset. If a SECURITY FREEZE LOCK command is issued when the device is in Frozen mode, then the command executes and the device shall remain in Frozen mode.

See table 10 for a list of commands disabled by the SECURITY FREEZE LOCK command.

Upon successful completion, IDENTIFY DEVICE data word 128 bit 3 (see 7.16.7.66) or IDENTIFY PACKET DEVICE data word 128 bit 3 (see 7.17.6.51) shall be set to one.

7.42.3 Inputs

See table 86 for the SECURITY FREEZE LOCK command inputs.

Table 86 — SECURITY FREEZE LOCK command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 F5h

7.42.4 Normal Outputs

See table 179.

7.42.5 Error Outputs

The Abort bit shall be set to one if the device is in the SEC3: Powered down/Security Enabled/ Locked/ Not Frozen state or the SEC4: Security Enabled/ Locked/ Not Frozen state (see figure 10). See table 198.

7.43 SECURITY SET PASSWORD - F1h, PIO Data-Out

7.43.1 Feature Set

This 28-bit command is for devices that implement the Security feature set (see 4.16).

7.43.2 Description

7.43.2.1 Overview

The SECURITY SET PASSWORD command transfers 512 bytes of data from the host. Table 88 defines the content of this information. The command sets only one password at a time.

7.43.2.2 Setting the Master Password

If a Master password (see 4.16.2.3) is specified, the device shall save the supplied Master password in a non-volatile location. The Master Password Capability (see 4.16.3) shall remain unchanged. This does not cause any changes to IDENTIFY DEVICE data words 85 or 128 (see table 46) or IDENTIFY PACKET DEVICE words 85 or 128 (see table 51).

If the device supports the Master Password Identifier feature (see 4.16.11) and a valid identifier is supplied (see 4.16.11), the device shall save the identifier in a non-volatile location. This new value shall be returned in IDENTIFY DEVICE data word 92 (see 7.16.7.46) or IDENTIFY PACKET DEVICE data word 92 (see 7.17.6.40). If the host attempts to set the Master Password Identifier to 0000h or FFFFh, then the device shall preserve the existing Master Password Identifier and return successful command completion.

If the device does not support the Master Password Identifier feature, then the device shall not:

a) validate the Identifier field;
b) change IDENTIFY DEVICE data word 92 (see 7.16.7.46);
c) change IDENTIFY PACKET DEVICE data word 92 (see 7.17.6.40); and
d) return command aborted based on the value supplied in the Master Password Identifier field (see 4.16.11).

7.43.2.3 Setting the User Password

If a User password (see 4.16.2.2) is specified, then the device shall save the User password in a non-volatile location and update the Master Password Capability (see 4.16.3). The Master Password Identifier (see 4.16.11) shall not be changed. These fields in the IDENTIFY DEVICE data (see table 46) or the IDENTIFY PACKET DEVICE data (see table 51) shall be updated as follows:

a) word 85, bit 1 shall be set to one (i.e., security is enabled);
b) word 128, bit 1 shall be set to one (i.e., security is enabled); and
c) word 128, bit 8 shall indicate the Master Password Capability (see 4.16.3).

7.43.3 Inputs

See table 87 for the SECURITY SET PASSWORD command inputs.

Table 87 — SECURITY SET PASSWORD command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 F1h

7.43.4 Normal Outputs

See table 179.

7.43.5 Error Outputs

If the device is locked (see 4.16.2.2) or in Frozen mode (see 4.16.4), then the device shall return command aborted. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 199.

7.43.6 Output From the Host to the Device Data Structure

Table 88 — SECURITY SET PASSWORD data content

Word	Description
0	Control word **Bit / Field Name / Description** 15:9 Reserved 8 Master Password Capability 0=High, 1=Maximum 7:1 Reserved 0 Identifier 0=set User password, 1=set Master password
1..16	Password (32 bytes)
17	Master Password Identifier. This word is valid if word 0 bit 0 is set to one.
18..255	Reserved

7.44 SECURITY UNLOCK - F2h, PIO Data-Out

7.44.1 Feature Set

This 28-bit command is for devices that implement the Security feature set (see 4.16).

7.44.2 Description

The SECURITY UNLOCK command transfers 512 bytes of data from the host. Table 90 defines the content of this information.

When security is disabled and the Identifier bit (see table 90) is cleared to zero (i.e., compare User password), then the device shall return command aborted.

If security is enabled, and the Master Password Capability (see 4.16.3) is cleared to zero (i.e., High), then:

a) if the Identifier bit is set to one (i.e., compare Master password), then the password supplied shall be compared with the stored Master password; or
b) if the Identifier bit is cleared to zero (i.e., compare User password), then the password supplied shall be compared with the stored User password.

If security is enabled and the Master Password Capability is set to Maximum, then:

a) if the Identifier bit is set to one (i.e., compare Master password), then the device shall return command aborted; or
b) if the Identifier bit is cleared to zero (i.e., compare User password), then the password supplied shall be compared with the stored User password.

If the password received in the data for the command does not match the password previously saved by the device, then the device shall return command aborted and decrement the password attempt counter. When this counter reaches zero, IDENTIFY DEVICE data word 128 bit 4 (see 7.16.7.66) or IDENTIFY PACKET DEVICE data word 128 bit 4 (see 7.17.6.51) shall be set to one, and the SECURITY UNLOCK command and the SECURITY ERASE UNIT command shall return 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.

Upon successful completion of this command, IDENTIFY DEVICE data word 128 bit 2 (see 7.16.7.66) or IDENTIFY PACKET DEVICE data word 128 bit 2 (see 7.17.6.51) shall be cleared to zero (i.e., the device is not in the SEC3: Powered down/Security Enabled/ Locked/ Not Frozen state or the SEC4: Security Enabled/ Locked/ Not Frozen state (see figure 10)).

7.44.3 Inputs

See table 89 for the SECURITY UNLOCK command inputs.

Table 89 — SECURITY UNLOCK command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 F2h

7.44.4 Normal Outputs

See table 179.

7.44.5 Error Outputs

If the device is in Frozen mode (see 4.16.4), an invalid password is supplied, or the password attempt counter has decremented to zero, then the device shall return command aborted.

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 199.

7.44.6 Output From the Host to the Device Data Structure

Table 90 — SECURITY UNLOCK data content

<table>
<tr><th>Word</th><th>Description</th></tr>
<tr><td>0</td><td>Control word
<table>
<tr><th>Bit</th><th>Field Name</th><th>Description</th></tr>
<tr><td>15:1</td><td>Reserved</td><td></td></tr>
<tr><td>0</td><td>Identifier</td><td>0=compare User password
1=compare Master password</td></tr>
</table></td></tr>
<tr><td>1..16</td><td>Password (32 bytes)</td></tr>
<tr><td>17..255</td><td>Reserved</td></tr>
</table>

7.45 SET FEATURES - EFh, Non-Data

7.45.1 Feature Set

This 28-bit command is mandatory for ATA devices (see 4.2) and ATAPI devices (see 4.3).

7.45.2 Description

The SET FEATURES command is used by the host to establish parameters that affect the processing of certain device features. Table 91 defines these features.

After a power-on reset or a hardware reset, the settings specified by the subcommands are vendor specific unless otherwise specified in this standard. Software reset is described in the individual subcommands as needed.

Table 91 — SET FEATURES Feature field definitions (Sheet 1 of 3)

Value	Description
00h	Reserved
01h	If the device implements the CFA feature set, then enable 8-bit PIO transfer mode (see 7.45.3); otherwise this value is reserved.
02h	Enable volatile write cache (see 7.45.4)
03h	Set transfer mode (see 7.45.5)
04h	Obsolete
05h	Enable the APM feature set (see 7.45.6)
06h	Enable the PUIS feature set (see 7.45.7)
07h	PUIS feature set device spin-up (see 7.45.8)
08h	Reserved
09h	If the device implements the CFA feature set, then this subcommand is reserved for CFA. Otherwise, this subcommand is reserved for Address Offset Reserved Area Boot Method.
0Ah	Enable CFA power mode 1 (see 7.45.9)
0Bh	Enable Write-Read-Verify feature set (see 7.45.10)
0Ch..0Fh	Reserved
10h	Enable use of SATA feature (see 7.45.15)
11h..1Fh	Reserved
20h	Reserved for TLC
21h	Reserved for TLC
22h..30h	Reserved
31h	Obsolete
32h	Reserved
33h	Obsolete
34h..40h	Reserved
41h	Enable the Free-fall Control feature set (see 7.45.14)
42h	Obsolete
43h	Set Maximum Host Interface Sector Times (see 7.45.11)
44h	Obsolete
45h..49h	Reserved
4Ah	Extended Power conditions (see 7.45.18)
4Bh..53h	Reserved

Table 91 — SET FEATURES Feature field definitions (Sheet 2 of 3)

Value	Description
54h	Obsolete
55h	Disable read look-ahead feature (see 7.45.12)
56h..5Ch	Vendor Specific
5Dh..5Eh	Obsolete
5Fh	Reserved for DDT
60h..61h	Reserved
62h	Long Physical Sector Alignment Error Reporting Control (see 7.45.17)
63h..65h	Reserved
66h	Disable reverting to power-on defaults (see 7.45.13)
67h..68h	Reserved
69h	If the device implements the CFA feature set, then this subcommand is reserved for CFA; otherwise this value is reserved.
6Ah..76h	Reserved
77h	Obsolete
78h..80h	Reserved
81h	If the device implements the CFA feature set, then disable 8-bit PIO transfer mode (see 7.45.3); otherwise this value is reserved.
82h	Disable volatile write cache (see 7.45.4)
83h	Reserved
84h	Obsolete
85h	Disable the APM feature set (see 7.45.6)
86h	Disable the PUIS feature set (see 7.45.7)
87h	Reserved
88h	Obsolete
89h	If the device implements the CFA feature set, then this subcommand is reserved for CFA; otherwise this subcommand is reserved for Address Offset Reserved Area Boot Method.
8Ah	Disable CFA power mode 1 (see 7.45.9)
8Bh	Disable Write-Read-Verify feature set (see 7.45.10)
8Ch..8Fh	Reserved
90h	Disable use of SATA feature (see 7.45.15)
91h..94h	Reserved
95h	Obsolete
96h..99h	Reserved
99h	Obsolete

Table 91 — SET FEATURES Feature field definitions (Sheet 3 of 3)

Value	Description
9Ah	Obsolete
9Bh..A9h	Reserved
AAh	Enable read look-ahead feature (see 7.45.12)
ABh	Obsolete
ACh..BAh	Reserved
BBh	Obsolete
BCh..C0h	Reserved
C1h	Disable the Free-fall Control feature set (see 7.45.14)
C2h	Obsolete
C3h	Enable/Disable the Sense Data Reporting feature set (see 7.45.16)
C4h..CBh	Reserved
CCh	Enable reverting to power-on defaults (see 7.45.13)
CDh..D5h	Reserved
D6h..DCh	Vendor Specific
DDh.DEh	Obsolete
DFh	Reserved for DDT
E0h	Vendor Specific
E1h..EFh	Reserved
F0h..F3h	Reserved for assignment by the CompactFlash Association
F4h..FFh	Reserved

7.45.3 Enable/disable 8-bit PIO data transfer

Subcommand codes 01h and 81h allow the host to enable or disable 8-bit PIO data transfers. CFA-APT devices shall support 8-bit PIO data transfers. All other devices shall not support 8-bit PIO data transfers. See the CFA specification for more information.

7.45.4 Enable/disable volatile write cache

Subcommand codes 02h and 82h allow the host to enable or disable volatile write cache in devices that implement volatile write cache. When the disable volatile write cache subcommand is issued, the device shall initiate the sequence to flush volatile cache to non-volatile media before command completion (see 7.14). These subcommands may affect caching for commands in the Streaming feature set. Support for the enable/disable volatile write cache subcommands are mandatory when a volatile write cache is implemented.

7.45.5 Set transfer mode

The set transfer mode subcommand is mandatory. The transfer mechanism is selected by Set Transfer Mode, subcommand code 03h, and specifying a value in the Count field. Bits (7:3) define the type of transfer and bits (2:0) encode the mode value. The selected modes may be changed by the SET FEATURES command.
Table 92 shows the available transfer modes.

Table 92 — Transfer modes

Mode	Bits (7:3)	Bits (2:0)
PIO default mode	0_0000b	000b
PIO default mode, disable IORDY	0_0000b	001b
PIO flow control transfer mode	0_0001b	Mode
Retired	0_0010b	N/A
Multiword DMA mode	0_0100b	Mode
Ultra DMA mode	0_1000b	Mode
Reserved	1_0000b	N/A

Key:

Mode = transfer mode number (see 7.16.7.24, 7.16.7.25, 7.16.7.42)

If a device receives a SET FEATURES command with a Set Transfer Mode subcommand and the Count field value set to 0000_0000b, then the device shall set the default PIO mode. If the Count field is set to 0000_0001b. and the device supports disabling of IORDY (see ATA8-APT), 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 should 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) (see ATA8-APT).

7.45.6 Enable/disable the APM feature set

Subcommand code 05h enables APM (see 4.5). The APM level is a scale from the lowest power consumption setting of 01h to the maximum performance level of FEh. Table 93 shows these values.

Table 93 — APM levels

Count	Level
00h	Reserved
01h	Minimum power consumption with Standby
02h-7Fh	Intermediate power management levels with Standby
80h	Minimum power consumption without Standby
81h-FDh	Intermediate power management levels without Standby
FEh	Maximum performance
FFh	Reserved

Device performance may increase with increasing APM levels. Device power consumption may increase with increasing power management levels. The APM levels may contain discrete bands (e.g., a device may implement one APM method from 80h to A0h and a higher performance, higher power consumption method from level A1h to FEh). APM levels 80h and higher do not permit the device to spin down to save power.

Subcommand code 85h disables APM. Subcommand 85h may not be implemented on all devices that implement SET FEATURES subcommand 05h.

7.45.7 Enable/disable the PUIS feature set

Subcommand code 06h enables the PUIS feature set (see 4.14). When this feature set is enabled, the device shall power-up into the PM4: PUIS state (i.e., the device shall be ready to receive commands but shall not spin-up) (see 4.14). Once this feature set is enabled, it shall only be disabled by a subsequent SET FEATURES command disabling this feature set. This feature set shall not be disabled by a power-on reset, a hardware reset, or a software reset.

Subcommand code 86h disables the PUIS 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.

7.45.8 PUIS 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 4.14 and figure 8).

7.45.9 Enable/disable CFA power mode 1

Subcommand code 0Ah causes a CFA device to transition to 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.

Subcommand 8Ah causes a CFA device to transition 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.

If a CFA device is in CFA Power Mode 0, then the device shall transition to CFA Power Mode 1 after processing of a power-on reset or a hardware reset.

If a CFA device is in CFA Power Mode 0 and in the Reverting to defaults enabled mode (see 7.45.13), then the device shall transition to CFA Power Mode 1 after processing of a software reset.

If a CFA device is in CFA Power Mode 0 and in the Reverting to defaults disabled mode (see 7.45.13), then the device shall not transition to CFA Power Mode 1 after processing of a software reset.

Enabling CFA Power Mode 1 does not cause a spin-up.

A device in Power Mode 0 shall accept the following commands:

a) IDENTIFY DEVICE;
b) SET FEATURES (subcommand codes 0Ah and 8Ah);
c) STANDBY;
d) STANDBY IMMEDIATE;
e) SLEEP;
f) CHECK POWER MODE;
g) EXECUTE DEVICE DIAGNOSTICS; and
h) CFA REQUEST EXTENDED ERROR.

A device in Power Mode 0 may accept any command that the device is capable of processing 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.

7.45.10 Enable/Disable Write-Read-Verify feature set

Subcommand code 0Bh enables the Write-Read-Verify feature set.

Bits (7:0) of the LBA field in the SET FEATURES command specify the Write-Read-Verify mode. Table 94 defines the Write-Read-Verify modes.

Table 94 — Write-Read-Verify modes

Mode	Description
00h [a]	Always enabled (i.e., the device shall perform a Write-Read-Verify for all logical sectors for all write commands).
01h [a]	The device shall perform a Write-Read-Verify on the first 65 536 logical sectors written after: a) spin-up; or b) the device completes a SET FEATURES command setting the Write-Read-Verify mode without error.
02h [a]	The number of logical sectors on which a device performs a Write-Read-Verify is vendor specific.
03h	The device shall perform a Write-Read-Verify on the first n logical sectors written by the host after: a) spin-up; or b) the device completes a SET FEATURES command setting the Write-Read-Verify mode without error. n=x * 1 024 where: x=number specified by the Count field.
04h-FFh	Reserved
[a] the Count field shall be ignored.	

Subcommand code 8Bh disables the Write-Read-Verify feature set.

A device shall set the Write-Read-Verify feature set to its factory default setting after processing a power-on reset or if the Software Settings Preservation feature set is disabled and a hardware reset is processed. If the Software Settings Preservation feature set is enabled and a hardware reset is processed, then the device shall not change the settings of the Write-Read-Verify feature set.

If a device is in the reverting to defaults enabled mode (see 7.45.13), then the device shall set the Write-Read-Verify feature set to its factory default setting after processing of a software reset.

If a device is in the reverting to defaults disabled mode (see 7.45.13), then the device shall not change the settings of the Write-Read-Verify feature set after processing of a software reset.

7.45.11 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 value of its Typical PIO Host Interface Sector Time (see table 95) to the Count field (7:0) and LBA (7:0) field and writes the value of its Typical DMA Host Interface Sector Time (see table 95) to the LBA (23:8) field. The Typical Host Interface Sector Times (see table 95) have the same units as IDENTITY DEVICE data word 96 (see 7.16.7.50) for DMA and IDENTITY DEVICE data word 104 (see 7.16.7.54) 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 96..97 (see 7.16.7.50 and 7.16.7.51) to allow for the specified host interface sector time. See table 95 for the Count field and LBA field definitions.

Table 95 — Maximum Host Interface Sector Times

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)

7.45.12 Enable/disable read look-ahead

Subcommand codes AAh and 55h enables or disables read look-ahead. Error recovery performed by the device is vendor specific.

7.45.13 Enable/disable reverting to defaults

Subcommand codes CCh and 66h enables or disables the reverting to defaults mode.

A device is in the reverting to defaults disabled mode after completing a SET FEATURES command with subcommand code 66h without error. A device should enter the reverting to defaults disabled mode after power-on reset or hardware reset. A device in the reverting to defaults disabled mode, shall not reset parameters to their default power-on values during the processing of a software reset.

A device is in the Reverting to defaults enabled mode after the device completes a SET FEATURES command with subcommand CCh without error. A device in the reverting to defaults enabled mode may reset parameters to their default power-on values during the processing of a software reset.

7.45.14 Enable/Disable the Free-fall Control feature set

Subcommand codes 41h and C1h allow the host to enable or disable the Free-fall Control feature set (see 4.8). To enable the Free-fall Control feature set, the host writes the Count field with the requested free-fall control sensitivity setting and processes a SET FEATURES command with subcommand code 41h.

The sensitivity is selected on a scale from 00h to FFh. A value of zero selects the device vendor's recommended setting. Other values are vendor specific. The higher the sensitivity value, the more sensitive the device is to changes in acceleration.

Enabling or disabling of the Free-fall Control feature set, and the current free-fall sensitivity setting shall be preserved by the device across all forms of reset (i.e., power-on reset, hardware reset, and software resets).

7.45.15 Enable/Disable SATA feature

7.45.15.1 Overview

Subcommand codes 10h and 90h allow the host to enable or disable Serial ATA features. The Count field contains the specific Serial ATA feature to enable or disable. The specific Serial ATA features in which SET

FEATURES is applicable are defined in table 96.

Table 96 — SATA features

Count	Description
00h	Reserved for Serial ATA
01h	Non-zero Buffer Offsets
02h	DMA Setup FIS Auto-Activate optimization
03h	Device-initiated interface power state transitions
04h	Guaranteed In-Order Data Delivery
05h	Asynchronous Notification
06h	Software Settings Preservation
07h-FFh	Reserved for Serial ATA

7.45.15.2 Enable/Disable Non-Zero Buffer Offsets

A Count field value of 01h is used to enable or disable non-zero buffer offsets for commands in the NCQ feature set (see 4.12). By default, non-zero buffer offsets are disabled. The enable/disable state for non-zero offsets shall be preserved across software reset. The enable/disable state for non-zero offsets shall be reset to its default state upon COMRESET. See SATA 2.6 for more information.

7.45.15.3 Enable/Disable DMA Setup FIS Auto-Activate Optimization

A Count field value of 02h is used to enable or disable DMA Setup FIS Auto-Activate optimization. See SATA 2.6 for more information. The enable/disable state for the auto-activate optimization shall be preserved across software reset. The enable/disable state for the auto-activate optimization shall be reset to its default state upon COMRESET.

7.45.15.4 Enable/Disable Device-Initiated Interface Power State Transitions

A Count field value of 03h is used to enable or disable device initiation of interface power state transitions. By default, the device is not permitted to initiate interface power state transitions. See SATA 2.6 for more information. The enable/disable state for device initiated power management shall persist across software reset. The enable/disable state shall be reset to its default disabled state upon COMRESET.

If device initiated interface power management is enabled, the device shall not attempt to initiate an interface power state transition between reset and the delivery of the device reset signature (see table 184).

7.45.15.5 Enable/Disable Guaranteed in-Order Data Delivery

A Count field value of 04h is used to enable or disable guaranteed in-order data delivery for commands in the NCQ feature set (see 4.12). This setting is only valid when non-zero buffer offsets are enabled. By default, guaranteed in-order data delivery is disabled. See SATA 2.6 for more information. The enable/disable state for guaranteed in-order data delivery shall be preserved across software reset. The enable/disable state for guaranteed in-order data delivery shall be reset to its default state upon COMRESET.

7.45.15.6 Enable/Disable Asynchronous Notification

For ATAPI devices, a Count field value of 05h is used to enable or disable asynchronous notification. By default, asynchronous notification is disabled. See SATA 2.6 for more information. The enable/disable state for asynchronous notification shall be preserved across software reset. The enable/disable state for asynchronous notification shall be reset to its default state upon COMRESET.

7.45.15.7 Enable/Disable Software Settings Preservation

See table 16 for a list of the preserved feature sets and settings. A Count field value of 06h is used to enable or disable software settings preservation. By default, if the device supports software settings preservation the feature is enabled when it processes a power-on reset. The enable/disable state for software settings preservation shall persist across software reset. The enable/disable state for software settings preservation shall be reset to its default state upon COMRESET. The host may disable software settings preservation in order to cause software settings to revert to their power-on default state when the device receives a COMRESET.

7.45.16 Enable/Disable the Sense Data Reporting feature set

Subcommand code C3h allows the application client to enable the Sense Data Reporting feature set (see 4.18) by issuing this subcommand with bit zero of the count field set to one.

The Sense Data Reporting feature set shall be disabled by issuing this subcommand with bit zero of the Count field cleared to zero.

All other sub-command specific fields are reserved.

7.45.17 Long Physical Sector Alignment Error Reporting Control

Subcommand code 62h allows the application client to control the reporting of errors associated with the LPS feature set (see 4.11). IDENTIFY DEVICE data word 69 bit 13 (see 7.16.7.30) indicates that Long Physical Sector Alignment Error Reporting is supported. IDENTIFY DEVICE data word 49 bits (1:0) (see 7.16.7.17) indicate the current Long Physical Sector Alignment Error Reporting setting.

If the Count field is cleared to zero, then the device shall disable Alignment Error reporting;

If the Count field is set to one, then the device shall process the command and shall report an Alignment (see 6.2.2) when the application client issues a write command in which:

a) the first byte of data transfer does not begin at the first byte of a physical sector (see 7.16.7.76); or
b) the last byte of data transfer does not end at the last byte of a physical sector (see 7.16.7.76).

If the Count field is set to two, then the device shall report an Alignment Error (see 6.2.2) and Command Aborted, leaving the condition of the data unknown, if the application client issues a write command in which:

a) the first byte of data transfer does not begin at the first byte of a physical sector (see 7.16.7.76); or
b) the last byte of data transfer does not end at the last byte of a physical sector (see 7.16.7.76).

If the Count field is set to 03h..FFh, the device shall report command aborted.

If Long Physical Sector Alignment Error Reporting Control is supported, then the device shall support the Long Physical Sector Mis-alignment log (see A.13).

This setting shall be preserved across all resets.

7.45.18 Extended power conditions

7.45.18.1 Overview

Subcommand code 4Ah enables, disables, and configures the use of the Extended Power Conditions feature set (see 4.7). If the EPC feature is not supported, then the device shall return command aborted. Table 97 describes the EPC subcommands and table 98 describes the power condition IDs.

Table 97 — Extended Power Conditions Subcommands

EPC Subcommand	Description
0h	Restore Power Condition Settings (see 7.45.18.2)
1h	Go To Power Condition (see 7.45.18.3)
2h	Set Power Condition Timer (see 7.45.18.4)
3h	Set Power Condition State (see 7.45.18.5)
4h	Enable the EPC feature set (see 7.45.18.6)
5h	Disable the EPC feature set (see 7.45.18.7)
6h..Fh	Reserved

Table 98 — Power Condition IDs

Power Condition ID	Power Condition Name	Description
00h	Standby_z	A substate of the PM2:Standby state [a]
01h	Standby_y	A substate of the PM2:Standby state [a]
02h..80h		Reserved
81h	Idle_a	A substate of the PM1:Idle state [a]
82h	Idle_b	A substate of the PM1:Idle state [a]
83h	Idle_c	A substate of the PM1:Idle state [a]
84h..FEh		Reserved
FFh	All	All supported EPC power conditions

[a] See 4.13.4 for the description of the power states.

7.45.18.2 Restore Power Condition Settings subcommand

7.45.18.2.1 Description

On successful completion of this EPC subcommand, the device shall update the Power Conditions log (see A.8) for the selected Power Condition ID(s) as follows:

1) if Default is set to one, then:
   A) copy the Default Timer Settings field (see A.8) to the Current Timer Settings field (see A.8); and
   B) copy the Default Timer Enabled field (see A.8) to the Current Timer Enabled field (see A.8);
2) if Default is cleared to zero, then:
   A) copy the Saved Timer Settings field (see A.8) to the Current Timer Settings field (see A.8); and
   B) copy the Saved Timer Enabled field (see A.8) to the Current Timer Enabled field (see A.8);

   and

3) if Save is set to one and the power condition is saveable, then:
   A) copy the Current Timer Settings field (see A.8) to the Saved Timer Settings field (see A.8); and
   B) copy the Current Timer Enabled field (see A.8) to the Saved Timer Enabled field (see A.8).

7.45.18.2.2 Inputs

See table 99 for the SET FEATURES command inputs.

Table 99 — Restore Power Condition Settings inputs

Name	Description
Count	Power Condition (see table 98)
LBA	**Bit Description** 27:7 Reserved 6 Default 1 = Restore from Default settings 0 = Restore from Saved settings 5 Reserved 4 Save 1 = Save settings on completion 0 = Do not save settings on completion 3:0 0h (i.e., Restore Power Condition subcommand (see table 97))

7.45.18.2.3 Normal Outputs

See table 179.

7.45.18.2.4 Error Outputs

If any selected Power Condition:

a) is not supported;
b) is not changeable; or
c) the Save bit is set to one and any selected power condition is not saveable,

then the device shall return command aborted. See table 198.

7.45.18.3 Go To Power Condition subcommand

7.45.18.3.1 Description

On successful completion of this EPC subcommand, the device shall:

1) stop all enabled EPC timers (see 4.7.3);
2) enter the selected EPC power condition (see 4.7.2) after command completion of the SET FEATURES command without having to wait for any timers to expire; and
3) the device shall remain in the selected power condition until the device processes the next command or reset.

7.45.18.3.2 Inputs

See table 100 for the SET FEATURES command inputs.

Table 100 — Go To Power Condition inputs

Name	Description
Count	Power Condition (see table 98)
LBA	**Bit** **Description** 27:4 Reserved 3:0 1h (i.e., Go To Power Condition subcommand (see table 97))

7.45.18.3.3 Normal Outputs

See table 179.

7.45.18.3.4 Error Outputs

If the Power condition ID is FFh, a reserved value, or is not supported, then the device shall return command aborted. See table 198.

7.45.18.4 Set Power Condition Timer subcommand

7.45.18.4.1 Description

On successful completion of this EPC subcommand, the device shall update the Power Conditions log (see A.8) for the selected and supported Power Condition (see 4.7.2) as follows:

1) copy the Timer field to the Current Timer Settings field;
2) if Enable is set to one and the Timer field is non-zero, then enable the Current Timer;
3) if Enable is set to one and the Timer field is zero, then disable the Current Timer;
4) if Enable is cleared to zero, then disable the Current Timer; and
5) if Save is set to one and the Power Condition settings are saveable, then:
   A) copy the Current Timer Settings field to the Saved Timer Settings field; and
   B) copy the Current Timer Enabled field to the Saved Timer Enabled field.

7.45.18.4.2 Inputs

See table 101 for the SET FEATURES command inputs.

Table 101 — Set Power Condition Timer inputs

Name	Description
Count	Power Condition (see table 98)
LBA	**Bit** **Description** 27:24 Reserved 23:8 Timer (15:0) (see 7.45.18.4.3) 7 Timer Units (see 7.45.18.4.4) 6 Reserved 5 Enable 1 = Enable the selected power condition 0 = Disable the selected power condition 4 Save 1 = Save settings on completion 0 = Do not save settings on completion 3:0 2h (i.e., Set Power Condition Timer subcommand (see table 97))

7.45.18.4.3 Timer (15:0)

If the new timer value is greater than the maximum value setting, then the device may set the value to the maximum setting. If the new timer value is less than the minimum setting, then the device may set the value to the minimum setting.

7.45.18.4.4 Timer Units

If the Timer Units bit is cleared to zero, then the Timer (15:0) shall be specified in units of 100 milliseconds.

If the Timer Units bit is set to one, then the Timer (15:0) shall be specified in units of 1 minute.

7.45.18.4.5 Normal Outputs

See table 179.

7.45.18.4.6 Error Outputs

The device shall return command aborted If:

a) the new timer value is:
   A) less than the maximum setting;

  - B) greater than the minimum setting; and
  - C) not supported by the device;
- b) the Power Condition field is invalid;
- c) the power condition is not changeable or not supported;
- d) the Save bit is set to one and the selected power condition is not saveable;
- e) the new time value is greater than the maximum setting (see A.8) and the device did not set the timer to the maximum setting; or
- f) the new time value is less than the minimum setting (see A.8) and the device did not set the timer to the minimum setting.

If command aborted is returned, then the device shall make no modifications to the power condition settings. See table 198.

7.45.18.5 Set Power Condition State subcommand

7.45.18.5.1 Description

On successful completion of this EPC subcommand, the device shall update the Power Conditions log (see A.8) for the Power Condition(s) as follows:

1) If the Enable bit (see A.8) is set to one, then enable the Current Timer (see A.8); otherwise disable the Current Timer; and
2) If the Save bit (see A.8) is set to one, then copy the Current Timer Enabled field to the Saved Timer Enabled field.

7.45.18.5.2 Inputs

See table 102 for the SET FEATURES command inputs.

Table 102 — Set Power Condition State inputs

Name	Description
Count	Power Condition (see table 98)
LBA	**Bit** **Description** 27:6 Reserved 5 Enable 1 = Enable the selected power condition 0 = Disable the selected power condition 4 Save 1 = Save settings on completion 0 = Do not save settings on completion 3:0 3h (i.e., Set Power Condition State subcommand (see table 97))

7.45.18.5.3 Normal Outputs

See table 179.

7.45.18.5.4 Error Outputs

If the Power Condition is invalid, not changeable, or not supported, then the device shall return command aborted. If the Save bit is set to one and the selected power condition is not saveable, then the device shall return command aborted. If command aborted is returned, then the device shall make no modifications to the power condition settings. See table 198.

7.45.18.6 Enable the EPC feature set subcommand

7.45.18.6.1 Description

On successful completion of this EPC subcommand, the device shall:

1) enable the EPC feature set;
2) set IDENITFY DEVICE data word 120 bit 7 to one;
3) disable the APM feature set; and
4) for each supported power condition:
    1) if the Saved Timer Setting field (see A.8.4.9) is cleared to zero, then:
        a) copy the value of the Default Timer Setting (see A.8.4) field to the Current Timer Setting field (see A.8.4.10); and
        b) copy the value of the Default Timer Enabled field (see A.8.4.5) to the Current Timer Enabled field (see A.8.4.7);
    2) if the Saved Timer Setting field is non-zero, then:
        a) copy the value of the Saved Timer Setting field to the Current Timer Setting field; and
        b) copy the value of the Saved Timer Enabled field to the Current Timer Enabled field;

    and

5) if the Current Timer Setting field is non-zero and the Current Timer Enabled field is set to one, then initialize and start the timer.

The EPC feature set shall remain enabled across all resets (i.e., power-on reset, hardware reset, and software reset).

7.45.18.6.2 Inputs

See table 100 for the SET FEATURES command inputs.

Table 103 — Enable the EPC feature set inputs

Name	Description
Count	Reserved
LBA	**Bit** **Description** 27:4 Reserved 3:0 4h (i.e., Enable the EPC feature set (see table 97))

7.45.18.6.3 Normal Outputs

See table 179.

7.45.18.6.4 Error Outputs

See table 198.

7.45.18.7 Disable the EPC feature set subcommand

7.45.18.7.1 Description

On successful completion of this EPC subcommand, the device shall:

a) stop all EPC timers;
b) disable the EPC feature set; and
c) clear IDENITFY DEVICE data word 120 bit 7 to zero.

The EPC feature set shall remain disabled across all resets (i.e., power-on reset, hardware reset, and software reset).

7.45.18.7.2 Inputs

See table 100 for the SET FEATURES command inputs.

Table 104 — Disable the EPC feature set inputs

Name	Description
Count	Reserved
LBA	**Bit Description** 27:0 Reserved 3:0 5h (i.e., Disable the EPC feature set (see table 97))

7.45.18.7.3 Normal Outputs

See table 179.

7.45.18.7.4 Error Outputs

See table 198.

7.45.19 Inputs

See table 105 for the SET FEATURES command inputs.

Table 105 — SET FEATURES command inputs

Name	Description
Feature	Subcommand Code - See table 91
Count	Subcommand specific
LBA	Subcommand specific
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 EFh

7.45.20 Normal Outputs

See table 179.

7.45.21 Error Outputs

The Abort bit shall be set to one if any subcommand input value is not supported or is invalid. See table 198.

7.46 SET MULTIPLE MODE - C6h, Non-Data

7.46.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.46.2 Description

The SET MULTIPLE MODE command establishes the number of logical sectors in the DRQ data block count for the READ MULTIPLE command, READ MULTIPLE EXT command, WRITE MULTIPLE command, and WRITE MULTIPLE EXT command. The content of the Count field shall be less than or equal to the value in IDENTIFY DEVICE data word 47 bits (7:0) (see 7.16.7.15). The host should set the content of the Count field to 1, 2, 4, 8, 16, 32, 64, or 128.

Devices shall support the DRQ data block size specified in the IDENTIFY DEVICE data word 47 bits (7:0) (see 7.16.7.15), 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 commands, READ MULTIPLE EXT commands, WRITE MULTIPLE commands, WRITE MULTIPLE EXT commands, and WRITE MULTIPLE FUA EXT commands and their processing is enabled.

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 command, READ MULTIPLE EXT command, WRITE MULTIPLE command, WRITE MULTIPLE EXT command, and WRITE MULTIPLE FUA EXT command with command aborted until a subsequent successful SET MULTIPLE command completion where the Count field is not set to zero.

If the content of the Count field is zero, then the device may:

a) disable multiple mode (i.e., respond with command aborted for all subsequent READ MULTIPLE commands, READ MULTIPLE EXT commands, WRITE MULTIPLE commands, WRITE MULTIPLE EXT commands, and WRITE MULTIPLE FUA EXT commands);
b) return command aborted for all SET MULTIPLE MODE commands; or
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 IDENTIFY DEVICE data word 59 (see 7.16.7.21).

After a power-on reset or hardware reset, if IDENTIFY DEVICE data word 59 bit 8 is set to one and IDENTIFY DEVICE data word 59 bits (7:0) are cleared to zero, a SET MULTIPLE command is required before issuing a READ MULTIPLE command, READ MULTIPLE EXT command, WRITE MULTIPLE command, 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 issued to change the multiple value required before issuing a READ MULTIPLE command, READ MULTIPLE EXT command, WRITE MULTIPLE command, or WRITE MULTIPLE EXT command.

7.46.3 Inputs

See table 106 for the SET MULTIPLE MODE command inputs.

Table 106 — SET MULTIPLE MODE command inputs

Name	Description
Feature	N/A
Count	DRQ data block count
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 C6h

7.46.4 Normal Outputs

See table 179.

7.46.5 Error Outputs

The Abort bit shall be set to one if the block count is not supported. See table 198.

7.47 SLEEP - E6h, Non-Data

7.47.1 Feature Set

This 28-bit command is for devices implementing the Power Management feature set (see 4.13).

7.47.2 Description

The SLEEP command causes the device to enter Sleep mode. The device shall exit Sleep (i.e., PM3 state (see 4.13.4)) only after processing a hardware reset, a software reset, or a DEVICE RESET command.

A device shall not power-on in Sleep mode.

7.47.3 Inputs

See table 107 for the SLEEP command inputs.

Table 107 — SLEEP command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E6h

7.47.4 Normal Outputs

See table 179.

7.47.5 Error Outputs

See table 198.

7.48 SMART

7.48.1 Overview

Individual SMART commands are identified by the value placed in the Feature field. Table 108 shows these values.

Table 108 — SMART Feature field values

Value	Command
00h-CFh	Reserved
D0h	SMART READ DATA (see 7.48.6)
D1h	Obsolete
D2h	SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE (see 7.48.3)
D3h	Obsolete
D4h	SMART EXECUTE OFF-LINE IMMEDIATE (see 7.48.5)
D5h	SMART READ LOG (see 7.48.7)
D6h	SMART WRITE LOG (see 7.48.9)
D7h	Obsolete
D8h	SMART ENABLE OPERATIONS (see 7.48.4)
D9h	SMART DISABLE OPERATIONS (see 7.48.2)
DAh	SMART RETURN STATUS (see 7.48.8)
DBh	Obsolete
DCh-DFh	Reserved
E0h-FFh	vendor specific

7.48.2 SMART DISABLE OPERATIONS - B0h/D9h, Non-Data

7.48.2.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.17).

7.48.2.2 Description

The SMART DISABLE OPERATIONS command shall disable all SMART operations. After completion of this command without error the device shall report command aborted for all other SMART commands (e.g., SMART DISABLE OPERATIONS commands), except for the SMART ENABLE OPERATIONS command and the SCT Command Transport commands, which shall be processed as defined. The state of SMART (i.e., enabled or disabled) shall be preserved by the device during all power-on reset events.

7.48.2.3 Inputs

See table 109 for the SMART DISABLE OPERATIONS command inputs.

Table 109 — SMART DISABLE OPERATIONS command inputs

Name	Description
Feature	D9h
Count	N/A
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.48.2.4 Normal Outputs

See table 179.

7.48.2.5 Error Outputs

The Abort bit shall be set to one if SMART is not enabled, or if an input value is invalid. See table 198.

7.48.3 SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE - B0h/D2h, Non-Data

7.48.3.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.17).

7.48.3.2 Description

The SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE command enables and disables the attribute autosave feature of the device. This command may either allow the device, after some vendor specified event, to save the device updated attributes 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 during all power and reset events.

The Count field set to zero shall cause the device to disable the attribute autosave feature. Disabling this feature does not preclude the device from saving SMART data to non-volatile memory during some other normal operation (e.g., during a power-on or power-off sequence or during an error recovery sequence).

The Count field set to F1h shall cause the device to enable the attribute autosave feature. If the Count field is not set to 00h or F1h, then the actions taken by a device are vendor specific.

If the device receives a command while processing the autosave routine the device shall begin processing the command within two seconds.

7.48.3.3 Inputs

See table 110 for the SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE command inputs.

Table 110 — SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE command inputs

Name	Description
Feature	D2h
Count	**Value** **Description** 00h Disable attribute autosave 01h-F0h Vendor specific F1h Enable attribute autosave F2h-FFh Vendor specific
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.48.3.4 Normal Outputs

See table 179.

7.48.3.5 Error Outputs

The Abort bit shall be set to one if SMART is not enabled, or if an input value is invalid. See table 198.

7.48.4 SMART ENABLE OPERATIONS - B0h/D8h, Non-Data

7.48.4.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.17).

7.48.4.2 Description

The SMART ENABLE OPERATIONS command enables access to all available SMART capabilities within the device. The state of SMART, either enabled or disabled, shall be preserved by the device during all power and reset events. Once enabled, the receipt of subsequent SMART ENABLE OPERATIONS commands shall not affect any SMART data or functions.

7.48.4.3 Inputs

See table 111 for the SMART ENABLE OPERATIONS command inputs.

Table 111 — SMART ENABLE OPERATIONS command inputs

Name	Description
Feature	D8h
Count	N/A
LBA	**Bit Description** 27:24 N/A 23:8 C24Fh 7:0 N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.48.4.4 Normal Outputs

See table 179.

7.48.4.5 Error Outputs

See table 198.

7.48.5 SMART EXECUTE OFF-LINE IMMEDIATE - B0h/D4h, Non-Data

7.48.5.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.17).

7.48.5.2 Description

7.48.5.2.1 Overview

The SMART EXECUTE OFF-LINE IMMEDIATE command causes the device to initiate the set of activities that collect SMART data in an off-line mode and then preserve this data across power and reset events, or process a vendor specific self-diagnostic test routine in either captive or off-line mode. Table 112 lists the SMART EXECUTE OFF-LINE IMMEDIATE Subcommands.

Table 112 — SMART EXECUTE OFF-LINE IMMEDIATE Subcommands

Value	Description of subcommand to be processed
00h	Execute SMART off-line routine (see 7.48.5.2.4) in off-line mode [a]
01h	Execute SMART Short self-test routine (see 7.48.5.2.5) in off-line mode [a]
02h	Execute SMART Extended self-test routine (see 7.48.5.2.6) in off-line mode [a]
03h	Execute SMART Conveyance self-test routine (see 7.48.5.2.7) in off-line mode [a]
04h	Execute SMART Selective self-test routine (see 7.48.5.2.8) in off-line mode [a]
05h-3Fh	Reserved
40h-7Eh	Vendor specific
7Fh	Abort off-line mode self-test routine
80h	Reserved
81h	Execute SMART Short self-test routine (see 7.48.5.2.5) in captive mode [b]
82h	Execute SMART Extended self-test routine (see 7.48.5.2.6) in captive mode [b]
83h	Execute SMART Conveyance self-test routine (see 7.48.5.2.7) in captive mode [b]
84h	Execute SMART Selective self-test routine (see 7.48.5.2.8) in captive mode [b]
85h-8Fh	Reserved
90h-FFh	Vendor specific

[a] See 7.48.5.2.2
[b] See 7.48.5.2.3

7.48.5.2.2 Off-line mode

The following describes the protocol for processing a SMART EXECUTE OFF-LINE IMMEDIATE subcommand routine, including a self-test routine, in the off-line mode:

1) the device shall report command completion before processing the subcommand routine;
2) the device shall remain ready to receive a new command during processing 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 command, SMART DISABLE OPERATIONS command, SMART EXECUTE OFF-LINE IMMEDIATE command, or STANDBY IMMEDIATE command, then the device shall suspend or abort the subcommand routine and begin processing the new command within two seconds after receipt of the new command. After servicing the interrupting command, the device may re-initiate or resume the subcommand routine without any additional commands from the host (see 7.48.6.9);
4) if the device is in the process of performing a subcommand routine and is interrupted by a SLEEP command from the host, then the device may abort the subcommand routine and process the SLEEP command. If the device is in the process of performing any self-test routine and is interrupted by a SLEEP command, then the device shall abort the subcommand routine and process 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, then the device shall suspend or abort the subcommand routine and begin processing the new command 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, then the device shall abort the subcommand routine and begin processing the new command within two seconds after receipt of the command. The device shall then process 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 command or IDLE IMMEDIATE command, then the device shall suspend or abort the subcommand routine, and begin processing the new command 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 unless these activities were aborted by the host;
8) while the device is performing the subcommand routine it shall not change power states (e.g., as a result of its Standby timer (see 4.13.3) expiring); and
9) if a test failure occurs while a device is performing a self-test routine, then the device may discontinue the testing and place the test results in the Self-test execution status byte (see table 115).

7.48.5.2.3 Captive mode

When processing a self-test in captive mode, the device processes the self-test routine after receipt of the command. At the end of the self-test routine the device places the results of this self-test routine in the Self-test execution status byte (see table 115) and reports command completion. If an error occurs while a device is performing the self-test routine, then the device may discontinue its testing, place the results of this self-test routine in the Self-test execution status byte, and complete the command.

7.48.5.2.4 SMART off-line routine

The SMART off-line routine shall only be processed in the off-line mode (see 7.48.5.2.2). The results of this routine are placed in the Off-line data collection status byte (see table 116).

7.48.5.2.5 SMART Short self-test routine

Depending on the value in the LBA field (7:0) (see table 112), the SMART Short self-test routine may be processed in either the captive mode or the off-line mode. The SMART Short self-test routine should take on the order of minutes to complete (see table 115).

7.48.5.2.6 SMART Extended self-test routine

Depending on the value in the LBA field (7:0) (see table 112), the SMART Extended self-test routine may be processed in either the captive mode or the off-line mode. The SMART Extended self-test routine should take on the order of tens of minutes to complete (see table 115).

7.48.5.2.7 SMART Conveyance self-test routine

Depending on the value in the LBA field (7:0) (see table 112), the SMART Conveyance self-test routine may be processed in either the captive mode or the off-line mode. The SMART Conveyance self-test routine may identify damage incurred during transporting of the device. The SMART Conveyance self-test routine should take on the order of minutes to complete (see table 115).

7.48.5.2.8 SMART Selective self-test routine

If the SMART Selective self-test routine is implemented, then all features of this self-routine shall be implemented. Support for the SMART Selective self-test routine is indicated in off-line data collection capabilities (see 7.48.6.9). When the value in the LBA field (7:0) is 4 or 132, the SMART Selective self-test routine shall be processed. This self-test routine shall include the initial tests performed by the Extended self-test routine plus a selectable read scan. The host should not write the Selective self-test log while the processing of a SMART Selective self-test routine is in progress.

A read scan of the specified areas of the media is requested by setting the test spans to be read scanned in the Selective self-test log (see A.17). The device shall process the specified test spans and they shall be read scanned in their entirety. If bit 1 in the Feature flags field of the Selective self-test log (see A.17) is cleared to zero, then the device shall not perform an off-line scan following the Selective self-test.

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 12 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.

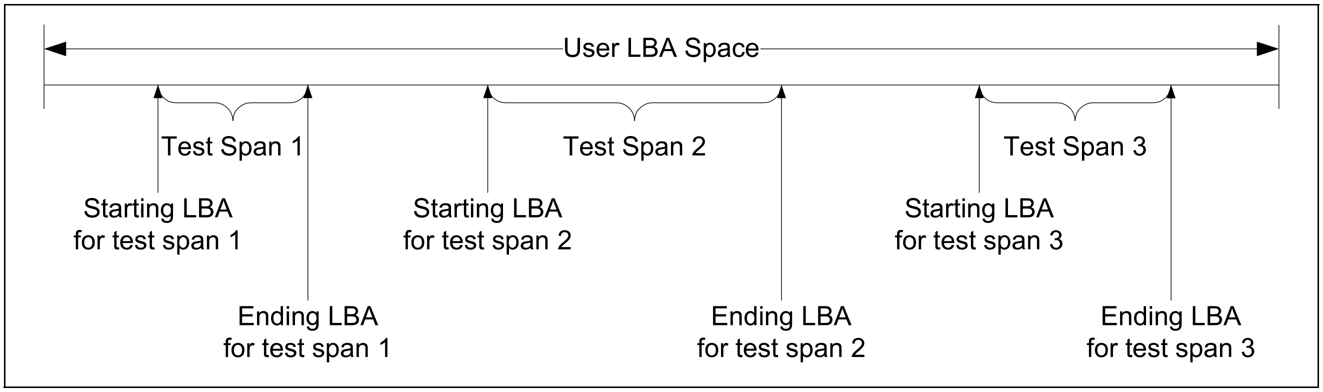

Figure 12 — Selective self-test span example

If bit 1 of the Feature flags field in the Selective self-test log (see A.17) is set to one, then after the scan of the selected spans described in this subclause, the device shall scan the rest of media in an off-line mode. 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 processed. When the test spans defined have been scanned, then the device shall:

a) set the off-line scan pending and active flags in the Selective self-test log to one;
b) set the span under test to a value greater than five;
c) set the self-test execution status in the SMART READ DATA response to 00h;
d) set a value of 03h in the off-line data collection status in the SMART READ DATA response; and
e) proceed to process an off-line read scan through all areas not included in the test spans.

This off-line read scan shall be completed with no pauses between block reads. Any errors encountered shall not be reported to the host. Error locations may be logged for future reallocation. If the device is powered-down before the off-line scan is completed, then the off-line scan shall resume when the device is 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 (see A.17). 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.

The time to complete off-line testing and the self-test polling times do not apply to the selective self-test. Progress through the test spans is indicated in the selective self-test log.

When bit 3 in the Selective self-test feature flags field is set to one (see A.17), a device shall continue processing the Selective self-test after processing a hardware reset or a software reset. When bit 3 in the Selective self-test feature flags field is cleared to zero, a device shall abort the Selective self-test during processing a hardware reset or a software reset.

If a device receives a SMART EXECUTE OFF-LINE IMMEDIATE command with the Abort off-line test routine subcommand, then the device shall abort the Selective self-test.

If a device receives a SMART EXECUTE OFF-LINE IMMEDIATE command specifying that the device perform a self-test while a selective self-test is in progress, the device shall abort the selective self-test and process the specified self-test.

7.48.5.3 Inputs

See table 113 for the SMART EXECUTE OFF-LINE IMMEDIATE command inputs.

Table 113 — SMART EXECUTE OFF-LINE IMMEDIATE command inputs

Name	Description
Feature	D4h
Count	N/A
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 Table 112 defines the subcommand that shall be processed
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.48.5.4 Normal Outputs

See table 187.

7.48.5.5 Error Outputs

The ID Not Found bit shall be set to one if the SMART data is not available. The Abort bit 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 210.

7.48.6 SMART READ DATA - B0h/D0h, PIO Data-In

7.48.6.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.17).

7.48.6.2 Description

The SMART READ DATA command returns the Device SMART data structure to the host.

7.48.6.3 Inputs

See table 114 for the SMART READ DATA command inputs.

Table 114 — SMART READ DATA command inputs

Name	Description
Feature	D0h
Count	N/A
LBA	**Bit Description** 27:24 N/A 23:8 C24Fh 7:0 N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.48.6.4 Normal Outputs

See table 179.

7.48.6.5 Error Outputs

If SMART data is uncorrectable, then the device shall return command completion with the Uncorrectable bit set to one. If the SMART data is not available or the data structure checksum is invalid, then the device shall return command completion with the ID Not Found bit set to one. If SMART is not enabled or if field values are invalid, then the device shall return command aborted. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 215.

NOTE 22 — There is no defined mechanism for a device to return an Interface CRC 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 may verify that an Interface CRC error occurred in these cases.

7.48.6.6 Input From the Device to the Host Data Structure

Table 115 defines the 512 bytes that make up the Device SMART data structure.

Table 115 — Device SMART data structure

Offset	F/V	Description
0..361	X	Vendor specific
362	V	Off-line data collection status
363	X	Self-test execution status byte
364..365	X	Vendor specific
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) (see 7.48.6.11)
373	F	Extended self-test routine recommended polling time in minutes. If FFh, use bytes 375 and 376 for the polling time (see 7.48.6.11)
374	F	Conveyance self-test routine recommended polling time in minutes (see 7.48.6.11)
375..376	F	Extended self-test routine recommended polling time in minutes (word) (see 7.48.6.11)
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 processed 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.

7.48.6.7 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 116 lists the values and their respective definitions.

Table 116 — Off-line data collection status byte values

Value	Description
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

7.48.6.8 Self-test execution status byte

The self-test execution status byte reports the status of the self-test routine as follows:

a) for bits (3:0) (i.e., Percent Self-Test Remaining), the value indicates an approximation of the percent of the self-test routine remaining until completion in ten percent increments. Valid values are nine through zero. A value of zero indicates that the self-test routine is complete. A value of nine indicates 90% of total test time is remaining; and
b) for bits (7:4) (i.e., Self-test Execution Status), the value:
    A) indicates the current Self-test Execution Status (see table 117);
    B) may be cleared to zero when the device processes a power-on reset; and
    C) shall be retained when the device processes a software reset or hardware reset.

Table 117 — Self-test execution status values

Value	Description
0h	Indicates a previous self-test routine completed without error or no self-test status is available
1h	The self-test routine was aborted by the host
2h	The self-test routine was interrupted by the host with a hardware or software reset
3h	A fatal error or unknown test error occurred while the device was executing its self-test routine and the device was unable to complete the self-test routine.
4h	The previous self-test completed having a test element that failed and the test element that failed is not known.
5h	The previous self-test completed having the electrical element of the test failed.
6h	The previous self-test completed having the servo and/or seek test element of the test failed.
7h	The previous self-test completed having the read element of the test failed.
8h	The previous self-test completed having a test element that failed and the device is suspected of having handling damage.
9h-Eh	Reserved.
Fh	Self-test routine in progress.

7.48.6.9 Off-line data collection capabilities

Table 118 defines 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.

Table 118 — Offline Data Collection Capabilities

Bit	Description
7	Reserved
6	Selective self-test implemented - 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.
5	Conveyance self-test implemented - 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.
4	Self-test implemented - 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.
3	Off-line read scanning implemented - 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.
2	Abort/restart off-line by host - If this bit is set to one, then the device shall abort all off-line data collection activity initiated by a 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.
1	Vendor specific.
0	EXECUTE OFF-LINE IMMEDIATE implemented - 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.

7.48.6.10 SMART capabilities

The following defines the SMART capabilities bits:

a) If bit 0 is set to one, then the device saves SMART data prior to going into a power saving mode (i.e., Idle, Standby, or Sleep) or upon return to Active mode or Idle mode from a Standby mode (see 4.13.4). If bit 0 is cleared to zero, then the device does not save SMART data prior to going into a power saving mode (Idle, Standby, or Sleep) or upon return to Active mode or Idle mode from a Standby mode;
b) Bit 1 shall be set to one to indicate that the device supports the SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE command; and
c) Bits (15:2) are reserved.

7.48.6.11 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 begin polling for test completion status. Actual test time may 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 before this time may extend the self-test processing time or abort the test depending on the state of Offline Data Collection Capabilities bit 2 (see table 118). Subsequent checking by the host should be at a vendor specific interval.

7.48.6.12 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 shall be zero when the checksum is correct. The checksum is placed in byte 511.

7.48.7 SMART READ LOG - B0h/D5h, PIO Data-In

7.48.7.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.17).

7.48.7.2 Description

The SMART READ LOG command returns the specified log to the host. See table A.2 for the list of logs.

7.48.7.3 Inputs

See table 119 for the SMART READ LOG command inputs.

Table 119 — SMART READ LOG command inputs

Name	Description
Feature	D5h
Count	Specifies the number of log pages to be read from the specified log. The log transferred by the ATA device shall start at the first page in the specified log, regardless of the Count requested
LBA	**Bit Description** 27:24 N/A 23:8 C24Fh 7:0 Log Address - Specifies the log to be read as described in table A.2. See 7.27.3.3 for more information
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.48.7.4 Normal Outputs

See table 179.

7.48.7.5 Error Outputs

The Uncorrectable Error bit shall be set to one if SMART data is uncorrectable. The ID Not Found bit shall be set to one if the data is not available or the data structure checksum is invalid. The Abort bit shall be set to one if SMART is not enabled, if the Count field is cleared to zero, or if field values are invalid. The Abort bit shall be set to one if the Count is larger than the log size reported in the SMART Log Directory (see A.3). A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 215.

7.48.8 SMART RETURN STATUS - B0h/DAh, Non-Data

7.48.8.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.17).

7.48.8.2 Description

The SMART RETURN STATUS command causes the device to communicate the reliability status of the device to the host.

7.48.8.3 Inputs

See table 120 for the SMART RETURN STATUS command inputs.

Table 120 — SMART RETURN STATUS command inputs

Name	Description
Feature	DAh
Count	N/A
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.48.8.4 Normal Outputs

See table 188.

7.48.8.5 Error Outputs

The Abort bit shall be set to one if SMART is not enabled. See table 198.

7.48.9 SMART WRITE LOG - B0h/D6h, PIO Data-Out

7.48.9.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.17).

7.48.9.2 Description

The SMART WRITE LOG command specifies the log to be written as described in table A.2. This command causes the device to write the specified number of log pages to the specified log. See table A.2 for the list of logs.

7.48.9.3 Inputs

7.48.9.3.1 Overview

See table 121 for the SMART WRITE LOG command inputs.

Table 121 — SMART WRITE LOG command inputs

Name	Description
Feature	D6h
Count	Specifies the number of log pages that shall be written. The data transferred to the device shall be stored starting at the first block in the specified log. If the device receives a value of zero in this field, then the device shall report command aborted
LBA	**Bit Description** 27:24 N/A 23:8 C24Fh 7:0 Log Address - See 7.48.9.3.2
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.48.9.3.2 Log Address

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 the host attempts to write to a read only log address, the device shall return command aborted.

7.48.9.4 Normal Outputs

See table 179.

7.48.9.5 Error Outputs

If the SMART data is not available, then the device shall return command completion with the ID Not Found bit set to one. If SMART is not enabled, the log is not implemented, or the Count field is cleared to zero, then the device shall return command aborted for the command. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 208.

7.49 STANDBY - E2h, Non-Data

7.49.1 Feature Set

This 28-bit command is for devices that implement the Power Management feature set (see 4.13).

7.49.2 Description

The STANDBY command causes the device to enter the Standby mode (see 4.13.4).

If the Count field is non-zero, then the Standby timer (see 4.13.3) shall be enabled. The value in the Count field shall be used to determine the time programmed into the Standby timer (see table 53).

If the Count field is zero, then the Standby timer is disabled.

See 4.7.4 for interactions with the EPC feature set.

7.49.3 Inputs

See table 122 for the STANDBY command inputs.

Table 122 — STANDBY command inputs

Name	Description
Feature	N/A
Count	This value shall determine the time period programmed into the Standby timer. Table 53 defines these values.
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E2h

7.49.4 Normal Outputs

See table 179.

7.49.5 Error Outputs

See table 198.

7.50 STANDBY IMMEDIATE - E0h, Non-Data

7.50.1 Feature Set

This 28-bit command is for devices that implement the Power Management feature set (see 4.13).

7.50.2 Description

The STANDBY IMMEDIATE command causes the device to enter the Standby mode (see 4.13.4).

Processing a STANDBY IMMEDIATE command should cause the device to prepare for a power cycle.

See 4.7.4 for interactions with the EPC feature set.

7.50.3 Inputs

See table 123 for the STANDBY IMMEDIATE command inputs.

Table 123 — STANDBY IMMEDIATE command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E0h

7.50.4 Normal Outputs

See table 179.

7.50.5 Error Outputs

See table 198.

7.51 TRUSTED NON-DATA - 5Bh, Non-Data

7.51.1 Feature Set

This 28-bit command is for devices implementing the Trusted Computing feature set (see 4.21).

7.51.2 Description

The TRUSTED NON-DATA command delivers the SP Specific field (see 7.52.6) using the specified Security Protocol.

7.51.3 Inputs

7.51.3.1 Overview

See table 124 for the TRUSTED NON-DATA command inputs.

Table 124 — TRUSTED NON-DATA command inputs

Name	Description
Feature	Security Protocol (see 7.52.3.2)
Count	Reserved
LBA	**Bit Description** 27:25 Reserved 24 0 - Non-Data TRUSTED SEND, 1 - Non-Data TRUSTED RECEIVE 23:8 SP Specific (15:0) - Security Protocol Specific (see 7.52.6) 7:0 Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 5Bh

7.51.3.2 Security Protocol

If Bit 24 is cleared to zero, then see 7.54.3.2, otherwise, see 7.52.3.2.

7.51.4 Normal Outputs

If Bit 24 is cleared to zero, then see 7.54.4, otherwise, see 7.52.4.

7.51.5 Error Outputs

If Bit 24 is cleared to zero, then see 7.54.5, otherwise, see 7.52.5.

7.52 TRUSTED RECEIVE - 5Ch, PIO Data-In

7.52.1 Feature Set

This 28-bit command is for devices implementing the Trusted Computing feature set (see 4.21).

7.52.2 Description

The TRUSTED RECEIVE command retrieves security protocol information (see 7.52.6) or the results from one or more TRUSTED SEND commands.

Any association between a previous TRUSTED SEND command and the data transferred by a TRUSTED RECEIVE command depends on the protocol specified by the Security Protocol field (see table 126). If the device has no data to transfer (e.g., the results for any previous TRUSTED SEND commands are not yet available), the device may transfer data indicating it has no other data to transfer.

Indications of data overrun or underrun and the mechanism, if any, for processing retries depend on the protocol specified by the Security Protocol field (see table 126).

For Security Protocol field set to 00h, the format of the data is described in 7.52.6. The format of the data for other Security Protocol values is specified by the group that owns the associated Security Protocol value.

Data transfer lengths for the TRUSTED RECIEVE command shall be non-zero multiples of 512 bytes. Pad bytes are appended as needed to meet this requirement. Pad bytes shall have a value of 00h.

The device shall retain data resulting from a TRUSTED SEND command awaiting retrieval by a TRUSTED RECEIVE command until one of the following events is processed:

a) the data is delivered according to the Security Protocol field (see table 126) specific rules for the TRUSTED RECEIVE command;
b) any reset; or
c) loss of communication with the host that sent the TRUSTED SEND command.

7.52.3 Inputs

7.52.3.1 Overview

See table 125 for the TRUSTED RECEIVE command inputs.

Table 125 — TRUSTED RECEIVE command inputs

Name	Description
Feature	Security Protocol (see 7.52.3.2)
Count	Transfer Length (7:0) - See 7.52.3.4
LBA	**Bit** **Description** 27:24 Reserved 23:8 SP Specific (15:0) - Security Protocol Specific (word) (see 7.52.3.3) 7:0 Transfer Length (15:8) - See 7.52.3.4
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 5Ch

7.52.3.2 Security Protocol

The Security Protocol field identifies which security protocol is being used. This determines the format of the SP Specific field and of the data that is transferred (see table 126). If the Security Protocol field is set to a reserved value, the device shall return command aborted.

Table 126 — TRUSTED RECEIVE Security Protocol field description

Value	Description
00h	Return security protocol information (see 7.52.6)
01h..06h	Reserved for TCG
07h..1Fh	Reserved
20h	Reserved for T10
21h..EBh	Reserved
ECh	JEDEC UFS RPMB [a]
EDh	Defined by SDCard TrustedFlash Security Systems Specification 1.1.3
EEh	Defined by IEEE 1667
EFh	Reserved for T10
F0h..FFh	Vendor Specific.

[a] JC64.1 (http://www.jedec.org)

7.52.3.3 SP Specific

The SP Specific field provides Security Protocol field specific information. The meaning of these fields are defined by each security protocol.

7.52.3.4 Transfer Length

The Transfer Length is security protocol specific

7.52.4 Normal outputs

See table 189.

7.52.5 Error outputs

The device shall return command aborted if an unrecoverable error occurred during the processing of the command. The amount of data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 200.

7.52.6 Security Protocol 00h Description

7.52.6.1 Overview

The Security Protocol 00h returns security protocol related information about the device. A TRUSTED RECEIVE command with Security Protocol field set to 00h is not linked to an earlier TRUSTED SEND command.

The Transfer Length field contains the number of 512-byte blocks of data to be transferred (e.g., one means 512 bytes, two means 1 024 bytes). A transfer length of zero is invalid.

If the length of the TRUSTED RECEIVE parameter data is greater than the Transfer Length, then the device shall return the TRUSTED RECEIVE parameter data truncated to the requested Transfer Length without indicating an error.

When the Security Protocol field is set to 00h, the SP Specific field is shown in table 127.

Table 127 — Security Protocol 00h - SP Specific field descriptions for Protocol 00h

SP Specific	Description	Support
0000h	Return supported security protocol list (see 7.52.6.2)	Mandatory
0001h	Return a certificate (see 7.52.6.3)	Mandatory
0002h	Return security compliance information (see 7.52.6.4)	Optional
0003h..FFFFh	Reserved	

If the SP Specific field is set to a reserved value, then the command shall be aborted.

Each time a TRUSTED RECEIVE command with Security Protocol field set to 00h is received, the device shall transfer the data starting with byte 0.

7.52.6.2 Supported security protocols list description

When the Security Protocol field is set to 00h, and the SP Specific field is set to 0000h in a TRUSTED RECEIVE command, the parameter data shall have the format shown in table 128.

Table 128 — TRUSTED RECEIVE parameter data for SP Specific=0000h

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	List Length (M-7) bits (15:8)							
7	List Length (M-7) bits (7:0)							
8	Supported Security Protocol List							
M								
M+1	Pad bytes (if any)							
511								

The List Length field indicates the total length, in bytes, of the supported security protocol list.

The Supported Security Protocol List field shall contain a list of all supported Security Protocol field values. Each byte indicates a supported Security Protocol field value. The values shall be in ascending order starting with 00h.

The total data length shall be 512 bytes. Pad bytes are appended as needed to meet this requirement. Pad bytes shall have a value of 00h.

7.52.6.3 Certificate data description

7.52.6.3.1 Certificate overview

A certificate is either an X.509 Attribute Certificate (see 2.4) or an X.509 Public Key Certificate (see 2.4) depending on the capabilities of the device.

When the Security Protocol field of the TRUSTED RECEIVE command is set to 00h, and the SP Specific field is 0001h, the parameter data shall have the format shown in table 129.

Table 129 — TRUSTED RECEIVE parameter data for SP Specific=0001h

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	(MSB)	CERTIFICATE LENGTH (M - 3)						
3								(LSB)
4	X.509 certificate bytes							
M								
M+1	Pad bytes (if any)							
511								

The CERTIFICATE LENGTH indicates the total length, in bytes, of the certificate(s). This length includes one or more certificates. If the device has no certificate to return, then the certificate length is set to 0000h, the 4 byte header, and 508 pad bytes are returned.

The contents of the certificate fields are defined in 7.52.6.3.2 and 7.52.6.3.3.

The total data length shall conform to the Transfer Length field (see 7.52.3.4) requirements.

7.52.6.3.2 Public Key certificate description

RFC 3280 defines the certificate syntax for certificates consistent with the X.509v3 Public Key Certificate Specification.

7.52.6.3.3 Attribute certificate description

RFC 3281 defines the certificate syntax for certificates consistent with the X.509v2 Attribute Certificate Specification.

7.52.6.4 Reporting security compliance

7.52.6.4.1 Overview

The security compliance information lists security-related standards that apply to this device.

Table 130 defines the security compliance reporting information that the device returns. The security compliance information is a variable length, unsorted list of Compliance Descriptors. The amount of data returned is one or more 512-byte data blocks, with pad bytes after the final Compliance Descriptor. Pad bytes shall have the value 00h.

Table 130 — TRUSTED RECEIVE parameter data for SP Specific=0002h

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)	Length of Compliance Descriptors (M - 3)						
3								(LSB)
4	Compliance Descriptors							
M								

7.52.6.4.2 Length of Compliance Descriptors

The Length of Compliance Descriptors indicates the number of bytes in the Compliance Descriptors field.

7.52.6.4.3 Compliance Descriptors

7.52.6.4.3.1 Overview

There may be zero or more Compliance Descriptors. The format of each Compliance Descriptor varies according to type. The header of each Compliance Descriptor contains a type identifier. Table 131 defines the

Compliance Descriptor Types. There may be more than one Compliance Descriptor with the same Compliance Descriptor Type. Compliance Descriptors may be returned in any order.

Table 131 — Compliance Descriptor Type

Compliance Descriptor Type	Description	Reference	Compliance Descriptor
0000h	Reserved		
0001h	Security requirements for cryptographic modules	FIPS 140-2, FIPS 140-3	7.52.6.4.3.3
0002h..FFFFh	Reserved		

Table 132 — Common Compliance Descriptor Header

Byte Offset	Type	Length	Description
0..1	Word	2	Compliance Descriptor Type (see table 131)
2..3	Word	2	Reserved
4..7	DWord	4	Descriptor Length

7.52.6.4.3.2 Descriptor Length

The Descriptor Length field indicates how many bytes of Compliance Descriptor data follow the Descriptor Length field.

7.52.6.4.3.3 Security Requirements for Cryptographic Modules descriptor

7.52.6.4.3.3.1 Overview

The Security Requirements for Cryptographic Modules descriptor (see table 133) contains information that may be used to locate information about a FIPS 140 certificate associated with the device. The device may or may not be operating in the mode specified by that certificate.

Table 133 — Security Requirements for Cryptographic Modules descriptor

Byte Offset	Type	Description
0..1	Word	Compliance Descriptor Type (i.e., 0001h) (see table 131)
2..3	Bytes	Reserved
4..7	DWord	Descriptor Length
8	ATA String	Revision (e.g., ‘2’)
9	ATA String	Overall security level (e.g., ‘1’)
10..15	Bytes	Reserved
16..143	ATA String	Hardware version
144.271	ATA String	Version
272.527	ATA String	Module name

7.52.6.4.3.3.2 Descriptor Length

The Descriptor Length shall be 520.

7.52.6.4.3.3.3 Revision

For FIPS 140-2, the Revision shall be ‘2’.

For FIPS 140-3, the Revision shall be ‘3’.

7.52.6.4.3.3.4 Overall security level

For FIPS 140-2, the Overall security level shall be ‘1’, ‘2’, ‘3’, or ‘4’.

For FIPS 140-3, the Overall security level shall be ‘1’, ‘2’, ‘3’, or ‘4’.

7.52.6.4.3.3.5 Hardware version

The Hardware version field shall contain the version number of the hardware in the module, as reported by NIST.

7.52.6.4.3.3.6 Version

The Version field shall contain the version number of the software or firmware in the module, as reported by NIST.

7.52.6.4.3.3.7 Module name

The Module name field shall contain the name or identifier of the cryptographic module, as reported by NIST.

7.53 TRUSTED RECEIVE DMA - 5Dh, DMA

7.53.1 Feature Set

This 28-bit command is for devices implementing the Trusted Computing feature set (see 4.21).

7.53.2 Description

See 7.52.2.

7.53.3 Inputs

See table 134 for the TRUSTED RECEIVE DMA command inputs.

Table 134 — TRUSTED RECEIVE DMA command inputs

Name	Description
Feature	Security Protocol (see 7.52.3.2)
Count	Transfer Length (7:0) - See 7.52.3.4
LBA	**Bit Description** 27:24 Reserved 23:8 SP Specific (15:0) - Security Protocol Specific (see 7.52.3.3) 7:0 Transfer Length (15:8) - See 7.52.3.4
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 5Dh

See 7.52.3.

7.53.4 Normal Outputs

See 7.52.4.

7.53.5 Error Outputs

See 7.52.5.

7.54 TRUSTED SEND - 5Eh, PIO Data-Out

7.54.1 Feature Set

This 28-bit command is for devices implementing the Trusted Computing feature set (see 4.21).

7.54.2 Description

The TRUSTED SEND command sends one or more Security Protocol specific instructions to be processed by the device. The host uses TRUSTED RECEIVE commands to retrieve any data resulting from these instructions.

Any association between a TRUSTED SEND command and a subsequent TRUSTED RECEIVE command depends on the protocol specified by the Security Protocol field (see table 136). Each protocol shall specify whether:

a) the device shall complete the command without error as soon as the device determines the data has been received without error. An indication that the data has been processed is obtained by sending a TRUSTED RECEIVE command and receiving the results in the associated data transfer; or
b) the device shall complete the command without error only after the data has been processed without error and an associated TRUSTED RECEIVE command is not required.

The completion of background activity resulting from a trusted command shall not return command aborted for any outstanding queued commands.

The format of the data and parameters depends on the protocol specified by the Security Protocol field (see table 136).

Data transfer lengths for the TRUSTED SEND command shall be non-zero multiples of 512 bytes. Pad bytes are appended as needed to meet this requirement. Pad bytes shall have a value of 00h.

7.54.3 Inputs

7.54.3.1 Overview

See table 135 for the TRUSTED SEND command inputs.

Table 135 — TRUSTED SEND command inputs

Name	Description
Feature	Security Protocol (see 7.54.3.2)
Count	Transfer Length (7:0) - See 7.54.3.4
LBA	**Bit** **Description** 27:24 Reserved 23:8 SP Specific (15:0) - Security Protocol Specific (see 7.54.3.3) 7:0 Transfer Length (15:8) - See 7.54.3.4
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 5Eh

7.54.3.2 Security Protocol

The Security Protocol field identifies which security protocol is being used. This determines the format of the parameters and of the data that is transferred (see table 136). If the Security Protocol field is set to a reserved value, the device shall return command aborted.

Table 136 — TRUSTED SEND - Security Protocol field description

Value	Description
00h	Reserved
01h..06h	Reserved for TCG
07h..1Fh	Reserved
20h	Reserved for T10
21h..EBh	Reserved
ECh	JEDEC UFS RPMB [a]
EDh	Reserved for SDCard
EEh	Reserved for IEEE 1667
EFh	Reserved for T10
F0h..FFh	Vendor Specific

[a] JC64.1 (http://www.jedec.org)

7.54.3.3 SP Specific

The meaning of the security protocol-specific field is defined by each security protocol.

7.54.3.4 Transfer Length

The Transfer Length is security protocol specific.

7.54.4 Normal outputs

See table 189

7.54.5 Error outputs

The device shall return command aborted if an unrecoverable error occurred during the processing of the command. The amount of data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 200.

7.55 TRUSTED SEND DMA - 5Fh, DMA

7.55.1 Feature Set

This 28-bit command is for devices implementing the Trusted Computing feature set (see 4.21).

7.55.2 Description

See 7.54.2.

7.55.3 Inputs

See table 137 for the TRUSTED SEND DMA command inputs.

Table 137 — TRUSTED SEND DMA command inputs

Name	Description
Feature	Security Protocol (see 7.54.3.2)
Count	Transfer Length (7:0) - See 7.54.3.4
LBA	**Bit Description** 27:24 Reserved 23:8 SP Specific (15:0) - Security Protocol Specific (see 7.54.3.3) 7:0 Transfer Length (15:8) - See 7.54.3.4
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 5Fh

See 7.54.3.

7.55.4 Normal Outputs

See 7.54.4.

7.55.5 Error Outputs

See 7.54.5.

7.56 WRITE BUFFER - E8h, PIO Data-Out

7.56.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.56.2 Description

The WRITE BUFFER command writes the contents of one 512-byte block of data to the device's buffer.

The READ BUFFER command and WRITE BUFFER command shall be synchronized within the device such that sequential WRITE BUFFER command and READ BUFFER command access the same bytes within the buffer.

7.56.3 Inputs

See table 138 for the WRITE BUFFER command inputs.

Table 138 — WRITE BUFFER command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 E8h

7.56.4 Normal Outputs

See table 179.

7.56.5 Error Outputs

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 199.

7.57 WRITE BUFFER DMA - EBh, DMA

7.57.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.57.2 Description

See 7.56.2

7.57.3 Inputs

See table 139 for the WRITE BUFFER DMA command inputs.

Table 139 — WRITE BUFFER DMA command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 EBh

7.57.4 Normal Outputs

See 7.56.4.

7.57.5 Error Outputs

See 7.56.5.

7.58 WRITE DMA - CAh, DMA

7.58.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.58.2 Description

The WRITE DMA command writes data using the DMA data transfer protocol.

7.58.3 Inputs

See table 140 for the WRITE DMA command inputs.

Table 140 — WRITE DMA command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 CAh

7.58.4 Normal Outputs

See table 179.

7.58.5 Error Outputs

See table 218.

7.59 WRITE DMA EXT - 35h, DMA

7.59.1 Feature Set

This 48-bit command is for devices that implement the 48-bit Address feature set (see 4.4).

7.59.2 Description

The WRITE DMA EXT command writes data using the DMA data transfer protocol.

7.59.3 Inputs

See table 141 for the WRITE DMA EXT command inputs.

Table 141 — WRITE DMA EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 35h

7.59.4 Normal Outputs

See table 189.

7.59.5 Error Outputs

See table 211.

7.60 WRITE DMA FUA EXT - 3Dh, DMA

7.60.1 Feature Set

This 48-bit command is for devices that implement the 48-bit Address feature set (see 4.4).

7.60.2 Description

The WRITE DMA FUA EXT command writes data using the DMA data transfer protocol and the user data shall be written to non-volatile media before command completion is reported regardless of whether or not volatile and/or non-volatile write caching in the device is enabled.

7.60.3 Inputs

See table 142 for the WRITE DMA FUA EXT command inputs.

Table 142 — WRITE DMA FUA EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 3Dh

7.60.4 Normal Outputs

See table 189.

7.60.5 Error Outputs

See table 211.

7.61 WRITE FPDMA QUEUED - 61h, DMA Queued

7.61.1 Feature Set

This 48-bit command is for devices implementing the NCQ feature set (see 4.12).

7.61.2 Description

The WRITE FPDMA QUEUED command causes data to be transferred from the host to the device.

7.61.3 Inputs

7.61.3.1 Overview

See table 143 for the WRITE FPDMA QUEUED command inputs.

Table 143 — WRITE FPDMA QUEUED command inputs

Name	Description
Feature	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred
Count	**Bit Description** 15 PRIO - See 7.26.3.2 14:8 Reserved 7:3 NCQ Tag - See 6.5.2 2:0 Reserved
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 FUA - See 7.61.3.2 6 Shall be set to one 5 Reserved 4 Shall be set to zero 3:0 Reserved
Command	7:0 61h

7.61.3.2 Forced Unit Access (FUA)

When the FUA bit is set to one regardless of whether volatile and/or non-volatile write caching in the device is enabled or not, the user data shall be written to non-volatile media before command completion is reported. When the FUA bit is cleared to zero the device may return command completion before the data is written to the non-volatile media.

7.61.4 Command Acceptance Outputs

See table 190.

7.61.5 Normal Outputs

See table 191.

7.61.6 Error Outputs

If the Error bit is set to one, then the device aborted the command due to LBA out of range, a duplicate tag number, an invalid tag number, or an Interface CRC error, see table 219 for more information.

Errors that occur during the processing of this command are reported by returning a transport dependent indicator with additional information available in the NCQ Command Error log, see table 220 for more information.

7.62 WRITE LOG EXT - 3Fh, PIO Data-Out

7.62.1 Feature Set

This 48-bit command is for devices that implement the General Purpose Logging feature set (see 4.9).

7.62.2 Description

The WRITE LOG EXT command writes a specified number of 512 byte blocks of data to the specified log. See table A.2 for the list of logs.

7.62.3 Inputs

7.62.3.1 Overview

See table 144 for the WRITE LOG EXT command inputs.

Table 144 — WRITE LOG EXT command inputs

Name	Description
Feature	Reserved
Count	Log Page Count - See 7.62.3.2
LBA	**Bit Description** 47:40 Reserved 39:32 Page # (15:8) - See 7.62.3.3 31:16 Reserved 15:8 Page # (7:0) - See 7.62.3.3 7:0 Log Address - Specifies the log to be written as described in table A.2. See 7.48.9.3.2
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 3Fh

7.62.3.2 Log Page Count

Specifies the number of log pages that shall be written to the specified log. If the number is zero, or the number is greater than the number indicated in the GPL Directory (see table A.3), the device shall return command aborted.

7.62.3.3 Page

Specifies the first page number to be written to the specified log address. Pages are numbered starting with zero.

7.62.4 Normal Outputs

See table 189.

7.62.5 Error Outputs

A device shall return command aborted for the command if:

a) the Count field is cleared to zero;
b) the feature set associated with the log specified in the LBA field (7:0) is not supported or not enabled;
c) the values in the Feature, Count, or LBA (47:8) fields are invalid;
d) the host attempts to write to a read only log address; or
e) the value in the Page # field plus the value in the Log Page Count field is larger than the log size reported in the GPL Directory (see A.2).

If the log data is not available or a data structure checksum error occurred, then the device shall return command completion for the command with the ID Not Found bit set to one.

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred.

See table 209.

7.63 WRITE LOG DMA EXT - 57h, DMA

7.63.1 Feature Set

This 48-bit command is for devices implementing the General Purpose Logging feature set (see 4.9).

7.63.2 Description

See 7.62.2.

7.63.3 Inputs

See table 145 for the WRITE LOG DMA EXT command inputs.

Table 145 — WRITE LOG DMA EXT command inputs

Name	Description
Feature	Reserved
Count	Log Page Count - See 7.62.3.2
LBA	**Bit Description** 47:40 Reserved 39:32 Page # (15:8) - See 7.62.3.3 31:16 Reserved 15:8 Page # (7:0) - See 7.62.3.3 7:0 Log Address - Specifies the log to be written as described in table A.2. See 7.48.9.3.2
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 57h

7.63.4 Normal Outputs

See 7.62.4.

7.63.5 Error Outputs

See 7.62.5.

7.64 WRITE MULTIPLE - C5h, PIO Data-Out

7.64.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.64.2 Description

The WRITE MULTIPLE 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 IDENTIFY DEVICE data word 59 (see 7.16.7.21).

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.

Device errors encountered during WRITE MULTIPLE commands shall be returned after the attempted device write of the DRQ data block or partial DRQ data block is 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 IDENTIFY DEVICE data word 59 bit 8 is cleared to zero or IDENTIFY DEVICE data word 59 bits (7:0) (see 7.16.7.21) are set to zero, and a WRITE MULTIPLE command is received by the device, and no successful SET MULTIPLE MODE command has been processed by the device, the device shall return command aborted. A successful SET MULTIPLE MODE command should precede a WRITE MULTIPLE command.

7.64.3 Inputs

See table 146 for the WRITE MULTIPLE command inputs.

Table 146 — WRITE MULTIPLE command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 C5h

7.64.4 Normal Outputs

See table 179.

7.64.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 217.

7.65 WRITE MULTIPLE EXT - 39h, PIO Data-Out

7.65.1 Feature Set

This 48-bit command is for devices that implement the 48-bit Address feature set (see 4.4).

7.65.2 Description

The WRITE MULTIPLE EXT 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 IDENTIFY DEVICE data word 59 (see 7.16.7.21).

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.

Device errors encountered during WRITE MULTIPLE EXT commands shall be returned after the attempted write of the DRQ data block or partial DRQ data block is 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 IDENTIFY DEVICE data word 59 bit 8 (see 7.16.7.21) is cleared to zero or IDENTIFY DEVICE data word 59 bits (7:0) (see 7.16.7.21) are set to zero, and a WRITE MULTIPLE EXT command is received by the device, and no successful SET MULTIPLE MODE command has been processed by the device, the device shall return command aborted. A successful SET MULTIPLE MODE command should precede a WRITE MULTIPLE EXT command.

7.65.3 Inputs

See table 147 for the WRITE MULTIPLE EXT command inputs.

Table 147 — WRITE MULTIPLE EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 39h

7.65.4 Normal Outputs

See table 189.

7.65.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 211.

7.66 WRITE MULTIPLE FUA EXT - CEh, PIO Data-Out

7.66.1 Feature Set

This 48-bit command is for devices that implement the 48-bit Address feature set (see 4.4).

7.66.2 Description

The WRITE MULTIPLE FUA EXT command writes the number of logical sectors specified in the Count field. The user data shall be written to non-volatile media before command completion is reported regardless of whether or not volatile and/or non-volatile write caching in the device is enabled.

The number of logical sectors per DRQ data block is defined by the content of IDENTIFY DEVICE data word 59 (see 7.16.7.21).

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.

Device errors encountered during WRITE MULTIPLE EXT commands shall be returned after the attempted write of the DRQ data block or partial DRQ data block is 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 IDENTIFY DEVICE data word 59 bit 8 (see 7.16.7.21) is cleared to zero or IDENTIFY DEVICE data word 59 bits (7:0) (see 7.16.7.21) are set to zero, and a WRITE MULTIPLE FUA EXT command is received by the device, and no successful SET MULTIPLE MODE command has been processed by the device, the device shall return command aborted. A successful SET MULTIPLE MODE command should precede a WRITE MULTIPLE FUA EXT command.

7.66.3 Inputs

See table 148 for the WRITE MULTIPLE FUA EXT command inputs.

Table 148 — WRITE MULTIPLE FUA EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 CEh

7.66.4 Normal Outputs

See table 189.

7.66.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 211.

7.67 WRITE SECTOR(S) - 30h, PIO Data-Out

7.67.1 Feature Set

This 28-bit command is for ATA devices (see 4.2).

7.67.2 Description

The WRITE SECTOR(S) command writes from 1 to 256 logical sectors as specified in the Count field.

7.67.3 Inputs

See table 149 for the WRITE SECTOR(S) command inputs.

Table 149 — WRITE SECTOR(S) command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 30h

7.67.4 Normal Outputs

See table 179.

7.67.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 217.

7.68 WRITE SECTOR(S) EXT - 34h, PIO Data-Out

7.68.1 Feature Set

This 48-bit command is for devices that implement the 48-bit Address feature set (see 4.4).

7.68.2 Description

The WRITE SECTOR(S) EXT command writes from 1 to 65 536 logical sectors as specified in the Count field.

7.68.3 Inputs

See table 150 for the WRITE SECTOR(S) EXT command inputs.

Table 150 — WRITE SECTOR(S) EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 34h

7.68.4 Normal Outputs

See table 189.

7.68.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 211.

7.69 WRITE STREAM DMA EXT - 3Ah, DMA

7.69.1 Feature Set

This 48-bit command is for devices that implement the Streaming feature set (see 4.20).

7.69.2 Description

The WRITE STREAM DMA EXT command writes data within an allotted time. This command specifies that additional actions are to be performed by the device prior to the completion of the command.

7.69.3 Inputs

7.69.3.1 Inputs overview

See table 151 for the WRITE STREAM DMA EXT command inputs.

Table 151 — WRITE STREAM DMA EXT command inputs

Name	Description
Feature	**Bit Description** 15:8 Command Completion Time Limit (CCTL) - See 7.33.3.2. 7 Obsolete 6 Write Continuous (WC) - See 7.69.3.2 5 Flush - See 7.69.3.3 4 Obsolete 3 Reserved 2:0 Stream ID – See 7.69.3.4
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 3Ah

7.69.3.2 Write Continuous (WC)

The WC bit specifies whether the Write Continuous mode is enabled or disabled.

If the WC bit 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 7.33.3.2) or Default CCTL (see 7.8.3) 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 (see A.20);

or

c) if the amount of time allowed for command completion based on the setting of the CCTL field (see 7.33.3.2) or Default CCTL (see 7.8.3) is reached, then the device:
   1) shall stop processing the command;
   2) shall report command completion;
   3) shall set the Command Completion Time Out bit in the Write Streaming Error log to one; and
   4) may continue writing data to the media.

If the WC bit 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.

7.69.3.3 Flush

If the Flush bit is set to one, the Default CCTL field is set to zero, and the CCTL field is cleared to zero, then the device shall write all data for the specified stream to the media before command completion is reported.

If the Flush bit is set to one and the Default CCTL field was not set to zero in the most recent CONFIGURE STREAM command (see 7.8) for the Stream ID, then the device shall report command completion within the time specified by the Default CCTL field (see 7.8.3.4).

If the Flush bit is set to one and the CCTL field is not set to zero, then the device shall report command completion within (CCTL * (IDENTIFY DEVICE data words 98..99 (see 7.16.7.52)) µs.

If the Flush bit is set to one and either the Default CCTL field was not set to zero in the most recent CONFIGURE STREAM command (see 7.8) for the Stream ID, or the CCTL field is not set to zero, then the device:

a) shall measure the time before reporting command completion from command acceptance;
b) shall set the Command Completion Time Out (see 6.3.3) 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.

7.69.3.4 Stream ID

The Stream ID field 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.

7.69.4 Normal Outputs

See table 183 for the definition of Normal Outputs.

7.69.5 Error Outputs

If:

a) The WC bit 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 the Stream Error bit to one and clear the Error bit to zero.

If:

a) The WC bit 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 Interface CRC error shall be reported at command completion),

then the device shall clear the Stream Error bit to zero and set the Error bit to one.

If:

a) The WC bit was cleared to zero in the command;

b) The CCTL field was not set to zero in the command, or the CCTL field was cleared to zero in the command and the Default CCTL field specified in the most recent CONFIGURE STREAM command (see 7.8) for the Stream ID field was not cleared to zero; and
c) the time specified for command completion by the CCTL field (see 7.33.3.2) or the Default CCTL (see 7.8.3) has been reached,

then the device shall clear the Stream Error bit to zero, set the Error bit to one, and set the Abort bit to one whether or not all data has been flushed to media.

If:

a) the WC bit was cleared to zero in the command;
b) the CCTL field was set to zero in the command; and
c) the Default CCTL field was set to zero in the most recent CONFIGURE STREAM command (see 7.8) for the Stream ID field,

then the device shall clear the Stream Error bit to zero, set the Error bit to one, and set the Interface CRC bit to one, ID Not Found bit to one, and/or Abort bit to one (i.e., indicating the error type).

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 212.

7.70 WRITE STREAM EXT - 3Bh, PIO Data-Out

7.70.1 Feature Set

This 48-bit command is for devices that implement the Streaming feature set (see 4.20).

7.70.2 Description

See 7.69.2.

7.70.3 Inputs

See table 152 for the WRITE STREAM EXT command inputs.

Table 152 — WRITE STREAM EXT command inputs

Name	Description
Feature	**Bit Description** 15:8 Command Completion Time Limit (CCTL) - See 7.33.3.2. 7 Obsolete 6 Write Continuous (WC) - See 7.69.3.2 5 Flush - See 7.69.3.3 4 Obsolete 3 Reserved 2:0 Stream ID – See 7.69.3.4
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 3Bh

7.70.4 Normal Outputs

See 7.69.4.

7.70.5 Error Outputs

See 7.69.5.

7.71 WRITE UNCORRECTABLE EXT - 45h, Non-Data

7.71.1 Feature Set

This 48-bit command is for ATA devices (see 4.2) and prohibited for ATAPI devices (see 4.3). The WRITE UNCORRECTABLE EXT command is not part of any feature set.

7.71.2 Description

7.71.2.1 Overview

The WRITE UNCORRECTABLE EXT command causes the device to report an uncorrectable error when the specified logical sectors are subsequently read.

When the device processes a read command, it shall set the Uncorrectable Error bit to one and the Error bit to one when a pseudo uncorrectable logical sector or flagged uncorrectable logical sector is read. Reading a flagged logical sector or pseudo uncorrectable logical sector may affect the Number of Reallocated Logical Sectors device statistic (see A.5.6.6).

If the device completes a write command to a pseudo uncorrectable logical sector or flagged uncorrectable logical sector without error, then the device:

a) shall write the data to the logical sector;
b) shall only cause the specified logical sectors to become valid;
c) shall not cause any other logical sectors (e.g., other logical sectors in the same physical sector) to become valid;
d) shall clear the pseudo uncorrectable attribute or flagged uncorrectable attribute of the logical sector; and
e) should verify that the logical sector may now be read without error.

The pseudo uncorrectable attribute or flagged uncorrectable attribute of a logical sector shall remain set during the processing of all power and reset events. If the device is unable to process a WRITE UNCORRECTABLE EXT command for any reason the device shall return command aborted.

7.71.2.2 Pseudo Uncorrectable Logical Sectors

When the Feature field (7:0) contains a value of 55h the WRITE UNCORRECTABLE EXT command shall cause the device to indicate a failure when subsequent reads to any of the logical sectors that are contained in the physical block of the specified logical sector are performed. These logical sectors are referred to as pseudo uncorrectable logical sectors. Whenever a pseudo uncorrectable logical sector is accessed via a read command the device shall perform normal error recovery to the fullest extent until:

a) the error recovery process is completed, the Uncorrectable Error bit is set to one, and the Error bit is set to one; or
b) a command time-out that applies to error recovery control occurs before error recovery is completed and an error is reported as a result of the command time-out (see 8.3.3).

When reading a pseudo uncorrectable logical sector, the device shall perform error logging (e.g., SMART, device statistics) in the same manner as an Uncorrectable error (see 6.3.10).

7.71.2.3 Flagged Uncorrectable Logical Sectors

When the Feature field (7:0) contains a value of AAh the WRITE UNCORRECTABLE EXT command shall cause the device to mark the specified logical sectors as flagged uncorrectable. Marking a logical sector as flagged uncorrectable shall cause the device to indicate a failure when subsequent reads to the specified logical sector are processed. When reading a flagged uncorrectable logical sector, the device should not perform error logging (e.g., SMART, device statistics) in the same manner as an Uncorrectable error (see 6.3.10).

7.71.3 Inputs

See table 153 for the WRITE UNCORRECTABLE EXT command inputs.

Table 153 — WRITE UNCORRECTABLE EXT command inputs

Name	Description
Feature	**Bit** **Description** 15:8 Reserved 7:0 Uncorrectable options **Value** **Description** 00h-54h Reserved 55h Create a pseudo-uncorrectable error with logging 56h-59h Reserved 5Ah Vendor specific 5Bh-A4h Reserved A5h Vendor Specific A6h-A9h Reserved AAh Create a flagged error without logging ABh-FFh Reserved
Count	The number of logical sectors to be marked. A value of 0000h indicates that 65 536 logical sectors are to be marked
LBA	LBA of first logical sector to be marked
Device	**Bit** **Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 45h

7.71.4 Normal Outputs

See table 179.

7.71.5 Error Outputs

See table 198.

8 SCT Command Transport

8.1 Introduction

8.1.1 Overview

The SCT Command Transport 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 logs. Log Address E0h (i.e., SCT Command/Status) (see 8.2.3 and 8.2.5) is used to issue commands and return status. Log Address E1h (i.e., SCT Data Transfer) (see 8.2.4) is used to transport data.

The following methods are used to access the logs defined for the SCT Command Transport:

a) using the SMART READ LOG command and SMART WRITE LOG command; and
b) using READ LOG (DMA) EXT command and WRITE LOG (DMA) EXT command.

These sets of commands access the same logs and provide the same capabilities. The two methods are also used in the same way (e.g., a command is issued, data is transferred, if necessary, and status may be retrieved multiple times).

If the SMART feature set (see 4.17) is supported and not enabled, then a device that implements this feature set shall support the SMART READ LOG command and SMART WRITE LOG command to the SCT Command/Status log and the SCT Data Transfer log.

Sending a key 512-byte block of data (i.e., key data block) to the SCT Command/Status log starts the command process. The key data block specifies an Action Code and Function Code along with the parameters that are required to process the action. The SCT command response (i.e., error or command) is the same for both methods of issuing commands.

SCT commands are processed like other ATA commands, therefore they take precedence over any background activity 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 processing.

A device supporting the SCT Command Transport should report a length of one in the General Purpose Log Directory (see A.2) and the SMART Log Directory (see A.3) for the SCT Command/Status log and the SCT Data Transfer log. The length of the SCT Data Transfer log does not indicate the length of an SCT Command Transport data transfer. This differs from the requirement in this standard that the GPL Directory (see A.2) and the SMART Log Directory (see A.3) report the actual length of the specified log pages.

8.1.2 SCT command nesting and interspersing with standard commands

Standard ATA commands may be interspersed with some SCT commands, but SCT commands shall not be nested. If an SCT command has not completed processing and another SCT command is received by the device (i.e., the host writes the SCT command/status log), then the first SCT command shall be aborted and the new SCT command shall be processed. SCT commands that do not require a subsequent data transfer operation are not interspersed with any ATA commands or each other. SCT commands that require data transfer shall not be nested (i.e., if the device receives another SCT command before all available data is transferred, then the device shall abort the current SCT operation and process the new SCT command without reporting an error).

8.1.3 Resets

A device shall terminate processing an SCT command during the processing of a software reset, hardware reset, or power-on reset. This may result in partial command processing or data loss. There is no indication once the device becomes ready that the previous command was terminated.

A device shall clear the SCT Status Response fields (i.e., Extended Status Code, Action Code, and Function Code) during the processing of a power-on reset and a hardware reset. A device shall clear the Extended status code during processing of a software reset and the other content of the SCT Status Response fields shall not be affected by the device processing the reset.

8.2 Processing SCT commands

8.2.1 Processing SCT commands overview

The following phases are required to process SCT commands:

1) Capability identification (see 8.2.2);
2) SCT 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

IDENTIFY DEVICE data word 206 indicates support for the SCT Command Transport and SCT commands (see 7.16.7.75).

8.2.3 SCT command transfer

Transfer of an SCT command occurs when a 512-byte data packet is written to the SCT Command/Status log (see A.1). The 512-byte data packet contains a single command as defined in the SCT Command Transport.

Table 154 defines the SCT command format, contained in the input data of the SMART WRITE LOG command (see 7.48.9).

Table 154 — Fields to issue an SCT command using SMART WRITE LOG

Name	Description
Feature	D6h (i.e., SMART WRITE LOG)
Count	01h
LBA	**Bit Description** 27:24 N/A 23:8 C24Fh 7:0 E0h (i.e., SCT Command/Status log address)
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

Table 155 defines the SCT command format, contained in the input data of the WRITE LOG (DMA) EXT command (see 7.62).

Table 155 — Fields to issue an SCT command using WRITE LOG (DMA) EXT

Name	Description
Feature	Reserved
Count	0001h
LBA	**Bit** **Description** 47:40 Reserved 39:32 00h 31:16 Reserved 15:8 00h 7:0 E0h (i.e., SCT Command/Status log address)
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 3Fh (i.e., WRITE LOG EXT) 57h (i.e., WRITE LOG DMA EXT)

Table 156 defines how a device shall set the fields after successful completion of an SCT command.

Table 156 — Successful SCT command response

Name	Description
Error	00h
Count	SCT Command Dependent Data
LBA	SCT Command Dependent Data
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5:1 N/A 0 Error - See 6.2.9

Table 157 defines how a device shall set the fields after an error occurred during processing of an SCT command.

Table 157 — SCT command error response

Name	Description
Error	**Bit** **Description** 7:5 N/A 4 ID Not Found - See 6.3.5. 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	Extended Status Code (7:0) (see table 158)
LBA	**Bit** **Description** 27:24 Reserved 23:8 SCT Command dependent. 7:0 Extended Status Code (15:8) (see table 158)
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent - See 6.2.12. 5:1 N/A 0 Error - See 6.2.9

Table 158 — Extended Status codes

Extended Status Code	Description
0000h	Command complete without error
0001h	Invalid Function Code
0002h	Input LBA out of range
0003h	Request 512-byte data block count overflow. The number of data blocks requested to transfer (Count field) in the log command is larger than specified by the SCT command
0004h	Invalid Function code in Error Recovery command
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	Obsolete
000Bh	SCT data transfer command was issued without first issuing an SCT command
000Ch	Invalid Function code in SCT Feature Control command
000Dh	Invalid Feature code in SCT Feature Control command
000Eh	Invalid New State value in SCT Feature Control command
000Fh	Invalid Option Flags value in SCT 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 in SCT data
0014h	Foreground SCT operation was terminated because of unrecoverable error
0015h	The most recent non-SCT command completed with an error due to the SCT Error Recovery Control Read Command Timer or SCT Error Recovery Control Write Command Timer expiring.
0016h-BEFFh	Reserved
BF00h-BFFFh	Reserved for Serial ATA
C000h-FFEFh	Vendor specific
FFF0h-FFFEh	Reserved
FFFFh	SCT command executing in background

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 the SCT Data Transfer log (see A.1). Up to 255 data blocks of 512-bytes each may be transferred at a time. If the SCT command requires more than 255 blocks of data transfer and SMART READ LOG commands and SMART WRITE LOG commands are used to transfer the data, then the data may be written or read in up to 255 data block increments. If GPL feature set (see 4.9) commands are used to transfer data, then up to 65 535 data blocks of 512-bytes each may be transferred by a single command. If more than 65 535 data blocks are required, then multiple GPL feature set commands may be issued. Table 159 shows how to perform an SCT data transfer using a SMART READ LOG command (see 7.48.7) or SMART WRITE LOG command (see 7.48.9).

Table 159 — SCT data transfer using SMART

Name	Description
Feature	D6h (i.e., SMART WRITE LOG) D5h (i.e., SMART READ LOG)
Count	Number of 512-byte data blocks to transfer
LBA	**Bit Description** 27:24 N/A 23:8 C24Fh 7:0 E1h (i.e., SCT Data Transfer)
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

Table 160 defines the fields for data transfer using a GPL feature set (see 4.9) command.

Table 160 — SCT data transfer using the GPL feature set

Name	Description
Feature	Reserved
Count	Number of 512-byte data blocks to transfer
LBA	**Bit** **Description** 47:40 Reserved 39:32 00h 31:16 Reserved 15:8 00h 7:0 E1h (i.e., SCT Data Transfer)
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 2Fh (i.e., READ LOG EXT) 47h (i.e., READ LOG DMA EXT) 3Fh (i.e., WRITE LOG EXT) 57h (i.e., WRITE LOG DMA EXT)

8.2.5 SCT status

Status for an SCT command may be read at any time by reading the SCT Command/Status log (see A.1). If the command involves data transfer, the host should check status before data is transferred to ensure that the device is ready. The host should also check status when the command is complete to confirm that the data was transferred without error. 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 SCT Write Same commands (see 8.3.2) that require the completion of the SCT action (i.e., SCT Write Same with function code 0101h and 0102h). Some commands may take several minutes or even hours to process. The host may determine processing progress by requesting SCT status. Some commands may require setup time before a device is ready to receive data. SCT status indicates when the device is ready to receive data.

Reading the SCT Command/Status log 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 (i.e., if the device is in the Standby state or Idle state (see 4.13.4), then the log request shall succeed).

Table 161 defines shows how to get the SCT status using a SMART READ LOG command (see 7.48.7).

Table 161 — SCT status request using SMART READ LOG

Name	Description
Feature	D5h (i.e., SMART READ LOG)
Count	01h
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 E0h (i.e., SCT Command/Status log address)
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

Table 162 defines the fields for retrieving status using a READ LOG EXT command (see 7.27) or READ LOG DMA EXT command (see 7.28).

Table 162 — SCT status request using the GPL feature set

Name	Description
Feature	Reserved
Count	0001h
LBA	**Bit** **Description** 47:40 Reserved 39:32 00h 31:16 Reserved 15:8 00h 7:0 E0h (i.e., SCT Command/Status log address)
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 2Fh (i.e., READ LOG EXT) 47h (i.e., READ LOG DMA EXT)

Table 163 defines the format of the status response information that shall be set by the device in the SCT Command/Status log.

Table 163 — Format of SCT status response (Sheet 1 of 2)

Offset	Type	Field Name	Description
0..1	Word	Format Version	0003h - Status Response format version number.
2..3	Word	SCT Version	Manufacturer's vendor specific implementation version number
4..5	Word	SCT Spec.	Obsolete
6..9	DWord	Status Flags	Bits (31:1) - Reserved Bit 0 - Segment Initialized Flag. If this bit is set to one, then an SCT Write Same command (see 8.3.2) to all logical blocks has completed without error. This bit shall be cleared to zero when any user LBA is written, even if write cache is enabled. This bit is preserved during the processing of all power and reset events.
10	Byte	Device State	00h - Active waiting for a command 01h - Stand-by 02h - Sleep 03h - DST processing in background 04h - SMART Off-line Data Collection processing in background 05h - SCT command processing in background 06h-FFh - Reserved

Table 163 — Format of SCT status response (Sheet 2 of 2)

Offset	Type	Field Name	Description
11..13	Byte [3]	reserved	
14..15	Word	Extended Status Code	Status of last SCT command issued. FFFFh if SCT command processing in background (see table 158).
16..17	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 processing.
18..19	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 processing.
20..39	Byte [20]	reserved	
40..47	QWord	LBA	Current LBA of SCT command processing in background. If there is no command currently processing in the background, this field is undefined.
48..199	Byte [152]	reserved	
200	Byte	HDA Temp	Current device temperature in degrees Celsius. This is a two's complement integer. 80h indicates that this value is invalid.
201	Byte	Min Temp	Minimum device temperature in degrees Celsius since the last power-on event. This is a two's complement integer. 80h indicates that this value is invalid.
202	Byte	Max Temp	Maximum device temperature in degrees Celsius since the last power-on event. This is a two's complement integer. 80h indicates that this value is invalid.
203	Byte	Life Min Temp	Minimum device temperature in degrees Celsius seen for the life of the device. This is a two's complement integer. 80h indicates that this value is invalid.
204	Byte	Life Max Temp	Maximum device temperature in degrees Celsius seen for the life of the device. This is a two's complement integer. 80h indicates that this value is invalid.
205	Byte	reserved	
206..209	DWord	Over Limit Count	Number of temperature recording intervals since the last power-on reset where the recorded temperature was greater than Max Op Limit. See table 175 for information about this interval.
210..213	DWord	Under Limit Count	Number of temperature recording intervals since the last power-on reset where the recorded temperature was less than Min Op Limit. See table 175 for information about this interval.
214..479	Byte [266]	reserved	
480..511	Byte [32]	Vendor Specific	

8.3 SCT Command Set

8.3.1 Overview

An SCT command shall be 512 bytes long. While an SCT command is being processed a host may use an SCT status request to retrieve status information (e.g., to determine if a command is active or complete, the current LBA, or error information) about the current SCT command.

Table 164 defines the format of an SCT command written to the SCT Command/Status log (see A.1).

Table 164 — SCT command format

Offset	Field	Words	Description
0..1	Action Code	1	This field specifies the command type and the type of data being accessed, or the action being performed. (See table 165 for definition of the Action Code field contents.)
2..3	Function Code	1	This field specifies the type of access and varies by command.
4..x	Parameter1	Depends on command	Depends on command
x+1..y	Parameter2	Depends on command	Depends on command
…	…	…	…
	Total Words	256	

Table 165 — SCT Action Codes

Action Code	Description
0000h	Reserved
0001h	Obsolete
0002h	SCT Write Same command (see 8.3.2)
0003h	SCT Error Recovery Control command (see 8.3.3)
0004h	SCT Feature Control command (see 8.3.4)
0005h	SCT Data Tables command (see 8.3.5)
0006h	Vendor specific
0007h	Reserved for Serial ATA
0008h-BFFFh	Reserved
C000h-FFFFh	Vendor specific

8.3.2 SCT Write Same command

The SCT Write Same command specifies that the device shall write a specific pattern to its media.

The SCT Write Same command shall cause the device to begin writing logical sectors from the first logical sector specified by the Start field (see table 166) in incrementing order until the number of logical sectors specified by the Count field (see table 166) have been written. If the Count field contains all zeros, then the device shall write all logical sectors beginning with the logical sector specified by the Start field through the last user addressable logical sector (see 4.1). Automatic sector reallocation is permitted during the processing of this SCT command.

If the Start field or the Start field plus the Count field specify an LBA greater than the last user addressable logical sector (see 4.1), then the device shall report an error and return command aborted. If the Start field and the Count field contain zero, then the device shall write the specified pattern to all user addressable logical sectors (see 4.1) on the device.

Any new command other than an SCT status request (e.g., IDENTIFY DEVICE command (see 7.16)), received by the device while this command is in progress shall terminate the SCT Write Same command and the device shall process the new command.

Repeat write data block (i.e., function code 0002h) and Repeat write data block foreground (i.e., function code 0102h) cause the device to accept one block of data from the host and then repeatedly write that block of data in the user area starting from the LBA value contained in the Start field for the number of logical sectors specified in the Count field.

While an SCT Write Same command with function code 0001h or function code 0002h is processed as a background activity, the SCT status error code shall be set to FFFFh. If the background activity completes without error, then the SCT status error code shall be set to 0000h. If any error occurs during the background activity, then the SCT status error code shall be set to a value less than FFFFh and greater than 0000h.

Once the key data block (see 8.1.1) has been issued, if the Function Code was 0002h and the input data structure indicates that the device is ready to receive data, the SCT Data Transfer log (see A.1) should be written to transfer the data.

For the SCT Write Same command with function code 0101h the Command Completion Status of the write to the SCT Command/Status log (see A.1) shall indicate the success or failure of this command. For the SCT Write Same command with function Code 0102h the Command Completion Status of the write to the SCT Data Transfer log shall indicate the success or failure of this SCT Write Same command. The Status field and Error field indicate the status values and error values as defined in clause 6. In the case of an error an SCT Status Request may be made by reading the SCT Command/Status log (see A.1) to obtain a more detailed analysis of the error.

The Write Same command may change the Segment Initialized Flag (see table 163). If the Write Same command writes all of the user data area and completes without 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 within the user data area on the device, except one caused by another SCT Write Same command with the Start field and the Count field set to zero (i.e., an SCT Write Same command causing the device to write to all of the user data area), shall cause the Segment Initialized Flag to be cleared. Reallocations as a result of reading data, either in the foreground or background, shall not clear the Device Zeroed flag.

Table 166 defines the format of a SCT Write Same command written to the SCT Command/Status log (see A.1).

Table 166 — SCT Write Same command

Word	Name	Value	Description
0	Action Code	0002h	This action writes a pattern or 512-byte data block repeatedly to the media.
1	Function Code	0000h	Reserved
		0001h	Repeat write pattern
		0002h	Repeat write data block
		0003h-0100h	Reserved
		0101h	Repeat write pattern foreground
		0102h	Repeat write data block foreground
		0103h-FFFFh	Reserved
2..5	Start	QWord	First logical sector to write 63:48 Reserved 47:0 First LBA
6..9	Count	QWord	Number of logical sectors to fill
10..11	Pattern	DWord	If the Function Code is 0001h or 0101h, this field contains a 32-bit pattern that is used to fill the user data area starting with the first byte of the sector specified in Start through that last byte specified by Start plus count.

Table 167 defines the format of the status response for a SCT Write Same command.

Table 167 — SCT Write Same command status response

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found - See 6.3.5. 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	Reserved
LBA	**Bit Description** 27:24 Reserved 23:8 0000h – If FC=0001h or FC=0101h 0001h – If FC=0002h or FC=0102h 7:0 Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5:1 N/A 0 Error - See 6.2.9

8.3.3 SCT Error Recovery Control command

The SCT Error Recovery Control command sets time limits for read and write error recovery. For commands that are not NCQ commands (see 4.12), these, these timers apply to command completion. For NCQ commands where in-order data delivery is enabled, these timers begin counting when the device begins to process the command, not when the command is sent to the device. These timers do not apply to streaming commands (see 4.20) or to queued commands (see 4.12) when out-of-order data delivery is enabled.

Table 168 defines the format of an SCT Error Recovery Control command written to the SCT Command/Status log (see A.1).

Table 168 — SCT Error Recovery Control command

Word	Name	Value	Description
0	Action Code	0003h	Set the read and write error recovery time
1	Function Code	0000h	Reserved
		0001h	Set New Value
		0002h	Return Current Value
		0003h-FFFFh	Reserved
2	Selection Code	0000h	Reserved
		0001h	Read Command Timer
		0002h	Write Command Timer
		0003h-FFFFh	Reserved
3	Recovery Time Limit		If the Function Code is 0001h, then this field contains the recovery time limit in 100 ms units (e.g., a value of 1 = 100 ms, 2 = 200 ms). The tolerance is vendor specific.

If the Selection Code field is set to 0001h, then:

a) the Recovery Time Limit field specifies the upper limit of the amount of time a device shall processes a read command in total;
b) the device shall set the Read Command Timer to the value of the Recovery Time Limit fields; and
c) if the Recovery Time Limit field is set to zero, then the device shall perform all available error recovery procedures (i.e., the Read Command Timer is disabled).

The device shall report command completion or stop processing the command and report an Uncorrectable Error (see 6.3.10) for the LBA that caused error recovery to be invoked prior to Read Command Timer expiration. Extended status code 0015h should be returned in the SCT Status data if the Read Command Timer expires. A failed logical sector may be recovered if the Recovery Time Limit is increased.

If the Selection Code field is set to 0002h, then:

a) the Recovery Time Limit field specifies the upper limit of the amount of time a device shall processes a write command in total;
b) the device shall set the Write Command Timer to the value of the Recovery Time Limit fields; and
c) if the Recovery Time Limit field is set to zero, then the device shall perform all available error recovery procedures (i.e., the Write Command Timer is disabled).

A large Write Command Timer value allows the device to use more available error recovery procedures. If the Write Command Timer is about to expire, then the device should attempt to reallocate the data before the Write Command Timer expires. Extended status code 0015h should be returned in the SCT Status data if the Write Command Timer expires. If the device is unable to complete data reallocation before the Write Command Timer expires, then the device fails the command when the Write Command Timer expires. When write cache is enabled the operation of the Write Command Timer is vendor specific.

NOTE 23 — A host implementor should use the Write Command Timer with great caution as a very small timer value may cause a device to permanently reallocate good logical sectors as the result of temporary, external conditions (e.g., induced vibration).

The Extended status code shall be cleared when the next non-SCT command is processed by the device, except when processing a read of the NCQ Command Error log (see A.14).

Read Command Timer and Write Command Timer values are set to default values after processing a power-on reset but may be altered by an SCT command at any time. A device shall not change these settings while processing a hardware reset or a software reset.

Table 169 defines the format of the status response for a SCT Error Recovery Control command.

Table 169 — SCT Error Recovery Control command status response

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found - See 6.3.5. 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	If Function Code was 0002h, then this is the requested recovery limit (7:0); otherwise, this field is reserved.
LBA	**Bit Description** 27:8 Reserved 7:0 If the Function Code was 0002h, then this is the requested recovery limit (15:8); otherwise, this field is reserved.
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5:1 N/A 0 Error - See 6.2.9

8.3.4 SCT Feature Control command

The SCT Feature Control command reports and sets the state (i.e., enabled or disabled) of the features specified by the command.

Table 170 defines the format of a SCT Feature Control command written to the SCT Command/Status log (see A.1).

Table 170 — SCT Feature Control command

Word	Name	Value	Description
0	Action Code	0004h	Set or return the state of device features defined in table 171
1	Function Code	0000h	Reserved
		0001h	Set state for a feature
		0002h	Return the current state of a feature
		0003h	Return feature option flags
		0004h-FFFFh	Reserved
2	Feature Code		See table 171 for definition of the Feature Code
3	State		Feature Code dependent value
4	Option Flags		**Bit Description** 15:1 Reserved 0 If the function code is 0001h, then setting bit 0 to one shall cause the requested feature state change to be preserved during all power and reset events. If the function code is 0001h, then clearing bit 0 to zero shall cause the requested feature state change to be volatile (i.e., a hard reset causes the device to revert to the default value or to the last non-volatile setting).

Table 171 — Feature Code list

Feature Code	State Definition
0000h	Reserved
0001h	If State is set to 0001h, then the SET FEATURES command (see 7.45) shall determine the state of the write cache (see 7.45.4). 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 and shall not change the operational state of the write cache. In all cases, IDENTIFY DEVICE data word 85 bit 5 (see 7.16.7.41) shall reflect the current operational state of write cache (i.e., if set to one, then volatile write cache is enabled, and if cleared to zero, then write cache is disabled. The default is State set to 0001h.
0002h	If State is set to 0001h, then volatile Write Cache Reordering shall be enabled (i.e., disk write scheduling may be reordered by the device), regardless of the enabled or disabled state of the volatile write cache. If State is set to 0002h, then volatile Write Cache Reordering shall be disabled, and disk write scheduling is processed on a first-in-first-out (FIFO) basis, regardless of the enabled or disabled state of the volatile write cache. If volatile write cache is disabled, then the current volatile Write Cache Reordering state has no effect on writes. The state of volatile Write Cache Reordering has no effect on NCQ commands (see 4.12). 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 (see table 175). Issuing this command shall cause: a) the queue to be reset and any prior values in the queues to be lost; b) the Queue Index (see table 175) to be set to zero; c) the first queue location to be set to the current value and all remaining queue locations set to 80h; and d) the Sample Period value, Max Op Limit value, Over Limit value, Min Op Limit value, and Under Limit value to be preserved (see table 175). The default is State set to 0001h.
0004h-0005h	Reserved for Serial ATA
0006h-CFFFh	Reserved
D000h-FFFFh	Vendor Specific

Table 172 defines the format of the status response for a SCT Feature Control command.

Table 172 — SCT Feature Control command status response

Name	Description
Error	**Bit** **Description** 7:5 N/A 4 ID Not Found - See 6.3.5. 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	If the Function Code was set to 0002h, then this is the Feature State (7:0). If the Function Code was set to 0003h, then this is the Option Flags (7:0). Otherwise this field is reserved.
LBA	**Bit** **Description** 27:8 Reserved 7:0 If the Function Code was set to 0002h, then this is the Feature State (15:8). If the Function Code was set to 0003h, then this is the Option Flags (15:8). Otherwise this field is reserved.
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent - See 6.2.12. 5:1 N/A 0 Error - See 6.2.9

8.3.5 SCT Data Table command

The SCT Data Table command reads the specified data table.

Table 173 defines the format of an SCT Data Table command written to the SCT Command/Status log (see A.1).

Table 173 — SCT Data Table command

Word	Name	Value	Description
0	Action Code	0005h	Read a data table
1	Function Code	0000h	Reserved
		0001h	Read Table
		0002h-FFFFh	Reserved
2	Table ID	Word	See Table 174 for a list of SCT data tables

Table 174 — SCT Data Tables (by Table Identifier)

Table Id	Description
0000h	Invalid
0001h	Reserved
0002h	HDA Temperature History Table (in degrees Celsius). See table 175 for more information.
0003h-0004h	Reserved for Serial ATA
0005h-CFFFh	Reserved
D000h-FFFFh	Vendor Specific

Table 175 — Absolute HDA Temperature (Sheet 1 of 2)

Offset	Size	Field Name	Description
0..1	Word	Format Version	0002h - Data table format version
2..3	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 operations or write operations, but does not interrupt operations in process. The Sampling Period may be smaller than the timer interval between entries in the history queue. A value of 0000h in this field indicates that sampling is disabled.
4..5	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 [c]. This is a 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 [c]. This is a 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 [c]. This is a 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.
9	Byte	Under Limit	Minimum temperature limit. Operating the device below this temperature may cause physical damage to the device [c]. This is a 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.
10..29	Byte [20]	reserved	
30..31	Word	CB Size	Number of entry locations in history buffer. This number shall be in the range of 128..478.
32..33	Word	CB Index	Last updated entry in buffer. CB Index is zero-based, so CB Index 0000h is the first location in the buffer (i.e., at offset 34). The most recent temperature entered in the buffer is at CB Index + 34 [a b].

Table 175 — Absolute HDA Temperature (Sheet 2 of 2)

Offset	Size	Field Name	Description
34..(CB Size + 33)	Byte [CB Size]	CB	This is a circular buffer of absolute HDA Temperature values. Other device activities (e.g., data transfer), take priority over writing this data to non-volatile storage. These are 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 [a]. 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.
(CB Size + 34)..511	Byte [512 - CB Size - 34]	reserved	Shall be zero.

[a] The Absolute HDA Temperature History is preserved during the processing of all power events and reset events 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) to indicate 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) (see 4.13.4), then a value of 80h is entered into the history queue to indicate that temperature sensing has resumed.

[b] 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.

[c] These values should take into account the accuracy of the temperature sensor. The placement, accuracy, and granularity of temperature sensors to support table 175 are vendor specific.

Table 176 defines the format of the status response for an SCT Data Table command.

Table 176 — SCT Data Table command status response

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found - See 6.3.5. 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	Reserved
LBA	**Bit Description** 27:24 Reserved 23:8 For Table ID 0002h, 0001h (i.e., Number of data blocks requested); otherwise reserved. 7:0 Reserved.
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5:1 N/A 0 Error - See 6.2.9

9 Normal and Error Outputs

9.1 Overview

The commands listed in clause 7 each have subclauses labeled Normal Outputs and Error Outputs. Subclauses 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, however, all the information specified in clause 9 shall also apply to the command.

The references preceding each table indicate each command that generates the output in the table.

9.2 Normal Outputs

The tables in this subclause specify the Normal Outputs a command returns.

Table 177 specifies the normal outputs for the commands defined in 7.2.

Table 177 — Error Bit Defined For Normal Output

Name	Description
Error	N/A
Count	N/A
LBA	N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 178 specifies the normal outputs for the commands defined in 7.3.

Table 178 — Extended Error Code for Normal Output

Name	Description
Error	Extended error code (see table 26)
Count	Vendor Specific
LBA	Vendor Specific
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5:2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 179 specifies the normal outputs for the commands defined in 7.14, 7.16, 7.17, 7.18, 7.22, 7.24, 7.29, 7.31, 7.35, 7.39, 7.40, 7.41, 7.42, 7.43, 7.44, 7.45, 7.45.18.2.3, 7.45.18.3.3, 7.45.18.4.5, 7.45.18.5.3, 7.46, 7.47, 7.48.2, 7.48.3, 7.48.4, 7.48.6, 7.48.7, 7.48.9, 7.49, 7.50, 7.56, 7.58, 7.64, 7.67, and 7.71.

Table 179 — Generic Normal Output (No LBA Return Value) for Normal Output

Name	Description
Error	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A or Alignment Error - See 6.2.2 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 180 specifies the normal outputs for the commands defined in 7.11 and 7.12.

Table 180 — Download Microcode Normal Output

Name	Description
Error	N/A
Count	If Download with offsets and save microcode for immediate and future use was specified (see 7.11), then this field contains a value as specified in table 39. Otherwise, this field is N/A.
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A or Alignment Error - See 6.2.2 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 181 specifies the normal outputs for the commands defined in 7.4, 7.5, and 7.6.

Table 181 — CFA Normal Output

Name	Description
Error	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5:2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 182 specifies the normal outputs for the commands defined in 7.7.

Table 182 — Check Power Mode Normal Output (Sheet 1 of 2)

<table>
<tr><th>Name</th><th>Description</th></tr>
<tr><td>Error</td><td>N/A</td></tr>
<tr><td>Count</td><td>
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>00h</td><td>Device is in the:
a) PM2:Standby state (see 4.13.4) and the EPC feature set (see 4.7) is not enabled; or
b) PM2:Standby state, the EPC feature set is enabled, and the device is in the Standby_z power condition (see 4.7.2).</td></tr>
<tr><td>01h</td><td>Device is in the PM2:Standby state, the EPC feature set is enabled, and the device is in the Standby_y power condition (see 4.7.2).</td></tr>
<tr><td>02h..3Fh</td><td>Reserved</td></tr>
<tr><td>40h..41h</td><td>Obsolete</td></tr>
<tr><td>42h..7Fh</td><td>Reserved</td></tr>
<tr><td>80h</td><td>Device is in the
a) PM1:Idle state (see 4.13.4) and EPC feature set is not supported; or
b) PM1:Idle state and EPC feature set is supported and the EPC feature set is disabled.</td></tr>
<tr><td>81h</td><td>Device is in the PM1:Idle State, the EPC feature set is enable, and the device is in the Idle_a power condition (see 4.7.2).</td></tr>
<tr><td>82h</td><td>Device is in the PM1:Idle State, the EPC feature set is enabled, and the device is in the Idle_b power condition (see 4.7.2).</td></tr>
<tr><td>83h</td><td>Device is in the PM1:Idle State, the EPC feature set is enabled, and the device is in the Idle_c power condition (see 4.7.2).</td></tr>
<tr><td>84h..FEh</td><td>Reserved</td></tr>
<tr><td>FFh</td><td>Device is in the PM0:Active state or PM1:Idle State.</td></tr>
</table>
</td></tr>
<tr><td>LBA</td><td>N/A</td></tr>
</table>

Table 182 — Check Power Mode Normal Output (Sheet 2 of 2)

Name	Description
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 183 specifies the normal outputs for the commands defined in 7.8, 7.33, and 7.69.

Table 183 — Stream Normal Output

Name	Description
Error	N/A
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5 Stream Error - See 6.2.11 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A or Alignment Error - See 6.2.2 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 184 specifies the normal outputs for the commands defined in 3.1.76, 7.10, 7.13, 7.16, and 7.31.

Table 184 — Device Signatures for Normal Output

<table>
<tr><th>Name</th><th>Description</th></tr>
<tr><td>Error</td><td>Diagnostic Results - The diagnostic code as described in table 42 is returned.
This field shall be reserved for the DEVICE RESET command (see 7.10). For the READ SECTOR(S) command (see 7.31) or the IDENTIFY DEVICE command (see 7.16), bit 2 of this field shall be set to one and the remaining bits are N/A.</td></tr>
<tr><td>Count</td><td rowspan="2">
<table>
<tr><th>Bit</th><th>ATA Device [a]</th><th>ATAPI Device [a]</th><th>Reserved for SATA [a]</th><th>Reserved for SATA [a]</th><th>Obsolete [a]</th></tr>
<tr><td>Count (7:0)</td><td>01h</td><td>01h</td><td>01h</td><td>01h</td><td>N/A</td></tr>
<tr><td>LBA (27:24)</td><td>Reserved</td><td>Reserved</td><td>Reserved</td><td>Reserved</td><td>Reserved</td></tr>
<tr><td>LBA (23:16)</td><td>00h</td><td>EBh</td><td>C3h</td><td>96h</td><td>AAh</td></tr>
<tr><td>LBA (15:8)</td><td>00h</td><td>14h</td><td>3Ch</td><td>69h</td><td>CEh</td></tr>
<tr><td>LBA (7:0)</td><td>01h</td><td>01h</td><td>01h</td><td>01h</td><td>N/A</td></tr>
</table>
</td></tr>
<tr><td>LBA</td></tr>
<tr><td>Device</td><td>
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>7</td><td>Obsolete</td></tr>
<tr><td>6</td><td>N/A</td></tr>
<tr><td>5</td><td>Obsolete</td></tr>
<tr><td>4</td><td>Transport Dependent - See 6.2.12</td></tr>
<tr><td>3:0</td><td>Reserved</td></tr>
</table>
</td></tr>
<tr><td>Status</td><td>
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>7:6</td><td>Transport Dependent - See 6.2.12</td></tr>
<tr><td>5</td><td>Device Fault - See 6.2.7</td></tr>
<tr><td>4</td><td>N/A</td></tr>
<tr><td>3</td><td>Transport Dependent - See 6.2.12</td></tr>
<tr><td>2</td><td>N/A</td></tr>
<tr><td>1</td><td>Sense Data Available - See 6.2.10</td></tr>
<tr><td>0</td><td>Shall be cleared to zero</td></tr>
</table>
</td></tr>
<tr><td colspan="2">[a] All other values are reserved</td></tr>
</table>

Table 185 specifies the normal outputs for the commands defined in 7.19.

Table 185 — IDLE Unload Normal Output

Name	Description
Error	N/A
Count	N/A
LBA	**Bit Description** 27:8 N/A 7:0 C4h
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 186 specifies the normal outputs for the commands defined in 7.21.6.

Table 186 — ATAPI Normal Output

Name	Description
Error	N/A
Interrupt Reason	**Bit** **Description** 7:2 Obsolete 1 Input/Output - See 6.4.3 0 Command/Data - See 6.4.2
LBA	**Bit** **Description** 27:24 N/A 23:8 Byte Count 7:0 N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7 Transport Dependent - See 6.2.12 6 N/A 5:4 Obsolete 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9. Shall be cleared to zero

Table 187 specifies the normal outputs for the commands defined in 7.48.5.

Table 187 — SMART Off-Line Immediate Normal Output

Name	Description
Error	N/A
Count	N/A
LBA	**Bit** **Description** 27:24 N/A 23:8 **Value** **Description** C24Fh The subcommand specified a captive self-test that has completed without error. All Other Values The subcommand specified an off-line routine including an off-line self-test routine. 7:0 N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent - See 6.2.12 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 188 specifies the normal outputs for the commands defined in 7.48.8.

Table 188 — SMART Return Status Normal Output

<table>
<tr><th>Name</th><th>Description</th></tr>
<tr><td>Error</td><td>N/A</td></tr>
<tr><td>Count</td><td>N/A</td></tr>
<tr><td>LBA</td><td>
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>27:24</td><td>N/A</td></tr>
<tr><td>23:8</td><td>
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>C24Fh</td><td>The subcommand specified a captive self-test that has completed without error.</td></tr>
<tr><td>2CF4h</td><td>The device has detected a threshold exceeded condition</td></tr>
<tr><td>All Other Values</td><td>Undefined</td></tr>
</table>
</td></tr>
<tr><td>7:0</td><td>N/A</td></tr>
</table>
</td></tr>
<tr><td>Device</td><td>
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>7</td><td>Obsolete</td></tr>
<tr><td>6</td><td>N/A</td></tr>
<tr><td>5</td><td>Obsolete</td></tr>
<tr><td>4</td><td>Transport Dependent - See 6.2.12</td></tr>
<tr><td>3:0</td><td>Reserved</td></tr>
</table>
</td></tr>
<tr><td>Status</td><td>
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>7:6</td><td>Transport Dependent - See 6.2.12</td></tr>
<tr><td>5</td><td>Device Fault - See 6.2.7</td></tr>
<tr><td>4</td><td>N/A</td></tr>
<tr><td>3</td><td>Transport Dependent - See 6.2.12</td></tr>
<tr><td>2</td><td>N/A</td></tr>
<tr><td>1</td><td>Sense Data Available - See 6.2.10</td></tr>
<tr><td>0</td><td>Error - See 6.2.9</td></tr>
</table>
</td></tr>
</table>

Table 189 specifies the normal outputs for the commands defined in 7.9, 7.15, 7.25, 7.27, 7.30, 7.32, 7.36, 7.52, 7.54, 7.59, 7.60, 7.62, 7.65, 7.66, and 7.68.

Table 189 — Generic Extended Normal Output

Name	Description
Error	Reserved
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A or Alignment Error - See 6.2.2 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 190 specifies the normal outputs for the commands defined in 7.26.4 and 7.61.4.

Table 190 — NCQ Command Acceptance Normal Output

Name	Description
Error	Shall be cleared to zero
Count	N/A
LBA	N/A
Device	**Bit** **Description** 7:4 N/A 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent - See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 191 specifies the normal outputs for the commands defined in 7.26.5 and 7.61.5.

Table 191 — NCQ Normal Outputs

Name	Description
SATA Status	Transport Dependent
Error	Shall be cleared to zero
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A or Alignment Error - See 6.2.2 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9
SActive	**Bit Description** 31:0 Transport dependent completion indicator

Table 192 specifies the normal outputs for the commands defined in 7.37.

Table 192 — REQUEST SENSE DATA EXT Normal Output

Name	Description
Error	Reserved
Count	Reserved
LBA	**Bit** **Description** 47:24 Vendor Specific 23:20 Reserved 19:16 Sense Key (see 7.37.4) 15:8 Additional Sense Code (see 7.37.4) 7:0 Additional Sense Code Qualifier (see 7.37.4)
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent - See 6.2.12. 5:2 Reserved 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 193 specifies the normal outputs for the commands defined in 7.38.

Table 193 — Sanitize Device Normal Output

Name	Description
Error	Reserved
Count	**Bit Description** 15 Sanitize operation completed without error. If the device processes BLOCK ERASE EXT command (see 7.38.2), CRYPTO SCRAMBLE EXT command (see 7.38.3), or a OVERWRITE EXT command (see 7.38.4), then this bit shall be cleared to zero. 14 Sanitize operation in progress 13 Device is in the Sanitize Frozen state (see figure 9) 12:0 Reserved
LBA	**Bit Description** 47:16 Reserved 15:0 Sanitize Progress Indication - Progress indicator for the current sanitize operation. This value shall be FFFFh if a sanitize operation is not in process. The returned value is a numerator that has 65 536 (1_0000h) as its denominator.
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

9.3 Error Outputs

The tables in this subclause specify the Error Outputs a command returns. References to these tables are found in clause 7.

If the Sense Data Reporting feature set is enabled and there is sense data available, then the Error field shall be set to 7Fh and the Error bit in the Status field shall be set to one. If the Sense Data Reporting feature set has been enabled with the Sense Data Available status bit reporting set to one (see 7.45.16), then the device notifies the host of additional information by setting the Sense Data Available bit in the Status field to one.

Table 194 specifies the error outputs for the commands defined in 7.1.9.

Table 194 — Unsupported Command Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7:4 N/A 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5:2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 195 specifies the error outputs for the commands defined in 7.2.

Table 195 — CFA Erase Error

Name	Description
Error	**Bit** **Description** 7:5 N/A 4 ID Not Found - See 6.3.5 3 N/A 2 Abort - See 6.3.2 1 N/A 0 Media Error - See 6.3.8
Count	N/A
LBA	LBA of first unrecoverable error
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4:2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 196 specifies the error outputs for the commands defined in 7.5 and 7.6.

Table 196 — CFA Write Error

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found - See 6.3.5 3 N/A 2 Abort - See 6.3.2 1 N/A 0 Media Error - See 6.3.8
Count	N/A
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 Transport Dependent - See 6.2.12 3:2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 197 specifies the error outputs for the commands defined in 7.3, 7.4, and 7.7.

Table 197 — CFA & Check Power Mode Abort Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4:2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 198 specifies the error outputs for the commands defined in 7.18, 7.19, 7.37, 7.40, 7.42, 7.45.21, 7.45.18.2.4, 7.45.18.3.4, 7.45.18.4.6, 7.45.18.5.4, 7.46, 7.47, 7.48.2, 7.48.3, 7.48.4, 7.48.8, 7.49, 7.50, and 7.71.

Table 198 — Generic Abort wo/ICRC Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 199 specifies the error outputs for the commands defined in 7.11, 7.16.6, 7.17, 7.22, 7.39, 7.41, 7.43, 7.44, and 7.56.

Table 199 — Generic Abort Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.7 6:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 200 specifies the error outputs for the commands defined in 7.52 and 7.54.

Table 200 — Trusted Abort Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.7 6:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 201 specifies the error outputs for the commands defined in 7.8.

Table 201 — Configure Stream Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Stream Error - See 6.2.11 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 202 specifies the error outputs for the commands defined in 7.14.

Table 202 — Flush Cache Error

Name	Description
Error	**Bit** **Description** 7:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	N/A
LBA	LBA of first unrecoverable error
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 203 specifies the error outputs for the commands defined in 7.15.

Table 203 — Flush Cache Ext Error

Name	Description
Error	**Bit** **Description** 7:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	Reserved
LBA	LBA of first unrecoverable error
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 204 specifies the error outputs for the commands defined in 7.25.

Table 204 — Read DMA Ext Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.7 6 Uncorrectable Error - See 6.3.10. 5 Obsolete 4 ID Not Found - See 6.3.5 3 Obsolete 2 Abort - See 6.3.2 1:0 Obsolete
Count	Reserved
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 205 specifies the error outputs for the commands defined in 7.27.

Table 205 — Read Log Ext Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.7 6 Uncorrectable Error - See 6.3.10. 5 N/A 4 ID Not Found - See 6.3.5 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 206 specifies the error outputs for the commands defined in 7.24, 7.29, 7.31, and 7.35.

Table 206 — Read PIO Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.7 6 Uncorrectable Error - See 6.3.10 5 Obsolete 4 ID Not Found - See 6.3.5 3 Obsolete 2 Abort - See 6.3.2 1:0 Obsolete
Count	N/A
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 207 specifies the error outputs for the commands defined in 7.33.

Table 207 — Read Stream Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.7 6 Uncorrectable Error - See 6.3.10. 5 Obsolete 4 ID Not Found - See 6.3.5 3 Obsolete 2 Abort - See 6.3.2 1 Obsolete 0 Command Completion Time Out - See 6.3.3
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
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Stream Error - See 6.2.11. 4 Deferred Write Error - See 6.2.6. 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 208 specifies the error outputs for the commands defined in 7.48.9.

Table 208 — Write Log Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.7 6:5 N/A 4 ID Not Found - See 6.3.5. 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 209 specifies the error outputs for the commands defined in 7.9 and 7.62.

Table 209 — Write Log Ext Error or Data Set Management Error

Name	Description
Error	**Bit** **Description** 7 Interface CRC - See 6.3.7 6:5 N/A 4 ID Not Found - See 6.3.5. 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	Reserved
LBA	Reserved
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent - See 6.2.12 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 210 specifies the error outputs for the commands defined in 7.48.5.

Table 210 — SMART Error

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found - See 6.3.5. 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	Reserved
LBA	**Bit Description** 27:24 N/A 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 field values are invalid) 2CF4h the subcommand specified a captive self-test routine that has failed during processing. All Other Values the subcommand specified an off-line routine including an off-line self-test routine. 7:0 N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 211 specifies the error outputs for the commands defined in 7.59, 7.60, 7.65, 7.66 and 7.68.

Table 211 — Write Extended Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.7 6:5 Obsolete. 4 ID Not Found - See 6.3.5 3 Obsolete 2 Abort - See 6.3.2 1 Obsolete 0 N/A
Count	Reserved
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 212 specifies the error outputs for the commands defined in 7.69.

Table 212 — Write Stream Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.7 6:5 Obsolete 4 ID Not Found - See 6.3.5 3 Obsolete 2 Abort - See 6.3.2 1 Obsolete 0 Command Completion Time Out - See 6.3.3
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
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Stream Error - See 6.2.11. 4 Deferred Write Error - See 6.2.6. 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9.

Table 213 specifies the error outputs for the commands defined in 7.20.

Table 213 — NOP Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort - See 6.3.2 1:0 N/A
Count	Initial Value
LBA	Initial Value
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 214 specifies the error outputs for the commands defined in 7.21.

Table 214 — PACKET command Error

Name	Description
Error	**Bit Description** 7:4 Sense Key - See 6.3.9 3 N/A 2 Abort - See 6.3.2 1 End of Media - See 6.3.4 0 Illegal Length Indicator - See 6.3.6
Interrupt Reason	**Bit Description** 7:2 Obsolete 1 Input/Output - See 6.4.3. Shall be set to one 0 Command/Data - See 6.4.2. Shall be set to one
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 N/A 4 Obsolete. 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Check Condition - See 6.2.4.

Table 215 specifies the error outputs for the commands defined in 7.48.6 and 7.48.7.

Table 215 — SMART Read Log/SMART Read Data Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.7 6 Uncorrectable Error - See 6.3.10. 5 N/A 4 ID Not Found - See 6.3.5 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 216 specifies the error outputs for the commands defined in 7.30, 7.32 and 7.36.

Table 216 — Read PIO Extended Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.7 6 Uncorrectable Error - See 6.3.10. 5 N/A 4 ID Not Found - See 6.3.5 3 N/A 2 Abort - See 6.3.2. 1 N/A 0 Obsolete
Count	Reserved
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 217 specifies the error outputs for the commands defined in 7.64 and 7.67.

Table 217 — Write Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.7 6:5 Obsolete 4 ID Not Found - See 6.3.5 3 Obsolete 2 Abort - See 6.3.2. 1 Obsolete 0 N/A
Count	N/A
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 218 specifies the error outputs for the commands defined in 7.58.

Table 218 — Write DMA Error

Name	Description
Error	**Bit** **Description** 7 Interface CRC - See 6.3.7 6:5 Obsolete 4 ID Not Found - See 6.3.5 3 Obsolete 2 Abort - See 6.3.2. 1:0 Obsolete
Count	N/A
LBA	LBA of first unrecoverable error
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 219 specifies the error outputs for the commands defined in 7.26.6 and 7.61.6.

Table 219 — NCQ Command Acceptance Error

Name	Description
Error	**Bit Description** 7 Interface CRC - See 6.3.7. 6:3 N/A 2 Abort - See 6.3.2. 1:0 N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7:4 N/A 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Table 220 specifies the error outputs for the commands defined in 7.61.6.

Table 220 — NCQ Write Command Aborted Error

Name	Description
SATA Status	Transport Dependent
Error	**Bit Description** 7 Interface CRC - See 6.3.7 6:5 Obsolete 4 ID Not Found - See 6.3.5 3 Obsolete 2 Abort - See 6.3.2 1:0 Obsolete
Status	**Bit Description** 7 Shall be cleared to zero 6 Transport Dependent - See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Shall be cleared to zero. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9
SActive	**Bit Description** 31:0 Transport dependent completion indicator

Table 221 specifies the error outputs for the commands defined in 7.26.6.

Table 221 — NCQ Read Command Aborted Error

Name	Description
SATA Status	Transport Dependent
Error	**Bit** **Description** 7 Interface CRC - See 6.3.7 6 Uncorrectable Error - See 6.3.10 5 Obsolete 4 ID Not Found - See 6.3.5 3 Obsolete 2 Abort - See 6.3.2 1:0 Obsolete
Status	**Bit** **Description** 7 Shall be cleared to zero 6 Transport Dependent - See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Shall be cleared to zero. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9
SActive	**Bit** **Description** 31:0 Transport dependent completion indicator

Table 222 specifies the error outputs for the commands defined in 7.38.

Table 222 — Sanitize Device Error

Name	Description
Error	Error **Bit Description** 7:3 Reserved 2 Abort - See 6.3.2. 1:0 Reserved
Count	N/A
LBA	**Bit Description** 47:8 N/A 7:0 **Value Description** 00h Reason not reported 01h Sanitize Command Unsuccessful. The sanitize operation completed with physical sectors that are available to be allocated for user data that were not successfully sanitized. 02h Invalid or unsupported Sanitize Device Feature Field Value 03h Device is in the Sanitize Frozen state (see figure 9) 04h..FFh Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent - See 6.2.12. 5 Device Fault - See 6.2.7 4 N/A 3 Transport Dependent - See 6.2.12. 2 N/A 1 Sense Data Available - See 6.2.10 0 Error - See 6.2.9

Annex A

(Normative)

Log Definitions

A.1 Overview

This Annex provides a description of all logs. All logs are optional unless otherwise specified. These logs are accessible via commands (see 7.27, 7.28, 7.48.7, 7.48.9, 7.62, 7.63). Table A.2 is a summary of these logs. The following terms are associated with logs:

a) name: the log name is a term that describes the data in the associated log;
b) address: each log name has an associated numeric value that is the log address; and
c) log page: each log is composed or one or more log pages.

The log address is used by read log commands and write log commands to access a specific log. Table A.1 shows an example layout of logs. Data transfer associated with the SMART READ LOG command and the SMART WRITE LOG command starts from the first log page. GPL feature set (see 4.9) commands allow the host to specify the starting log page number.

Table A.1 — Example Log Structure

Log Name	Log Address	Log pages
Log Directory	00h	log page #0 (the Log Directory only has 1 512-byte log page)
Host Specific (see A.10)	80h	Log page #0 (first 512-byte log page)
		Log page #1 (second 512-byte log page)
		…
		Log page #15 (last 512-byte log page)
Host Specific	81h	Log page #0 (first 512-byte log page)
		Log page #1 (second 512-byte log page)
		…
		Log page #15 (last 512-byte log page)
…		
Host Specific	9Fh	Log page #0 (first 512-byte log page)
		Log page #1 (second 512-byte log page)
		…
		Log page #15 (last 512-byte log page)

Table A.2 — Log address definition (Sheet 1 of 2)

Log Address	Log Name	Feature Set	R/W	Access
00h	Log directory, see A.2 and A.3	N/A	RO	GPL,SL
01h	Summary SMART Error log, see A.19	SMART	RO	SL
02h	Comprehensive SMART Error log, see A.4	SMART	RO	SL
03h	Extended Comprehensive SMART Error log, see A.7	SMART	RO	GPL
04h	Device Statistics, see A.5	N/A	RO	GPL,SL
05h	Reserved for the CompactFlash Association.			
06h	SMART Self-Test log, see A.18	SMART	RO	SL
07h	Extended SMART Self-Test log, see A.9	SMART	RO	GPL
08h	Power Conditions, see A.8	EPC	RO	GPL
09h	Selective Self-Test log, see A.17	SMART	R/W	SL
0Ah..0Ch	Reserved	N/A	Reserved	
0Dh	LPS Mis-alignment log, see A.13	LPS	RO	GPL,SL
0Eh..0Fh	Reserved			
10h	NCQ Command Error log, see A.14	NCQ	RO	GPL
11h	SATA Phy Event Counters log, see A.16	N/A	RO	GPL
12h..17h	Reserved for Serial ATA	N/A	Reserved	
18h	Reserved	N/A	Reserved	
19h	LBA Status (see A.12)	N/A	RO	GPL
1Ah..20h	Reserved			
20h	Obsolete			
21h	Write Stream Error log, see A.20	Streaming	RO	GPL
22h	Read Stream Error log, see A.15	Streaming	RO	GPL
23h	Obsolete			
24h	Current Device Internal Status Data log, see A.21	N/A	RO	GPL
25h	Saved Device Internal Status Data log, see A.22	N/A	RO	GPL
26h..2Fh	Reserved	N/A	Reserved	

Key -

RO - Log is read only.
R/W - Log is read or written.
VS - Log is vendor specific thus read/write ability is vendor specific.
GPL - General Purpose Logging
SL - SMART Logging

Note 1 - The device shall return command aborted if a GPL feature set command (see 4.9) accesses a log that is marked only with SL.

Note 2 - The device shall return command aborted if a SMART feature set command (see 4.17) accesses a log that is marked only with GPL.

Table A.2 — Log address definition (Sheet 2 of 2)

Log Address	Log Name	Feature Set	R/W	Access
30h	IDENTIFY DEVICE data, see A.11	N/A	RO	GPL, SL
31h..7Fh	Reserved			
80h..9Fh	Host Specific, see A.10	SMART	R/W	GPL,SL
A0h..DFh	Device Vendor Specific, see A.6	SMART	VS	GPL,SL
E0h	SCT Command/Status, see 8.1	SCT	R/W	GPL,SL
E1h	SCT Data Transfer, see 8.1	SCT	R/W	GPL,SL
E2h..FFh	Reserved	N/A		

Key -

RO - Log is read only.
R/W - Log is read or written.
VS - Log is vendor specific thus read/write ability is vendor specific.
GPL - General Purpose Logging
SL - SMART Logging

Note 1 - The device shall return command aborted if a GPL feature set command (see 4.9) accesses a log that is marked only with SL.

Note 2 - The device shall return command aborted if a SMART feature set command (see 4.17) accesses a log that is marked only with GPL.

A.2 General Purpose Log Directory (GPL Log Address 00h)

Table A.3 defines the 512 bytes that make up the General Purpose Log Directory.

Table A.3 — General Purpose Log Directory

Word	Description
0	General Purpose Logging Version (word)
1	Number of log pages at log address 01h (word)
2	Number of log pages at log address 02h (word)
3	Number of log pages at log address 03h (word)
4	Number of log pages at log address 04h (word)
…	
128	Number of log pages at log address 80h (word)
129	Number of log pages at log address 81h (word)
…	
255	Number of log pages at log address FFh (word)

The value of the General Purpose Logging Version word shall be 0001h.

A.3 SMART Log Directory (SMART Logging Log Address 00h)

Table A.4 defines the 512-bytes that make up the SMART Log Directory. The SMART Log Directory is defined as one log page.

Table A.4 — SMART Log Directory

Offset	Description
0..1	SMART Logging Version (word)
2	Number of log pages at log address 1
3	Reserved
4	Number of log pages at log address 2
5	Reserved
…	…
510	Number of log pages at log address 255
511	Reserved

The value of the SMART Logging Version word shall be 0001h if the device supports multi-block SMART logs.

If the device does not support multi-block SMART logs, then log address 00h is defined as reserved.

A.4 Comprehensive SMART Error log (Log Address 02h)

A.4.1 Overview

Table A.5 defines the format of each of the log pages that are part of the Comprehensive SMART Error log. The Comprehensive SMART Error log provides logging for 28-bit addressing only. For 48-bit addressing, see A.7. The maximum size of the Comprehensive SMART Error log shall be 51 log pages. Devices may support fewer than 51 log pages. The comprehensive error log data structures:

a) shall include Uncorrectable errors;
b) shall include ID Not Found errors for which the LBA requested was valid;
c) shall include servo errors;
d) shall include write fault errors; and
e) other error conditions.

Comprehensive SMART Error log data structures shall not include errors attributed to the receipt of faulty commands (e.g., command codes not supported by the device or requests with invalid parameters or invalid LBAs).

Table A.5 — Comprehensive SMART Error log

Offset	First Log Page [b]	Subsequent Log Pages
0	SMART error log version	Reserved
1	Error log index	Reserved
2..91	First error log data structure	Data structure 5n [a]+1
92..181	Second error log data structure	Data structure 5n [a]+2
182..271	Third error log data structure	Data structure 5n [a]+3
272..361	Fourth error log data structure	Data structure 5n [a]+4
362..451	Fifth error log data structure	Data structure 5n [a]+5
452..453	Device error count	Reserved
454..510	Reserved	Reserved
511	Data structure checksum	Data structure checksum

[a] n is the nth log page within the log.
[b] The first log page is numbered zero.

A.4.2 Error log version

The value of the error log version byte shall be set to 01h.

A.4.3 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, then the error log index shall be set to zero. Valid values for the error log index are zero to 255.

A.4.4 Error log data structure

The error log is a circular buffer (i.e., when the last supported error log block has been filled, the next error shall create an error log data structure that replaces the first error log data structure in log page zero. The next error after that shall create an error log data structure that replaces the second error log data structure, etc.).

The device may support from two to 51 error log blocks.

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 A.19.4.

A.4.5 Device error count

The Device Error Count field is defined in A.19.5.

A.4.6 Data structure checksum

The data structure checksum is defined in A.7.6.

A.5 Device Statistics log (Log Address 04h)

A.5.1 Overview

The Device Statistics log contains selected statistics about the device.

The number of log pages may be greater than one.

See table A.6 for a list of defined log pages. Each supported log page shall consist of a header field that may be followed by defined statistics fields. If the Revision Number field in the log page header is 0000h, then that log page is not supported. All log page data following the last defined statistic for that log page is reserved.

If an unsupported log page is requested, then 512 bytes of all zeros shall be returned for that log page.

Table A.6 — Defined Device Statistics log pages

Log page	Description
00h	List of supported log pages (see A.5.2)
01h	General Statistics (see A.5.4)
02h	Free Fall Statistics (see A.5.3)
03h	Rotating Media Statistics (see A.5.6)
04h	General Errors Statistics (see A.5.8)
05h	Temperature Statistics (see A.5.8)
06h	Transport Statistics (see A.5.9)
07h	Solid State Device Statistics (see A.5.7)
08h..FFh	Reserved

Each statistic (see table A.7) shall:

a) be one QWord in length;
b) contain a Device Statistic Flag field (see table A.8); and
c) contain a Value field.

Table A.7 — Example Device Statistic

Bits	Field	Description
63:56	Flags	See table A.8
55:0	Value	The contents of the statistic itself.

Table A.8 — Device Statistic Flags

Bit	Field	F/V	Description
63	Supported	F	1 = This statistic is supported (i.e., the other device statistic flags contain valid information). 0 = This statistic is not supported (i.e., the other statistic flags and the Value field in this statistic are N/A)
62	ValidValue	V	1 = The Value field for this statistic is valid. 0 = The Value field for this statistic is not valid (e.g., it is numerically not accurate or it is not able to be retrieved by normal means). The ValidValue bit may be set to one or cleared to zero independent of the initialization of the Value field unless stated otherwise.
61	Normalized	F	This statistic may define a normalization algorithm. 1 = The Value field contains a normalized value. 0 = The Value field is not normalized.
60:56	Reserved		

Key:
F/V – Fixed/variable content
F – The content of the field is fixed and does not change.
V – The contents of the field is variable and may change depending on the state of the device or the commands processed by the device.

This standard describes the following for each statistic:

a) a name;
b) the location (i.e., byte offset from the beginning of the Device Statistics log page);
c) a description of the meaning of the statistic, when and how the value changes, and whether the statistic is volatile;
d) a definition of bits within the value field;
e) an optional normalization algorithm;
f) update criteria;
g) the measurement units; and
h) initialization information.

The following update criteria apply to all supported statistics unless explicitly stated otherwise:

a) a set of all statistics shall reside in a non-volatile location;
b) the device may maintain a set of current statistics that is volatile. The current statistics may differ from those saved in non-volatile locations;
c) unless otherwise stated, if a Value field that increments reaches its maximum value, then the Value field shall remain at the maximum value;
d) for the Device Statistics log pages read, the device shall save all statistics whose values have changed to a non-volatile location when the device processes a command to read the Device Statistics log;
e) the device shall save all statistics whose values have changed to a non-volatile location before entering PM2:Standby state (see 4.13.4) or any power management state (see 4.13.4) where the media is not accessible to the host;
f) there may be a statistic update timer that periodically causes a statistic to be copied to a non-volatile location;
g) if the device is in the PM3:Sleep state (see 4.13.4):
    A) the current statistics shall not be updated to the non-volatile locations;
    B) the statistic update timer shall not continue operation; and
    C) the device shall not exit PM3:Sleep to update the non-volatile statistics;
h) if the device is in the PM2:Standby state (see 4.13.4):
    A) the current statistics may be saved to the non-volatile locations;

    B) if the statistics are saved to the non-volatile locations, then the statistic update timer shall be re-initialized and shall continue operation while in the PM2:Standby power management state;
    C) if the statistics are not saved to the non-volatile locations, then the statistic update timer shall not continue operation while in the PM2:Standby power management state; and
    D) the device shall not exit PM2:Standby to update the non-volatile statistics;
    and
i) if the device is in the PM0:Active state (see 4.13.4) or PM1:Idle state (see 4.13.4), then the specified statistic update timer shall be re-initialized when the current value is saved to a non-volatile location and:
    A) when the statistic update timer expires and if a statistic value has not changed, then:
        a) the statistic's value should not be saved; and
        b) the specified statistic update timer is re-initialized when the statistic update timer expires;
        or
    B) if a statistic's value has changed, then:
        a) if the statistic update timer expires and a command is not being processed, then the device shall save the statistic to a non-volatile location; or
        b) if the statistic update timer expires during the processing of a command, then the statistic shall be updated either during command processing or after command completion. The statistic shall be updated before processing the next command.

A.5.2 List of Supported Device Statistics log pages (log page 00h)

The List of Supported Device Statistics log pages contains a list of the supported device statistics log pages as described in Table 4. If the Device Statistics log is supported and any device statistics log page other than the General Statics log page (see A.5.4) is supported, then this device statistics log page shall be implemented. Entries shall be in order of ascending log page number. Every log page for which there is at least one supported statistic shall be listed.

Table A.9 — List of supported Device Statistics log pages

Offset	Type	Description
0..7	QWord	Device Statistics Information Header. This device statistics log page lists the number of the supported device statistics log pages.
		Bit Description 63:24 Reserved 23:16 Log page number. Shall be set to 00h. 15:0 Revision number. Shall be set to 0001h
8	Byte	Number of entries (n) in the following list
9	Byte	Log page number of first supported device statistics log page (00h)
10	Byte	Log page number of second supported device statistics log page
…		
n+8	Byte	Log page number of nth supported device statistics log page
n+9..511		Reserved

A.5.3 Free Fall Statistics (log page 02h)

A.5.3.1 Overview

The Free Fall Statistics log page contains free-fall information as described in table A.10.

The Free Fall statistics are as follows:

a) Device Statistics Information Header;

b) Number of Free-Fall Events Detected; and
c) Overlimit Shock Events.

Table A.10 — Free Fall Statistics

Offset	Type	Description
0..7	QWord	Device Statistics Information Header **Bit Description** 63:24 Reserved 23:16 log page number Shall be set to 02h 15:0 Revision number Shall be set to 0001h
8..15	QWord	Number of Free-Fall Events Detected **Bit Description** 63:56 Device Statistics Flags (see table A.8) 55:32 Reserved 31:0 Number of Free-Fall Events Detected (DWord)
16..23	QWord	Overlimit Shock Events **Bit Description** 63:56 Device Statistics Flags (see table A.8) 55:32 Reserved 31:0 Number of shock events detected where the magnitude of the event exceeds the maximum rating of the device (DWord)
24..511	Byte	Reserved

A.5.3.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table A.10) for this log page.

A.5.3.3 Number of Free-Fall Events Detected

A.5.3.3.1 Description

The Number of Free-Fall Events Detected statistic is a counter that records the number of free-fall events detected by the device. This statistic is incremented by one for each free-fall event detected.

A.5.3.3.2 Update Interval

One hour.

A.5.3.3.3 Measurement Units

Events.

A.5.3.3.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.3.4 Overlimit Shock Events

A.5.3.4.1 Description

The Overlimit Shock Events statistic is a counter that records the number of shock events detected by the device with the magnitude higher than the maximum rating of the device. This statistic is incremented by one for each event detected.

A.5.3.4.2 Update Interval

One hour.

A.5.3.4.3 Measurement Units

Events.

A.5.3.4.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.4 General Statistics (log page 01h)

A.5.4.1 Overview

The General Statistics log page contains general information about the device as described in table A.11.

The General Statistics statistics are as follows:

a) Device Statistics Information Header;
b) Lifetime Power-on Resets;
c) Power-on Hours;
d) Logical Sectors Written;
e) Number of Write Commands;
f) Logical Sectors Read; and
g) Number of Read Commands.

Table A.11 — General Statistics (Sheet 1 of 2)

Offset	Type	Description	
0..7	QWord	Device Statistics Information Header (see A.5.4.2)	
		Bit	**Description**
		63:24	Reserved
		23:16	Log page number Shall be set to 01h.
		15:0	Revision number Shall be set to 0002h
8..15	QWord	Lifetime Power-On Resets (see A.5.4.3)	
		Bit	**Description**
		63:56	Device Statistics Flags (see table A.8).
		55:32	Reserved
		31:0	Number of times that the device has processed a Power-On Reset event (DWord)

Table A.11 — General Statistics (Sheet 2 of 2)

Offset	Type	Description
16..23	QWord	Power-on Hours (see A.5.4.4)
		Bit Description 63:32 Reserved 31:0 Power-on Hours (DWord)
24..31	QWord	Logical Sectors Written (see A.5.4.5)
		Bit Description 63:56 Device Statistics Flags (see table A.8) 55:48 Reserved 47:0 Logical Sectors Written
32..39	QWord	Number of Write Commands (see A.5.4.6)
		Bit Description 63:56 Device Statistics Flags (see table A.8) 55:48 Reserved 47:0 Number of Write Commands
40..47	QWord	Logical Sectors Read (see A.5.4.7)
		Bit Description 63:56 Device Statistics Flags (see table A.8) 55:48 Reserved 47:0 Logical Sectors Read
48..55	QWord	Number of Read Commands (see A.5.4.8)
		Bit Description 63:56 Device Statistics Flags (see table A.8) 55:48 Reserved 47:0 Number of Read Commands
56..511	Byte	Reserved

A.5.4.2 Device Statistics Information Header

The Device Statistics Information Header indicates the format of the structure (see table A.11) for this log page.

A.5.4.3 Lifetime Power-On Resets

A.5.4.3.1 Description

Lifetime Power-On Resets is a counter that records the number of times that the device has processed a power-on reset.

A.5.4.3.2 Update Interval

Lifetime Power-On Resets is incremented by one after processing each Power-On Reset and the device is capable of recording this statistic.

A.5.4.3.3 Measurement Units

Events.

A.5.4.3.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.4.4 Power-on Hours

A.5.4.4.1 Description

The Power-on Hours statistic is a value that records the amount of time that the device has been operational since the device was manufactured. The device:

a) shall increment this statistic when it is in PM0:Active state (see 4.13.4);
b) shall increment this statistic when it is in PM1:Idle state (see 4.13.4);
c) should increment this statistic when it is in the PM2:Standby state (see 4.13.4); and
d) shall not increment this statistic when it is in PM3:Sleep state (see 4.13.4).

This statistic is incremented in a volatile location with a resolution of one minute or less. This volatile value is accumulated into a non-volatile location per the update interval.

A.5.4.4.2 Update Interval

One hour.

A.5.4.4.3 Measurement Units

Hours.

A.5.4.4.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.4.5 Logical Sectors Written

A.5.4.5.1 Description

The Logical Sectors Written statistic is a value that records the number of logical sectors received from the host. This statistic is incremented by one for each logical sector that was successfully received from the host.

A.5.4.5.2 Update Interval

One hour.

A.5.4.5.3 Measurement Units

Logical sectors.

A.5.4.5.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.4.6 Number of Write Commands

A.5.4.6.1 Description

The Number of Write Commands statistic is the number of write commands that completed successfully. This statistic is incremented by one for each write command that successfully completes.

A.5.4.6.2 Update Interval

One hour.

A.5.4.6.3 Measurement Units

Events.

A.5.4.6.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.4.7 Logical Sectors Read

A.5.4.7.1 Description

The Logical Sectors Read statistic is a value that records the number of logical sectors sent to the host. This statistic is incremented by one for each logical sector that was successfully sent to the host.

A.5.4.7.2 Update Interval

One hour.

A.5.4.7.3 Measurement Units

Logical sectors.

A.5.4.7.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.4.8 Number of Read Commands

A.5.4.8.1 Description

The Number of Read Commands statistic is the number of read commands that completed successfully. This statistic is incremented by one for each read command that successfully completes.

A.5.4.8.2 Update Interval

One hour.

A.5.4.8.3 Measurement Units

Events.

A.5.4.8.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.5 General Errors Statistics (log page 04h)

A.5.5.1 Overview

General Errors Statistics log page contains general error information about the device as described in table A.12.

The General Errors Statistics are as follows:

a) Device Statistics Information Header;
b) Number of Reported Uncorrectable Errors; and
c) Number of Resets Between Command Acceptance and Command Completion.

Table A.12 — General Error Statistics

Offset	Type	Description
0..7	QWord	Device Statistics Information Header
		Bit Description 63:24 Reserved 23:16 Log page number Shall be set to 04h. 15:0 Revision number Shall be set to 0001h
8..15	QWord	Number of Reported Uncorrectable Errors (see A.5.5.3)
		Bit Description 63:56 Device Statistics Flags (see table A.8). 55:32 Reserved 31:0 Number of Reported Uncorrectable Errors (DWord)
16..23	QWord	Number of Resets Between Command Acceptance and Command Completion (see A.5.5.4)
		Bit Description 63:56 Device Statistics Flags (see table A.8) 55:32 Reserved 31:0 Number of Resets Between Command Acceptance and Command Completion (DWord)
24..511	Byte	Reserved

A.5.5.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table A.12) for this log page.

A.5.5.3 Number of Reported Uncorrectable Errors

A.5.5.3.1 Description

The Number of Reported Uncorrectable Errors statistic is a counter that records the number of errors that are reported as an Uncorrectable Error (see 6.3.10). This statistic shall be incremented by one for each event. Uncorrectable errors that occur during background activity shall not be counted. Uncorrectable errors reported by reads to flagged uncorrectable (see 7.71.2) logical blocks should not be counted.

A.5.5.3.2 Update Interval

One hour.

A.5.5.3.3 Measurement Units

Events.

A.5.5.3.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.5.4 Number of Resets Between Command Acceptance and Command Completion

A.5.5.4.1 Description

The Number of Resets Between Command Acceptance and Command Completion statistic is a counter that records the number of software reset or hardware reset events that occur when one or more commands have been accepted by the device but have not reached command completion. This statistic shall be incremented by one for each event.

A.5.5.4.2 Update Interval

One hour.

A.5.5.4.3 Measurement Units

Events.

A.5.5.4.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.6 Rotating Media Statistics (log page 03h)

A.5.6.1 Overview

The Rotating Media Statics log page contains device rotating media information as described in table A.13.

The Rotating Media Statics statistics are as follows:

a) Device Statistics Information Header;
b) Spindle Motor Power-on Hours;
c) Head Flying Hours;
d) Head Loaded Events;
e) Number of Reallocated Logical Sectors;
f) Read Recovery Attempts;
g) Number of Mechanical Start Failures; and
h) Number of Reallocation Candidate Logical Sectors.

Table A.13 — Rotating Media Statistics (Sheet 1 of 2)

Offset	Type	Description
0..7	QWord	Device Statistics Information Header **Bit** **Description** 63:24 Reserved 23:16 Log page number Shall be set to 03h 15:0 Revision number Shall be set to 0001h
8..15	QWord	Spindle Motor Power-on Hours (see A.5.6.3) **Bit** **Description** 63:56 Device Statistics Flags (see table A.8). 55:32 Reserved 31:0 Spindle Motor Power-on Hours (DWord)
16..23	QWord	Head Flying Hours (see A.5.6.4) **Bit** **Description** 63:56 Device Statistics Flags (see table A.8). 55:32 Reserved 31:0 Head Flying Hours (DWord)
24..31	QWord	Head Load Events (see A.5.6.5) **Bit** **Description** 63:56 Device Statistics Flags (see table A.8). 55:32 Reserved 31:0 Head Load Events (DWord)
32..39	QWord	Number of Reallocated Logical Sectors (see A.5.6.6) **Bit** **Description** 63:56 Device Statistics Flags (see table A.8). 55:32 Reserved 31:0 Number of Reallocated Logical Sectors (DWord)
40..47	QWord	Read Recovery Attempts (see A.5.6.7) **Bit** **Description** 63:56 Device Statistics Flags (see table A.8). 55:32 Reserved 31:0 Read Recovery Attempts (DWord)
48..55	QWord	Number of Mechanical Start Failures (see A.5.6.8) **Bit** **Description** 63:56 Device Statistics Flags (see table A.8). 55:32 Reserved 31:0 Number of Mechanical Start Failures (DWord)

Table A.13 — Rotating Media Statistics (Sheet 2 of 2)

Offset	Type	Description
56..63	QWord	Number of Reallocation Candidate Logical Sectors (see A.5.6.9) **Bit** **Description** 63:56 Device Statistics Flags (see table A.8). 55:32 Reserved 31:0 Number of Reallocation Candidate Logical Sectors (DWord)
64..511	Byte	Reserved

A.5.6.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table A.13) for this log page.

A.5.6.3 Spindle Motor Power-on Hours

A.5.6.3.1 Description

The Spindle Motor Power-on Hours statistic is a value that records the amount of time that the spindle motor has been powered on since the device was manufactured. This statistic is incremented in a volatile location with a resolution of one minute or less. This volatile value is accumulated into a non-volatile location per the update interval.

A.5.6.3.2 Update Interval

One hour.

A.5.6.3.3 Measurement Units

Hours.

A.5.6.3.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.6.4 Head Flying Hours

A.5.6.4.1 Description

The Head Flying Hours statistic is a value that records number of hours that the device heads have been flying over the surface of the media since the device was manufactured. This statistic is incremented in a volatile location with a resolution of one minute or less. This volatile value is accumulated into a non-volatile location per the update interval.

A.5.6.4.2 Update Interval

One hour.

A.5.6.4.3 Measurement Units

Hours.

A.5.6.4.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.6.5 Head Load Events

A.5.6.5.1 Description

The Head Load Events statistic is a value that records the number of head load events. A head load event is defined as:

a) when the heads are loaded from the ramp to the media for a ramp load device; or
b) when the heads take off from the landing zone for a contact start stop device.

This statistic is incremented by one each time a head load event occurs.

A.5.6.5.2 Update Interval

One hour.

A.5.6.5.3 Measurement Units

Events.

A.5.6.5.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.6.6 Number of Reallocated Logical Sectors

The Number of Reallocated Logical Sectors statistic is a counter that records the number of logical sectors that have been reallocated after device manufacture. This statistic shall incremented by one for each logical sector.

A.5.6.6.1 Update Interval

One hour.

A.5.6.6.2 Measurement Units

Logical sectors.

A.5.6.6.3 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.6.7 Read Recovery Attempts

A.5.6.7.1 Description

Read Recovery Attempts is a counter that records the number of logical sectors that require three or more attempts to read the data from the media for each read command. This statistic shall be incremented by one for each logical sector that encounters a read recovery attempt. These events may be caused by external environmental conditions (e.g., operating in a moving vehicle).

A.5.6.7.2 Update Interval

One hour.

A.5.6.7.3 Measurement Units

Events.

A.5.6.7.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.6.8 Number of Mechanical Start Failures

A.5.6.8.1 Description

The Number of Mechanical Start Failures statistic is a counter that records the number of mechanical start failures after device manufacture. A mechanical start failure is a failure that prevents the device from achieving a normal operating condition. This statistic shall be incremented by one for each mechanical start failure event encountered.

A.5.6.8.2 Update Interval

One hour.

A.5.6.8.3 Measurement Units

Events.

A.5.6.8.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.6.9 Number of Reallocation Candidate Logical Sectors

A.5.6.9.1 Description

The number of Reallocation Candidate Logical Sectors statistic is a counter that records the number of logical sectors that are candidates for reallocation. A reallocation candidate sector is a logical sector that the device has determined may need to be reallocated. This statistic is incremented by one for each logical sector that is determined to be a candidate for reallocation. The counter shall be decremented by one for each logical sector that is removed from the candidate sector list (e.g., by reallocation, repair, or transient condition). Logical sectors marked as pseudo uncorrectable (see 7.71) shall be considered reallocation candidates. Logical sectors marked as flagged uncorrectable (see 7.71) should not be considered reallocation candidates.

A.5.6.9.2 Update Interval

One hour.

A.5.6.9.3 Measurement Units

Logical sectors.

A.5.6.9.4 Initialization

This statistic shall be initialized to zero at the time of manufacture.

A.5.7 Solid State Device Statistics (log page 07h)

A.5.7.1 Overview

The Solid State Device Statistics log page contains solid state device information about the device as described in table A.14.

The Solid State Device Statistics are as follows:

a) Device Statistics Information Header; and
b) Percentage Used Endurance Indicator.

Table A.14 — Solid State Device Statistics

Offset	Type	Description
0..7	QWord	Device Statistics Information Header
		Bit **Description** 63:24 Reserved 23:16 Log page number Shall be set to 07h. 15:0 Revision number Shall be set to 0001h
8..15	QWord	Percentage Used Endurance Indicator (see A.5.7.3)
		Bit **Description** 63:56 Device Statistics Flags (see table A.8). 55:8 Reserved 7:0 Percentage Used Endurance Indicator (Byte)
16..511	Byte	Reserved

A.5.7.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table A.14) for this log page.

A.5.7.3 Percentage Used Endurance Indicator

A.5.7.3.1 Description

The Percentage Used Endurance Indicator is an vendor specific estimate of the percentage of device life used based on the actual device usage and the manufacturer's prediction of device life. A value of 100 indicates that the estimated endurance of the device has been consumed, but may not indicate a device failure (e.g., minimum power-off data retention capability reached for devices using NAND flash technology). The value is allowed to exceed 100. The volatile value shall be updated once per power-on hour independent of the update interval specified below. Percentages greater than 254 shall be represented as 255.

A.5.7.3.2 Update Interval

One hour.

A.5.7.3.3 Measurement Units

Percent.

A.5.7.3.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.8 Temperature Statistics (log page 05h)

A.5.8.1 Overview

The Temperature Statistics log page contains general information about the device as described in table A.15. The value in the temperature field is a two’s complement integer in degrees Celsius.

The Temperature Statistics are as followed:

a) Device Statistics Information Header;
b) Current Temperature;
c) Average Short Term Temperature;
d) Average Long Term Temperature;
e) Highest Temperature;
f) Lowest Temperature;
g) Highest Average Short Term Temperature;
h) Lowest Average Short Term Temperature;
i) Highest Average Long Term Temperature;
j) Lowest Average Long Term Temperature;
k) Time in Over-Temperature;
l) Specified Maximum Operating Temperature;
m) Time in Under-Temperature; and
n) Specified Minimum Operating Temperature.

Table A.15 — Temperature Statistics (Sheet 1 of 3)

Offset	Type	Description
0..7	QWord	Device Statistics Information Header **Bit Description** 63:24 Reserved 23:16 Log page number Shall be set to 05h 15:0 Revision number Shall be set to 0001h
8..15	QWord	Current Temperature (see A.5.8.3) **Bit Description** 63:56 Device Statistics Flags (see table A.8) 55:8 Reserved 7:0 Current Temperature (signed byte)
16..23	QWord	Average Short Term Temperature (see A.5.8.4) **Bit Description** 63:56 Device Statistics Flags (see table A.8) 55:8 Reserved 7:0 Average Short Term Temperature (signed byte)

Table A.15 — Temperature Statistics (Sheet 2 of 3)

Offset	Type	Description
24..31	QWord	Average Long Term Temperature (see A.5.8.5)
		Bit Description 63:56 Device Statistics Flags (see table A.8) 55:8 Reserved 7:0 Average Long Term Temperature (signed byte)
32..39	QWord	Highest Temperature (see A.5.8.6)
		Bit Description 63:56 Device Statistics Flags (see table A.8) 55:8 Reserved 7:0 Highest Temperature (signed byte)
40..47	QWord	Lowest Temperature (see A.5.8.7)
		Bit Description 63:56 Device Statistics Flags (see table A.8) 55:8 Reserved 7:0 Lowest Temperature (signed byte)
48..55	QWord	Highest Average Short Term Temperature (see A.5.8.8)
		Bit Description 63:56 Device Statistics Flags (see table A.8). 55:8 Reserved 7:0 Highest Average Short Term Temperature (signed byte)
56..63	QWord	Lowest Average Short Term Temperature (see A.5.8.9)
		Bit Description 63:56 Device Statistics Flags (see table A.8) 55:8 Reserved 7:0 Lowest Average Short Term Temperature (signed byte)
64..71	QWord	Highest Average Long Term Temperature (see A.5.8.10)
		Bit Description 63:56 Device Statistics Flags (see table A.8) 55:8 Reserved 7:0 Highest Average Long Term Temperature (signed byte)
72..79	QWord	Lowest Average Long Term Temperature (see A.5.8.11)
		Bit Description 63:56 Device Statistics Flags (see table A.8) 55:8 Reserved 7:0 Lowest Average Long Term Temperature (signed byte)

Table A.15 — Temperature Statistics (Sheet 3 of 3)

Offset	Type	Description
80..87	QWord	Time in Over-Temperature (see A.5.8.12)
		Bit **Description** 63:56 Device Statistics Flags (see table A.8) 55:32 Reserved 31:0 Time in Over-Temperature (DWord)
88..95	QWord	Specified Maximum Operating Temperature (see A.5.8.13)
		Bit **Description** 63:56 Device Statistics Flags (see table A.8) 55:8 Reserved 7:0 Specified Maximum Operating Temperature (signed byte)
96..103	QWord	Time in Under-Temperature (see A.5.8.14)
		Bit **Description** 63:56 Device Statistics Flags (see table A.8) 55:32 Reserved 31:0 Time in Under-Temperature (DWord)
104..111	QWord	Specified Minimum Operating Temperature (see A.5.8.15)
		Bit **Description** 63:56 Device Statistics Flags (see table A.8) 55:8 Reserved 7:0 Specified Minimum Operating Temperature (signed byte)
112..511	Byte	Reserved

A.5.8.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table A.15) for this log page.

A.5.8.3 Current Temperature

A.5.8.3.1 Description

The Current Temperature statistic is the temperature measured by the device at the time this log page is read.

A.5.8.3.2 Update Interval

None.

A.5.8.3.3 Measurement Units

Degrees Celsius.

A.5.8.3.4 Initialization

None.

A.5.8.4 Average Short Term Temperature

A.5.8.4.1 Description

The Average Short Term Temperature statistic is a value based on the most recent 144 temperature samples in a 24 hour period. The device enters the current temperature sample into the Average Short Term Temperature FIFO once every nominal ten minutes period. The Average Short Term Temperature FIFO consists of at least 144 temperature entries (i.e., 24 recorded hours). This statistic is calculated by averaging the last 144 Average Short Term Temperature FIFO entries.

A.5.8.4.2 Update Interval

One hour.

A.5.8.4.3 Measurement Units

Degrees Celsius.

A.5.8.4.4 Initialization

This statistic is not initialized at the time of manufacture. The ValidValue bit shall not be set to one and the data in bits (7:0) are not valid until after the device collects 144 temperature samples.

A.5.8.5 Average Long Term Temperature

A.5.8.5.1 Description

The Average Long Term Temperature statistic is a value based on the most recent 42 Average Short Term Temperature values. The device enters the current value of the Average Short Term Temperature into the Average Long Term Temperature FIFO once every nominal 24 hour period. The Average Long Term Temperature FIFO consists of at least 42 temperature entries (i.e., 1 008 recorded hours). This statistic is calculated by averaging the last 42 Average Long Term Temperature FIFO entries.

A.5.8.5.2 Update Interval

One hour.

A.5.8.5.3 Measurement Units

Degrees Celsius

A.5.8.5.4 Initialization

This statistic is not initialized at the time of manufacture. The ValidValue bit shall not be set to one and the data in bits (7:0) are not valid until after the device collects 42 Average Short Term Temperature data samples.

A.5.8.6 Highest Temperature

A.5.8.6.1 Description

The Highest Temperature statistic is the highest temperature measured after the device is manufactured. This data is calculated by comparing the current temperature value and the Highest Temperature value and storing the higher value. The comparison shall occur when a new temperature value is entered into the Average Short Term Temperature FIFO.

A.5.8.6.2 Update Interval

One hour.

A.5.8.6.3 Measurement Units

Degrees Celsius.

A.5.8.6.4 Initialization

This statistic is not initialized at the time of manufacture. The ValidValue bit shall not be set to one and the data in bits (7:0) are not valid until after the device collects the first Average Short Term Temperature data sample.

A.5.8.7 Lowest Temperature

A.5.8.7.1 Description

The Lowest Temperature statistic is the lowest temperature measured after the device is manufactured. This data is calculated by comparing the current temperature value and the Lowest Temperature value and storing the lower value. The comparison shall occur when a new temperature value is entered into the Average Short Term Temperature FIFO.

A.5.8.7.2 Update Interval

One hour.

A.5.8.7.3 Measurement Units

Degrees Celsius.

A.5.8.7.4 Initialization

This statistic is not initialized at the time of manufacture. The ValidValue bit shall not be set to one and the data in bits (7:0) are not valid until after the device collects the first Average Short Term Temperature data sample.

A.5.8.8 Highest Average Short Term Temperature

A.5.8.8.1 Description

The Highest Average Short Term Temperature statistic is a value that records the highest device Average Short Term Temperature after the device is manufactured. This data is calculated by comparing the current Average Short Term Temperature value and the Highest Average Short Term Temperature value and storing the higher value.

A.5.8.8.2 Update Interval

One hour.

A.5.8.8.3 Measurement Units

Degrees Celsius.

A.5.8.8.4 Initialization

This statistic is not initialized at the time of manufacture. The ValidValue bit shall not be set to one and the data in bits (7:0) are not valid until after the device collects 144 temperature samples.

A.5.8.9 Lowest Average Short Term Temperature

A.5.8.9.1 Description

The Lowest Average Short Term Temperature statistic is a value that records the lowest device Average Short Term Temperature after the device is manufactured. This data is calculated by comparing the current Average Short Term Temperature value and the Lowest Average Short Term Temperature value and storing the lower value.

A.5.8.9.2 Update Interval

One hour.

A.5.8.9.3 Measurement Units

Degrees Celsius.

A.5.8.9.4 Initialization

This statistic is not initialized at the time of manufacture. The ValidValue bit shall not be set to one and the data in bits (7:0) are not valid until after the device collects 144 temperature samples.

A.5.8.10 Highest Average Long Term Temperature

A.5.8.10.1 Description

The Highest Average Long Term Temperature statistic is a value that records the highest device Average Long Term Temperature after the device is manufactured. This data is calculated by comparing the current Average Long Term Temperature value and the Highest Average Long Term Temperature value and storing the higher value.

A.5.8.10.2 Update Interval

One hour.

A.5.8.10.3 Measurement Units

Degrees Celsius

A.5.8.10.4 Initialization

This statistic is not initialized at the time of manufacture. The ValidValue bit shall not be set to one and the data in bits (7:0) are not valid until after the device collects 42 Average Short Term Temperature data samples.

A.5.8.11 Lowest Average Long Term Temperature

A.5.8.11.1 Description

The Lowest Average Long Term Temperature statistic is a value that records the lowest device Average Long Term Temperature after the device is manufactured. This data is calculated by comparing the current Average Long Term Temperature value and the Lowest Average Long Term Temperature value and storing the lower value.

A.5.8.11.2 Update Interval

One hour.

A.5.8.11.3 Measurement Units

Degrees Celsius

A.5.8.11.4 Initialization

This statistic is not initialized at the time of manufacture. The ValidValue bit shall not be set to one and the data in bits (7:0) are not valid until after the device collects 42 Average Short Term Temperature data samples.

A.5.8.12 Time in Over-Temperature

A.5.8.12.1 Description

The Time in Over-Temperature statistic is a value that records the nominal amount of time that the device has been operational in an environment that exceeds the device's specified Maximum Operating Temperature (see A.5.8.13) since the device was manufactured.

The nominal sampling time of the temperature is ten minutes. This statistic is calculated by adding ten minutes for each sample taken that exceeds the temperature limit. This statistic is recorded in minutes of over-temperature operation. This statistic records the number of minutes that the device has been operational while the device temperature specification has been exceeded.

A.5.8.12.2 Update Interval

One hour.

A.5.8.12.3 Measurement Units

Minutes.

A.5.8.12.4 Initialization

This statistic shall be initialized to zero at the time of manufacture.

A.5.8.13 Specified Maximum Operating Temperature

A.5.8.13.1 Description

The Specified Maximum Operating Temperature is a value that reports the maximum operating temperature device is designed to operate. This value is used for the calculation of the Time in Over-Temperature statistic.

A.5.8.13.2 Update Interval

None.

A.5.8.13.3 Measurement Units

Degrees Celsius.

A.5.8.13.4 Initialization

This value shall be set at the time of manufacture.

A.5.8.14 Time in Under-Temperature

A.5.8.14.1 Description

The Time in Under-Temperature statistic is a value that records the nominal amount of time that the device has been operational in an environment that goes below the device’s specified minimum operating temperature (see A.5.8.15) since the device was manufactured.

The nominal sampling time of the temperature is ten minutes. This statistic is calculated by adding ten minutes for each sample taken that goes below the temperature limit. This statistic is recorded in minutes of over-temperature operation. This statistic records the number of minutes that the device has been operational while the temperature is lower than the device minimum temperature specification.

A.5.8.14.2 Update Interval

One hour.

A.5.8.14.3 Measurement Units

Minutes.

A.5.8.14.4 Initialization

This statistic shall be initialized to zero at the time of manufacture.

A.5.8.15 Specified Minimum Operating Temperature

A.5.8.15.1 Description

The Specified Minimum Operating Temperature is a value that reports the minimum operating temperature device is designed to operate. This value is used for the calculation of the Time in Under-Temperature statistic.

A.5.8.15.2 Update Interval

None.

A.5.8.15.3 Measurement Units

Degrees Celsius.

A.5.8.15.4 Initialization

This value shall be set at the time of manufacture.

A.5.9 Transport Statistics (log page 06h)

A.5.9.1 Overview

The Transport Statistics log page contains interface transport information about the device as described in table A.16.

The Transport Statistics are as follows:

a) Device Statistics Information Header;
b) Number of hardware resets;
c) Number of ASR Events; and
d) Number of Interface CRC Errors.

Table A.16 — Transport Statistics

Offset	Type	Description
0..7	QWord	Device Statistics Information Header
		Bit Description 63:24 Reserved 23:16 Log page number Shall be set to 06h. 15:0 Revision number Shall be set to 0001h
8..15	QWord	Number of hardware resets (see A.5.9.3)
		Bit Description 63:56 Device Statistics Flags (see table A.8). 55:32 Reserved 31:0 Number of hardware resets (DWord)
16..23	QWord	Number of ASR Events (see A.5.9.4)
		Bit Description 63:56 Device Statistics Flags (see table A.8) 55:32 Reserved 31:0 Number of ASR Events (DWord)
24..31	QWord	Number of Interface CRC Errors (see A.5.9.5)
		Bit Description 63:56 Device Statistics Flags (see table A.8) 55:32 Reserved 31:0 Number of Interface CRC Errors (DWord)
32..511	Byte	Reserved

A.5.9.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table A.16) for this log page.

A.5.9.3 Number of hardware resets

A.5.9.3.1 Description

The Number of hardware resets statistic is the number of hardware resets received by the device. This statistic is incremented by one for each hardware reset. For SATA devices, this includes all COMRESETs regardless of whether the Software Settings Preservation feature set (see 4.19) is enabled or not.

A.5.9.3.2 Update Interval

Ten minutes.

A.5.9.3.3 Measurement Units

Events.

A.5.9.3.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.9.4 Number of ASR Events

A.5.9.4.1 Description

The Number of ASR Events statistic is a counter that records the number of ASR events (see SATA 2.6). This statistic is incremented by one for each ASR event detected.

A.5.9.4.2 Update Interval

Ten minutes.

A.5.9.4.3 Measurement Units

Events.

A.5.9.4.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.9.5 Number of Interface CRC Errors

A.5.9.5.1 Description

The Number of Interface CRC Errors statistic is a counter that records the number of Interface CRC errors (see 6.3.7) reported in the Error field since the device was manufactured. This statistic is incremented by one for each Interface CRC error reported in the Error field.

A.5.9.5.2 Update Interval

Ten minutes.

A.5.9.5.3 Measurement Units

Events.

A.5.9.5.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

A.5.10 Reserved (log page 08h..FFh)

A.6 Device Vendor Specific logs (Log Addresses A0h-DFh)

Device Vendor Specific logs may be used by the device vendor to store any data and need only be implemented if used.

A.7 Extended Comprehensive SMART Error log (Log Address 03h)

A.7.1 Overview

Table A.17 defines the format of each of the log pages that define the Extended Comprehensive SMART Error log. The maximum size of the Extended Comprehensive SMART Error log is 16 383 log pages. Devices may support fewer than 16 383 log pages. Error log data structures shall include, but are not limited to, Uncorrectable errors (see 6.3.10), ID Not Found errors (see 6.3.5) for which the LBA requested was valid, servo errors, and write fault errors. Error log data structures shall not include errors attributed to the receipt of faulty commands (e.g., command codes not implemented by the device or requests with invalid parameters or invalid LBAs).

All 28-bit entries contained in the Comprehensive SMART log (see A.4), shall also be included in the Extended Comprehensive SMART Error log with the 48-bit entries.

Table A.17 — Extended Comprehensive SMART Error log

Offset	First Log Page [b]	Subsequent Log Pages
0	SMART error log version	Reserved
1	Reserved	Reserved
2..3	Error log index (word)	Reserved
4..127	First error log data structure	Data structure 4n [a]+1
128..251	Second error log data structure	Data structure 4n [a]+2
252..375	Third error log data structure	Data structure 4n [a]+3
376..499	Fourth error log data structure	Data structure 4n [a]+4
500..501	Device error count (word)	Reserved
502..510	Reserved	Reserved
511	Data structure checksum	Data structure checksum

[a] n is the logical log page number within the log.
[b] The first log page is numbered zero.

A.7.2 Error log version

The value of the SMART error log version byte shall be 01h.

A.7.3 Error log index

The error log index is the error log data structure number representing the most recent error. If there have been no error log entries, the error log index is cleared to zero.

A.7.4 Extended Error log data structure

A.7.4.1 Overview

The Extended Comprehensive SMART Error log is viewed as a circular buffer. 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 A.18.

Table A.18 — Extended Error log data structure

Offset	Description
n..n+17	First command data structure
n+18..n+35	Second command data structure
n+36..n+53	Third command data structure
n+54..n+71	Fourth command data structure
n+72..n+89	Fifth command data structure
n+90..n+123	Error data structure

A.7.4.2 Command data structure

The extended error log data structure is filled as follows:

1) the fifth command data structure shall contain the command or reset for which the error is being reported;
2) the fourth command data structure should contain the command or reset that preceded the command or reset for which the error is being reported;
3) the third command data structure should contain the command or reset preceding the one in the fourth command data structure;
4) the second command data structure should contain the command or reset preceding the one in the third command data structure; and
5) the first command data structure should contain the command or reset preceding the one in the second command data structure.

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 (e.g., 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). Devices that are not able to report the commands that preceded the command for which the error is being reported or that preceded a reset shall zero fill the command data structures.

If the command data structure represents a command or software reset, then the content of the command data structure shall be as shown in Table A.19. If the command data structure represents a hardware reset, then 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 A.19 — Command data structure

Offset	Description
n	Content of the Device Control field when the Command was initiated.
n+1	Content of the Feature field (7:0) when the Command was initiated.
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 (31:24) when the Command was initiated.
n+7	Content of the LBA field (15:8) when the Command was initiated.
n+8	Content of the LBA field (39:32) when the Command was initiated.
n+9	Content of the LBA field (23:16) when the Command was initiated.
n+10	Content of the LBA field (47:40) when the Command was initiated.
n+11	Content of the Device field when the Command was initiated.
n+12	Content written to the Command field when the command was initiated
n+13	Reserved
n+14..n+17	Timestamp (DWord) shall be the time since power-on in milliseconds when command acceptance occurred. This timestamp may wrap.

A.7.4.3 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 A.20. 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 A.20.

Table A.20 — Error data structure

Offset	Description
n	Transport specific value when the Command was initiated. See the appropriate transport standard, reference Device Control field.
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.
n+3	Content of the Count field (15:8) after command completion occurred.
n+4	Content of the LBA field (7:0) when the command completion occurred.
n+5	Content of the LBA field (31:24) when the command completion occurred.
n+6	Content of the LBA field (15:8) when the command completion occurred.
n+7	Content of the LBA field (39:32) when the command completion occurred.
n+8	Content of the LBA field (23:16) when the command completion occurred.
n+9	Content of the LBA field (47:40) when the command completion occurred.
n+10	Content of the Device field after command completion occurred.
n+11	Content written to the Status field after command completion occurred.
n+12..n+30	Extended error information
n+31	State
n+32..n+33	Life timestamp (word)

Extended error information shall be vendor specific.

State shall contain a value indicating the state of the device when the command was initiated or the reset occurred as described in Table A.21.

Table A.21 — State field values

Value [a]	State
x0h	Unknown
x1h	Sleep
x2h	Standby
x3h	Active/Idle
x4h	Executing SMART off-line or self-test
x5h-xAh	Reserved
xBh-xFh	Vendor specific
[a] The value of x is vendor specific and may be different for each state.	

Sleep indicates the reset for which the error being reported was received when the device was in the Sleep mode.

Standby indicates the command or reset for which the error being reported was received when the device was in the Standby mode.

Active/Idle indicates the command or reset for which the error being reported was received when the device was in the Active or Idle mode.

Executing SMART off-line or self-test indicates the command or reset for which the error being reported was received when the device was processing a SMART off-line or self-test.

Life timestamp shall contain the power-on lifetime of the device in hours when command completion occurred.

A.7.5 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 (e.g., Uncorrectable errors (see 6.3.10), ID Not Found errors (see 6.3.5) for which the LBA requested was valid, servo errors, write fault errors). This device error count shall not include errors attributed to the receipt of faulty commands (e.g., command codes not implemented by the device or requests with invalid parameters or invalid LBAs). If the maximum value for this field is reached, then the count shall remain at the maximum value when additional errors are encountered and logged.

A.7.6 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 shall be zero when the checksum is correct. The checksum is placed in byte 511.

A.8 Power Conditions log (Log Address 08h)

A.8.1 Overview

If the Extended Power Conditions feature set is supported, then the Power Conditions log shall be supported. If the Extended Power Conditions feature set (see 4.7) is not supported, then the Power Conditions log shall not be supported.

The Power Conditions log is non-volatile.

A.8.2 Idle power conditions (log page 00h)

Table A.22 defines log page 00h of the power conditions log. The format of each Idle power condition descriptor is shown in table A.24.

Table A.22 — Idle Power Conditions log page

Byte Offset	Type	Description
0..63	Byte	Idle_a power conditions descriptor (see table A.24). Power condition supported shall be set to one to indicate that the Idle_a power condition is supported.
64..127	Byte	Idle_b power conditions descriptor (see table A.24).
128..191	Byte	Idle_c power conditions descriptor (see table A.24).
192..511		Reserved

A.8.3 Standby power conditions (log page 01h)

Table A.23 defines log page 01h of the power conditions log. The format of each Standby power condition descriptor is shown in table A.24.

Table A.23 — Standby Power Conditions log page

Byte Offset	Type	Description
0..383		reserved
384..447	Byte	Standby_y power condition descriptor (see table A.24).
448..511	Byte	Standby_z power condition descriptor (see table A.24).

A.8.4 Power Conditions log descriptor

A.8.4.1 Power Conditions log descriptor overview

Table A.24 defines the Power Conditions log descriptor. Each power condition has its own descriptor.

Table A.24 — Power Conditions log descriptor

Byte Offset	Type	Description
0	Byte	reserved
1	Byte	Power Condition Flags (byte) **Bit Description** 7 Power Condition Supported (see A.8.4.2) 6 Timer Saveable (see A.8.4.3) 5 Timer Changeable (see A.8.4.4) 4 Default Timer Enabled (see A.8.4.5) 3 Saved Timer Enabled (see A.8.4.6) 2 Current Timer Enabled (see A.8.4.7) 1:0 Reserved
2..3	Byte	Reserved
4..7	DWord	Default Timer Setting (see A.8.4.8)
8..11	DWord	Saved Timer Setting (see A.8.4.9)
12..15	DWord	Current Timer Setting (see A.8.4.10)
16..19	DWord	Nominal Recovery time to PM0:Active (see A.8.4.11)
20..23	DWord	Minimum Timer Setting (see A.8.4.12)
24..27	DWord	Maximum Timer Setting (see A.8.4.13)
28..63	DWord	Reserved

A.8.4.2 Power Condition Supported

The Power Condition Supported bit is valid if the EPC feature set is supported, regardless of whether EPC is enabled or disabled.

If the Power Condition Supported bit is set to one, then the power condition is supported. If the Power Condition Supported bit is cleared to zero, then the power condition is not supported.

A.8.4.3 Timer Saveable

The Timer Saveable bit is valid if the Power Condition Supported bit is set to one, regardless of whether EPC is enabled or disabled.

If the Timer Saveable bit is set to one, then the power condition is saveable if EPC is enabled. If the Timer Saveable bit is cleared to zero, then the power condition is not saveable.

A.8.4.4 Timer Changeable

The Timer Changeable bit is valid if the Power Condition Supported bit is set to one, regardless of whether EPC is enabled or disabled.

If the Timer Changeable bit is set to one, then the power condition is changeable if EPC is enabled. If the Timer Changeable bit is cleared to zero, then the power condition is not changeable

A.8.4.5 Default Timer Enabled

The Default Timer Enabled bit is valid if the Power Condition Supported bit is set to one, regardless of whether EPC is enabled or disabled.

A.8.4.6 Saved Timer Enabled

The Saved Timer Enabled bit is valid if the Power Condition Supported bit is set to one, regardless of whether EPC is enabled or disabled.

A.8.4.7 Current Timer Enabled

If EPC is disabled, then the Current Timer Enabled bit shall be cleared to zero.

If EPC is enabled and the Current Timer Setting field is non-zero and the Current Timer Enabled bit is set to one, then the power condition timer is enabled.

If EPC is enabled and the Current Timer Enabled bit is cleared to zero, then the power condition timer is disabled.

A.8.4.8 Default Timer Setting

The Default Timer field is set at the time of manufacture.

The Default Timer Setting field is valid if the Power Condition Supported bit is set to one, regardless of whether EPC is enabled or disabled.

A value of FFFF_FFFFh indicates that the time is greater than or equal to 429_496_729_500 milliseconds.

Measurement Units: 100 milliseconds.

A.8.4.9 Saved Timer Setting

The Saved Timer Setting field is a value that has been saved by a SET FEATURES Set Power Condition Timer subcommand (see 7.45.18.4).

The Saved Timer Setting field is valid if the Power Condition Supported bit is set to one, regardless of whether EPC is enabled or disabled.

A value of zero indicates that this power condition is disabled if the EPC feature set is enabled.

A value of FFFF_FFFFh indicates that the time is greater than or equal to 429_496_729_500 milliseconds.

Measurement Units: 100 milliseconds.

A.8.4.10 Current Timer Setting

The Current Timer setting is the minimum time that the device shall wait after command completion before entering this power condition if the EPC feature set is enabled.

The Current Timer Setting field shall be cleared to zero if:

a) EPC is disabled;
b) the Power Condition Supported bit is cleared to zero; or
c) the Current Timer Enabled field is cleared to zero.

A value of FFFF_FFFFh indicates that the time is greater than or equal to 429_496_729_500 milliseconds.

Measurement Units: 100 milliseconds.

A.8.4.11 Nominal Recovery time to PM0:Active

The Nominal Recovery time to PM0:Active is the nominal time required to transition from this power condition to PM0:Active (see 4.13.4) if the EPC feature set is enabled. This time does not include processing time for the command that caused this transition to occur.

The Nominal Recovery time to PM0:Active field is valid if the Power Condition Supported bit is set to one, regardless of whether EPC is enabled or disabled.

A value of zero indicates that the nominal recovery time is not specified. A value of FFFF_FFFFh indicates that the recovery time is greater than or equal to 429_496_729_500 milliseconds.

This value shall be preserved over all resets.

Measurement Units: 100 milliseconds.

A.8.4.12 Minimum Timer Setting

The Minimum Timer Setting is the minimum timer value allowed by the Set Power Condition Timer subcommand (see 7.45.18.4) for this power condition if the EPC feature set is enabled.

The Minimum Timer Setting field is valid if the Power Condition Supported bit is set to one, regardless of whether EPC is enabled or disabled.

A value of zero indicates that the nominal recovery time is not specified. A value of FFFF_FFFFh indicates that the recovery time is greater than or equal to 429_496_729_500 milliseconds.

This value shall be preserved over all resets.

Measurement Units: 100 milliseconds.

A.8.4.13 Maximum Timer Setting

The Maximum timer setting is the maximum timer value allowed by the Set Power Condition Timer subcommand (see 7.45.18.4) for this power condition if the EPC feature set is enabled.

The Maximum Timer Setting field is valid if the Power Condition Supported bit is set to one, regardless of whether EPC is enabled or disabled.

A value of zero indicates that the nominal recovery time is not specified. A value of FFFF_FFFFh indicates that the recovery time is greater than or equal to 429_496_729_500 milliseconds.

This value shall be preserved over all resets.

Measurement Units: 100 milliseconds.

A.9 Extended SMART Self-Test log (Log Address 07h)

A.9.1 Overview

Table A.25 defines the format of each of the log pages that define the Extended SMART Self-Test log. The maximum size of the self-test log is 3 449 log pages. Devices may support fewer than 3 449 log pages.

The Extended SMART Self-Test log shall support 48-bit and 28-bit addressing. All 28-bit entries contained in the SMART Self-Test log, defined in A.18 shall also be included in the Extended SMART Self-Test log with all 48-bit entries.

Table A.25 — Extended Self-test log data structure

Offset	First Log Page [b]	Subsequent Log Pages
0	Self-test log data structure revision number	Reserved
1	Reserved	Reserved
2..3	Self-test descriptor index (word)	Reserved
4..29	Descriptor entry 1	Descriptor entry 19n [a]+1
30..55	Descriptor entry 2	Descriptor entry 19n [a]+2
…	…	…
472..497	Descriptor entry 19	Descriptor entry 19n [a]+19
498..499	Vendor specific	Vendor specific
500..510	Reserved	Reserved
511	Data structure checksum	Data structure checksum

[a] n is the nth log page within the log.
[b] The first log page is number zero.

The Extended Self-test log is a circular buffer. All unused self-test descriptors shall be filled with zeros.

A.9.2 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.

A.9.3 Self-test log data structure revision number

The value of the self-test log data structure revision number shall be 01h.

A.9.4 Extended Self-test log descriptor entry

The content of the self-test descriptor entry is shown in Table A.26.

Table A.26 — Extended Self-test log descriptor entry

Offset	Description
n	Content of the LBA field (7:0)
n+1	Content of the self-test execution status byte
n+2..n+3	Life timestamp (word)
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+11..n+25	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 7.48.5.2).

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 7.48.6.8).

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.

A.9.5 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 is zero when the checksum is correct. The checksum is placed in byte 511.

A.10 Host Specific logs (Log Addresses 80h-9Fh)

The mandatory Host Specific logs shall each contain sixteen log pages. The content of the Host Specific logs shall be common to all log commands (e.g., if the host places data in a Host Specific log page using the SMART WRITE LOG command and issues a READ LOG EXT command to the same log page, then the host receives the same data that was originally stored by SMART WRITE LOG command).

Host Specific logs may be used by the host to store any data. If a Host Specific log has never been written by the host, when read the content of the log shall be zeros.

A.11 IDENTIFY DEVICE data log (Log Address 30h)

A.11.1 Overview

The mandatory IDENTIFY DEVICE data log reports device configuration information. This log shall be read-only. See table A.27 for a list of defined pages. Each page shall consist of a header field that may be followed by defined statistics fields. If the Revision Number field in the page header is 0000h, then that page is not supported. All page data following the last defined statistic for that page is reserved.

Editor's Note 11: Did not import HDD multiple stuff. I can if we want…

Editor's Note 12: Need to figure out what to do with Hardware result in PATA page

Editor's Note 13: Need to figure out a proper WWN layout.

Editor's Note 14: Need to import SCT

Editor's Note 15: Need to import CFA power mode word 160 and remove the gratuitous bit I added.

Editor's Note 16: Did not import NV Cache since this is obsoleting.

If an unsupported page is requested, then 512 bytes of all zeros shall be returned for that page.

Table A.27 — Defined IDENTIFY DEVICE data pages

Page	Description	Required
00h	List of supported pages (see A.11.2)	M
01h	Copy of IDENTIFY DEVICE data (see 7.16.7)	M
02h	Capacity (see A.11.4)	M
03h	Supported Capabilities (see A.11.5)	M
04h	Current Settings (see A.11.6)	M
05h	ATA Strings (see A.11.7)	M
06h	Security (see A.11.8)	M
07h	Parallel ATA (see A.11.9)	P
08h	Reserved for Serial ATA	S
09h..FFh	Reserved	

Key:
M - Mandatory for all devices
O - Optional for all devices
S - Mandatory for SATA
P - Mandatory for PATA

A.11.2 List of Supported IDENTIFY DEVICE data log pages (Page 00h)

IDENTIFY DEVICE data log page 00h contains a list of the supported pages as described in table A.28. Entries shall be in order of ascending page number (e.g., 00h, 01h, 07h).

Table A.28 — List of supported IDENTIFY DEVICE data pages

Offset	Type	Content
0..7	QWord	IDENTIFY DEVICE data log Information Header. This log page lists the numbers of the supported log pages **Bit** **Meaning** 63:24 Reserved 23:16 Page Number. Shall be set to 00h. 15:0 Revision number. Shall be set to 0001h
8	Byte	Number of entries (n) in the following list
9	Byte	Shall be set to zero to indicate that page 00h is supported
10	Byte	Shall be set to one to indicate that page 01h is supported
…		
n+8	Byte	Page number of nth supported IDENTIFY DEVICE data log page
n+9..511		Reserved

A.11.3 Copy of IDENTIFY DEVICE data (page 01h)

This page is a copy of IDENTIFY DEVICE data words 0..255.

NOTE 24 — This page does not have the header QWord which is present on all the other pages in this log.

A.11.4 Capacity (page 02)

A.11.4.1 Overview

The Capacity log page (see table A.29) provides information about the capacity of the device.

Table A.29 — Capacity

Offset	Type	Content
0..7	QWord	Capacity page information header.
		Bit **Meaning**
		63 Shall be set to one.
		62:24 Reserved
		23:16 Page Number. Shall be set to 02h.
		15:0 Revision number. Shall be set to 0001h
8..15	QWord	Device Capacity (see A.11.4.2) [was 100..103]
		Bit **Meaning**
		63 Shall be set to one.
		62:48 Reserved
		47:0 Total Number of User Addressable Logical Sectors
16..23	QWord	Physical/Logical Sector Size (see A.11.4.3) [was words 49, 106 and 209]
		Bit **Meaning**
		63 Contents of the QWord are valid
		62 Device has multiple logical sectors per physical sector
		61 Device has a logical sector size greater than 256 words
		60:22 Reserved
		21:20 Alignment Error reporting
		19:16 2^x logical sectors per physical sectors
		15:0 Logical sector offset within the first physical sector where the first logical sector is placed
24..31	QWord	Logical Sector Size (see A.11.4.4) [was words 117..118]
		Bit **Meaning**
		63 Contents of the QWord are valid
		62..32 Reserved
		31..0 Logical Sector Size
32..39	QWord	Nominal Buffer Size [from e09143r2]
		63 Contents of the QWord are valid
		62:0 Buffer size (bytes) (see A.11.4.5)
40..511		Reserved

A.11.4.2 Device Capacity

Device Capacity is a mandatory field which contains a value that is one greater than the maximum LBA in user accessible space. The maximum value that shall be placed in this field is FFFF_FFFF_FFFFh.

A.11.4.3 Physical/Logical Sector Size

A.11.4.3.1 Device has multiple logical sectors per physical sector

If Device has multiple logical sectors per physical sector is set to one, then the device has more than one logical sector per physical sector and 2x logical sectors per physical sectors is valid. See A.11.4.3.5 for information on the alignment of logical sectors within a physical sector.

A.11.4.3.2 Device has a logical sector size greater than 256 words

If Device has a logical sector size greater than 256 words is set to one, then the device has been formatted with a logical sector size larger than 256 words and Logical Sector Size (see A.11.4.4) is valid. If Device has a logical sector size greater than 256 words is cleared to zero, then Logical Sector Size is invalid and the logical sector size is 256 words.

A.11.4.3.3 Alignment Error reporting

If Long Physical Sector Alignment Error Reporting Control is supported (see x.x.x and 7.45.17) is set to one, then if Alignment Error reporting is:

a) set to 00b, then Long Physical Sector Alignment Error reporting is disabled;
b) set to 01b, then Long Physical Sector Alignment Error reporting is enabled;
c) set to 10b, then the device shall report command aborted when an Alignment Error occurs; and
d) set to 11b, then this value is reserved.

A.11.4.3.4 2x logical sectors per physical sectors

2x logical sectors per physical sectors indicate the size of the device physical sectors in power of two logical sectors.

Example:

Bits (3:0): 0 = 2^0 = 1 logical sector per physical sector
Bits (3:0): 1 = 2^1 = 2 logical sectors per physical sector
Bits (3:0): 2 = 2^2 = 4 logical sectors per physical sector
Bits (3:0): 3 = 2^3 = 8 logical sectors per physical sector

A.11.4.3.5 Logical sector offset within the first physical sector where the first logical sector is placed

Logical sector offset within the first physical sector where the first logical sector is placed shall report the location of logical sector zero within the first physical sector of the media. See Annex E for more information.

A.11.4.4 Logical Sector Size

Logical Sector Size indicates the size of device logical sectors in words. The value of logical sector size shall be greater than or equal to 256. The value of logical sector size shall be valid when Device has a logical sector size greater than 256 words (see A.11.4.3.2) is set to one. All logical sectors on a device shall be this length. If Device has a logical sector size greater than 256 words is cleared to zero, then Logical Sector Size shall be cleared to zero.

A.11.4.5 Nominal Buffer Size

The nominal buffer size reports the size, in bytes, of the buffer supported by the device. The partitioning of the buffer is vendor specific.

A.11.5 Supported Capabilities (page 03h)

A.11.5.1 Overview

The Supported Capabilities log page (see table A.30) provides a mechanism for the device to report support for feature sets, features, commands and other device capabilities.

Table A.30 — Supported Capabilities (Sheet 1 of 3)

Offset	Type	Content	
0..7	QWord	Supported Capabilities page information header.	
		Bit	**Meaning**
		63	Shall be set to one.
		62:24	Reserved
		23:16	Page Number. Shall be set to 03h.
		15:0	Revision number. Shall be set to 0001h
8..15	QWord	Supported Capabilities [was words 69, 82, 83, 84, and 119]	
		Bit	**Meaning**
		63	Shall be set to one.
		62:41	Reserved
		40	CFast Specification Support (see A.11.5.2.2)
		39	Deterministic read after TRIM is supported (see A.11.5.2.3)
		38	Long Physical Sector Alignment Error Reporting Control is supported (see A.11.5.2.4)
		37	DEVICE CONFIGURATION IDENTIFY DMA and DEVICE CONFIGURATION SET DMA are supported (see A.11.5.2.5)
		36	READ BUFFER DMA is supported (see A.11.5.2.6)
		35	WRITE BUFFER DMA is supported (see A.11.5.2.7)
		34	SET MAX SET PASSWORD DMA and SET MAX UNLOCK DMA are supported (see A.11.5.2.8)
		33	DOWNLOAD MICROCODE DMA is supported (see A.11.5.2.9)
		32	Optional ATA device 28-bit commands supported (see A.11.5.2.10)
		31	Trimmed LBA range(s) returning zeroed data is supported (see A.11.5.2.11)
		30	All write cache is non-volatile (see A.11.5.2.12)
		29	The NOP command is supported (see A.11.5.2.13)
		28	The READ BUFFER command is supported (see A.11.5.2.14)
		27	The WRITE BUFFER command is supported (see A.11.5.2.15)
		26	The HPA feature set is supported (see A.11.5.2.16)
		25	Read look-ahead is supported (see A.11.5.2.17)
		24	The volatile write cache is supported (see A.11.5.2.18)
		23	The SMART feature set is supported (see A.11.5.2.19)
		22	The FLUSH CACHE EXT command is supported (see A.11.5.2.20)
		21	The DCO feature set is supported (see A.11.5.2.21)
		20	The 48-bit Address feature set is supported (see A.11.5.2.22)
		19	The SET MAX security extension is supported (see A.11.5.2.23)

Table A.30 — Supported Capabilities (Sheet 2 of 3)

Offset	Type	Content
		18 SET FEATURES subcommand is required to spin-up after power-up (see A.11.5.2.24)
		17 The PUIS feature set is supported (see A.11.5.2.25)
		16 The APM feature set is supported (see A.11.5.2.26)
		15 The CFA feature set is supported (see A.11.5.2.27)
		14 The DOWNLOAD MICROCODE command is supported (see A.11.5.2.28)
		13 The IDLE IMMEDIATE command with UNLOAD feature is supported (see A.11.5.2.29)
		12 The WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported (see A.11.5.2.30)
		11 The GPL feature set is supported (see A.11.5.2.31)
		10 The Streaming feature set is supported (see A.11.5.2.32)
		9 Media serial number is supported (see A.11.5.2.33)
		8 The SMART self-test is supported (see A.11.5.2.34)
		7 SMART error logging is supported (see A.11.5.2.35)
		6 Extended Power Conditions feature set is supported (see A.11.5.2.36)
		5 Sense Data Reporting feature set is supported (see A.11.5.2.37)
		4 The Free-fall Control feature set is supported (see A.11.5.2.38)
		3 The DOWNLOAD MICROCODE command with mode 3 is supported (see A.11.5.2.39)
		2 The READ LOG DMA EXT and WRITE LOG DMA EXT commands are supported (see A.11.5.2.40)
		1 The WRITE UNCORRECTABLE EXT command is supported (see A.11.5.2.41)
		0 The Write-Read-Verify feature set is supported (see A.11.5.2.42)
16..23	QWord	DOWNLOAD MICROCODE Capabilities [words 234,235]
		Bit Meaning
		63 Contents of the QWord are valid
		62:35 Reserved
		34 Subcommands 0Eh and 0Fh are supported (see A.11.5.3.1)
		33 Subcommand 07h is supported (see A.11.5.3.2)
		32 Subcommand 03h is supported (see A.11.5.3.3)
		31:16 Maximum number of 512-byte data blocks per DOWNLOAD MICROCODE command mode 03h (see A.11.5.3.4)
		15:0 Minimum number of 512-byte data blocks per DOWNLOAD MICROCODE command mode 03h (see A.11.5.3.5)
24..31	QWord	Nominal Media Rotation Rate [was word 217]
		Bit Meaning
		63 Shall be set to one
		62:16 Reserved
		15:0 Nominal Media Rotation Rate (see A.11.5.4)
32..39	QWord	Nominal Form Factor [was word 168]

Table A.30 — Supported Capabilities (Sheet 3 of 3)

Offset	Type	Content
		Bit **Meaning**
		63 Contents of the QWord are valid
		62:4 Reserved
		3:0 Nominal Form Factor (see A.11.5.5)
40..47	QWord	Write-Read-Verify Sector Count Mode 3 [was word 210]
		Bit **Meaning**
		63 Contents of the QWord are valid
		62:32 Reserved
		31:0 Write-Read-Verify Sector Count Mode 3 (see A.11.5.6)
48..55	QWord	Write-Read-Verify Sector Count Mode 2 [was word 212]
		Bit **Meaning**
		63 Contents of the QWord are valid
		62:32 Reserved
		31:0 Write-Read-Verify Sector Count Mode 2 (see A.11.5.7)
56..71	DQWord	World wide name [was word 108]
		Bit **Meaning**
		127 Shall be set to one
		126:64 Reserved
		63:0 World wide name (see A.11.5.8)
72..79	QWord	DATA SET MANAGEMENT [was word 169]
		Bit **Meaning**
		63 Shall be set to one
		62:1 Reserved
		0 Trim (see A.11.5.9.1)
80..511		Reserved

A.11.5.2 Supported Capabilities

A.11.5.2.1 Overview

Supported Capabilities shall indicate features and command sets supported. If a defined bit is cleared to zero, the indicated features and command set is not supported.

A.11.5.2.2 CFast Specification Support

If CFast Specification Support is set to one, then the device supports the CFast specification.

A.11.5.2.3 Deterministic read after TRIM is supported

If Trim (see A.11.5.9.1) is set to one and Deterministic read after TRIM is supported cleared to zero, then the Trim function of the DATA SET MANAGEMENT command (see 7.9.3.2) supports indeterminate read after trim behavior. If Trim (see A.11.5.9.1) is set to one and Deterministic read after TRIM is supported is set to one, the Trim function of the DATA SET MANAGEMENT command supports deterministic read after trim behavior. If word Trim (see A.11.5.9.1) is cleared to zero, then Deterministic read after TRIM is supported is reserved.

Editor's Note 17: Should these instances say "shall be set to zero" instead of reserved?

A.11.5.2.4 Long Physical Sector Alignment Error Reporting Control is supported

If Long Physical Sector Alignment Error Reporting Control is supported is set to one, then the device supports the SET FEATURES command with the Long Physical Sector Alignment Error Reporting Control subcommand (see 7.45.17).

A.11.5.2.5 DEVICE CONFIGURATION IDENTIFY DMA and DEVICE CONFIGURATION SET DMA are supported

If DEVICE CONFIGURATION IDENTIFY DMA and DEVICE CONFIGURATION SET DMA are supported is set to one, then the DEVICE CONFIGURATION IDENTIFY DMA command and DEVICE CONFIGURATION SET DMA command are supported.

A.11.5.2.6 READ BUFFER DMA is supported

If READ BUFFER DMA is supported is set to one, then the READ BUFFER DMA command is supported.

A.11.5.2.7 WRITE BUFFER DMA is supported

If WRITE BUFFER DMA is supported is set to one, then the WRITE BUFFER DMA command is supported.

A.11.5.2.8 SET MAX SET PASSWORD DMA and SET MAX UNLOCK DMA are supported

If SET MAX SET PASSWORD DMA and SET MAX UNLOCK DMA are supported is set to one, then the SET MAX SET PASSWORD DMA command and SET MAX UNLOCK DMA command are supported.

A.11.5.2.9 DOWNLOAD MICROCODE DMA is supported

If DOWNLOAD MICROCODE DMA is supported is set to one, then the DOWNLOAD MICROCODE DMA command is supported.

A.11.5.2.10 Optional ATA device 28-bit commands supported

Optional ATA device 28-bit commands supported shall be cleared to zero if all of the following commands are supported:

a) FLUSH CACHE;
b) READ DMA;
c) READ MULTIPLE;
d) READ SECTOR(S);
e) READ VERIFY SECTOR(S);
f) SET MULTIPLE MODE;
g) WRITE DMA;
h) WRITE MULTIPLE; and
i) WRITE SECTOR(S).

Optional ATA device 28-bit commands supported shall be set to one if any of the following commands are not supported:

a) FLUSH CACHE;
b) READ DMA;
c) READ MULTIPLE;

d) READ SECTOR(S);
e) READ VERIFY SECTOR(S);
f) SET MULTIPLE MODE;
g) WRITE DMA;
h) WRITE MULTIPLE; or
i) WRITE SECTOR(S).

A.11.5.2.11 Trimmed LBA range(s) returning zeroed data is supported

If Deterministic read after TRIM is supported (see A.11.5.2.3) is set to one and Trimmed LBA range(s) returning zeroed data is supported is set to one, then a read operation after a Trim operation returns data from trimmed LBAs as all words cleared to zero. If Deterministic read after TRIM is supported (see A.11.5.2.3) is set to one and Trimmed LBA range(s) returning zeroed data is supported is cleared to zero, then a read operation after a Trim operation may have words set to any value. If Deterministic read after TRIM is supported (see A.11.5.2.3) is cleared to zero, then Trimmed LBA range(s) returning zeroed data is supported is reserved.

A.11.5.2.12 All write cache is non-volatile

If All write cache is non-volatile is set to one, then all the of write cache on the device is non-volatile. If All write cache is non-volatile is cleared to zero then the write cache may be volatile.

NOTE 25 — Non-volatile write cache is independent of the NV Cache Feature Set.

A.11.5.2.13 The NOP command is supported

If The NOP command is supported is set to one, then the NOP command (see 7.20) is supported.

A.11.5.2.14 The READ BUFFER command is supported

If The READ BUFFER command is supported is set to one, then the READ BUFFER command is supported.

A.11.5.2.15 The WRITE BUFFER command is supported

If The WRITE BUFFER command is supported is set to one, then the WRITE BUFFER command is supported.

A.11.5.2.16 The HPA feature set is supported

If The HPA feature set is supported is set to one, then the HPA feature set is supported.

Editor’s Note 18: f10203r0-Obsolete HPA appears to have missed the fact that this subclause needs to be deleted.

A.11.5.2.17 Read look-ahead is supported

If Read look-ahead is supported is set to one, then read look-ahead is supported.

A.11.5.2.18 The volatile write cache is supported

If The volatile write cache is supported is set to one, then volatile write cache is supported.

Editor’s Note 19: The Power Management feature set is mandatory, so no bit has been included here.

A.11.5.2.19 The SMART feature set is supported

If The SMART feature set is supported is set to one, then the SMART feature set is supported.

A.11.5.2.20 The FLUSH CACHE EXT command is supported

If The FLUSH CACHE EXT command is supported is set to one, then the FLUSH CACHE EXT command is supported.

A.11.5.2.21 The DCO feature set is supported

If The DCO feature set is supported is set to one, then the DCO feature set is supported.

A.11.5.2.22 The 48-bit Address feature set is supported

If The 48-bit Address feature set is supported is set to one, then the 48-bit Address feature set is supported.

A.11.5.2.23 The SET MAX security extension is supported

If The SET MAX security extension is supported is set to one, then the HPA Security Extensions (see 4.11.2) are supported.

Editor’s Note 20: f10203r0-Obsolete HPA appears to have missed the fact that this subclause needs to be deleted.

A.11.5.2.24 SET FEATURES subcommand is required to spin-up after power-up

If SET FEATURES subcommand is required to spin-up after power-up is set to one, then the device requires the SET FEATURES subcommand to spin-up after power-up if the PUIS feature set is enabled (see 7.45.8).

A.11.5.2.25 The PUIS feature set is supported

If The PUIS feature set is supported is set to one, then the PUIS feature set is supported.

A.11.5.2.26 The APM feature set is supported

If The APM feature set is supported is set to one, then the APM feature set is supported.

A.11.5.2.27 The CFA feature set is supported

If The CFA feature set is supported is set to one, then the CFA feature set is supported.

A.11.5.2.28 The DOWNLOAD MICROCODE command is supported

If The DOWNLOAD MICROCODE command is supported is set to one, then the DOWNLOAD MICROCODE command is supported.

A.11.5.2.29 The IDLE IMMEDIATE command with UNLOAD feature is supported

If The IDLE IMMEDIATE command with UNLOAD feature is supported is set to one, then the IDLE IMMEDIATE command with unload feature is supported.

A.11.5.2.30 The WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported

If The 48-bit Address feature set is supported is set to one, then The WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported shall be set to one to indicate that the WRITE DMA FUA EXT command and WRITE MULTIPLE FUA EXT command are supported. If The 48-bit Address feature set is supported is cleared to zero, then The WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported shall be cleared to zero.

A.11.5.2.31 The GPL feature set is supported

If The GPL feature set is supported is set to one, then the GPL feature set is supported.

A.11.5.2.32 The Streaming feature set is supported

If The Streaming feature set is supported is set to one, then the Streaming feature set is supported.

A.11.5.2.33 Media serial number is supported

Editor's Note 21: Not sure we need this bit.

If Media serial number is supported is set to one, then the Current media serial number field (see A.11.7.6) is supported.

A.11.5.2.34 The SMART self-test is supported

If The SMART self-test is supported is set to one, SMART self-test is supported. This bit is valid if The SMART feature set is supported (see A.11.5.2.19) is set to one indicating that the SMART feature set is supported.

A.11.5.2.35 SMART error logging is supported

If SMART error logging is supported is set to one, SMART error logging is supported. This bit is valid if The SMART feature set is supported (see A.11.5.2.19) is set to one indicating that the SMART feature set is supported.

A.11.5.2.36 Extended Power Conditions feature set is supported

If Extended Power Conditions feature set is supported is set to one, then the Extended Power Conditions feature is supported (see 7.45.18).

A.11.5.2.37 Sense Data Reporting feature set is supported

If Sense Data Reporting feature set is supported is set to one, then the Sense Data Reporting feature set is supported.

A.11.5.2.38 The Free-fall Control feature set is supported

If The Free-fall Control feature set is supported is set to one, then the Free-fall Control feature set is supported.

A.11.5.2.39 The DOWNLOAD MICROCODE command with mode 3 is supported

If The DOWNLOAD MICROCODE command with mode 3 is supported is set to one, then the DOWNLOAD MICROCODE command and DOWNLOAD MICROCODE DMA command requesting the offset transfer method is supported.

A.11.5.2.40 The READ LOG DMA EXT and WRITE LOG DMA EXT commands are supported

If The READ LOG DMA EXT and WRITE LOG DMA EXT commands are supported is set to one, then the READ LOG DMA EXT command and WRITE LOG DMA EXT command are supported. This bit shall only be set to one if The GPL feature set is supported (see A.11.5.2.31) is set to one.

A.11.5.2.41 The WRITE UNCORRECTABLE EXT command is supported

If The WRITE UNCORRECTABLE EXT command is supported is set to one, then the WRITE UNCORRECTABLE EXT command is supported.

A.11.5.2.42 The Write-Read-Verify feature set is supported

If The Write-Read-Verify feature set is supported is set to one, then the Write-Read-Verify feature set is supported.

A.11.5.3 DOWNLOAD MICROCODE Capabilities

A.11.5.3.1 Subcommands 0Eh and 0Fh are supported

If Subcommands 0Eh and 0Fh are supported is set to one, then:

a) if the DOWNLOAD MICROCODE command is supported (i.e., The DOWNLOAD MICROCODE command is supported (see A.11.5.2.28) is set to one), then the device supports subcommands 0Eh and 0Fh (see 7.11.2.4 and 7.11.2.5) of the DOWNLOAD MICROCODE command; and
b) if the DOWNLOAD MICROCODE DMA command is supported (i.e., DOWNLOAD MICROCODE DMA is supported (see A.11.5.2.9) is set to one), then the device supports subcommands 0Eh and 0Fh (see 7.11.2.4 and 7.11.2.5) of the DOWNLOAD MICROCODE DMA command.

A.11.5.3.2 Subcommand 07h is supported

If Subcommand 07h is supported is set to one, then:

a) if the DOWNLOAD MICROCODE command is supported (i.e., The DOWNLOAD MICROCODE command is supported (see A.11.5.2.28) is set to one), then the device supports subcommand 07h (see 7.11.2.3) of the DOWNLOAD MICROCODE command; and
b) if the DOWNLOAD MICROCODE DMA command is supported (i.e., DOWNLOAD MICROCODE DMA is supported (see A.11.5.2.9) is set to one), then the device supports subcommand 07h (see 7.11.2.3) of the DOWNLOAD MICROCODE DMA command.

A.11.5.3.3 Subcommand 03h is supported

If Subcommand 03h is supported is set to one, then:

a) if the DOWNLOAD MICROCODE command is supported (i.e., The DOWNLOAD MICROCODE command is supported (see A.11.5.2.28) is set to one), then the device supports subcommand 03h (see 7.11.2.2) of the DOWNLOAD MICROCODE command; and
b) if the DOWNLOAD MICROCODE DMA command is supported (i.e., DOWNLOAD MICROCODE DMA is supported (see A.11.5.2.9) is set to one), then the device supports subcommand 03h (see 7.11.2.2) of the DOWNLOAD MICROCODE DMA command.

A.11.5.3.4 Maximum number of 512-byte data blocks per DOWNLOAD MICROCODE command mode 03h

Maximum number of 512-byte data blocks per DOWNLOAD MICROCODE command mode 03h contains the minimum number of 512-byte data blocks per Download Microcode mode 3 operation that the ATA device accepts when using the offset transfer method (see 7.11). This word is valid if The DOWNLOAD MICROCODE command is supported (see A.11.5.2.28) and The DOWNLOAD MICROCODE command with mode 3 is supported (see A.11.5.2.39) are set to one (i.e., the DOWNLOAD MICROCODE command and DOWNLOAD

MICROCODE DMA command using the offset transfer method is supported). The values 0000h and FFFFh indicate no minimum is specified (i.e., that there is no minimum number of 512-byte data blocks).

Editor's Note 22: Since word 86 bit 0 is a copy of word 83 bit 0, the condition makes no sense. Removed the requirement of checking bit 0 of word 86 in both the minimum and maximum settings. Since Bit 4 of word 120 is a copy of bit 4 of word 119, used bit 4 of word 119 instead.

A.11.5.3.5 Minimum number of 512-byte data blocks per DOWNLOAD MICROCODE command mode 03h

Minimum number of 512-byte data blocks per DOWNLOAD MICROCODE command mode 03h contains the maximum number of 512-byte data blocks per Download Microcode mode 3 operation that the ATA device shall accept when using the offset transfer method (see 7.11). This word is valid if The DOWNLOAD MICROCODE command is supported (see A.11.5.2.28) and The DOWNLOAD MICROCODE command with mode 3 is supported (see A.11.5.2.39) are set to one (i.e., the DOWNLOAD MICROCODE command and DOWNLOAD MICROCODE DMA command using the offset transfer method is supported). The values 0000h and FFFFh indicate no maximum is specified (i.e., that there is no maximum number of 512-byte data blocks)

A.11.5.4 Nominal Media Rotation Rate

The Nominal Media Rotation Rate indicates the nominal media rotation rate of the device and is defined in table A.31.

Table A.31 — Nominal Media Rotation Rate

Value	Description
0000h	Rate not reported
0001h	Non-rotating media (e.g., solid state device)
0002h-0400h	Reserved
0401h-FFFEh	Nominal media rotation rate in rotations per minute (rpm) (e.g., 7 200 rpm = 1C20h)
FFFFh	Reserved

A.11.5.5 Nominal Form Factor

The Nominal Form Factor indicates the nominal form factor of the device and is defined in table A.32.

Table A.32 — Device Nominal Form Factor

Value	Description
0h	Nominal form factor not reported
1h	5.25 inch nominal form factor
2h	3.5 inch nominal form factor
3h	2.5 inch nominal form factor
4h	1.8 inch nominal form factor
5h	Less than 1.8 inch nominal form factor
6h..Fh	Reserved

A.11.5.6 Write-Read-Verify Sector Count Mode 3

The Write-Read-Verify Sector Count Mode 3 shall indicate the number of logical sectors to be verified after every spin-up, if Write-Read-Verify feature set mode 3 is selected (i.e., Current mode of the Write-Read-Verify feature set (see A.11.6.3.2) is 03h). This field is valid if The Write-Read-Verify feature set is enabled (see A.11.6.2.15) is set to one and Current mode of the Write-Read-Verify feature set (see A.11.6.3.2) is 03h.

A.11.5.7 Write-Read-Verify Sector Count Mode 2

The Write-Read-Verify Sector Count Mode 2 shall indicate the number of logical sectors to be verified after every spin-up, when Write-Read-Verify feature set mode 2 is selected (i.e., Current mode of the Write-Read-Verify feature set (see A.11.6.3.2) is 02h). These words are valid if The Write-Read-Verify feature set is enabled (see A.11.6.2.15) is set to one.

Editor's Note 23: This says that these words are valid even when mode 2 is not selected. Was this intended to be different than mode 3?

A.11.5.8 World Wide Name

The World Wide Name contains a mandatory World Wide Name (WWN) in the NAA IEEE Registered identifier format.

Editor's Note 24: This section needs reworking. I think it should be done in terms of the 64 bits, but they need to be laid out properly.

Word 108 bits (15:12) shall contain 5h.

Word 108 bits (11:0) and word 109 bits (15:4) shall contain the OUI (i.e., company ID) for the device manufacturer assigned by the IEEE.

Word 109 bits (3:0), word 110, and word 111 shall contain a value assigned by the vendor that is unique for the device in the OUI domain.

The IDENTIFY DEVICE data World Wide Name field is shown by word number in table A.33.

Table A.33 — IDENTIFY DEVICE data World Wide Name field (word-based view)

Word	Bit number within each word															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
108	NAA (5h)				bit 23 (MSB)			IEEE OUI								bit 12
109	bit 11											(LSB) bit 0	bit 35 (MSB)			bit 32
110	bit 31						Unique ID									bit 16
111	bit 15															(LSB) bit 0

The World Wide Name field is shown by byte number in table A.34.

Table A.34 — IDENTIFY DEVICE data World Wide Name field (byte-based view)

Word	Offset	Bit number within each byte							
		7	6	5	4	3	2	1	0
108	216	bit 19			IEEE OUI				bit 12
	217	NAA (5h)				bit 23 (MSB)			bit 20
109	218	bit 3			(LSB) bit 0	bit 35 (MSB)		Unique ID	bit 32
	219	bit 11			IEEE OUI				bit 4
110	220	bit 23			Unique ID				bit 16
	221	bit 31							bit 24
111	222	bit 7							(LSB) bit 0
	223	bit 15							bit 8

A.11.5.9 DATA SET MANAGEMENT

A.11.5.9.1 Trim

If Trim is set to one, then the device supports the Trim bit of the DATA SET MANAGEMENT command. See 7.16.7.30 and 7.9.3.2 for reporting Trim methods.

If Trim is cleared to zero, then the Trim bit in the DATA SET MANAGEMENT command is not supported and:

a) word 105 is reserved;
b) bit 5 of word 69 is reserved; and
c) Deterministic read after TRIM is supported (see A.11.5.2.3) is reserved.

A.11.6 Current Settings (page 04h)

A.11.6.1 Overview

The Current Settings log page (see table A.35) provides a mechanism for the device to report the current settings for feature sets, features, and other device capabilities.

Table A.35 — Current Settings (Sheet 1 of 3)

Offset	Type	Content	
0..7	QWord	Current Settings page information header.	
		Bit	**Meaning**
		63	Shall be set to one.
		62:24	Reserved
		23:16	Page Number. Shall be set to 04h.
		15:0	Revision number. Shall be set to 0001h

Table A.35 — Current Settings (Sheet 2 of 3)

Offset	Type	Content	
8..15	QWord	Current Settings	
		Bit	**Meaning**
		63	Shall be set to one.
		62:16	Reserved
		15	The EPC feature set is enabled
		14	8-bit PIO data transfers are enabled
		13	Volatile write cache is enabled
		12	CFA Power Mode 1 is enabled
		11	Reverting to defaults is enabled
		10	Sense Data Reporting is enabled
		9	the EPC feature set is enabled
		8	All write cache is nonvolatile
		7	Read look-ahead is enabled
		6	The SMART feature set is enabled
		5	The AAM feature set is enabled
		4	the SET MAX security extension is enabled
		3	The PUIS feature set is enabled
		2	The APM feature set is enabled
		1	The Free-fall Control feature set is enabled
		0	The Write-Read-Verify feature set is enabled
16..23	QWord	Feature Settings	
		Bit	**Meaning**
		63	Contents of the QWord are valid
		62:16	reserved
			Set Transfer Mode
		15:8	APM Level (see table 55, APM levels) [was word 91]
		7:0	Current mode of the Write-Read-Verify feature set (see A.11.6.3.2) [was word 220]
24..31	QWord	DMA Host Interface Sector Times [was word 96, name change matches SET FEATURES description]	
		Bit	**Meaning**
		63	Contents of the QWord are valid
		62:16	Reserved
		15:0	Host Interface Sector Times
32..39	QWord	PIO Host Interface Sector Times [was word 104 name change matches SET FEATURES description]	
		Bit	**Meaning**
		63	Contents of the QWord are valid
		62:16	Reserved
		15:0	Host Interface Sector Times

Table A.35 — Current Settings (Sheet 3 of 3)

Offset	Type	Content
40..47	QWord	Streaming minimum request size [was word 95]
		Bit **Meaning** 63 Contents of the QWord are valid 62:16 Reserved 15:0 Streaming minimum request size
48..55	QWord	Streaming access latency [was word 97]
		Bit **Meaning** 63 Contents of the QWord are valid 62:16 Reserved 15:0 Streaming access latency
56..63		Streaming Performance Granularity [was word 98]
		Bit **Meaning** 63 Contents of the QWord are valid 62:32 Reserved 31:0 Streaming Performance Granularity
64..71		Free-fall Control Sensitivity [was word 53]
		Bit **Meaning** 63 Contents of the QWord are valid 62:16 Reserved 7:0 Free-fall Control Sensitivity
72..79		Device Maintenance Schedule
		Bit **Meaning** 63:48 Reserved 47:32 Time scheduled for device maintenance (see A.11.6.10.1) 31:16 Time to performance degradation (see A.11.6.10.2) 15:0 Minimum inactive time (see A.11.6.10.3)
80..511		Reserved

A.11.6.2 Current Settings

A.11.6.2.1 Overview

Current Settings indicate features, feature sets and command sets that are enabled. If a defined bit is cleared to zero, the indicated features, feature sets and command sets are not enabled.

A.11.6.2.2 The EPC feature set is enabled

If The EPC feature set is enabled is set to one, then the EPC feature set is enabled (see 7.45.18.6). If The EPC feature set is enabled is cleared to zero, then the EPC feature set is disabled (see 7.45.18.7).

A.11.6.2.3 8-bit PIO data transfers are enabled

Editor’s Note 25: new text

If 8-bit PIO data transfers are enabled is set to one, then 8-bit PIO data transfers are enabled (see 7.45.3). Otherwise, 8-bit PIO data transfers are disabled.

A.11.6.2.4 Volatile write cache is enabled

If Volatile write cache is enabled is set to one, then volatile write cache is enabled (see 7.45.4). If Volatile write cache is enabled is cleared to zero, then volatile write cache is disabled. This bit is valid if The volatile write cache is supported (see A.11.5.2.18) is set to one indicating write cache is supported.

A.11.6.2.5 CFA Power Mode 1 is enabled

Editor's Note 26: new text. This one seems strange because both modes have power constraints but neither appears to be the default.

If CFA Power Mode 1 is enabled is set to one, then CFA Power Mode 1 is enabled (see 7.45.9). If CFA Power Mode 1 is enabled is set to zero, then CFA Power Mode 0 is enabled. This bit is valid if The CFA feature set (see A.11.5.2.27) is supported is set to one.

A.11.6.2.6 Reverting to defaults is enabled

Editor's Note 27: new text

If Reverting to defaults is enabled is set to one, then Reverting to defaults is enabled (see 7.45.13). Otherwise, Reverting to defaults is disabled.

A.11.6.2.7 Sense Data Reporting is enabled

If Sense Data Reporting is enabled is set to one, then the Sense Data Reporting feature set is enabled.

A.11.6.2.8 All write cache is nonvolatile

The Nonvolatile Write Cache bit shall be set to one if all of the write cache on the device is nonvolatile. The Nonvolatile Write Cache bit shall be set to zero if the write cache may be volatile.

Editor's Note 28: If write cache is disabled we need to say something … (e.g., the Nonvolatile Write Cache bit shall be set to one)

NOTE 26 — A nonvolatile write cache is independent of the NV Cache Feature Set

A.11.6.2.9 Read look-ahead is enabled

If Read look-ahead is enabled is set to one, then read look-ahead is enabled (see 7.45.12). If Read look-ahead is enabled is cleared to zero, then read look-ahead is disabled. This bit is valid if bit 6 of word 82 is set to one indicating read look-ahead is supported.

A.11.6.2.10 The SMART feature set is enabled

If The SMART feature set is enabled is set to one, then the SMART feature set is enabled (see 7.48.4). If The SMART feature set is enabled is cleared to zero, then the SMART feature set is disabled (see 7.48.2). This bit is valid if The SMART feature set is supported (see A.11.5.2.19) is set to one indicating SMART feature set is supported.

A.11.6.2.11 The SET MAX security extension is enabled

If The SET MAX security extension is enabled is set to one, then the HPA Security Extensions are enabled (see 7.50.5). This bit is valid if The SET MAX security extension is supported (see A.11.5.2.23) is set to one indicating the HPA Security Extensions are supported.

Editor's Note 29: f10203r0-Obsolete HPA appears to have missed the fact that this subclause needs to be deleted.

A.11.6.2.12 The PUIS feature set is enabled

If The PUIS feature set is enabled is set to one, then the PUIS feature set is enabled (see 7.45.7). If The PUIS feature set is enabled is cleared to zero, then the PUIS feature set is disabled. This bit is valid if The PUIS feature set is supported (see A.11.5.2.25) is set to one indicating PUIS feature set is supported.

A.11.6.2.13 The APM feature set is enabled

If The APM feature set is enabled is set to one, then the APM feature set is enabled (see 7.45.6). If The APM feature set is enabled is cleared to zero, the APM feature set is disabled.

A.11.6.2.14 The Free-fall Control feature set is enabled

If The Free-fall Control feature set is enabled is set to one, then the Free-fall Control feature set is enabled. If The Free-fall Control feature set is enabled is cleared to zero, then the Free-fall Control feature set is disabled.

A.11.6.2.15 The Write-Read-Verify feature set is enabled

If The Write-Read-Verify feature set is enabled is set to one, then the Write-Read-Verify feature set is enabled. If The Write-Read-Verify feature set is enabled is cleared to zero, then the Write-Read-Verify feature set is disabled.

A.11.6.3 Feature Settings

A.11.6.3.1 APM Level

APM Level contains the current APM level setting (see table 93). Support of this word is mandatory if the APM feature set is supported. This word is valid if the APM feature set is supported (see A.11.5.2.26) is set to one and the APM feature set is enabled (see A.11.6.2.13) is set to one.

A.11.6.3.2 Current mode of the Write-Read-Verify feature set

The Current mode of the Write-Read-Verify feature set contains the current mode of the Write-Read-Verify feature set, as set by the SET FEATURES Enable/Disable Write-Read-Verify subcommand. See 7.45.10 for more information on setting Write-Read-Verify mode.

A.11.6.4 DMA Host Interface Sector Times

DMA Host Interface Sector Times defines the Streaming Transfer Time for DMA mode. The worst-case sustainable transfer time per logical sector for the device is calculated as follows:

$$\text{Worst Case Sustainable Transfer Time} = \frac{x \times y}{65\,536}$$

Where:

x = Streaming Performance Granularity (see A.11.6.8); and
y = Streaming Transfer Time for DMA mode.

The content of DMA Host Interface Sector Times may be affected by the host issuing a Set Maximum Host Interface Sector Times (see 7.45.11). As a result, the host should issue an IDENTIFY DEVICE command after issuing a SET FEATURES command that may affect this word. If the Streaming feature set is not supported by the device, then the content of DMA Host Interface Sector Times shall be zero.

This word is valid if The Streaming feature set is supported (see A.11.5.2.32) is set to one indicating that the Streaming feature set is supported.

Editor's Note 30: Streaming minimum request size has this extra statement: "If the Streaming feature set is not supported by the device, then the content of Streaming minimum request size shall be zero" should this be here as well?

A.11.6.5 PIO Host Interface Sector Times [was word 104 name change matches SET FEATURES description]

PIO Host Interface Sector Times defines the Streaming Transfer Time for PIO mode. The worst-case sustainable transfer time per logical sector for the device is calculated as follows:

$$\text{Worst Case Sustainable Transfer Time} = \frac{x \times y}{65\ 536}$$

Where:

x = Streaming Performance Granularity (see A.11.6.8); and
y = Streaming Transfer Time for PIO mode.

The content of PIO Host Interface Sector Times may be affected by the host issuing a Set Maximum Host Interface Sector Times (see 7.45.11). As a result, the host should issue an IDENTIFY DEVICE command after issuing a SET FEATURES command that may affect this word. If the Streaming feature set is not supported by the device, then the content of PIO Host Interface Sector Times shall be zero.

This word is valid if The Streaming feature set is supported (see A.11.5.2.32) is set to one indicating that the Streaming feature set is supported.

Editor's Note 31: Streaming minimum request size has this extra statement: "If the Streaming feature set is not supported by the device, then the content of Streaming minimum request size shall be zero" should this be here as well?

A.11.6.6 Streaming minimum request size

Streaming minimum request size contains the 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. The starting LBA value for each streaming command should be evenly divisible by this request size. This word is valid if The Streaming feature set is supported (see A.11.5.2.32) is set to one, indicating that the Streaming feature set is supported. If the Streaming feature set is not supported by the device, then the content of Streaming minimum request size shall be zero.

A.11.6.7 Streaming access latency [was word 97]

Streaming access latency 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:

$$\text{Worst Case Access Latency} = \frac{x \times y}{256}$$

Where:

x = Streaming Performance Granularity (see A.11.6.8); and
y = Streaming Access Latency for DMA and PIO mode.

Editor's Note 32: Need to modify this type of advice to use the log…

The host should issue an IDENTIFY DEVICE command after issuing a SET FEATURES command that may affect this word. If the Streaming feature set is not supported by the device, then the content of Streaming access latency shall be zero.

This word is valid if The Streaming feature set is supported (see A.11.5.2.32) is set to one.

A.11.6.8 Streaming Performance Granularity [was word 98]

Streaming Performance Granularity defines the fixed unit of time that is used in DMA Host Interface Sector Times (see A.11.6.4), PIO Host Interface Sector Times (see A.11.6.5) and Streaming access latency (see A.11.6.6), SET FEATURES subcommand Set Maximum Host Interface Sector Times (see 7.45.11), 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 10 000 indicates 10 milliseconds). If yy was returned by the ATA device as the Streaming Performance Granularity, then:

a) the Command Completion Time Limit in the Feature field for a streaming command shall be yy microseconds;
b) the Streaming Transfer Time shall be:
   A) ((DMA Host Interface Sector Times (see A.11.6.4)) * (yy / 65 536)) microseconds; or
   B) ((PIO Host Interface Sector Times (see A.11.6.5)) * (yy / 65 536)) microseconds;
c) the Streaming Access Latency shall be ((Streaming access latency (see A.11.6.6)) * (yy / 256)) microseconds; and
d) taking these units into account, the host may calculate the estimated time for a streaming command of size S logical sectors as:
   A) for PIO (((PIO Host Interface Sector Times (see A.11.6.5)) * S / 65 536) + ((Streaming access latency (see A.11.6.6))/ 256)) * yy microseconds; or
   B) for DMA (((DMA Host Interface Sector Times (see A.11.6.4)) * S / 65 536) + ((Streaming access latency (see A.11.6.6)) / 256)) * yy microseconds.

The value of the Streaming Performance Granularity is vendor specific and fixed for a device.

This word is valid if The Streaming feature set is supported (see A.11.5.2.32) is set to one.

A.11.6.9 Free-fall Control Sensitivity

Editor's Note 33: This needs formalizing

00h = Vendors recommended setting

01h..FFh = sensitivity level. A larger number is more sensitive

A.11.6.10 Device Maintenance Schedule

A.11.6.10.1 Time scheduled for device maintenance

The device shall set the Time scheduled for device maintenance field to the number of cumulative seconds that the host should avoid sending commands. This field indicates the total number of seconds that the device is requesting for internal maintenance.

A.11.6.10.2 Time to performance degradation

The device shall set the Time to performance degradation field to the estimated number of minutes until performance degradation may occur due to insufficient idle time to perform internal maintenance. This field indicates the minimum number of minutes before the device may begin performance degrading internal maintenance.

A.11.6.10.3 Minimum inactive time

The device shall set the Minimum inactive time field to the minimum number of continuous seconds that the host should avoid sending commands. This field indicates the minimum number of seconds that the device requires to make progress on internal maintenance.

A.11.7 Strings (page 05h)

A.11.7.1 Overview

The Strings log page (see table A.36) provides a mechanism for the device to report ATA String based information.

Table A.36 — Strings

Offset	Type	Content
0..7	QWord	Strings page information header.
		Bit **Meaning** 63 Shall be set to one. 62:24 Reserved 23:16 Page Number. Shall be set to 05h. 15:0 Revision number. Shall be set to 0001h
8..17	ATA String	Serial number [was 10-19]
18..23		Reserved
24..27	ATA String	Firmware revision [was 23-26]
28..31		Reserved
32..51	ATA String	Model number [was 27-46]
52..55		Reserved
56..59	ATA String	Additional Product Identifier [was 170-173]
60..63		Reserved
64..93	ATA String	Current media serial number [was 176-205]
94..511		Reserved

A.11.7.2 Serial number

Serial number contains the serial number of the device. The contents of this field is an ATA string of twenty bytes in the format defined by 3.3.10. The device shall pad the string with spaces (i.e., 20h), if necessary, to ensure that the string is the proper length. The combination of Serial number and Model number (see A.11.7.4) shall be unique for a given manufacturer.

A.11.7.3 Firmware revision

Firmware revision contains the firmware revision of the device. The contents of this field is an ATA string of eight bytes in the format defined by 3.3.10. The device shall pad the string with spaces (20h), if necessary, to ensure that the string is the proper length.

A.11.7.4 Model number

Model number contains the model number of the device. The contents of this field is an ATA string of forty bytes in the format defined by 3.3.10. The device shall pad the string with spaces (i.e., 20h), if necessary, to ensure that the string is the proper length. The combination of Serial number (see A.11.7.2) and Model number shall be unique for a given manufacturer.

A.11.7.5 Additional Product Identifier

Additional Product Identifier contains the Additional Product Identifier. The contents of this field is an ATA string of eight bytes in the format defined by 3.3.10. The device shall pad the string with spaces (i.e., 20h), if necessary, to ensure that the string is the proper length. If the Additional Product Identifier is not present, then this field is reserved.

A.11.7.6 Current media serial number

Current media serial number contains the current media serial number. Media serial numbers shall be an ATA string of 60 bytes in the format defined by 3.3.10. The first 40 bytes shall indicate the media serial number and the remaining 20 bytes shall indicate the media manufacturer.

Editor’s Note 34: Should there be a statement like: If the Current media serial number is not present, then this field is zero?

A.11.8 Security (page 06h)

A.11.8.1 Overview

Editor’s Note 35: Would it make sense just to state that if this page is preset the devices supports security and eliminate the bit from the supported list?

The Security log page (see table A.37) provides a mechanism for the device to report Security based information.

Table A.37 — Security (Sheet 1 of 3)

Offset	Type	Content
0..7	QWord	Security page information header. **Bit** **Meaning** 63 Shall be set to one. 62:24 Reserved 23:16 Page Number. Shall be set to 06h. 15:0 Revision number. Shall be set to 0001h
8..15	QWord	Master Password Identifier [was word 92] **Bit** **Meaning** 63 Contents of the QWord are valid. 62:16 Reserved 15:0 Master Password Identifier

Table A.37 — Security (Sheet 2 of 3)

Offset	Type	Content
16..23	QWord	Security Status [was word 128]
		Bit **Meaning** 63 Contents of the QWord are valid 62:7 Reserved 6 The Security feature set is supported (see A.11.8.3.1) 5 Master Password Capability (see A.11.8.3.2) 4 Enhanced security erase supported (see A.11.8.3.3) 3 Security count expired (see A.11.8.3.4) 2 Security frozen (see A.11.8.3.5) 1 Security locked (see A.11.8.3.6) 0 Security enabled (see A.11.8.3.7)
24..31	QWord	Time required for an Enhanced Erase mode SECURITY ERASE UNIT command [was word 89]
		Bit **Meaning** 63 Contents of the QWord are valid 62:8 Reserved 7:0 Time required for an Enhanced Erase mode SECURITY ERASE UNIT command Editor’s Note 36: Could change to 16 bits, but ranges are currently documented in text.
32..39	QWord	Time required for a Normal Erase mode SECURITY ERASE UNIT command [was word 90]
		Bit **Meaning** 63 Contents of the QWord are valid 62:8 Reserved 7:0 Time required for Normal Erase mode SECURITY ERASE UNIT command Editor’s Note 37: Could change to 16 bits, but ranges are currently documented in text.
40..47		Trusted Computing feature set [was word 48]
		Bit **Meaning** 63 Contents of the QWord are valid 62:1 Reserved 0 Trusted Computing feature set is supported

Table A.37 — Security (Sheet 3 of 3)

<table>
<tr><th>Offset</th><th>Type</th><th>Content</th></tr>
<tr><td>48..55</td><td></td><td>Security Capabilities [word 59 and word 69]
<table>
<tr><th>Bit</th><th>Meaning</th></tr>
<tr><td>63</td><td>Contents of the QWord are valid</td></tr>
<tr><td>62:5</td><td>Reserved</td></tr>
<tr><td>4</td><td>BLOCK ERASE EXT command is supported</td></tr>
<tr><td>3</td><td>OVERWRITE EXT command is supported</td></tr>
<tr><td>2</td><td>CRYPTO SCRAMBLE EXT command is supported</td></tr>
<tr><td>1</td><td>Sanitize Device feature set is supported</td></tr>
<tr><td>0</td><td>Device Encrypts All User Data</td></tr>
</table></td></tr>
<tr><td>56..511</td><td></td><td>Reserved</td></tr>
</table>

A.11.8.2 Master Password Identifier

If the Security feature set is not supported (See x.x.x.x) or the Master Password Identifier feature is not supported, then Master Password Identifier shall contain 0000h or FFFFh.

If the Security feature set and the Master Password Identifier feature are supported, then the Master Password Identifier contains the value of the Master Password Identifier set when the Master Password was last changed.

A.11.8.3 Security Status

A.11.8.3.1 The Security feature set is supported

If The Security feature set is supported is set to one, then the Security feature set is supported.

A.11.8.3.2 Master Password Capability

Master Password Capability indicates the Master Password Capability. If security is enabled and the Master Password Capability is high, then Master Password Capability shall be cleared to zero. If security is enabled and the Master Password Capability is maximum, the Master Password Capability shall be set to one. If security is disabled, then Master Password Capability shall be cleared to zero.

A.11.8.3.3 Enhanced security erase supported

If Enhanced security erase supported is set to one, then the enhanced mode of the SECURITY ERASE UNIT command is supported.

A.11.8.3.4 Security count expired

If Security count expired (i.e., Password Attempt Counter Exceeded bit) is set to one, then the password attempt counter has decremented to zero.

A.11.8.3.5 Security frozen

If Security frozen is set to one, then security is frozen.

A.11.8.3.6 Security locked

If Security locked is set to one, then security is locked.

A.11.8.3.7 Security enabled

Editor's Note 38: There were 2 versions of security enabled, one in word 85 and the other in word 128. Placed the word 85 description here because it is much more descriptive.

If Security enabled is set to one, then security has been enabled by setting a User password via the SECURITY SET PASSWORD command. If Security enabled is cleared to zero, then there is no valid User password. If the Security feature set is not supported, then this bit shall be cleared to zero. This bit is valid if bit 1 of word 82 is set to one indicating Security feature set is supported.

A.11.8.4 Time required for an Enhanced Erase mode SECURITY ERASE UNIT command

Time required for an Enhanced Erase mode SECURITY ERASE UNIT command specifies the estimated time required for the SECURITY ERASE UNIT command to complete its enhanced mode erasure as follows:

a) if bit 15 is cleared to zero, then the estimated time is defined in table A.38; and
b) if bit 15 is set to one, then the estimated time is defined in table A.39.

Support of this word is mandatory if support of the Security feature set is supported (see 4.16). If the Security feature set is not supported, this word shall be cleared to zero.

Table A.38 — Enhanced Erase Mode Time

Value	Time
0	Value not specified
1..254	(Value*2) minutes
255	>508 minutes

Table A.39 — Extended Enhanced Erase Mode Time

Value	Time
0	Value not specified
1..32766	(Value*2) minutes
32767	>65532 minutes

A.11.8.5 Time required for a Normal Erase mode SECURITY ERASE UNIT command

Time required for a Normal Erase mode SECURITY ERASE UNIT command specifies the estimated time required for the SECURITY ERASE UNIT command to complete its normal mode erasure as follows:

a) if bit 15 is cleared to zero, then the estimated time is defined in table A.40; and
b) if bit 15 is set to one, then the estimated time is defined in table A.41.

Support of this word is mandatory if the Security feature set is supported (see 4.16). If the Security feature set is not supported, this word shall be cleared to zero.

Table A.40 — Normal Erase Mode Time

Value	Time
0	Value not specified
1..254	(Value*2) minutes
255	>508 minutes

Table A.41 — Extended Normal Erase Mode Time

Value	Time
0	Value not specified
1..32766	(Value*2) minutes
32767	>65532 minutes

A.11.8.6 Trusted Computing feature set

If Trusted Computing feature set is set to one, then the Trusted Computing feature set is supported.

A.11.8.7 Security Capabilities

A.11.8.7.1 BLOCK ERASE EXT command is supported

If BLOCK ERASE EXT command is supported is set to one, then the device supports the Sanitize Device feature set BLOCK ERASE EXT command (see 7.38.2).

A.11.8.7.2 OVERWRITE EXT command is supported

If OVERWRITE EXT command is supported is set to one, then the device supports the Sanitize Device feature set OVERWRITE EXT command (see 7.38.4).

A.11.8.7.3 CRYPTO SCRAMBLE EXT command is supported

If CRYPTO SCRAMBLE EXT command is supported is set to one, then the device supports the Sanitize Device feature set CRYPTO SCRAMBLE EXT command (see 7.38.3).

A.11.8.7.4 Sanitize Device feature set is supported

If Sanitize Device feature set is supported is set to one the device supports the Sanitize Device feature set.

A.11.8.7.5 Device Encrypts All User Data

If Device Encrypts All User Data is set to one the device encrypts all user data. If Device Encrypts All User Data is cleared to zero the device may not encrypt all user data.

NOTE 27 — This standard does not provide a method to cryptographically authenticate the state of Device Encrypts All User Data.

A.11.9 Parallel ATA (page 07h)

A.11.9.1 Overview

The Parallel ATA log page (see table A.42) provides information about the Parallel ATA Transport.

Table A.42 — Parallel ATA (Sheet 1 of 3)

Offset	Type	Content	
0..7	QWord	Parallel ATA page information header.	
		Bit	**Meaning**
		63	Shall be set to one.
		62:24	Reserved
		23:16	Page Number. Shall be set to 07h.
		15:0	Revision number. Shall be set to 0001h

Table A.42 — Parallel ATA (Sheet 2 of 3)

Offset	Type	Content	
8..15	QWord	Parallel ATA Capabilities [was 49, 63, 88, 93]	
		Bit	**Meaning**
		63	Shall be set to one
		62:39	Reserved
		38	IORDY supported
		37	IORDY may be disabled
		36	DMA supported
		35	Multiword DMA mode 2 is selected
		34	Multiword DMA mode 1 is selected
		33	Multiword DMA mode 0 is selected
		32	Multiword DMA mode 2 and below are supported
		31	Multiword DMA mode 1 and below are supported
		30	Multiword DMA mode 0 is supported
		29	Ultra DMA mode 6 is selected
		28	Ultra DMA mode 5 is selected
		27	Ultra DMA mode 4 is selected
		26	Ultra DMA mode 3 is selected
		25	Ultra DMA mode 2 is selected
		24	Ultra DMA mode 1 is selected
		23	Ultra DMA mode 0 is selected
		22	Ultra DMA mode 6 and below are supported
		21	Ultra DMA mode 5 and below are supported
		20	Ultra DMA mode 4 and below are supported
		19	Ultra DMA mode 3 and below are supported
		18	Ultra DMA mode 2 and below are supported
		17	Ultra DMA mode 1 and below are supported
		16	Ultra DMA mode 0 is supported
		15:0	Hardware result
16..23	QWord	PIO Modes Supported [was word 64]	
		Bit	**Meaning**
		63	Shall be set to one
		62:2	Reserved
		1	PIO Mode 4 is supported
		0	PIO Mode 3 is supported
24..31	QWord	Multiword DMA transfer cycle time [was word 65,66]	
		Bit	**Meaning**
		63	Shall be set to one
		62:32	Reserved
		31:16	Manufacturer’s recommended Multiword DMA transfer cycle time
		15:0	Minimum Multiword DMA transfer cycle time

Table A.42 — Parallel ATA (Sheet 3 of 3)

Offset	Type	Content
32..39	QWord	Minimum PIO transfer cycle time [was word 67, 68]
		Bit **Meaning** 63 Shall be set to one 62:32 Reserved 31:16 Minimum PIO transfer cycle time with IORDY flow control 15:0 Minimum PIO transfer cycle time without flow control
40..511		Reserved

A.11.9.2 Parallel ATA Capabilities

A.11.9.2.1 IORDY supported

For PATA devices, if IORDY supported is set to one, then the device supports the IORDY signal (see ATA8-APT). All PATA devices, except CFA-APT devices, shall set IORDY supported to one.

For SATA devices, IORDY supported shall be set to one.

A.11.9.2.2 IORDY may be disabled

For PATA devices, if IORDY may be disabled is set to one, then the device supports the disabling of IORDY (see ATA8-APT) via the SET FEATURES command.

For SATA devices, IORDY may be disabled shall be set to one.

A.11.9.2.3 DMA supported

If DMA supported is set to one, then the device supports the DMA data transfer protocols. All devices, except CFA-APT devices, shall set this bit to one.

A.11.9.2.4 Multiword DMA

A.11.9.2.4.1 Overview

Multiword DMA 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.

A.11.9.2.4.2 Multiword DMA mode 2 is selected

If Multiword DMA mode 2 is selected 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 Multiword DMA mode 1 is selected is set to one or Multiword DMA mode 0 is selected is set to one, then this bit shall be cleared to zero.

A.11.9.2.4.3 Multiword DMA mode 1 is selected

If Multiword DMA mode 1 is selected 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 Multiword DMA mode 2 is selected is set to one or Multiword DMA mode 0 is selected is set to one, then this bit shall be cleared to zero.

A.11.9.2.4.4 Multiword DMA mode 0 is selected

If Multiword DMA mode 0 is selected 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 Multiword DMA mode 2 is selected is set to one or Multiword DMA mode 1 is selected is set to one, then this bit shall be cleared to zero.

A.11.9.2.4.5 Multiword DMA mode 2 and below are supported

For PATA devices, if Multiword DMA mode 2 and below are supported is:

a) set to one, then Multiword DMA modes 2 and below are supported (i.e., if Multiword DMA mode 2 is supported, then Multiword DMA modes 1 and 0 shall be supported);
b) cleared to zero, then Multiword DMA mode 2 is not supported; and
c) set to one, then Multiword DMA mode 0 is supported shall be set to one and Multiword DMA mode 1 and below are supported shall be set to one.

For SATA devices, Multiword DMA mode 2 and below are supported shall be set to one.

A.11.9.2.4.6 Multiword DMA mode 1 and below are supported

For PATA devices, if Multiword DMA mode 1 and below are supported is:

a) set to one, then Multiword DMA modes 1 and below are supported (i.e., if Multiword DMA mode 1 is supported, then Multiword DMA mode 0 shall also be supported);
b) cleared to zero, then Multiword DMA mode 1 is not supported; and
c) set to one, then Multiword DMA mode 0 shall be set to one.

For SATA devices, Multiword DMA mode 1 and below are supported shall be set to one.

A.11.9.2.4.7 Multiword DMA mode 0 is supported

For PATA devices, if Multiword DMA mode 0 is supported is set to one, then Multiword DMA mode 0 is supported.

For SATA devices, Multiword DMA mode 0 is supported shall be set to one.

A.11.9.2.5 Ultra DMA

A.11.9.2.5.1 Overview

Ultra DMA 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 any Ultra DMA mode is supported.

A.11.9.2.5.2 Ultra DMA mode 6 is selected

If Ultra DMA mode 6 is selected 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 Ultra DMA mode 5 is selected or Ultra DMA mode 4 is selected or Ultra DMA mode 3 is selected or Ultra DMA mode 2 is selected or Ultra DMA mode 1 is selected or Ultra DMA mode 0 is selected is set to one, then this bit shall be cleared to zero.

A.11.9.2.5.3 Ultra DMA mode 5 is selected

If Ultra DMA mode 5 is selected 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 Ultra DMA mode 6 is selected or Ultra DMA mode 4 is selected or Ultra DMA mode 3 is selected or Ultra DMA mode 2 is selected or Ultra DMA mode 1 is selected or Ultra DMA mode 0 is selected is set to one, then this bit shall be cleared to zero.

A.11.9.2.5.4 Ultra DMA mode 4 is selected

If Ultra DMA mode 4 is selected 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 Ultra DMA mode 6 is selected or Ultra DMA mode 5 is selected or Ultra DMA mode 3 is selected or Ultra DMA mode 2 is selected or Ultra DMA mode 1 is selected or Ultra DMA mode 0 is selected is set to one, then this bit shall be cleared to zero.

A.11.9.2.5.5 Ultra DMA mode 3 is selected

If Ultra DMA mode 3 is selected 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 Ultra DMA mode 6 is selected or Ultra DMA mode 5 is selected or Ultra DMA mode 4 is selected or Ultra DMA mode 2 is selected or Ultra DMA mode 1 is selected or Ultra DMA mode 0 is selected is set to one, then this bit shall be cleared to zero.

A.11.9.2.5.6 Ultra DMA mode 2 is selected

If Ultra DMA mode 2 is selected 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 Ultra DMA mode 6 is selected or Ultra DMA mode 5 is selected or Ultra DMA mode 4 is selected or Ultra DMA mode 3 is selected or Ultra DMA mode 1 is selected or Ultra DMA mode 0 is selected is set to one, then this bit shall be cleared to zero.

A.11.9.2.5.7 Ultra DMA mode 1 is selected

If Ultra DMA mode 1 is selected 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 Ultra DMA mode 6 is selected or Ultra DMA mode 5 is selected or Ultra DMA mode 4 is selected or Ultra DMA mode 3 is selected or Ultra DMA mode 2 is selected or Ultra DMA mode 0 is selected is set to one, then this bit shall be cleared to zero.

A.11.9.2.5.8 Ultra DMA mode 0 is selected

If Ultra DMA mode 0 is selected 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 Ultra DMA mode 6 is selected or Ultra DMA mode 5 is selected or Ultra DMA mode 4 is selected or Ultra DMA mode 3 is selected or Ultra DMA mode 2 is selected or Ultra DMA mode 1 is selected is set to one, then this bit shall be cleared to zero.

A.11.9.2.5.9 Ultra DMA mode 6 and below are supported

For PATA devices if Ultra DMA mode 6 and below are supported 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:

a) Ultra DMA mode 5 and below are supported;
b) Ultra DMA mode 4 and below are supported;
c) Ultra DMA mode 3 and below are supported;
d) Ultra DMA mode 2 and below are supported;
e) Ultra DMA mode 1 and below are supported; and
f) Ultra DMA mode 0 is supported,

shall be set to one.

For SATA devices, Ultra DMA mode 6 and below are supported may be set to one.

A.11.9.2.5.10 Ultra DMA mode 5 and below are supported

For PATA devices if Ultra DMA mode 5 and below are supported 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:

a) Ultra DMA mode 4 and below are supported;
b) Ultra DMA mode 3 and below are supported;
c) Ultra DMA mode 2 and below are supported;

d) Ultra DMA mode 1 and below are supported; and
e) Ultra DMA mode 0 is supported,

shall be set to one.

For SATA devices, Ultra DMA mode 5 and below are supported shall be set to one.

A.11.9.2.5.11 Ultra DMA mode 4 and below are supported

For PATA devices if Ultra DMA mode 4 and below are supported 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:

a) Ultra DMA mode 3 and below are supported;
b) Ultra DMA mode 2 and below are supported;
c) Ultra DMA mode 1 and below are supported; and
d) Ultra DMA mode 0 is supported,

shall be set to one.

For SATA devices, Ultra DMA mode 4 and below are supported shall be set to one.

A.11.9.2.5.12 Ultra DMA mode 3 and below are supported

For PATA devices if Ultra DMA mode 3 and below are supported 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:

a) Ultra DMA mode 2 and below are supported;
b) Ultra DMA mode 1 and below are supported; and
c) Ultra DMA mode 0 is supported,

shall be set to one.

For SATA devices, Ultra DMA mode 3 and below are supported shall be set to one.

A.11.9.2.5.13 Ultra DMA mode 2 and below are supported

For PATA devices if Ultra DMA mode 2 and below are supported 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, then:

a) Ultra DMA mode 1 and below are supported; and
b) Ultra DMA mode 0 is supported,

shall be set to one.

For SATA devices, Ultra DMA mode 2 and below are supported shall be set to one.

A.11.9.2.5.14 Ultra DMA mode 1 and below are supported

For PATA devices if Ultra DMA mode 1 and below are supported 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, then Ultra DMA mode 0 is supported shall be set to one.

For SATA devices, Ultra DMA mode 1 and below are supported shall be set to one.

A.11.9.2.5.15 Ultra DMA mode 0 is supported

For PATA devices if Ultra DMA mode 0 set to one, then Ultra DMA mode 0 is supported. If this bit is cleared to zero, then Ultra DMA mode 0 is not supported.

For SATA devices, Ultra DMA mode 0 shall be set to one.

A.11.9.2.5.16 Hardware result

Editor's Note 39: Not quite sure how to integrate this. Probably should move out of here to its own qword.

A.11.9.3 PIO Modes Supported

Editor's Note 40: Restructured these bits. Original text made this dependent on word 53 and indicated that bits (7:2) are reserved for future PATA modes. I added (7:2) to the reserved pool.

A.11.9.3.1 PIO Mode 3 is supported

For PATA devices, If PIO Mode 3 is supported is set to one, then the device supports PIO mode 3. All devices except CFA-APT devices shall support PIO mode 3 and shall set this bit to one. See ATA8-APT for more information.

For SATA devices, PIO Mode 3 is supported shall be set to one.

A.11.9.3.2 PIO Mode 4 is supported

For PATA devices, If PIO Mode 4 is supported is set to one, then the device supports PIO mode 4. See ATA8-APT for more information.

For SATA devices, PIO Mode 4 is supported shall be set to one.

A.11.9.4 Multiword DMA transfer cycle time

A.11.9.4.1 Manufacturer's recommended Multiword DMA transfer cycle time

For PATA devices:

a) Manufacturer's recommended Multiword DMA transfer cycle time contains the Multiword DMA transfer cycle time recommended by the device in nanoseconds (i.e., 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);

Editor's Note 41: Delete: "if this field is supported, then bit 1 of word 53 shall be set to one;"

b) any device that supports Multiword DMA mode 1 or above shall support this field;
c) the Manufacturer's recommended Multiword DMA transfer cycle time shall not be less than the Minimum Multiword DMA transfer cycle time (see A.11.9.4.2);

Editor's Note 42: Change "if bit 1 of word 53 is set to one because a device supports a field in words 64..70 other than this field, and the device does not support word 66, then the device shall return a value of zero in word 66; and" to If Manufacturer's recommended Multiword DMA transfer cycle time is not supported, then this field shall be set to zero.

d) if a host runs at a faster cycle rate by operating at a cycle time of less than this value, then the device may negate DMARQ for flow control. The rate at which DMARQ is negated may result in reduced throughput despite the faster cycle rate. Transfer at this rate does not ensure that flow control is not used, but implies that higher performance may result (see ATA8-APT).

For SATA devices, Manufacturer's recommended Multiword DMA transfer cycle time shall be set to 78h to indicate 120 ns.

A.11.9.4.2 Minimum Multiword DMA transfer cycle time

For PATA devices, Minimum Multiword DMA transfer cycle time 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.

For SATA devices, Minimum Multiword DMA transfer cycle time shall be set to indicate 120 ns.

Editor's Note 43: deleted "If word 65 is supported, bit 1 of word 53 shall be set to one." word 53 is not replicated.

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.

Editor's Note 44: Delete: "If bit 1 of word 53 is set to one because a device supports a field in words 64..70 other than this field and the device does not support this field, then the device shall return a value of zero in this field."

A.11.9.5 Minimum PIO transfer cycle time

A.11.9.5.1 Minimum PIO transfer cycle time with IORDY flow control

For PATA devices Minimum PIO transfer cycle time with IORDY flow control is defined as the minimum PIO transfer with IORDY (see ATA8-APT) flow control cycle time. This field defines, in nanoseconds, the minimum cycle time that the device supports while performing data transfers while utilizing IORDY (see ATA8-APT) flow control.

For SATA devices Minimum PIO transfer cycle time with IORDY flow control shall be set to indicate 120 ns.

All devices except CFA-APT devices shall support PIO mode 3 and shall support this field, and the value in Minimum PIO transfer cycle time with IORDY flow control shall be the fastest defined PIO mode supported by the device. The maximum value reported in this field shall be 180 (i.e., PIO mode 3 or above).

Editor's Note 45: Deleted "If bit 1 of word 53 is set to one because a device supports a field in words 64..70 other than this field and the device does not support this field, then the device shall return a value of zero in this field." because there is no replication of word 53.

A.11.9.5.2 Minimum PIO transfer cycle time without flow control

For PATA devices, Minimum PIO transfer cycle time without flow control is defined as the minimum PIO transfer without IORDY (see ATA8-APT) 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 (see ATA8-APT) flow control.

For SATA devices Minimum PIO transfer cycle time without flow control shall be set to indicate 120 ns.

If Minimum PIO transfer cycle time without flow control 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.

Editor's Note 46: Deleted "If bit 1 of word 53 is set to one because a device supports a field in words 64..70 other than this field and the device does not support this field, then the device shall return a value of zero in this field." This function is duplicated by simply providing the PATA page.

A.12 LBA Status log (Log Address 19h)

A.12.1 LBA Status log overview

The LBA Status log contains the LBA status for all user accessible LBAs (see 4.1).

See table A.43 for the defined log pages.

Log pages other than log page 0000h contain:

a) header fields that specify:
  A) the starting LBA of the first LBA status descriptor contained within this log page; and
  B) the last LBA represented by the last LBA status descriptor contained within this log page;

  and

b) a list of LBA status descriptors, if any.

The list of LBA status descriptors are returned:

a) in LBA ascending order with no overlapping LBAs; and
b) there shall be no gaps (i.e., LBA status descriptors with a zero value in the Number Of Logical Blocks field) between LBA status descriptors.

If the last LBA Status log page contains less than 15 valid LBA status descriptors (i.e., nonzero value in the Number of Logical Blocks field), then the remaining LBA status descriptors in that LBA Status log page shall be padded with zero filled LBA status descriptors.

Editor's Note 47: The following paragraph references table 0.6. I am unable to find this table.

If this log is not able to return LBA status for all LBAs, then the last LBA Status Descriptor (see table A.46) shall indicate that the remaining LBA statuses are unknown (see table 0.6).

Table A.43 — Defined LBA Status log pages

Log Page	Description
0000h	Number of LBA ranges
0001h	LBA status
0002h	LBA status
0003h	LBA status
…	
n	LBA status

A.12.2 Number of LBA Ranges log page (Page 0000h)

The Number of LBA Ranges log page (see table A.44) contains the number LBA status descriptors that contain valid LBA status.

Table A.44 — Number of LBA Ranges

Offset	Type	Description
0..7	QWord	Number of LBA Status Descriptors The Number of LBA Status Descriptors is the number of LBA Status Descriptors contained in the LBA Status log.
8..15	Byte	Reserved

A.12.3 LBA Status log pages

The LBA Status log pages (see table A.45) contain:

a) header fields that specify:
   A) the starting LBA of the first LBA status descriptor contained within that LBA status log page; and
   B) the last LBA represented by the last LBA status descriptor contained within that LBA Status log page;

   and

b) a list of LBA status descriptors.

The First Logical Block Address field in the first LBA Status log page (i.e., 0001h) shall be set to zero.

The First Logical Block Address field in all LBA Status log pages, except the first LBA Status log page shall be set to the sum of:

a) the Starting Logical Block Address field in the last LBA Status Descriptor of the previous LBA Status Log page; and

b) the Number Of Logical Blocks field in the last LBA Status Descriptor of the previous LBA Status Log page.

Table A.45 — LBA Status

Offset	Type	Description
0..7	QWord	First Logical Block Address The First Logical Block Address is the LBA returned in the first LBA Status Descriptor returned in this LBA Status log page.
8..15	QWord	Last Logical Block Address The Last Logical Block Address is the last LBA represented by the sum of the Starting Logical Block Address field in the last valid LBA Status Descriptor of this LBA Status log page plus the Number Of Logical Blocks field in the last valid LBA Status Descriptor of this LBA Status log page.
16..31		LBA Status Descriptor (first) LBA Status Descriptor (first) is the first LBA Status Descriptor for this LBA Status log page.
32..47		LBA Status Descriptor (second) LBA Status Descriptor (second) is the second LBA Status Descriptor for this LBA Status log page.
…		
469..511		LBA Status Descriptor (15) LBA Status Descriptor (15) is the last LBA Status Descriptor for this LBA Status log page.

A.12.4 LBA Status Descriptor

The content of the LBA Status Descriptor is shown in table A.46.

Table A.46 — LBA Status Descriptor

Offset	Description
n..n+7	Starting Logical Block Address
n+8..n+11	Number of Logical Blocks
n+12..n+13	Trim Status **Bit Description** 15:14 Reserved 0 Trim status
n+14..n+15	Reserved

The Starting Logical Block Address field shall contain the starting LBA of the range of LBAs for which this descriptor reports LBA status.

The Number of Logical Blocks field shall contain the number of logical blocks in the range of LBAs for which this descriptor reports LBA status.

The Trim Status bit set to one indicates the range of LBAs specified by this descriptor is trimmed (see 7.9.3.2). The Trim Status bit cleared to zero indicates the range of LBAs specified by this descriptor is not trimmed or the status is unknown.

The Starting Logical Block Address field in the first LBA Status Descriptor returned in this LBA Status log page shall contain the value specified in the First Logical Block Address field of this LBA Status log page. For subsequent LBA Status Descriptors, the contents of the Starting Logical Block Address field shall contain the sum of the values in:

a) the Starting Logical Block Address field in the previous LBA Status Descriptor; and
b) the Number Of Logical Blocks field in the previous LBA Status Descriptor.

A.13 Adjacent LBA Status Descriptors may or may not have different values for the Trim Status bit.LPS Mis-alignment log (Log Address 0Dh)

Table A.47 and table A.48 define the format of the LPS Mis-alignment log. The LPS Mis-alignment log contains the starting LBA of the first write commands for which:

a) the first byte of data did not begin at the first byte of a physical sector; or
b) the last byte of data did not end at the last byte of a physical sector.

If the device receives a command to read the LPS Mis-alignment log, then the device shall:

1) return the log; and
2) clear the number of mis-aligned logical sectors contained in this log to zero.

The LPS Mis-alignment log shall be preserved across all resets.

The LPS Mis-alignment log is not affected by Long Physical Sector Alignment Error Reporting Control (see 7.45.17).

Table A.47 — LPS Mis-alignment log (log page 0)

<table>
<tr><th>Offset</th><th>Type</th><th colspan="2">Description</th></tr>
<tr><td rowspan="6">0..7</td><td rowspan="6">QWord</td><td colspan="2">Structure Version</td></tr>
<tr><td>Bit</td><td>Description</td></tr>
<tr><td>63:32</td><td>Reserved</td></tr>
<tr><td>31:16</td><td>Number of mis-aligned logical sectors contained in this log</td></tr>
<tr><td>15:0</td><td>Revision number
Shall be set to 0001h</td></tr>
<tr><td></td><td></td></tr>
<tr><td rowspan="5">8..15</td><td rowspan="5">QWord</td><td colspan="2">Mis-aligned sector 0</td></tr>
<tr><td>Bit</td><td>Description</td></tr>
<tr><td>63</td><td>1 = This entry has valid content, 0 = This entry shall be ignored.</td></tr>
<tr><td>62:48</td><td>Reserved</td></tr>
<tr><td>47:0</td><td>LBA of mis-aligned logical sector</td></tr>
<tr><td rowspan="5">16..23</td><td rowspan="5">QWord</td><td colspan="2">Mis-aligned sector 1</td></tr>
<tr><td>Bit</td><td>Description</td></tr>
<tr><td>63</td><td>1 = This entry has valid content, 0 = This entry shall be ignored.</td></tr>
<tr><td>62:48</td><td>Reserved</td></tr>
<tr><td>47:0</td><td>LBA of mis-aligned logical sector</td></tr>
<tr><td colspan="4">…</td></tr>
</table>

Table A.47 — LPS Mis-alignment log (log page 0)

Offset	Type	Description
504..511	QWord	Mis-aligned sector 62
		Bit **Description** 63 1 = This entry has valid content, 0 = This entry shall be ignored. 62:48 Reserved 47:0 LBA of mis-aligned logical sector

Table A.48 — LPS Mis-alignment log (log pages 1..x)

Offset	Type	Description
0..7	QWord	Mis-aligned sector 63 + (((log page number) - 1) * 63)
		Bit **Description** 63 1 = This entry has valid content, 0 = This entry shall be ignored. 62:48 Reserved 47:0 LBA of mis-aligned logical sector
8..15	QWord	Mis-aligned sector 64 + (((log page number) - 1) * 63)
		Bit **Description** 63 1 = This entry has valid content, 0 = This entry shall be ignored. 62:48 Reserved 47:0 LBA of mis-aligned logical sector
…		
504..511	QWord	Mis-aligned sector 126 + (((log page number) - 1) * 63)
		Bit **Description** 63 1 = This entry has valid content, 0 = This entry shall be ignored. 62:48 Reserved 47:0 LBA of mis-aligned logical sector

A.14 NCQ Command Error log (Log Address 10h)

A.14.1 Overview

The NCQ Command Error log describes the most recent NCQ command failure, is one log page in length, and is defined in table A.49. Devices supporting the NCQ feature set (see 4.12) shall support log address 10h (i.e., NCQ Command Error).

Table A.49 — NCQ Command Error log

Offset	Description
0	**Bit Name** 7 NQ (see A.14.3) 6 UNL (see A.14.4) 5 Reserved 4:0 NCQ Tag (see A.14.2)
1	Reserved
2	Status
3	Error
4	LBA (7:0)
5	LBA (15:8)
6	LBA (23:16)
7	Device
8	LBA (31:24)
9	LBA (39:32)
10	LBA (47:40)
11	Reserved
12	Count (7:0)
13	Count (15:8)
14..255	Reserved
256..510	Vendor Specific
511	Checksum

A.14.2 NCQ Tag

If the NQ bit is cleared to zero, then the NCQ Tag field contains the NCQ Tag (see 4.12.1) corresponding to the NCQ command (see 4.12.1) that failed.

A.14.3 NQ

The NQ bit set to one indicates that the NCQ Tag field is not valid as the result of non-NCQ command having been issued. The NQ bit cleared to zero indicates that the NCQ Tag field is valid and that the error condition applies to a NCQ command.

A.14.4 Unload (UNL)

The UNL bit set to one indicates that the error condition was the result of receiving an IDLE IMMEDIATE command with the Unload Feature specified. The UNL bit cleared to zero indicates the reason for the error was not the reception of an IDLE IMMEDIATE command with the Unload Feature specified. If the last command received was an Unload Immediate command, then the device shall not load the heads when reading the NCQ Command Error log.

If UNL is set to one, the NQ bit shall also be set to one to indicate the failure was due to reception of a non-NCQ command. If the UNL bit is set to one, then the value of the Status field, Error field, and LBA Low field (i.e., bytes 3..5) in the log page shall be set as follows:

Status:	The Busy (see ATA8-APT) bit shall be cleared to zero and the Error bit (see 6.2.9) shall be set to one.
Error:	The Abort bit (see 6.3.2) shall be set to one.
LBA [7:0]:	Shall be set to C4h if the unload is being executed or has completed successfully.
	Shall be set to 4Ch if the unload was not accepted or has failed.

A.14.5 Return Fields

The Status field, Error field, LBA field and Count field indicate the error that caused the device to stop processing NCQ commands.

> NOTE 28 — The value returned in the Error field of the NCQ Command Error log may be different than the value returned in the Error field of the command Error Output structure when the initial error condition is indicated. The Error field in command Error Output structure is used for the purpose of signaling an error for an NCQ command, while the value in the Error field of the NCQ Command Error log provides specific information about the error condition.

A.14.6 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 8-bit unsigned arithmetic and overflow shall be ignored. The sum of all 512 bytes of the data structure shall be zero.

A.15 Read Stream Error log (Log Address 22h)

Table A.50 defines the format of the Read Stream Error log. Entries are placed into the Read Stream Error log only when the Stream Error bit is set to one in the Status field. 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 read of the Read Stream Error log. 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 its maximum value, after the next error is detected the Read Stream Error Count shall remain at the maximum value.

During processing of a READ LOG EXT command with the LBA field (7:0) set to 22h (see 7.27), a device shall clear the:

a) Read Stream Error Log:
b) Error Log Index to zero; and
c) Read Stream Error Count to zero.

When the Error Log Index is zero there are no error log entries. A device shall clear the content of the Read Stream Error log during processing of a power-on reset. If the device enters the PM3:Sleep state (see 4.13.4), then the device may clear the content of the Read Stream Error log. For a PATA device, the log is also cleared when processing a hardware reset. For a SATA device, the Read Stream Error log is cleared on a hardware reset if Software Settings Preservation is disabled (see 7.45.15.7), otherwise it is preserved.

Table A.50 — Read Stream Error log

Offset	Description
0	Structure Version
1	Error Log Index
2..3	Read Stream Error log Count (word)
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 logical sector entries 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 one through 31 are valid.

Table A.51 defines the format of each entry in the Read Stream Error log.

Table A.51 — Stream Error Log Entry

Offset	Description
0	Feature (7:0)
1	Feature (15:8)
2	Status
3	Error
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	Count (7:0)
13	Count (15:8)
14	Reserved
15	Reserved

Byte 0..1 contains the contents of the Feature field when the error occurred. In the Write Stream Error log (see A.20), this value shall be set to FFFFh for a deferred write error.

Byte 2 contains the contents of the Status field when the error occurred.

Byte 3 contains the contents of the Error field when the error occurred.

Bytes 4..9 indicate the starting LBA of the error.

Bytes 12..13 contain the contents of the Count field indicating the length of the error. Each entry may describe a range of logical sectors starting at the given LBA and spanning the specified number of logical sectors.

A.16 SATA Phy Event Counters log (Log Address 11h)

A.16.1 Overview

The SATA Phy Event Counters log is one log page in length. The first Dword of the log page contains information that applies to the rest of the log page. The application client should continue to process counters until a counter identifier with value 0h is found or the entire log page has been read. A counter identifier with value 0h indicates that the log page contains no more counter values past that point. The SATA Phy Event Counters log is defined in table A.52.

Table A.52 — SATA Phy Event Counters log Format

Offset	Description
0..3	Reserved
4..5	Counter 0 Identifier (word)
6..Counter 0 Length+5	Counter 0 Value
…	…
n..n+1	Counter x Identifier (word)
n+2..Counter x Length+n+1	Counter x Value
…	…
508..510	Reserved
511	Checksum

If the device receives a BIST Activate FIS, then the device shall reset all SATA Phy event counters to their reset value (see SATA 2.6).

If the SATA Phy Event Counters log is read and bit 0 in the Feature field is set to one, then the device shall return the current counter values for the command and then reset all Phy event counter values.

A.16.2 Counter x Identifier

SATA Phy event counter identifier that corresponds to Counter n Value. Specifies the particular event counter that is being reported. Valid identifiers are listed in SATA 2.6.

A.16.3 Counter x Value

Value of the SATA Phy event counter that corresponds to Counter x Identifier. The number of significant bits is determined by Counter x Identifier bits (14:12), see SATA 2.6 for more information. The length of Counter x Value shall always be a multiple of 16-bits. All counters are one-extended (e.g., if a counter is only physically implemented as 8-bits when it reaches the maximum value of FFh, it shall be one-extended to FFFFh). The counter shall stop (i.e., not wrap to zero) after reaching its maximum value.

A.16.4 Counter x Length

Size of the SATA Phy event counter as defined by bits (14:12) of Counter n Identifier. The size of the SATA Phy event counter shall be a multiple of 16-bits.

A.16.5 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 of the data structure is zero when the checksum is correct.

A.17 Selective Self-Test log (Log Address 09h)

A.17.1 Overview

The Selective Self-Test log may be both written and read by the host. The Selective Self-Test log allows the host to select the parameters for the self-test and to monitor the progress of the self-test. Table A.53 defines the content of the Selective Self-Test log.

Table A.53 — Selective Self-Test log

Offset	Type	Description	Read/Write
0..1	Word	Data structure revision number	R/W
2..9	Qword	Starting LBA for test span 1	R/W
10..17	Qword	Ending LBA for test span 1	R/W
18..25	Qword	Starting LBA for test span 2	R/W
26..33	Qword	Ending LBA for test span 2	R/W
34..41	Qword	Starting LBA for test span 3	R/W
42..49	Qword	Ending LBA for test span 3	R/W
50..57	Qword	Starting LBA for test span 4	R/W
58..65	Qword	Ending LBA for test span 4	R/W
66..73	Qword	Starting LBA for test span 5	R/W
74..81	Qword	Ending LBA for test span 5	R/W
82..337		Reserved	Reserved
338..491		Vendor specific	Vendor specific
492..499	Qword	Current LBA under test	Read [a]
500..501	Word	Current span under test	Read [a]
502..503	Word	Feature flags	R/W
504..507		Vendor specific	Vendor specific
508..509	Word	Selective self-test pending time	R/W
510		Reserved	Reserved
511		Data structure checksum	R/W

[a] Fields marked Read shall be ignored by the device when the host writes them.

A.17.2 Data structure revision number

The value of the data structure revision number shall be 01h. This value shall be written by the host and returned unmodified by the device.

A.17.3 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 LBA of the last logical sector tested in the test span. If the starting LBA and ending LBA values for a test span are both zero, then a test span is not defined and not tested. The Starting LBA and Ending LBA for each test span are written by the host and shall be returned unmodified by the device.

A.17.4 Current LBA under test

The device shall modify this value to contain the LBA of the logical sector currently under test at least once every 65 536 logical sectors tested. When the self-test including the off-line scan between test spans has been completed, a zero value shall be placed in this field.

A.17.5 Current span under test

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, then a value greater than 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 shall be placed in this field.

A.17.6 Feature flags

The Feature flags define the features of Selective self-test to be processed (see table A.54).

Table A.54 — Selective self-test feature flags

Bit	Description
5:15	Reserved.
4	When set to one, off-line scan after selective test is active.
3	When set to one, off-line scan after selective test is pending.
2	Vendor specific
1	When set to one, perform off-line scan after selective test.
0	Vendor specific

Feature flag bit (1) shall be written by the host and returned unmodified by the device. Feature flag bits (4:3) shall be cleared to zero by the host and the device shall modify them as the test progresses.

A.17.7 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 to one. At the expiration of this time, the device sets the active bit (i.e.,Selective self-test feature flags bit 4) to one, and resumes the off-line scan that had begun before power-down.

A.17.8 Data structure checksum

The data structure checksum is defined in A.19.6.

A.18 SMART Self-Test log (Log Address 06h)

A.18.1 Overview

Table A.55 defines the content of the SMART Self-Test log. The SMART Self-Test log supports 28-bit addressing only.

Table A.55 — Self-test log data structure

Offset	Description
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

The SMART Self-Test log is a circular buffer. If fewer than 21 self-tests have been performed by the device, the unused descriptor entries shall be filled with zeroes.

A.18.2 Self-test log data structure revision number

The value of the self-test log data structure revision number shall be 0001h.

A.18.3 Self-test log descriptor entry

The content of the self-test descriptor entry is shown in table A.56.

Table A.56 — Self-test log descriptor entry

Offset	Description
n	Content of the LBA field (7:0)
n+1	Content of the self-test execution status byte
n+2..n+3	Life timestamp (word)
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..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 7.48.5.2).

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 7.48.6.8).

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.

A.18.4 Self-test index

The self-test index shall point to the most recent entry. If the log is empty, then 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.

A.18.5 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 is zero when the checksum is correct. The checksum is placed in byte 511.

A.19 Summary SMART Error log (Log Address 01h)

A.19.1 Overview

Table A.57 defines the log page that makes up the SMART summary error log. Summary SMART Error log data structures shall include, but are not limited to, Uncorrectable errors, ID Not Found errors for which the LBA requested was valid, servo errors, write fault errors. Summary error log data structures shall not include errors attributed to the receipt of faulty commands (e.g., command codes not implemented by the device or requests with invalid parameters or invalid LBAs). If the device supports the Comprehensive SMART Error log (see A.4), then the Summary SMART Error log duplicates the last five error entries in the Comprehensive SMART Error log. The Summary SMART Error log supports 28-bit addressing only.

Table A.57 — Summary SMART Error log

Offset	Description
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 (word)
454..510	Reserved
511	Data structure checksum

A.19.2 Error log version

The value of the Summary SMART Error log version byte shall be 01h.

A.19.3 Error log index

The error log index indicates the error log data structure representing the most recent error. Only values zero through five are valid. If there are no error log entries, the value of the error log index shall be zero.

A.19.4 Error log data structure

A.19.4.1 Overview

An Error log data structure shall contain the last five errors reported by the device. These Error log data structure entries are a circular buffer. The Error log index 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 A.58 describes the content of a valid Error log data structure.

Table A.58 — Error log data structure

Offset	Description
n - n+11	First command data structure
n+12 - n+23	Second command data structure
n+24 - n+35	Third command data structure
n+36 - n+47	Fourth command data structure
n+48 - n+59	Fifth command data structure
n+60 - n+89	Error data structure

A.19.4.2 Command data structure

The Error log data structures contain the following:

a) the fifth command data structure shall contain the command or reset for which the error is being reported;
b) the fourth command data structure should contain the command or reset that preceded the command or reset for which the error is being reported;
c) the third command data structure should contain the command or reset preceding the one in the fourth command data structure;
d) the second command data structure should contain the command or reset preceding the one in the third command data structure; and
e) the first command data structure should contain the command or reset preceding the one in the second command data structure.

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 (e.g., 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 A.59. 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 A.59 — Command data structure

Offset	Description
n	Transport specific value when the Command was initiated. See the appropriate transport standard, reference Device Control field.
n+1	Content of the Feature (7:0) when the Command was initiated
n+2	Content of the Count (7:0) 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	Content of the Device field when the Command was initiated
n+7	Content written when the Command was initiated
n+8..n+11	Timestamp (DWord)

Timestamp shall be the time since power-on in milliseconds when command acceptance occurred. This timestamp may wrap around.

A.19.4.3 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 A.59. 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 A.60.

Table A.60 — Error data structure

Offset	Description
n	Reserved
n+1	Content of the Error (7:0) after command completion occurred
n+2	Content of the Count (7:0) 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	Content of the Device field after command completion occurred
n+7	Content written to the Status field after command completion occurred
n+8..n+26	Extended error information
n+27	State
n+28..n+29	Life timestamp (word)

Extended error information shall be vendor specific.

The State field shall contain a value indicating the state of the device when the command was initiated or the reset occurred as described in table A.61.

Table A.61 — 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 specific
The value of x is vendor specific and may be different for each state.	

Sleep indicates the reset for which the error being reported was received when the device was in the Sleep mode (see 4.13.4).

Standby indicates the command or reset for which the error being reported was received when the device was in the Standby mode (see 4.13.4).

Active/Idle indicates the command or reset for which the error being reported was received when the device was in the Active mode or Idle mode (see 4.13.4).

Processing SMART off-line or SMART self-test indicates the command or reset for which the error being reported was received when the device was processing a SMART off-line (see 7.48.5.2.4) or SMART self-test (see 7.48.5.2.1).

The Life timestamp field shall contain the power-on lifetime of the device in hours when command completion occurred.

A.19.5 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 (e.g., these errors shall include Uncorrectable errors, ID Not Found errors for which the LBA requested was valid, servo errors, write fault errors). The device error count shall not include errors attributed to the receipt of faulty commands (e.g., command codes not implemented by the device or requests with invalid parameters or invalid LBAs). If the maximum value for this field is reached, the count shall remain at the maximum value when additional errors are encountered and logged.

A.19.6 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 shall be zero when the checksum is correct. The checksum is placed in byte 511.

A.20 Write Stream Error log (Log Address 21h)

Table A.62 defines the format of the Write Stream Error log. Entries are placed into the Write Stream Error log only when the Stream Error bit is set to one in the Status field. The log page 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 reading of the Write Stream Error log. 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 its maximum value, then after the next error is detected the Write Stream Error Count shall remain at the maximum value.

When the Write Stream Error log has been read by the host, the device shall clear the:

a) Write Stream Error Log;
b) Error Log Index to zero; and
c) Write Stream Error Count to zero.

If the Error Log Index is zero, then there are no entries in the Write Stream Error log. A device shall clear the content of the Write Stream Error log during processing of a power-on reset. If the device enters the PM3:Sleep state (see 4.13.4), then the device may clear the content of the Write Stream Error log. For a PATA device, the log is also cleared when processing a hardware reset. For a SATA device, the log is cleared on a hardware reset if Software Settings Preservation is disabled (see 7.45.15.7), otherwise it is preserved.

Table A.62 — Write Stream Error log

Offset	Description
0	Structure Version
1	Error Log Index
2..3	Write Stream Error log Count (word)
4..15	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 EXT command (see 7.70) entries since the last power-on reset, hardware reset, or since this log was last read.

The Error Log Index indicates the error log data structure representing the most recent error. Only values one through 31 are valid.

Table A.51 defines the format of each Write Stream Error log Entry.

A.21 Current Device Internal Status Data log (Log Address 24h)

A.21.1 Overview

The Current Device Internal Status Data log consists of:

a) the Current Device Internal Status Data header page (i.e., log page 0) (see A.21.2); and
b) zero or more Current Device Internal Status Data pages (i.e., log pages 1..n) (see A.21.3).

The current device internal status data is the data representing the internal state of the device at the time the Current Device Internal Status Data log was read with bit 0 in the Feature field set to one. The current device internal status data may be retrieved by one or more reads of log pages within the range of 0..n.

After a reset, the contents of the Current Device Internal Status Data log are not defined until the Current Device Internal Status Data log has been read with bit 0 in the Feature field set to one.

The current device internal status data log consists of three areas where the size of:

a) Device Internal Status data area 1 is less than or equal to the size of Device Internal Status data area 2; and
b) Device Internal Status data area 2 is less than or equal to the size of Device Internal Status data area 3.

A.21.2 Current Device Internal Status Data header page

A.21.2.1 Current Device Internal Status Data header page overview

The Current Device Internal Status Data header is described in table A.63.

Table A.63 — Current Device Internal Status Data header (page 0)

Offset	Type	Description
0	Byte	Log address
1..3	Bytes	Reserved
4..7	DWord	Organization identifier **Bit** **Description** 31:24 Reserved 23:0 IEEE OUI
8..9	Word	Device Internal Status data area 1 last log page
10..11	Word	Device Internal Status data area 2 last log page
12..13	Word	Device Internal Status data area 3 last log page
14..381	Bytes	Reserved
382	Byte	Saved data available
383	Byte	Saved data generation number
384..511	Bytes	Reason identifier

A.21.2.2 Log address

The log address field shall be set to 24h.

A.21.2.3 Organization identifier

The organization identifier field shall contain an Organization Unique Identifier (OUI) of the organization that is able to interpret the Current Device Internal Status Data in this log.

A.21.2.4 Device Internal Status data area 1 last log page

The device internal status data area 1 last log page field contains the value of the last log page of Device Internal Status data area 1 within the Device Internal Status data pages. Device Internal Status data area 1 begins at log page 1 and ends at the log page address contained in device internal status data area 1 last log page field. See figure A.1.

A.21.2.5 Device Internal Status data area 2 last log page

The device internal status data area 2 last log page field contains the value of the last page of Device Internal Status data area 2 within the Device Internal Status data pages. Device Internal Status data area 2 begins at the log page after the log page address contained in device internal status data area 1 last log page field and ends at the log page address contained in device internal status data area 2 last log page field. The size of Device Internal Status data area 2 shall be greater than or equal to the size of Device Internal Status data area 1. See figure A.1.

A.21.2.6 Device Internal Status data area 3 last log page

The device internal status data area 3 last log page field contains the value of the last page of Device Internal Status data area 3 within the Device Internal Status data pages. Device Internal Status data area 3 begins at the log page after the log page address contained in device internal status data area 2 last log page field and ends at the log page address contained in device internal status data area 3 last log page field. The size of Device Internal Status data area 3 shall be greater than or equal to the size of Device Internal Status data area 2.

The structure of Device Internal Status log pages is shown in figure A.1.

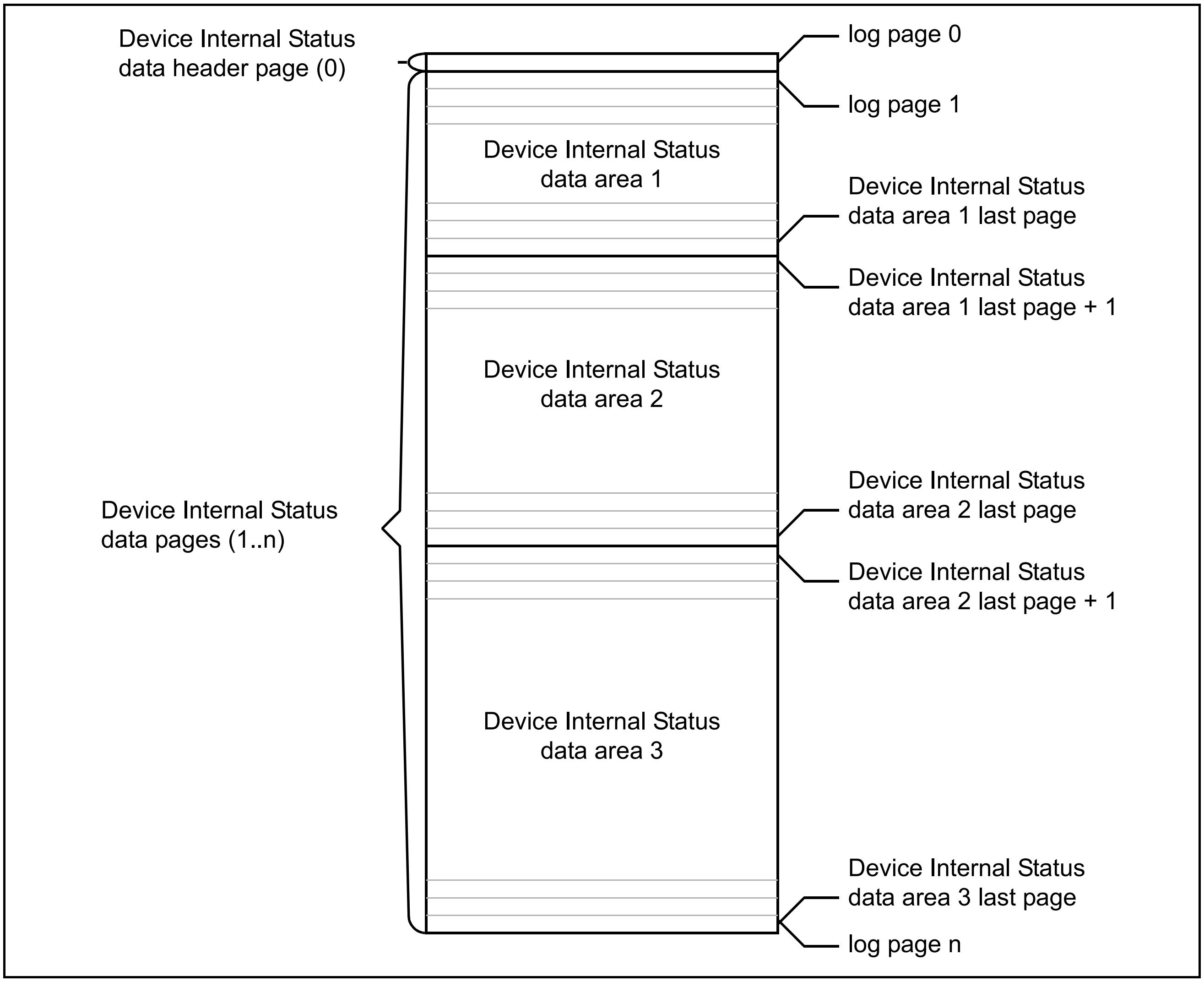

Figure A.1 — Device Internal Status log pages structure

A.21.2.7 Saved data available

If the Saved Device Internal Status Data log is supported, then the saved data available field shall contain the value of the saved data available field in the Saved Device Internal Status Data log (see A.22.2.7).

If the Saved Device Internal Status Data log is not supported, then the saved data available field shall be reserved.

A.21.2.8 Saved data generation number

If the Saved Device Internal Status Data log is supported, then the saved data generation number field shall contain the value of the saved data generation number field in the Saved Device Internal Status Data log (see A.22.2.8).

If the Saved Device Internal Status Data log is not supported, then the saved data generation number field shall be reserved.

A.21.2.9 Reason identifier

The reason identifier field contains a vendor specific identifier that describes the operating conditions of the device at the time of capture. The reason identifier field should provide an identification of different unique operating conditions of the device.

A.21.3 Current Device Internal Status data pages

The Current Device Internal Status Data log pages (see table A.64) shall represent the device internal state.

Table A.64 — Current Device Internal Status Data (pages 1..n)

Offset	Type	Description
0..511	Bytes	Vendor Specific

A.22 Saved Device Internal Status Data log (Log Address 25h)

A.22.1 Overview

The Saved Device Internal Status Data Log consists of:

a) the Saved Device Internal Status Data header page (i.e., log page 0) (see A.22.2); and
b) zero or more Saved Device Internal Status Data pages (i.e., log pages 1..n) (see A.22.3).

The saved device internal status data in the Saved Device Internal Status Data log is a device initiated capture of the device internal state. The contents of the Saved Device Internal Status Data log shall persist across all resets.

The saved device internal status data log consists of three areas where the size of:

a) Device Internal Status data area 1 is less than or equal to the size of Device Internal Status data area 2; and
b) Device Internal Status data area 2 is less than or equal to the size of Device Internal Status data area 3.

A.22.2 Saved Device Internal Status Data header page

A.22.2.1 Saved Device Internal Status Data header page overview

The Saved Device Internal Status Data header is described in table A.65.

Table A.65 — Saved Device Internal Status Data header (page 0)

Offset	Type	Description
0	Byte	Log address
1..3	Bytes	Reserved
4..7	DWord	Organization identifier **Bit** **Description** 31:24 Reserved 23:0 IEEE OUI
8..9	Word	Editor's Note 48: Unlike table A.63, f10122r5 does not include a definition for these two bytes. Instead, all the other "last log page" fields are moved down by two bytes.
10..11	Word	Device Internal Status data area 1 last log page
12..13	Word	Device Internal Status data area 2 last log page
14..15	Word	Device Internal Status data area 3 last log page
16..381	Bytes	Reserved
382	Byte	Saved data available
383	Byte	Saved data generation number
384..511	Bytes	Reason identifier

A.22.2.2 Log address

The log address field shall be set to 25h.

A.22.2.3 Organization identifier

See A.21.2.3.

A.22.2.4 Device Internal Status data area 1 last log page

See A.21.2.4.

A.22.2.5 Device Internal Status data area 2 last log page

See A.21.2.5.

A.22.2.6 Device Internal Status data area 3 last log page

See A.21.2.6.

A.22.2.7 Saved data available

If the saved data available field is cleared to 00h, then the Saved Device Internal Status Data log does not contain saved Device Internal Status Data. If the saved data available field is set to 01h, then the Saved Device Internal Status Data log contains Saved Device Internal Status Data.

If any page of the Saved Device Internal Status Data in the Saved Device Internal Status Data log is read, then the saved data available field shall be cleared to 00h

If the device saves Saved Device Internal Status Data in the Saved Device Internal Status Data log, then the saved data available field shall be set to 01h.

A.22.2.8 Saved data generation number

The saved data generation number field shall contain a value that is incremented each time the device initiates a capture of its internal device state into the Saved Device Internal Status Data.

A.22.2.9 Reason identifier

See A.21.2.9.

A.22.3 Current Device Internal Status data pages

The Saved Device Internal Status Data log pages (see table A.66) shall represent the device internal state.

Table A.66 — Saved Device Internal Status Data (pages 1..n)

Offset	Type	Description
0..511	Bytes	Vendor Specific

Annex B

(Informative)

Command Set summary

Table B.1 provides information on which command codes are currently defined. Table B.2 provides a list of all of the commands in order of command code with the required use for each. Table B.3 provides a summary of all commands in alphabetical order with the required use for each. Table B.4 provides the assignment history of each opcode by ATA standard. Table B.5 provides the assignment history of each SET FEATURES code by ATA standard.

Table B.1 — Command Matrix

	x0h	x1h	x2h	x3h	x4h	x5h	x6h	x7h	x8h	x9h	xAh	xBh	xCh	xDh	xEh	xFh
0xh	C	R	R	C	R	R	C*	R	C	R	R	C*	R	R	R	R
1xh	O	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
2xh	C	O	O	O	C	C	O*	O	R	C	C	C	R	R	R	C
3xh	C	O	O	O	C	C	O*	O	C	C	C	C	O	C	O*	C
4xh	C	O	C	R	R	C	R	C	R	R	R	R	R	R	R	R
5xh	O	C	R	R	R	R	R	C	R	R	R	C	C	C	C	C
6xh	C	C	S	S	S	S	S	S	R	R	R	R	R	R	R	R
7xh	O	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
8xh	V	V	V	V	V	V	V	F	V	V	V	V	V	V	V	V
9xh	C	O	C	C*	E	E	E	E	E	E	V	R	R	R	R	R
Axh	C	C	O*	R	R	R	R	R	R	R	R	R	R	R	R	R
Bxh	C	O	R	R	C*	R	O	R	A	A	A	R	R	R	R	R
Cxh	F	V	V	V	C	C	C	O*	C	O	C	O	O*	C	C	R
Dxh	R	O	R	R	R	R	R	R	R	R	O	E	E	E	O	O
Exh	C	C	C	C	C	C	C	C	C	C*	C	C*	C	O	O	C
Fxh	V	C	C	C	C	C	C	V	O	O	V	V	V	V	V	V

Key:

C = defined command.
R = Reserved, undefined in current specifications.
V = Vendor specific commands.
O = Obsolete.
E = retired command.
F = If the device does not implement the CFA feature set (see 4.6), this command code is Vendor specific.
A = Reserved for assignment by the CompactFlash Association
S = Reserved for Serial ATA
* indicates that the entry in this table has changed from ATA8-ACS.

Table B.2 — Command codes (sorted by command code) (Sheet 1 of 4)

Command	Command Code	ATA device	ATAPI device	Protocol	Argument
NOP	00h	O	M	ND	28-bit
Reserved	01h..02h				
CFA REQUEST EXTENDED ERROR	03h	O	N	ND	28-bit
Reserved	04h..05h				
DATA SET MANAGEMENT	06h	O	P	DM	48-bit
Reserved	07h				
DEVICE RESET	08h	N	M	DR	28-bit
Reserved	09h..0Ah				
REQUEST SENSE DATA EXT	0Bh	O	P	ND	48-bit
Reserved	0Ch..0Fh				
Obsolete	10h				
Retired	11h..1Fh				
READ SECTOR(S)	20h	O	M	PI	28-bit
Obsolete	21h..23h				
READ SECTOR(S) EXT	24h	O	N	PI	48-bit
READ DMA EXT	25h	O	N	DM	48-bit
Obsolete	26h				
Obsolete	27h				
Reserved	28h				
READ MULTIPLE EXT	29h	O	N	PI	48-bit
READ STREAM DMA EXT	2Ah	O	N	DM	48-bit
READ STREAM EXT	2Bh	O	N	PI	48-bit
Reserved	2Ch..2Fh				
READ LOG EXT	2Fh	O	O	PI	48-bit
WRITE SECTOR(S)	30h	O	N	PO	28-bit
Obsolete	31h..33h				
WRITE SECTOR(S) EXT	34h	O	N	PO	48-bit
WRITE DMA EXT	35h	O	N	DM	48-bit
Obsolete	36h				
Obsolete	37h				
CFA WRITE SECTORS WITHOUT ERASE	38h	O	N	PO	28-bit
WRITE MULTIPLE EXT	39h	O	N	PO	48-bit
WRITE STREAM DMA EXT	3Ah	O	N	DM	48-bit
WRITE STREAM EXT	3Bh	O	N	PO	48-bit

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 specific

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 (see 4.6), this command code is Vendor specific.

Table B.2 — Command codes (sorted by command code) (Sheet 2 of 4)

Command	Command Code	ATA device	ATAPI device	Protocol	Argument
Obsolete	3Ch				
WRITE DMA FUA EXT	3Dh	O	N	DM	48-bit
Obsolete	3Eh				
WRITE LOG EXT	3Fh	O	O	PO	48-bit
READ VERIFY SECTOR(S)	40h	O	N	ND	28-bit
Obsolete	41h				
READ VERIFY SECTOR(S) EXT	42h	O	N	ND	48-bit
Reserved	43h..44h				
WRITE UNCORRECTABLE EXT	45h	O	N	ND	48-bit
Reserved	46h				
READ LOG DMA EXT	47h	O	O	DM	48-bit
Reserved	48h..4Fh				
Obsolete	50h				
CONFIGURE STREAM	51h	O	O	ND	48-bit
Reserved	52h..56h				
WRITE LOG DMA EXT	57h	O	O	DM	48-bit
Reserved	58h..5Ah				
TRUSTED NON-DATA	5Bh	O	P	ND	28-bit
TRUSTED RECEIVE	5Ch	O	P	PI	28-bit
TRUSTED RECEIVE DMA	5Dh	O	P	DM	28-bit
TRUSTED SEND	5Eh	O	P	PO	28-bit
TRUSTED SEND DMA	5Fh	O	P	DM	28-bit
READ FPDMA QUEUED	60h	O	N	DMQ	48-bit
WRITE FPDMA QUEUED	61h	O	N	DMQ	48-bit
Reserved	62h..6Fh				
Obsolete	70h				
Retired	71h..7Fh				
Vendor Specific	80h..86h			VS	
CFA TRANSLATE SECTOR	87h	O	N	PI	28-bit
Vendor Specific	88h..8Fh			VS	
EXECUTE DEVICE DIAGNOSTIC	90h	M	M	DD	28-bit
Obsolete	91h				
DOWNLOAD MICROCODE	92h	O	N	PO	28-bit
DOWNLOAD MICROCODE DMA	93h	O	N	DM	28-bit
Retired	94h..99h				

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 specific

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 (see 4.6), this command code is Vendor specific.

Table B.2 — Command codes (sorted by command code) (Sheet 3 of 4)

Command	Command Code	ATA device	ATAPI device	Protocol	Argument
Vendor Specific	9Ah				
Reserved	9Bh..9Fh				
PACKET	A0h	N	M	P	
IDENTIFY PACKET DEVICE	A1h	N	M	PI	28-bit
Obsolete	A2h	O	O	P/DMQ	
Reserved	A3h..AFh				
SMART	B0h	O	N	ND	
Obsolete	B1h				
Reserved	B2h..B3h				
Sanitize Device	B4h	O	N	ND	48-bit
Reserved	B5h				
Obsolete	B6h				
Reserved for the CompactFlash Association	B7h..BBh				
Reserved	BCh..BFh				
CFA ERASE SECTORS	C0h	F	N	ND	28-bit
Vendor Specific	C1h..C3h			VS	
READ MULTIPLE	C4h	O	N	PI	28-bit
WRITE MULTIPLE	C5h	O	N	PO	28-bit
SET MULTIPLE MODE	C6h	O	N	ND	28-bit
Obsolete	C7h				
READ DMA	C8h	O	N	DM	28-bit
Obsolete	C9h				
WRITE DMA	CAh	O	N	DM	28-bit
Obsolete	CBh				
Obsolete	CCh				
CFA WRITE MULTIPLE WITHOUT ERASE	CDh	O	N	PO	28-bit
WRITE MULTIPLE FUA EXT	CEh	O	N	PO	48-bit
Reserved	CFh				
Reserved	D0h				
Obsolete	D1h				
Reserved	D2h..D9h				
Obsolete	DAh				
Retired	DBh..DDh				
Obsolete	DEh				
Obsolete	DFh				

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 specific

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 (see 4.6), this command code is Vendor specific.

Table B.2 — Command codes (sorted by command code) (Sheet 4 of 4)

Command	Command Code	ATA device	ATAPI device	Protocol	Argument
STANDBY IMMEDIATE	E0h	M	M	ND	28-bit
IDLE IMMEDIATE	E1h	M	M	ND	28-bit
STANDBY	E2h	M	O	ND	28-bit
IDLE	E3h	M	O	ND	28-bit
READ BUFFER	E4h	O	N	PI	28-bit
CHECK POWER MODE	E5h	M	M	ND	28-bit
SLEEP	E6h	M	M	ND	28-bit
FLUSH CACHE	E7h	O	O	ND	28-bit
WRITE BUFFER	E8h	O	N	PO	28-bit
READ BUFFER DMA	E9h	O	N	DM	28-bit
FLUSH CACHE EXT	EAh	O	N	ND	28-bit
WRITE BUFFER DMA	EBh	O	N	DM	28-bit
IDENTIFY DEVICE	ECh	M	M	PI	28-bit
Obsolete	EDh				
Obsolete	EEh				
SET FEATURES	EFh	M	M	ND	28-bit
Vendor Specific	F0h			VS	
SECURITY SET PASSWORD	F1h	O	O	PO	28-bit
SECURITY UNLOCK	F2h	O	O	PO	28-bit
SECURITY ERASE PREPARE	F3h	O	O	ND	28-bit
SECURITY ERASE UNIT	F4h	O	O	PO	28-bit
SECURITY FREEZE LOCK	F5h	O	O	ND	28-bit
SECURITY DISABLE PASSWORD	F6h	O	O	PO	28-bit
Vendor Specific	F7h				
Obsolete	F8h				
Obsolete	F9h				
Vendor Specific	FAh..FFh			VS	

Key:

ND = Non-Data command	M = Mandatory
PI = PIO Data-In command	O = Optional
PO = PIO Data-Out command	N = Use prohibited
DM = DMA command	V = Vendor specific implementation
DMQ = DMA QUEUED command	E = Retired
DR = DEVICE RESET command	B = Obsolete
DD = EXECUTE DEVICE DIAGNOSTIC command	R = Reserved
P = PACKET command	F = If the device does not implement the CFA feature set (see 4.6), this command code is Vendor specific.
VS = Vendor specific	

Table B.3 — Command codes (sorted by command name) (Sheet 1 of 3)

Command	Command Code	ATA device	ATAPI device	Protocol	Argument
CFA ERASE SECTORS	C0h	F	N	ND	28-bit
CFA REQUEST EXTENDED ERROR	03h	O	N	ND	28-bit
CFA TRANSLATE SECTOR	87h	O	N	PI	28-bit
CFA WRITE MULTIPLE WITHOUT ERASE	CDh	O	N	PO	28-bit
CFA WRITE SECTORS WITHOUT ERASE	38h	O	N	PO	28-bit
CHECK POWER MODE	E5h	M	M	ND	28-bit
CONFIGURE STREAM	51h	O	O	ND	48-bit
DATA SET MANAGEMENT	06h	O	P	DM	48-Bit
DEVICE RESET	08h	N	M	DR	28-bit
DOWNLOAD MICROCODE	92h	O	N	PO	28-bit
DOWNLOAD MICROCODE DMA	93h	O	N	DM	28-bit
EXECUTE DEVICE DIAGNOSTIC	90h	M	M	DD	28-bit
FLUSH CACHE	E7h	O	O	ND	28-bit
FLUSH CACHE EXT	EAh	O	N	ND	28-bit
IDENTIFY DEVICE	ECh	M	M	PI	28-bit
IDENTIFY PACKET DEVICE	A1h	N	M	PI	28-bit
IDLE	E3h	M	O	ND	28-bit
IDLE IMMEDIATE	E1h	M	M	ND	28-bit
NOP	00h	O	M	ND	28-bit
Obsolete	10h, 21h..23h, 26h, 27h, 31h..33h, 36h, 37h, 3Ch, 3Eh, 41h, 50h, 70h, 91h, A2h, B1h, B6h, C7h, C9h, CBh..CCh, D1h, DAh, DEh, DFh, EDh..EEh, F8h, F9h				
PACKET	A0h	N	M	P	
READ BUFFER	E4h	O	N	PI	28-bit
READ BUFFER DMA	E9h	O	N	DM	28-bit
READ DMA	C8h	O	N	DM	28-bit
READ DMA EXT	25h	O	N	DM	48-bit
READ FPDMA QUEUED	60h	O	N	DMQ	48-bit
READ LOG DMA EXT	47h	O	O	DM	48-bit
READ LOG EXT	2Fh	O	O	PI	48-bit
READ MULTIPLE	C4h	O	N	PI	28-bit
READ MULTIPLE EXT	29h	O	N	PI	48-bit
READ SECTOR(S)	20h	O	M	PI	28-bit
READ SECTOR(S) EXT	24h	O	N	PI	48-bit
READ STREAM DMA EXT	2Ah	O	N	DM	48-bit

Key:

ND = Non-Data command	M = Mandatory
PI = PIO Data-In command	O = Optional
PO = PIO Data-Out command	N = Use prohibited
DM = DMA command	E = Retired
DMQ = DMA QUEUED command	R = Reserved
DR = DEVICE RESET command	F = If the device does not implement the CFA feature set (see 4.6), this command code is Vendor specific.
DD = EXECUTE DEVICE DIAGNOSTIC command	
P = PACKET command	

Table B.3 — Command codes (sorted by command name) (Sheet 2 of 3)

Command	Command Code	ATA device	ATAPI device	Protocol	Argument
READ STREAM EXT	2Bh	O	N	PI	48-bit
READ VERIFY SECTOR(S)	40h	O	N	ND	28-bit
READ VERIFY SECTOR(S) EXT	42h	O	N	ND	48-bit
REQUEST SENSE DATA EXT	0Bh	O	P	ND	48-bit
Reserved	01h..02h, 04h..05h, 07h, 09h..0Ah, 0Ch..0Fh, 28h, 2Ch..2Fh, 43h..44h, 46h, 48h..4Fh, 52h..56h, 58h..5Ah, 62h..6Fh, 9Bh..9Fh, A3h..AFh, B2h..B3h, B5h, BCh..BFh, CFh, D0h, D2h..D9h				
Reserved for the CompactFlash Association	B7h..BBh				
Retired	11h..1Fh, 71h..7Fh, 94h..99h, DBh..DDh				
Sanitize Device	B4h	O	N	ND	48-bit
SECURITY DISABLE PASSWORD	F6h	O	O	PO	28-bit
SECURITY ERASE PREPARE	F3h	O	O	ND	28-bit
SECURITY ERASE UNIT	F4h	O	O	PO	28-bit
SECURITY FREEZE LOCK	F5h	O	O	ND	28-bit
SECURITY SET PASSWORD	F1h	O	O	PO	28-bit
SECURITY UNLOCK	F2h	O	O	PO	28-bit
SET FEATURES	EFh	M	M	ND	28-bit
SET MULTIPLE MODE	C6h	O	N	ND	28-bit
SLEEP	E6h	M	M	ND	28-bit
SMART	B0h	O	N	ND	
STANDBY	E2h	M	O	ND	28-bit
STANDBY IMMEDIATE	E0h	M	M	ND	28-bit
TRUSTED NON-DATA	5Bh	O	P	ND	28-bit
TRUSTED RECEIVE	5Ch	O	P	PI	28-bit

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

M = Mandatory
O = Optional
N = Use prohibited
E = Retired
R = Reserved
F = If the device does not implement the CFA feature set (see 4.6), this command code is Vendor specific.

Table B.3 — Command codes (sorted by command name) (Sheet 3 of 3)

Command	Command Code	ATA device	ATAPI device	Protocol	Argument
TRUSTED RECEIVE DMA	5Dh	O	P	DM	28-bit
TRUSTED SEND	5Eh	O	P	PO	28-bit
TRUSTED SEND DMA	5Fh	O	P	DM	28-bit
Vendor Specific	80h..86h, 88h..8Fh, 9Ah, C1h..C3h, F0h, F7h, FAh..FFh				
WRITE BUFFER	E8h	O	N	PO	28-bit
WRITE BUFFER DMA	EBh	O	N	DM	28-bit
WRITE DMA	CAh	O	N	DM	28-bit
WRITE DMA EXT	35h	O	N	DM	48-bit
WRITE DMA FUA EXT	3Dh	O	N	DM	48-bit
WRITE FPDMA QUEUED	61h	O	N	DMQ	48-bit
WRITE LOG DMA EXT	57h	O	O	DM	48-bit
WRITE LOG EXT	3Fh	O	O	PO	48-bit
WRITE MULTIPLE	C5h	O	N	PO	28-bit
WRITE MULTIPLE EXT	39h	O	N	PO	48-bit
WRITE MULTIPLE FUA EXT	CEh	O	N	PO	48-bit
WRITE SECTOR(S)	30h	O	N	PO	28-bit
WRITE SECTOR(S) EXT	34h	O	N	PO	48-bit
WRITE STREAM DMA EXT	3Ah	O	N	DM	48-bit
WRITE STREAM EXT	3Bh	O	N	PO	48-bit
WRITE UNCORRECTABLE EXT	45h	O	N	ND	48-bit

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

M = Mandatory
O = Optional
N = Use prohibited
E = Retired
R = Reserved
F = If the device does not implement the CFA feature set (see 4.6), this command code is Vendor specific.

Table B.4 — Historical Command Assignments (Sheet 1 of 10)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2	ACS3
00h	NOP	C	C	C	C	C	C	C	C	C	C
01h		R	R	R	R	R	R	R	R	R	R
02h		R	R	R	R	R	R	R	R	R	R
03h	CFA REQUEST EXTENDED ERROR	R	R	R	C	C	C	C	C	C	C
04h		R	R	R	R	R	R	R	R	R	R
05h		R	R	R	R	R	R	R	R	R	R
06h	DATA SET MANAGEMENT	R	R	R	R	R	R	R	R	C*	C*
07h		R	R	R	R	R	R	R	R	R	R
08h	ATAPI Soft Reset / DEVICE RESET	R	R	C	C	C	C	C	C	C	C
09h		R	R	R	R	R	R	R	R	R	R
0Ah		R	R	R	R	R	R	R	R	R	R
0Bh	REQUEST SENSE DATA EXT	R	R	R	R	R	R	R	R	C	C
0Ch		R	R	R	R	R	R	R	R	R	R
0Dh		R	R	R	R	R	R	R	R	R	R
0Eh		R	R	R	R	R	R	R	R	R	R
0Fh		R	R	R	R	R	R	R	R	R	R
10h	RECALIBRATE	C	C	C	O	O	O	O	O	O	O
11h	RECALIBRATE	C	C	O	E	E	E	E	E	E	E
12h	RECALIBRATE	C	C	O	E	E	E	E	E	E	E
13h	RECALIBRATE	C	C	O	E	E	E	E	E	E	E
14h	RECALIBRATE	C	C	O	E	E	E	E	E	E	E
15h	RECALIBRATE	C	C	O	E	E	E	E	E	E	E
16h	RECALIBRATE	C	C	O	E	E	E	E	E	E	E
17h	RECALIBRATE	C	C	O	E	E	E	E	E	E	E
18h	RECALIBRATE	C	C	O	E	E	E	E	E	E	E
19h	RECALIBRATE	C	C	O	E	E	E	E	E	E	E
1Ah	RECALIBRATE	C	C	O	E	E	E	E	E	E	E
1Bh	RECALIBRATE	C	C	O	E	E	E	E	E	E	E
1Ch	RECALIBRATE	C	C	O	E	E	E	E	E	E	E

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 (see 4.6), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
*Indicates this definition is new to ACS-2.

Table B.4 — Historical Command Assignments (Sheet 2 of 10)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2	ACS3
1Dh	RECALIBRATE	C	C	O	E	E	E	E	E	E	E
1Eh	RECALIBRATE	C	C	O	E	E	E	E	E	E	E
1Fh	RECALIBRATE	C	C	O	E	E	E	E	E	E	E
20h	READ SECTORS	C	C	C	C	C	C	C	C	C	C
21h	READ SECTORS WITHOUT RETRY	C	C	C	C	O	O	O	O	O	O
22h	READ LONG	C	C	C	O	O	O	O	O	O	O
23h	READ LONG WITHOUT RETRY	C	C	C	O	O	O	O	O	O	O
24h	READ SECTORS EXT	R	R	R	R	R	C	C	C	C	C
25h	READ DMA EXT	R	R	R	R	R	C	C	C	C	C
26h	READ DMA QUEUED EXT	R	R	R	R	R	C	C	C	O	O
27h	READ NATIVE MAX ADDRESS EXT	R	R	R	R	R	C	C	C	C	O
28h		R	R	R	R	R	R	R	R	R	R
29h	READ MULTIPLE EXT	R	R	R	R	R	C	C	C	C	C
2Ah	READ STREAM DMA	R	R	R	R	R	R	C	C	C	C
2Bh	READ STREAM	R	R	R	R	R	R	C	C	C	C
2Ch		R	R	R	R	R	R	R	R	R	R
2Dh		R	R	R	R	R	R	R	R	R	R
2Eh		R	R	R	R	R	R	R	R	R	R
2Fh	READ LOG EXT	R	R	R	R	R	C	C	C	C	C
30h	WRITE SECTORS	C	C	C	C	C	C	C	C	C	C
31h	WRITE SECTORS WITHOUT RETRY	C	C	C	C	O	O	O	O	O	O
32h	WRITE LONG	C	C	C	O	O	O	O	O	O	O
33h	WRITE LONG WITHOUT RETRY	C	C	C	O	O	O	O	O	O	O
34h	WRITE SECTORS EXT	R	R	R	R	O	C	C	C	C	C
35h	WRITE DMA EXT	R	R	R	R	R	C	C	C	C	C
36h	WRITE DMA QUEUED EXT	R	R	R	R	R	C	C	C	O	O

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 (see 4.6), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
*Indicates this definition is new to ACS-2.

Table B.4 — Historical Command Assignments (Sheet 3 of 10)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2	ACS3
37h	SET NATIVE MAX ADDRESS EXT	R	R	R	R	R	C	C	C	C	O
38h	CFA WRITE SECTORS WITHOUT ERASE	R	R	R	C	C	C	C	C	C	C
39h	WRITE MULTIPLE EXT	R	R	R	R	R	C	C	C	C	C
3Ah	WRITE STREAM DMA	R	R	R	R	R	R	C	C	C	C
3Bh	WRITE STREAM	R	R	R	R	R	R	C	C	C	C
3Ch	WRITE VERIFY	C	C	C	O	O	O	O	O	O	O
3Dh	WRITE DMA FUA EXT	R	R	R	R	R	R	C	C	C	C
3Eh	WRITE DMA QUEUED FUA EXT	R	R	R	R	R	R	C	C	O	O
3Fh	WRITE LOG EXT	R	R	R	R	R	C	C	C	C	C
40h	READ VERIFY SECTORS	C	C	C	C	C	C	C	C	C	C
41h	READ VERIFY SECTORS WITHOUT RETRY	C	C	C	C	O	O	O	O	O	O
42h	READ VERIFY SECTORS EXT	R	R	R	R	R	C	C	C	C	C
43h		R	R	R	R	R	R	R	R	R	R
44h		R	R	R	R	R	R	R	R	R	R
45h	WRITE UNCORRECTABLE EXT	R	R	R	R	R	R	R	C	C	C
46h		R	R	R	R	R	R	R	R	R	R
47h	READ LOG DMA EXT	R	R	R	R	R	R	R	C	C	C
48h		R	R	R	R	R	R	R	R	R	R
49h		R	R	R	R	R	R	R	R	R	R
4Ah		R	R	R	R	R	R	R	R	R	R
4Bh		R	R	R	R	R	R	R	R	R	R
4Ch		R	R	R	R	R	R	R	R	R	R
4Dh		R	R	R	R	R	R	R	R	R	R
4Eh		R	R	R	R	R	R	R	R	R	R
4Fh		R	R	R	R	R	R	R	R	R	R

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 (see 4.6), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
*Indicates this definition is new to ACS-2.

Table B.4 — Historical Command Assignments (Sheet 4 of 10)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2	ACS3
50h	FORMAT TRACK	C	C	C	O	O	O	O	O	O	O
51h	CONFIGURE STREAM	R	R	R	R	R	R	C	C	C	C
52h		R	R	R	R	R	R	R	R	R	R
53h		R	R	R	R	R	R	R	R	R	R
54h		R	R	R	R	R	R	R	R	R	R
55h		R	R	R	R	R	R	R	R	R	R
56h		R	R	R	R	R	R	R	R	R	R
57h	WRITE LOG DMA EXT	R	R	R	R	R	R	R	C	C	C
58h		R	R	R	R	R	R	R	R	R	R
59h		R	R	R	R	R	R	R	R	R	R
5Ah		R	R	R	R	R	R	R	R	R	R
5Bh	TRUSTED NON-DATA	R	R	R	R	R	R	R	C	C	C
5Ch	TRUSTED RECEIVE	R	R	R	R	R	R	R	C	C	C
5Dh	TRUSTED RECEIVE DMA	R	R	R	R	R	R	R	C	C	C
5Eh	TRUSTED SEND	R	R	R	R	R	R	R	C	C	C
5Fh	TRUSTED SEND DMA	R	R	R	R	R	R	R	C	C	C
60h	READ FPDMA QUEUED	R	R	R	R	R	R	S	C	C	C
61h	WRITE FPDMA QUEUED	R	R	R	R	R	R	S	C	C	C
62h	SATA (reserved)	R	R	R	R	R	R	S	S	S	S
63h	SATA (reserved)	R	R	R	R	R	R	S	S	S	S
64h	SATA (reserved)	R	R	R	R	R	R	S	S	S	S
65h	SATA (reserved)	R	R	R	R	R	R	S	S	S	S
66h	SATA (reserved)	R	R	R	R	R	R	S	S	S	S
67h	SATA (reserved)	R	R	R	R	R	R	S	S	S	S
68h		R	R	R	R	R	R	S	S	S	S
69h		R	R	R	R	R	R	S	S	S	S
6Ah		R	R	R	R	R	R	S	S	S	S
6Bh		R	R	R	R	R	R	S	S	S	S
6Ch		R	R	R	R	R	R	S	S	S	S

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 (see 4.6), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
*Indicates this definition is new to ACS-2.

Table B.4 — Historical Command Assignments (Sheet 5 of 10)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2	ACS3
6Dh		R	R	R	R	R	R	S	S	S	S
6Eh		R	R	R	R	R	R	S	S	S	S
6Fh		R	R	R	R	R	R	S	S	S	S
70h	SEEK	C	C	C	C	C	C	O	O	O	O
71h	SEEK	C	C	O	E	E	E	E	E	E	E
72h	SEEK	C	C	O	E	E	E	E	E	E	E
73h	SEEK	C	C	O	E	E	E	E	E	E	E
74h	SEEK	C	C	O	E	E	E	E	E	E	E
75h	SEEK	C	C	O	E	E	E	E	E	E	E
76h	SEEK	C	C	O	E	E	E	E	E	E	E
77h	SEEK	C	C	O	E	E	E	E	E	E	E
78h	SEEK	C	C	O	E	E	E	E	E	E	E
79h	SEEK	C	C	O	E	E	E	E	E	E	E
7Ah	SEEK	C	C	O	E	E	E	E	E	E	E
7Bh	SEEK	C	C	O	E	E	E	E	E	E	E
7Ch	SEEK	C	C	O	E	E	E	E	E	E	E
7Dh	SEEK	C	C	O	E	E	E	E	E	E	E
7Eh	SEEK	C	C	O	E	E	E	E	E	E	E
7Fh	SEEK	C	C	O	E	E	E	E	E	E	E
80h	(vendor specific)	V	V	V	V	V	V	V	V	V	V
81h	(vendor specific)	V	V	V	V	V	V	V	V	V	V
82h	(vendor specific)	V	V	V	V	V	V	V	V	V	V
83h	(vendor specific)	V	V	V	V	V	V	V	V	V	V
84h	(vendor specific)	V	V	V	V	V	V	V	V	V	V
85h	(vendor specific)	V	V	V	V	V	V	V	V	V	V
86h	(vendor specific)	V	V	V	V	V	V	V	V	V	V
87h	(vendor specific) / CFA TRANSLATE SECTOR	V	V	V	F	F	F	F	F	F	F
88h	(vendor specific)	V	V	V	V	V	V	V	V	V	V
89h	(vendor specific)	V	V	V	V	V	V	V	V	V	V
8Ah	(vendor specific)	V	V	V	V	V	V	V	V	V	V
8Bh	(vendor specific)	V	V	V	V	V	V	V	V	V	V
8Ch	(vendor specific)	V	V	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 (see 4.6), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
*Indicates this definition is new to ACS-2.

Table B.4 — Historical Command Assignments (Sheet 6 of 10)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2	ACS3
8Dh	(vendor specific)	V	V	V	V	V	V	V	V	V	V
8Eh	(vendor specific)	V	V	V	V	V	V	V	V	V	V
8Fh	(vendor specific)	V	V	V	V	V	V	V	V	V	V
90h	EXECUTE DEVICE DIAGNOSTICS	C	C	C	C	C	C	C	C	C	C
91h	INITIALIZE DEVICE PARAMETERS	C	C	C	C	C	O	O	O	O	O
92h	DOWNLOAD MICROCODE	R	C	C	C	C	C	C	C	C	C
93h	DOWNLOAD MICROCODE DMA	R	R	R	R	R	R	R	R	C*	C*
94h	STANDBY IMMEDIATE	C	C	C	E	E	E	E	E	E	E
95h	IDLE IMMEDIATE	C	C	C	E	E	E	E	E	E	E
96h	STANDBY	C	C	C	E	E	E	E	E	E	E
97h	IDLE	C	C	C	E	E	E	E	E	E	E
98h	CHECK POWER MODE	C	C	C	E	E	E	E	E	E	E
99h	SLEEP	C	C	C	E	E	E	E	E	E	E
9Ah	(vendor specific)	V	V	V	V	V	V	V	V	V	V
9Bh		R	R	R	R	R	R	R	R	R	R
9Ch		R	R	R	R	R	R	R	R	R	R
9Dh		R	R	R	R	R	R	R	R	R	R
9Eh		R	R	R	R	R	R	R	R	R	R
9Fh		R	R	R	R	R	R	R	R	R	R
A0h	PACKET	R	R	C	C	C	C	C	C	C	C
A1h	IDENTIFY PACKET DEVICE	R	R	C	C	C	C	C	C	C	C
A2h	SERVICE	R	R	C	C	C	C	C	C	O	O
A3h		R	R	R	R	R	R	R	R	R	R
A4h		R	R	R	R	R	R	R	R	R	R
A5h		R	R	R	R	R	R	R	R	R	R
A6h		R	R	R	R	R	R	R	R	R	R
A7h		R	R	R	R	R	R	R	R	R	R
A8h		R	R	R	R	R	R	R	R	R	R

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 (see 4.6), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
*Indicates this definition is new to ACS-2.

Table B.4 — Historical Command Assignments (Sheet 7 of 10)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2	ACS3
A9h		R	R	R	R	R	R	R	R	R	R
AAh		R	R	R	R	R	R	R	R	R	R
ABh		R	R	R	R	R	R	R	R	R	R
ACh		R	R	R	R	R	R	R	R	R	R
ADh		R	R	R	R	R	R	R	R	R	R
AEh		R	R	R	R	R	R	R	R	R	R
AFh		R	R	R	R	R	R	R	R	R	R
B0h	SMART	R	R	C	C	C	C	C	C	C	C
B1h	DEVICE CONFIGURATION	R	R	R	R	R	C	C	C	C	O
B2h		R	R	R	R	R	R	R	R	R	R
B3h		R	R	R	R	R	R	R	R	R	R
B4h	Sanitize Device	R	R	R	R	R	R	R	R	C*	C*
B5h		R	R	R	R	R	R	R	R	R	R
B6h	NV CACHE	R	R	R	R	R	R	R	C	C	O
B7h	Reserved for the CompactFlash Association	R	R	R	R	R	R	R	R	R	R
B8h	Reserved for the CompactFlash Association	R	R	R	R	A	A	A	A	A	A
B9h	Reserved for the CompactFlash Association	R	R	R	R	A	A	A	A	A	A
BAh	Reserved for the CompactFlash Association	R	R	R	R	A	A	A	A	A	A
BBh	Reserved for the CompactFlash Association	R	R	R	R	A	A	A	A	A	A
BCh	Reserved	R	R	R	R	A	A	A	R	R	R
BDh	Reserved	R	R	R	R	A	A	A	R	R	R
BEh	Reserved	R	R	R	R	A	A	A	R	R	R
BFh	Reserved	R	R	R	R	A	A	A	R	R	R
C0h	(vendor specific) / CFA ERASE SECTORS	V	V	V	F	F	F	F	F	F	F

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 (see 4.6), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
*Indicates this definition is new to ACS-2.

Table B.4 — Historical Command Assignments (Sheet 8 of 10)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2	ACS3
C1h	(vendor specific)	V	V	V	V	V	V	V	V	V	V
C2h	(vendor specific)	V	V	V	V	V	V	V	V	V	V
C3h	(vendor specific)	V	V	V	V	V	V	V	V	V	V
C4h	READ MULTIPLE	C	C	C	C	C	C	C	C	C	C
C5h	WRITE MULTIPLE	C	C	C	C	C	C	C	C	C	C
C6h	SET MULTIPLE MODE	C	C	C	C	C	C	C	C	C	C
C7h	READ DMA QUEUED	R	R	R	C	C	C	C	C	O	O
C8h	READ DMA	C	C	C	C	C	C	C	C	C	C
C9h	READ DMA WITHOUT RETRIES	C	C	C	C	O	O	O	O	O	O
CAh	WRITE DMA	C	C	C	C	C	C	C	C	C	C
CBh	WRITE DMA WITHOUT RETRIES	C	C	C	C	O	O	O	O	O	O
CCh	WRITE DMA QUEUED	R	R	R	C	C	C	C	C	O	O
CDh	CFA WRITE MULTIPLE WITHOUT ERASE	R	R	R	C	C	C	C	C	C	C
CEh	WRITE MULTIPLE FUA EXT	R	R	R	R	R	R	C	C	C	C
CFh		R	R	R	R	R	R	R	R	R	R
D0h		R	R	R	R	R	R	R	R	R	R
D1h	CHECK MEDIA CARD TYPE	R	R	R	R	R	C	C	C	O	O
D2h	Reserved for the Media Card Pass Through Command feature set	R	R	R	R	R	M	M	M	R	R
D3h	Reserved for the Media Card Pass Through Command feature set	R	R	R	R	R	M	M	M	R	R
D4h	Reserved for the Media Card Pass Through Command feature set	R	R	R	R	R	M	M	M	R	R

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 (see 4.6), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
*Indicates this definition is new to ACS-2.

Table B.4 — Historical Command Assignments (Sheet 9 of 10)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2	ACS3
D5h		R	R	R	R	R	R	R	R	R	R
D6h		R	R	R	R	R	R	R	R	R	R
D7h		R	R	R	R	R	R	R	R	R	R
D8h		R	R	R	R	R	R	R	R	R	R
D9h		R	R	R	R	R	R	R	R	R	R
DAh	GET MEDIA STATUS	R	R	R	C	C	C	C	O	O	O
DBh	ACKNOWLEDGE MEDIA CHANGE	C	C	O	E	E	E	E	E	E	E
DCh	BOOT POST BOOT	C	C	O	E	E	E	E	E	E	E
DDh	BOOT PRE BOOT	C	C	O	E	E	E	E	E	E	E
DEh	MEDIA LOCK	C	C	C	C	C	C	C	O	O	O
DFh	MEDIA UNLOCK	C	C	C	C	C	C	C	O	O	O
E0h	STANDBY IMMEDIATE	C	C	C	C	C	C	C	C	C	C
E1h	IDLE IMMEDIATE	C	C	C	C	C	C	C	C	C	C
E2h	STANDBY	C	C	C	C	C	C	C	C	C	C
E3h	IDLE	C	C	C	C	C	C	C	C	C	C
E4h	READ BUFFER	C	C	C	C	C	C	C	C	C	C
E5h	CHECK POWER MODE	C	C	C	C	C	C	C	C	C	C
E6h	SLEEP	C	C	C	C	C	C	C	C	C	C
E7h	FLUSH CACHE	R	R	R	C	C	C	C	C	C	C
E8h	WRITE BUFFER	C	C	C	C	C	C	C	C	C	C
E9h	(WRITE SAME) READ BUFFER DMA	C	C	O	E	E	E	E	E	C*	C*
EAh	FLUSH CACHE EXT	R	R	R	R	R	C	C	C	C	C
EBh	WRITE BUFFER DMA	R	R	R	R	R	R	R	R	C*	C*

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 (see 4.6), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
*Indicates this definition is new to ACS-2.

Table B.4 — Historical Command Assignments (Sheet 10 of 10)

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2	ACS3
ECh	IDENTIFY DEVICE	C	C	C	C	C	C	C	C	C	C
EDh	MEDIA EJECT	R	C	C	C	C	C	C	O	O	O
EEh	IDENTIFY DEVICE DMA	R	R	C	O	O	O	O	O	O	O
EFh	SET FEATURES	C	C	C	C	C	C	C	C	C	C
F0h	(vendor specific)	V	V	V	V	V	V	V	V	V	V
F1h	SECURITY SET PASSWORD	V	V	C	C	C	C	C	C	C	C
F2h	SECURITY UNLOCK	V	V	C	C	C	C	C	C	C	C
F3h	SECURITY ERASE PREPARE	V	V	C	C	C	C	C	C	C	C
F4h	SECURITY ERASE UNIT	V	V	C	C	C	C	C	C	C	C
F5h	SECURITY FREEZE LOCK	V	V	C	C	C	C	C	C	C	C
F6h	SECURITY DISABLE PASSWORD	V	V	C	C	C	C	C	C	C	C
F7h	(vendor specific)	V	V	V	V	V	V	V	V	V	V
F8h	READ NATIVE MAX ADDRESS	V	V	V	C	C	C	C	C	C	O
F9h	SET MAX ADDRESS	V	V	V	C	C	C	C	C	C	O
FAh	(vendor specific)	V	V	V	V	V	V	V	V	V	V
FBh	(vendor specific)	V	V	V	V	V	V	V	V	V	V
FCh	(vendor specific)	V	V	V	V	V	V	V	V	V	V
FDh	(vendor specific)	V	V	V	V	V	V	V	V	V	V
FEh	(vendor specific)	V	V	V	V	V	V	V	V	V	V
FFh	(vendor specific)	V	V	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 (see 4.6), this command code is Vendor specific.
M = Reserved for the Media Card Pass Through Command feature set.
S = Reserved for Serial ATA.
*Indicates this definition is new to ACS-2.

Table B.5 — Historical SET FEATURE Code Assignments (Sheet 1 of 9)

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
01h	Enable 8-bit data transfers	C	C	O	E	F	F	F	F	F
02h	Enable write cache	V	V	C	C	C	C	C	C	C
03h	Set transfer mode	C	C	C	C	C	C	C	C	C
04h	Enable all automatic defect reassignment	R	R	C	O	O	O	O	O	O
05h	Enable advanced power management	R	R	R	C	C	C	C	C	C
06h	Enable Power-Up in Standby feature set	R	R	R	R	C	C	C	C	C
07h	Power-up in Standby feature set device spin-up	R	R	R	R	C	C	C	C	C
09h	Reserved for Address offset reserved boot area method technical report	R	R	R	R	C	C	C	C	C
0Ah	Enable CFA power mode 1	R	R	R	R	C	C	C	C	C
0Bh	Reserved	R	R	R	R	R	R	R	R	R
0Ch	Reserved	R	R	R	R	R	R	R	R	R
0Dh	Reserved	R	R	R	R	R	R	R	R	R
0Eh	Reserved	R	R	R	R	R	R	R	R	R
0Fh	Reserved	R	R	R	R	R	R	R	R	R
10h	Enable use of SATA feature	R	R	R	R	R	R	S	C	C
11h	Reserved	R	R	R	R	R	R	R	R	R
12h	Reserved	R	R	R	R	R	R	R	R	R
13h	Reserved	R	R	R	R	R	R	R	R	R
14h	Reserved	R	R	R	R	R	R	R	R	R
15h	Reserved	R	R	R	R	R	R	R	R	R
16h	Reserved	R	R	R	R	R	R	R	R	R
17h	Reserved	R	R	R	R	R	R	R	R	R
18h	Reserved	R	R	R	R	R	R	R	R	R
19h	Reserved	R	R	R	R	R	R	R	R	R
1Ah	Reserved	R	R	R	R	R	R	R	R	R
1Bh	Reserved	R	R	R	R	R	R	R	R	R

Key:

C = a defined command.
E = a retired command.
O = Obsolete.
R = Reserved, undefined in current specifications.
V = Vendor specific command.
A = Reserved for assignment by the CompactFlash Association.
F = If the device does not implement the CFA feature set (see 4.6), 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).
*Indicates this definition is new to ACS-2

Table B.5 — Historical SET FEATURE Code Assignments (Sheet 2 of 9)

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
1Ch	Reserved	R	R	R	R	R	R	R	R	R
1Dh	Reserved	R	R	R	R	R	R	R	R	R
1Eh	Reserved	R	R	R	R	R	R	R	R	R
1Fh	Reserved	R	R	R	R	R	R	R	R	R
20h	Reserved for Technical Report (T13/DT1696)	R	R	R	R	R	R	T	T	T
21h	Reserved for Technical Report (T13/DT1696)	R	R	R	R	R	R	T	T	T
22h	Reserved	R	R	R	R	R	R	R	R	R
23h	Reserved	R	R	R	R	R	R	R	R	R
24h	Reserved	R	R	R	R	R	R	R	R	R
25h	Reserved	R	R	R	R	R	R	R	R	R
26h	Reserved	R	R	R	R	R	R	R	R	R
27h	Reserved	R	R	R	R	R	R	R	R	R
28h	Reserved	R	R	R	R	R	R	R	R	R
29h	Reserved	R	R	R	R	R	R	R	R	R
2Ah	Reserved	R	R	R	R	R	R	R	R	R
2Bh	Reserved	R	R	R	R	R	R	R	R	R
2Ch	Reserved	R	R	R	R	R	R	R	R	R
2Dh	Reserved	R	R	R	R	R	R	R	R	R
2Eh	Reserved	R	R	R	R	R	R	R	R	R
2Fh	Reserved	R	R	R	R	R	R	R	R	R
30h	Reserved	R	R	R	R	R	R	R	R	R
31h	Disable Media Status Notification	R	R	R	C	C	C	C	O	O
32h	Reserved	R	R	R	R	R	R	R	R	R
33h	Disable retry	V	V	C	C	O	O	O	O	O
34h	Reserved	R	R	R	R	R	R	R	R	R
35h	Reserved	R	R	R	R	R	R	R	R	R
36h	Reserved	R	R	R	R	R	R	R	R	R
37h	Reserved	R	R	R	R	R	R	R	R	R
38h	Reserved	R	R	R	R	R	R	R	R	R
39h	Reserved	R	R	R	R	R	R	R	R	R

Key:

C = a defined command.
E = a retired command.
O = Obsolete.
R = Reserved, undefined in current specifications.
V = Vendor specific command.
A = Reserved for assignment by the CompactFlash Association.

F = If the device does not implement the CFA feature set (see 4.6), 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).
*Indicates this definition is new to ACS-2

Table B.5 — Historical SET FEATURE Code Assignments (Sheet 3 of 9)

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
3Ah	Reserved	R	R	R	R	R	R	R	R	R
3Bh	Reserved	R	R	R	R	R	R	R	R	R
3Ch	Reserved	R	R	R	R	R	R	R	R	R
3Dh	Reserved	R	R	R	R	R	R	R	R	R
3Eh	Reserved	R	R	R	R	R	R	R	R	R
3Fh	Reserved	R	R	R	R	R	R	R	R	R
40h	Reserved	R	R	R	R	R	R	R	R	R
41h	Enable Free-fall Control feature set	R	R	R	R	R	R	R	C	C
42h	Enable Automatic Acoustic Management feature set	R	R	R	R	R	C	C	C	O
43h	Set Maximum Host Interface Sector Times	R	R	R	R	R	R	C	C	C
44h	Vendor specific length of ECC on read long/write long commands	C	C	C	O	O	O	O	O	O
45h	Reserved	R	R	R	R	R	R	R	R	R
46h	Reserved	R	R	R	R	R	R	R	R	R
47h	Reserved	R	R	R	R	R	R	R	R	R
48h	Reserved	R	R	R	R	R	R	R	R	R
49h	Reserved	R	R	R	R	R	R	R	R	R
4Ah	Extended Power Conditions	R	R	R	R	R	R	R	R	C*
4Bh	Reserved	R	R	R	R	R	R	R	R	R
4Ch	Reserved	R	R	R	R	R	R	R	R	R
4Dh	Reserved	R	R	R	R	R	R	R	R	R
4Eh	Reserved	R	R	R	R	R	R	R	R	R
4Fh	Reserved	R	R	R	R	R	R	R	R	R
50h	Reserved	R	R	R	R	R	R	R	R	R
51h	Reserved	R	R	R	R	R	R	R	R	R
52h	Reserved	R	R	R	R	R	R	R	R	R
53h	Reserved	R	R	R	R	R	R	R	R	R
54h	Set cache segments to the Count field value	V	V	C	O	O	O	O	O	O

Key:

C = a defined command.
E = a retired command.
O = Obsolete.
R = Reserved, undefined in current specifications.
V = Vendor specific command.
A = Reserved for assignment by the CompactFlash Association.
F = If the device does not implement the CFA feature set (see 4.6), 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).
*Indicates this definition is new to ACS-2

Table B.5 — Historical SET FEATURE Code Assignments (Sheet 4 of 9)

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
55h	Disable read look-ahead feature	C	C	C	C	C	C	C	C	C
56h	Vendor Specific	R	R	R	R	R	R	R	V	V
57h	Vendor Specific	R	R	R	R	R	R	R	V	V
58h	Vendor Specific	R	R	R	R	R	R	R	V	V
59h	Vendor Specific	R	R	R	R	R	R	R	V	V
5Ah	Vendor Specific	R	R	R	R	R	R	R	V	V
5Bh	Vendor Specific	R	R	R	R	R	R	R	V	V
5Ch	Vendor Specific	R	R	R	R	R	R	R	V	V
5Dh	Enable release interrupt	R	R	R	C	C	C	C	C	O*
5Eh	Enable SERVICE interrupt	R	R	R	C	C	C	C	C	O*
5Fh	Reserved	R	R	R	R	R	R	R	R	R
60h	Reserved	R	R	R	R	R	R	R	R	R
61h	Reserved	R	R	R	R	R	R	R	R	R
62h	Reserved	R	R	R	R	R	R	R	R	R
63h	Reserved	R	R	R	R	R	R	R	R	R
64h	Reserved	R	R	R	R	R	R	R	R	R
65h	Reserved	R	R	R	R	R	R	R	R	R
66h	Disable reverting to power on defaults	C	C	C	C	C	C	C	C	C
67h	Reserved	R	R	R	R	R	R	R	R	R
68h	Reserved	R	R	R	R	R	R	R	R	R
69h	Long Physical Sector Alignment Error Reporting Control	R	R	R	R	R	R	R	R	C*
6Ah	Reserved	R	R	R	R	R	R	R	R	R
6Bh	Reserved	R	R	R	R	R	R	R	R	R
6Ch	Reserved	R	R	R	R	R	R	R	R	R
6Dh	Reserved	R	R	R	R	R	R	R	R	R
6Eh	Reserved	R	R	R	R	R	R	R	R	R
6Fh	Reserved	R	R	R	R	R	R	R	R	R
70h	Reserved	R	R	R	R	R	R	R	R	R
71h	Reserved	R	R	R	R	R	R	R	R	R

Key:

C = a defined command.
E = a retired command.
O = Obsolete.
R = Reserved, undefined in current specifications.
V = Vendor specific command.
A = Reserved for assignment by the CompactFlash Association.
F = If the device does not implement the CFA feature set (see 4.6), 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).
*Indicates this definition is new to ACS-2

Table B.5 — Historical SET FEATURE Code Assignments (Sheet 5 of 9)

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
72h	Reserved	R	R	R	R	R	R	R	R	R
73h	Reserved	R	R	R	R	R	R	R	R	R
74h	Reserved	R	R	R	R	R	R	R	R	R
75h	Reserved	R	R	R	R	R	R	R	R	R
76h	Reserved	R	R	R	R	R	R	R	R	R
77h	Disable ECC	V	V	C	O	O	O	O	O	O
78h	Reserved	R	R	R	R	R	R	R	R	R
79h	Reserved	R	R	R	R	R	R	R	R	R
7Ah	Reserved	R	R	R	R	R	R	R	R	R
7Bh	Reserved	R	R	R	R	R	R	R	R	R
7Ch	Reserved	R	R	R	R	R	R	R	R	R
7Dh	Reserved	R	R	R	R	R	R	R	R	R
7Eh	Reserved	R	R	R	R	R	R	R	R	R
7Fh	Reserved	R	R	R	R	R	R	R	R	R
80h	Reserved	R	R	R	R	R	R	R	R	R
81h	Disable 8-bit data transfers	C	C	O	E	F	F	F	F	F
82h	Disable write cache	V	V	C	C	C	C	C	C	C
83h	Reserved	R	R	R	R	R	R	R	R	R
84h	Disable all automatic defect reassignment	R	R	C	O	O	O	O	O	O
85h	Disable advanced power management	R	R	R	C	C	C	C	C	C
86h	Disable Power-Up in Standby feature set	R	R	R	R	C	C	C	C	C
87h	Reserved	R	R	R	R	R	R	R	R	R
88h	Enable ECC	V	V	C	C	C	O	O	O	O
89h	Reserved for Address offset reserved boot area method technical report	R	R	R	R	C	C	C	C	C
8Ah	Disable CFA power mode 1	R	R	R	R	C	C	F	F	F
8Bh	Reserved	R	R	R	R	R	R	R	R	R
8Ch	Reserved	R	R	R	R	R	R	R	R	R
8Dh	Reserved	R	R	R	R	R	R	R	R	R

Key:

C = a defined command.
E = a retired command.
O = Obsolete.
R = Reserved, undefined in current specifications.
V = Vendor specific command.
A = Reserved for assignment by the CompactFlash Association.
F = If the device does not implement the CFA feature set (see 4.6), 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).
*Indicates this definition is new to ACS-2

Table B.5 — Historical SET FEATURE Code Assignments (Sheet 6 of 9)

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
8Eh	Reserved	R	R	R	R	R	R	R	R	R
8Fh	Reserved	R	R	R	R	R	R	R	R	R
90h	Disable use of SATA feature	R	R	R	R	R	R	S	C	C
91h	Reserved	R	R	R	R	R	R	R	R	R
92h	Reserved	R	R	R	R	R	R	R	R	R
93h	Reserved	R	R	R	R	R	R	R	R	R
94h	Reserved	R	R	R	R	R	R	R	R	R
95h	Enable Media Status Notification	R	R	R	C	C	C	C	O	O
96h	Reserved	R	R	R	R	R	R	R	R	R
97h	Reserved	R	R	R	R	R	R	R	R	R
98h	Reserved	R	R	R	R	R	R	R	R	R
99h	Enable retries	V	V	C	O	O	O	O	O	O
9Ah	Set device maximum average current	R	R	C	O	O	O	O	O	O
9Bh	Reserved	R	R	R	R	R	R	R	R	R
9Ch	Reserved	R	R	R	R	R	R	R	R	R
9Dh	Reserved	R	R	R	R	R	R	R	R	R
9Eh	Reserved	R	R	R	R	R	R	R	R	R
9Fh	Reserved	R	R	R	R	R	R	R	R	R
A0h	Reserved	R	R	R	R	R	R	R	R	R
A1h	Reserved	R	R	R	R	R	R	R	R	R
A2h	Reserved	R	R	R	R	R	R	R	R	R
A3h	Reserved	R	R	R	R	R	R	R	R	R
A4h	Reserved	R	R	R	R	R	R	R	R	R
A5h	Reserved	R	R	R	R	R	R	R	R	R
A6h	Reserved	R	R	R	R	R	R	R	R	R
A7h	Reserved	R	R	R	R	R	R	R	R	R
A8h	Reserved	R	R	R	R	R	R	R	R	R
A9h	Reserved	R	R	R	R	R	R	R	R	R
AAh	Enable read look-ahead features	C	C	C	C	C	C	C	C	C

Key:

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O = Obsolete.
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V = Vendor specific command.
A = Reserved for assignment by the CompactFlash Association.
F = If the device does not implement the CFA feature set (see 4.6), 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).
*Indicates this definition is new to ACS-2

Table B.5 — Historical SET FEATURE Code Assignments (Sheet 7 of 9)

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
ABh	Set maximum prefetch using the Count field value	V	V	C	O	O	O	O	O	O
ACh	Reserved	R	R	R	R	R	R	R	R	R
ADh	Reserved	R	R	R	R	R	R	R	R	R
AEh	Reserved	R	R	R	R	R	R	R	R	R
AFh	Reserved	R	R	R	R	R	R	R	R	R
B0h	Reserved	R	R	R	R	R	R	R	R	R
B1h	Reserved	R	R	R	R	R	R	R	R	R
B2h	Reserved	R	R	R	R	R	R	R	R	R
B3h	Reserved	R	R	R	R	R	R	R	R	R
B4h	Reserved	R	R	R	R	R	R	R	R	R
B5h	Reserved	R	R	R	R	R	R	R	R	R
B6h	Reserved	R	R	R	R	R	R	R	R	R
B7h	Reserved	R	R	R	R	R	R	R	R	R
B8h	Reserved	R	R	R	R	R	R	R	R	R
B9h	Reserved	R	R	R	R	R	R	R	R	R
BAh	Reserved	R	R	R	R	R	R	R	R	R
BBh	4 bytes of ECC apply on read long/write long commands	C	C	C	O	O	O	O	O	O
BCh	Reserved	R	R	R	R	R	R	R	R	R
BDh	Reserved	R	R	R	R	R	R	R	R	R
BEh	Reserved	R	R	R	R	R	R	R	R	R
BFh	Reserved	R	R	R	R	R	R	R	R	R
C0h	Reserved	R	R	R	R	R	R	R	R	R
C1h	Disable Free-fall Control feature set	R	R	R	R	R	R	R	C	C
C2h	Disable Automatic Acoustic Management feature set	R	R	R	R	R	C	C	C	O
C3h	Enabled/Disable the Sense Data Reporting feature set	R	R	R	R	R	R	R	R	C
C4h	Reserved	R	R	R	R	R	R	R	R	R
C5h	Reserved	R	R	R	R	R	R	R	R	R
C6h	Reserved	R	R	R	R	R	R	R	R	R

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*Indicates this definition is new to ACS-2

Table B.5 — Historical SET FEATURE Code Assignments (Sheet 8 of 9)

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
C7h	Reserved	R	R	R	R	R	R	R	R	R
C8h	Reserved	R	R	R	R	R	R	R	R	R
C9h	Reserved	R	R	R	R	R	R	R	R	R
CAh	Reserved	R	R	R	R	R	R	R	R	R
CBh	Reserved	R	R	R	R	R	R	R	R	R
CCh	Enable reverting to power on defaults	C	C	C	C	C	C	C	C	C
CDh	Reserved	R	R	R	R	R	R	R	R	R
CEh	Reserved	R	R	R	R	R	R	R	R	R
CFh	Reserved	R	R	R	R	R	R	R	R	R
D0h	Reserved	R	R	R	R	R	R	R	R	R
D1h	Reserved	R	R	R	R	R	R	R	R	R
D2h	Reserved	R	R	R	R	R	R	R	R	R
D3h	Reserved	R	R	R	R	R	R	R	R	R
D4h	Reserved	R	R	R	R	R	R	R	R	R
D5h	Reserved	R	R	R	R	R	R	R	R	R
D6h	Vendor Specific	R	R	R	R	R	R	R	V	V
D7h	Vendor Specific	R	R	R	R	R	R	R	V	V
D8h	Vendor Specific	R	R	R	R	R	R	R	V	V
D9h	Vendor Specific	R	R	R	R	R	R	R	V	V
DAh	Vendor Specific	R	R	R	R	R	R	R	V	V
DBh	Vendor Specific	R	R	R	R	R	R	R	V	V
DCh	Vendor Specific	R	R	R	R	R	R	R	V	V
DDh	Disable release interrupt	R	R	R	C	C	C	C	C	O*
DEh	Disable SERVICE interrupt	R	R	R	C	C	C	C	C	O*
DFh	Reserved	R	R	R	R	R	R	R	R	R
E0h	Vendor specific	R	R	R	R	R	R	O	O	O
E1h	Reserved	R	R	R	R	R	R	R	R	R
E2h	Reserved	R	R	R	R	R	R	R	R	R
E3h	Reserved	R	R	R	R	R	R	R	R	R
E4h	Reserved	R	R	R	R	R	R	R	R	R
E5h	Reserved	R	R	R	R	R	R	R	R	R

Key:

C = a defined command.
E = a retired command.
O = Obsolete.
R = Reserved, undefined in current specifications.
V = Vendor specific command.
A = Reserved for assignment by the CompactFlash Association.
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*Indicates this definition is new to ACS-2

Table B.5 — Historical SET FEATURE Code Assignments (Sheet 9 of 9)

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8	ACS2
E6h	Reserved	R	R	R	R	R	R	R	R	R
E7h	Reserved	R	R	R	R	R	R	R	R	R
E8h	Reserved	R	R	R	R	R	R	R	R	R
E9h	Reserved	R	R	R	R	R	R	R	R	R
EAh	Reserved	R	R	R	R	R	R	R	R	R
EBh	Reserved	R	R	R	R	R	R	R	R	R
ECh	Reserved	R	R	R	R	R	R	R	R	R
EDh	Reserved	R	R	R	R	R	R	R	R	R
EEh	Reserved	R	R	R	R	R	R	R	R	R
EFh	Reserved	R	R	R	R	R	R	R	R	R
F0h		R	R	R	R	A	A	A	A	A
F1h		R	R	R	R	A	A	A	A	A
F2h		R	R	R	R	A	A	A	A	A
F3h		R	R	R	R	A	A	A	A	A
F4h		R	R	R	R	A	A	A	A	A
F5h		R	R	R	R	A	A	A	A	A
F6h		R	R	R	R	A	A	A	A	A
F7h		R	R	R	R	A	A	A	A	A
F8h		R	R	R	R	A	A	A	A	A
F9h		R	R	R	R	A	A	A	A	A
FAh		R	R	R	R	A	A	A	A	A
FBh		R	R	R	R	A	A	A	A	A
FCh		R	R	R	R	A	A	A	A	A
FDh		R	R	R	R	A	A	A	A	A
FEh		R	R	R	R	A	A	A	A	A
FFh		R	R	R	R	A	A	A	A	A

Key:

C = a defined command.
E = a retired command.
O = Obsolete.
R = Reserved, undefined in current specifications.
V = Vendor specific command.
A = Reserved for assignment by the CompactFlash Association.

F = If the device does not implement the CFA feature set (see 4.6), this command code is Vendor specific.
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Annex C

(Informative)

Design and programming considerations for large physical sector devices

C.1 Physical sectors

Because the 512-byte sector has been a constant since the beginning of ATA many software changes are required if device logical sectors were made larger. To preserve the legacy software that assumes a 512-byte logical sector, logical addressing based on 512-byte sectors has been retained. Larger physical sectors are implemented as power of two multiples of the logical sector size (e.g., 1, 2, 4, 8, 16). For example, devices may have physical sectors that are eight logical sectors long (i.e., 4 096 bytes). Reporting a logical sector that spans two physical sectors in not defined by this standard.

C.2 Unaligned write

While allowing a logical sector to be smaller than a physical sector maintains software compatibility, it introduces a potential performance issue (i.e., unaligned write) which should be avoided. A physical sector is written to the media in a single operation. To complete a write command that writes a fraction of a physical sector the device reads the entire physical sector into buffer memory, updates the buffer memory with the write data, then writes the entire physical sector to the media. This may incur a performance penalty of one media revolution or more.

Write commands may 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 should begin with the first sector of a physical sector and end with the last sector of a physical sector.

Figure C.1 is an example of an unaligned write on a device with 2 048 byte physical sectors. The first four logical sectors, LBA 0 - LBA 3, reside on physical sector 0. To write only LBA 3 the host sends a conventional write command and the data for LBA 3. On receipt of the write command the device seeks to the physical sector that contains LBA 3, which is physical sector 0. If physical sector 0 is read into the device's buffer, then the new write data for LBA 3 is placed in the buffer, overwriting a segment of the buffer. The buffer data is then written to the media, physical sector 0.

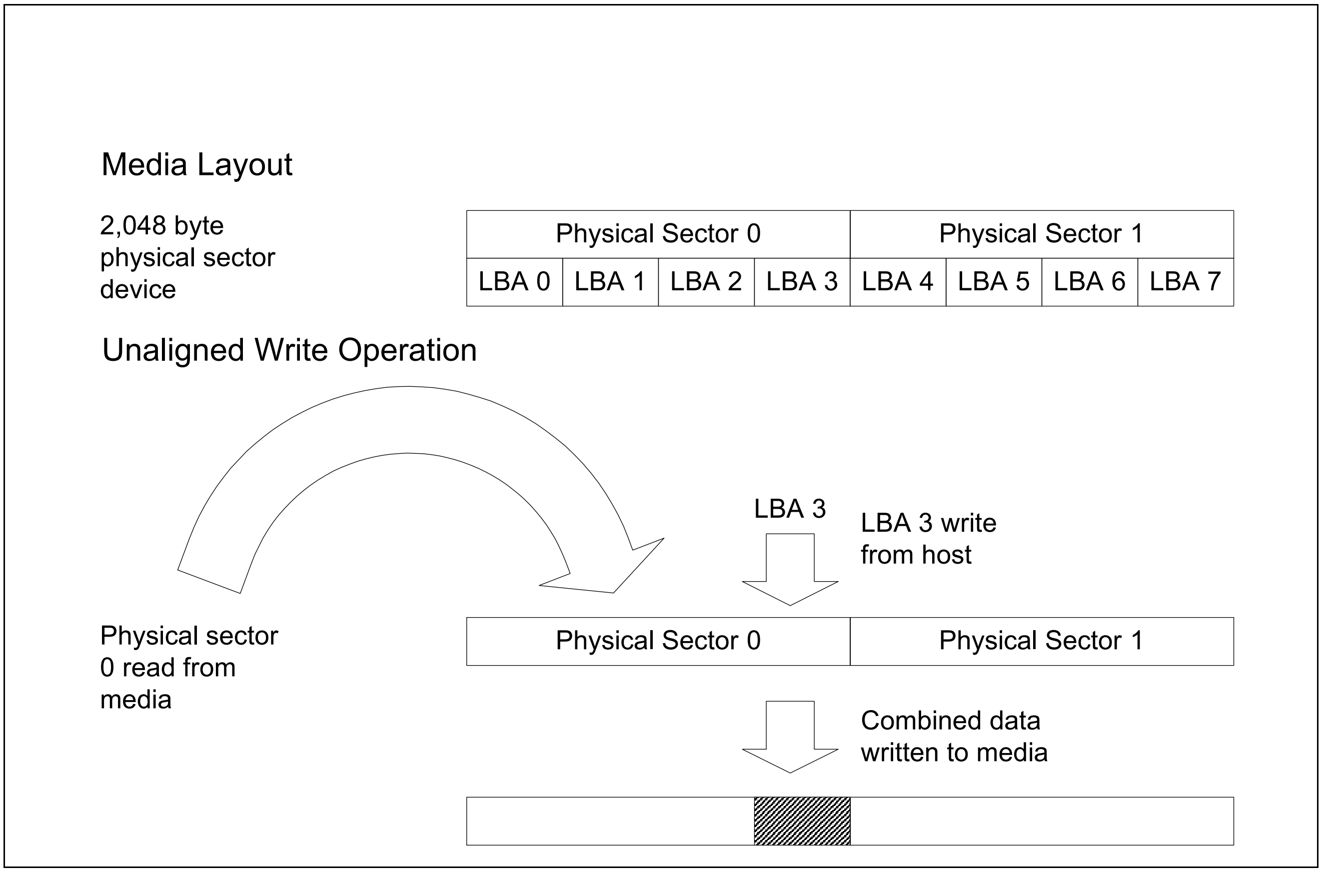

Figure C.1 — Unaligned Write Example

C.3 Software compatibility

Even though this specification allows devices to report up to 2^{15} (i.e., 32 768) logical sectors per physical sector there are file system limitations in existing systems that restrict practical device implementations to 4 096 bytes per physical sector.

Annex D

(Informative)

How to use SCT commands

D.1 How to use SCT commands overview

SCT commands use the following standard ATA commands:

a) SMART READ LOG;
b) SMART WRITE LOG;
c) READ LOG EXT;
d) READ LOG DMA EXT;
e) WRITE LOG EXT; and
f) WRITE LOG DMA EXT.

As viewed on the ATA transport, an SCT command is seen as data being transferred by these commands. However, from the perspective of a device that implements this feature set, this data is interpreted as an SCT command request, an SCT command response, SCT command status, or SCT command data.

Figure D.1 is an example flowchart that shows how to process SCT commands using read log commands and write log commands:

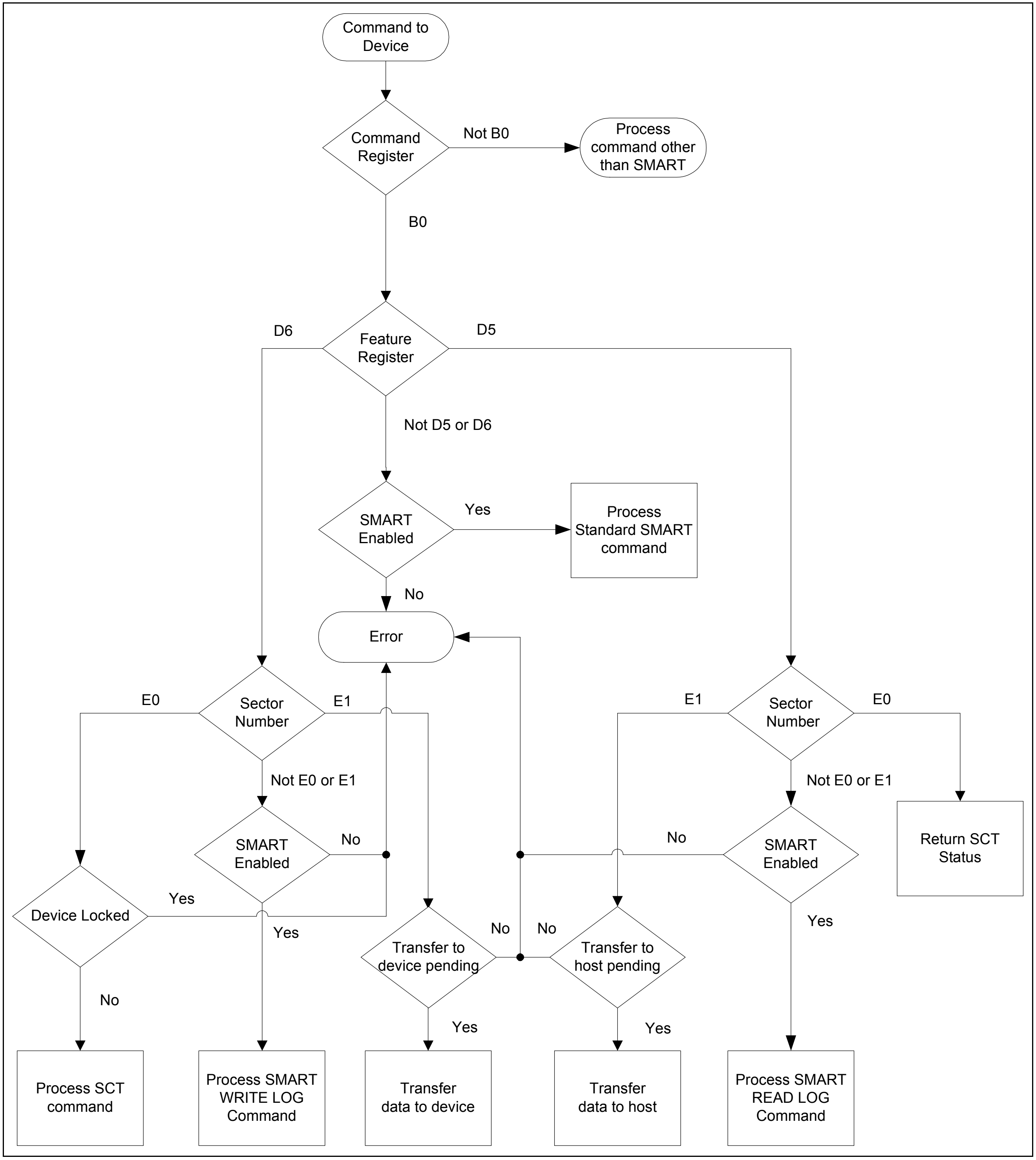

Figure D.1 — Example flowchart for SCT commands

D.2 Examples of Log page command sequences

Figure D.2 shows an example of a foreground write same with a repeating write pattern.

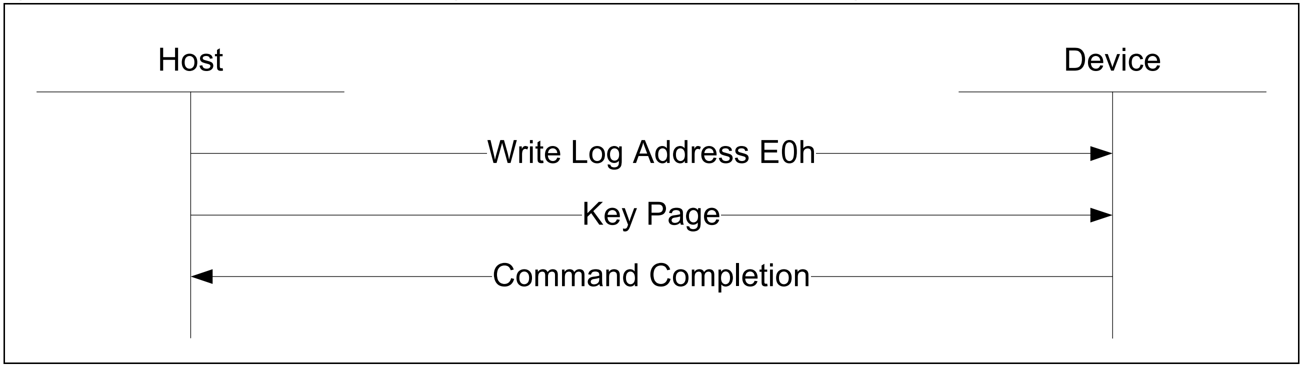

Figure D.2 — Example sequence for foreground write same with a repeating pattern

Figure D.3 shows an example of a foreground write same with a repeating sector.

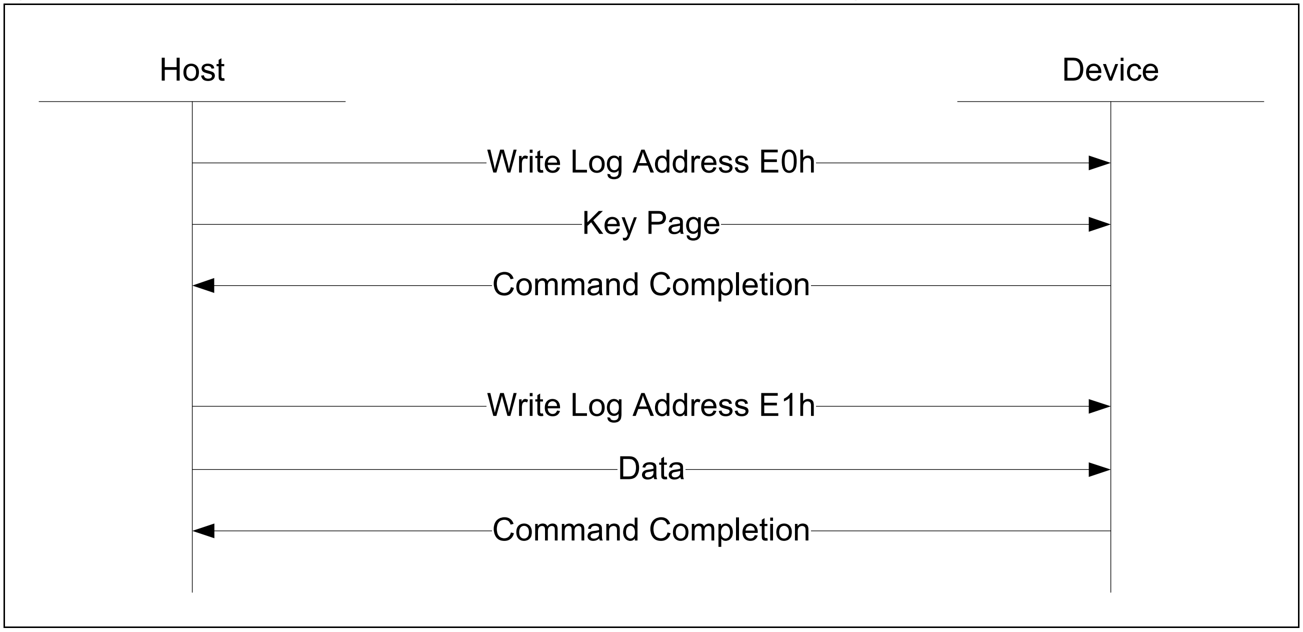

Figure D.3 — Example sequence for foreground write same with a repeating sector

Figure D.4 shows an example command sequence for writing data to a device using an SCT command with no background activity.

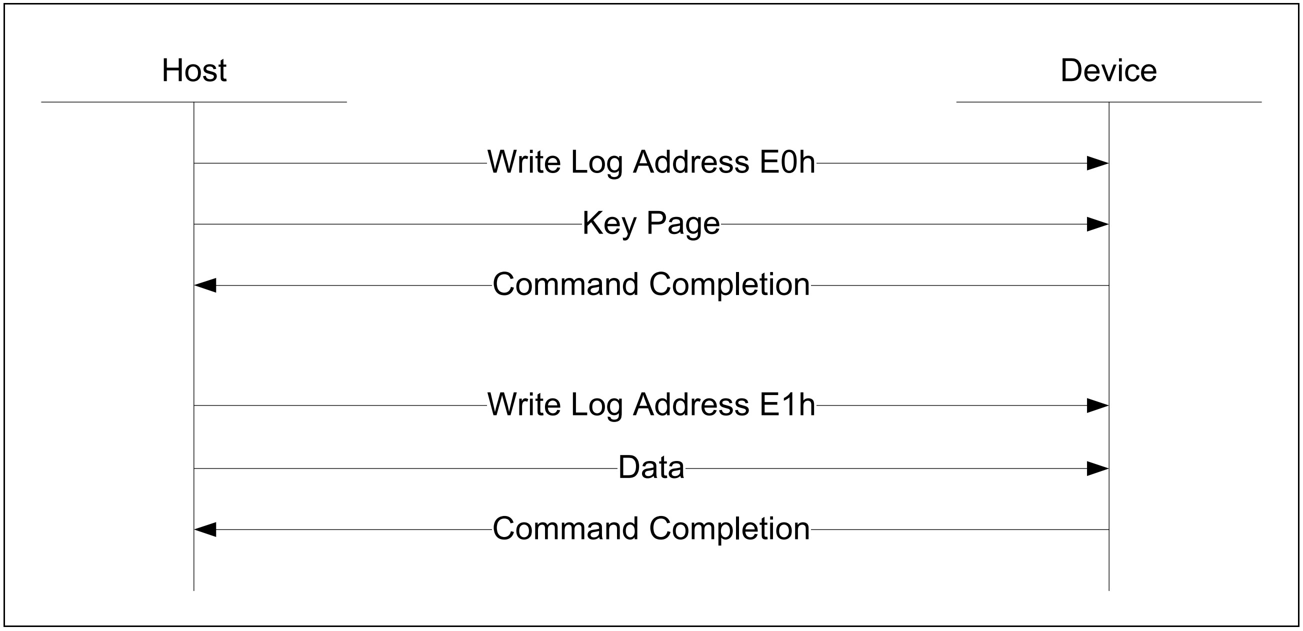

Figure D.4 — Example sequence for writing data using an SCT command with no background activity

Figure D.5 shows an example command sequence for reading data from a device using an SCT command with no background activity.

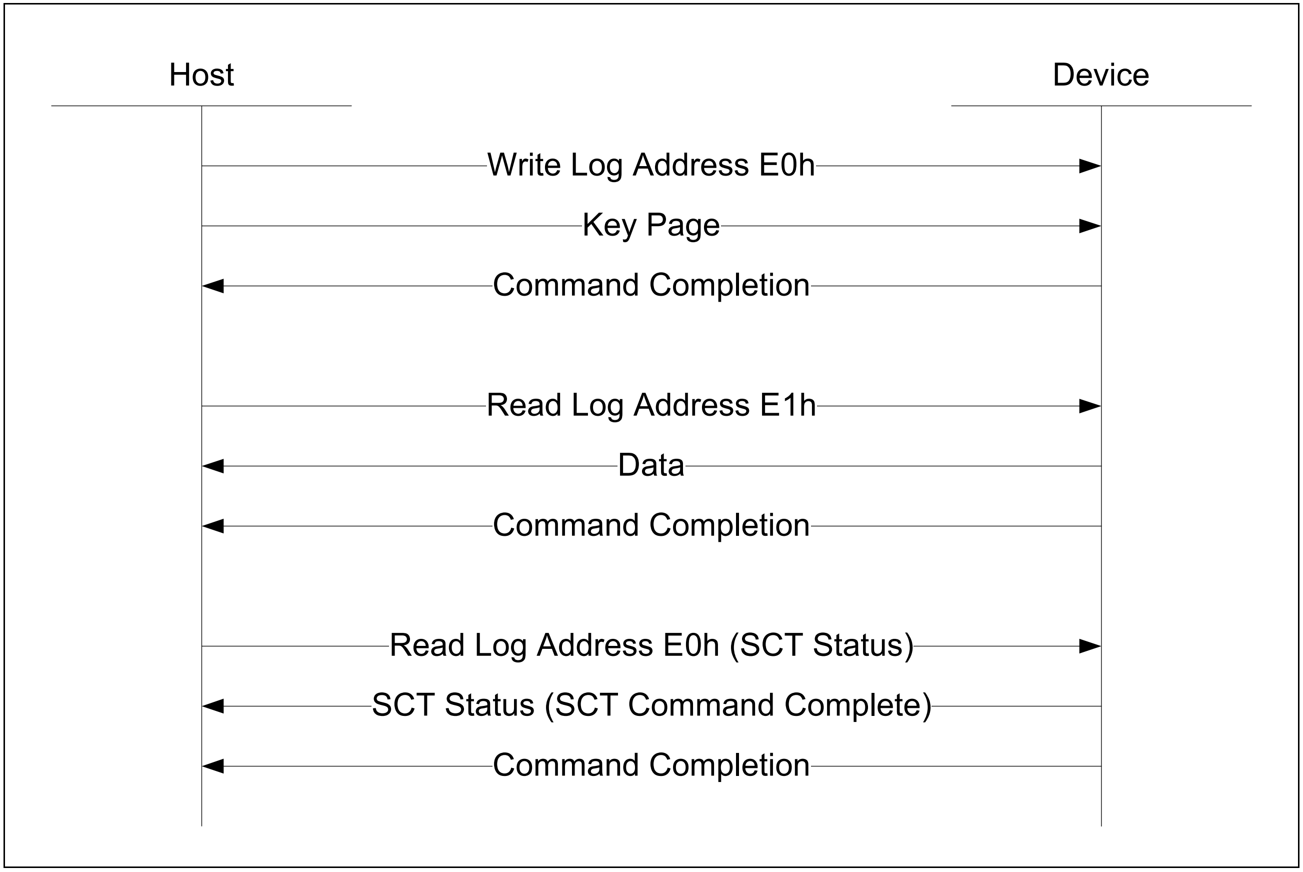

Figure D.5 — Example sequence for reading data using an SCT command with no background activity

Figure D.6 shows an example command sequence for issuing a Log page command that does not transfer data and has no background activity.

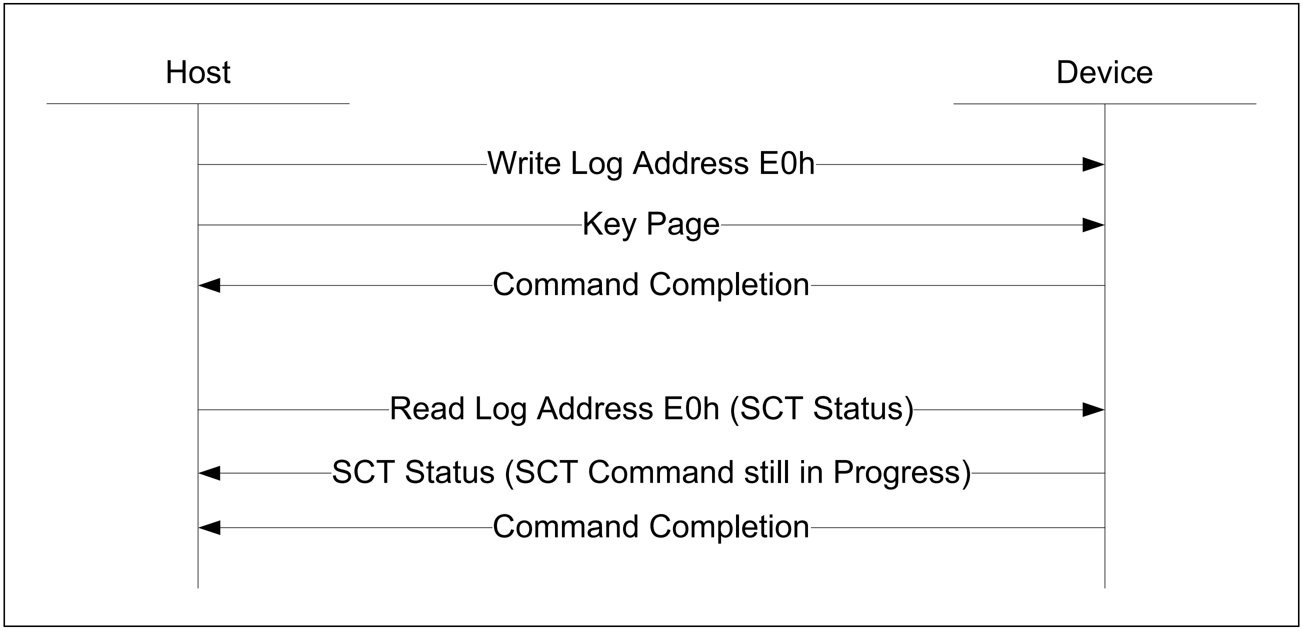

Figure D.6 — Example sequence for a Non-Data SCT command with no background activity

Figure D.7 shows an example command sequence for issuing an SCT command that writes data in the background.

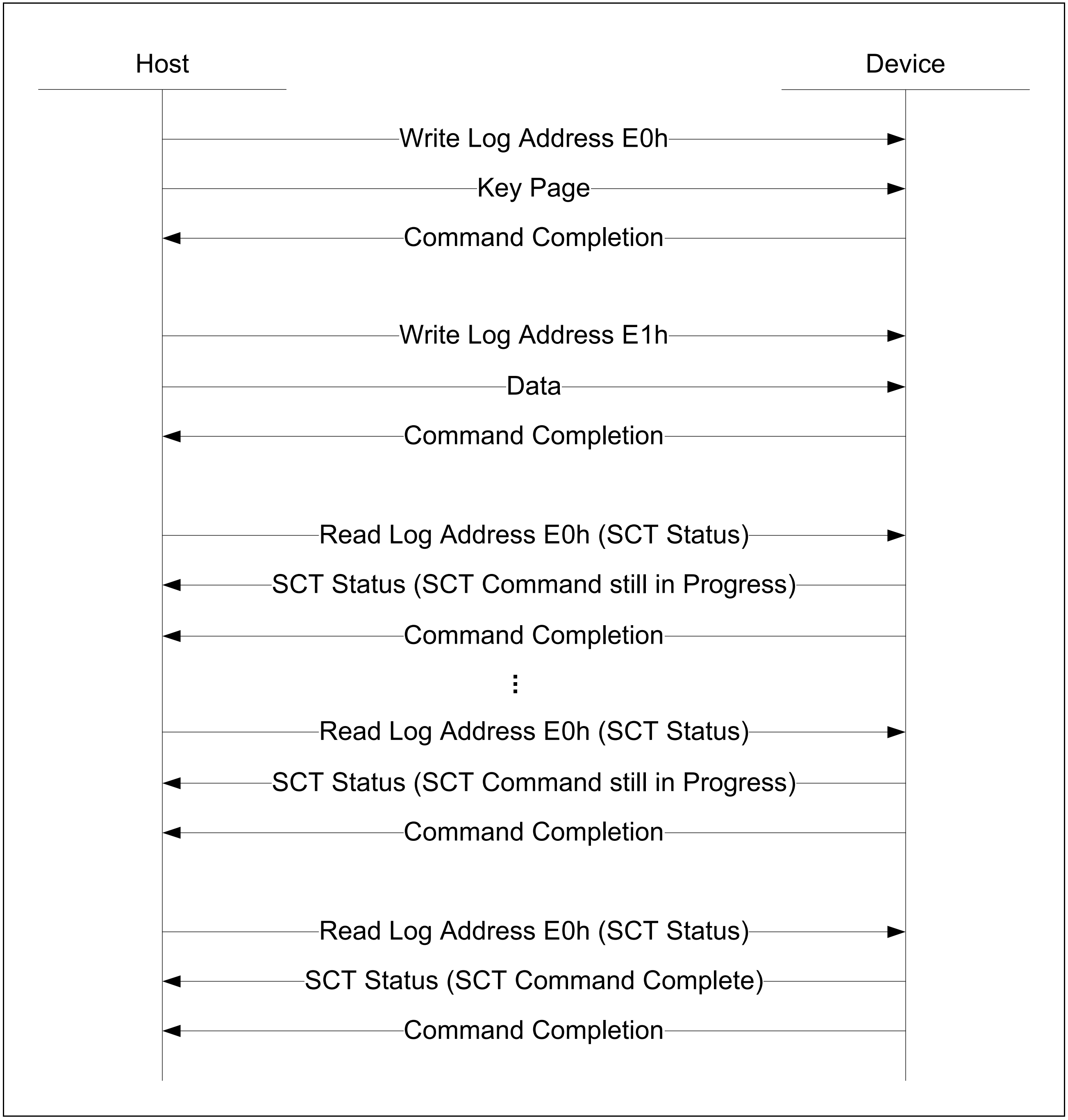

Figure D.7 — Example sequence for writing data using an SCT command with background activity

Figure D.8 shows an example command sequence for issuing an SCT command that is processed in the background but does not require the transfer of data to or from the host.

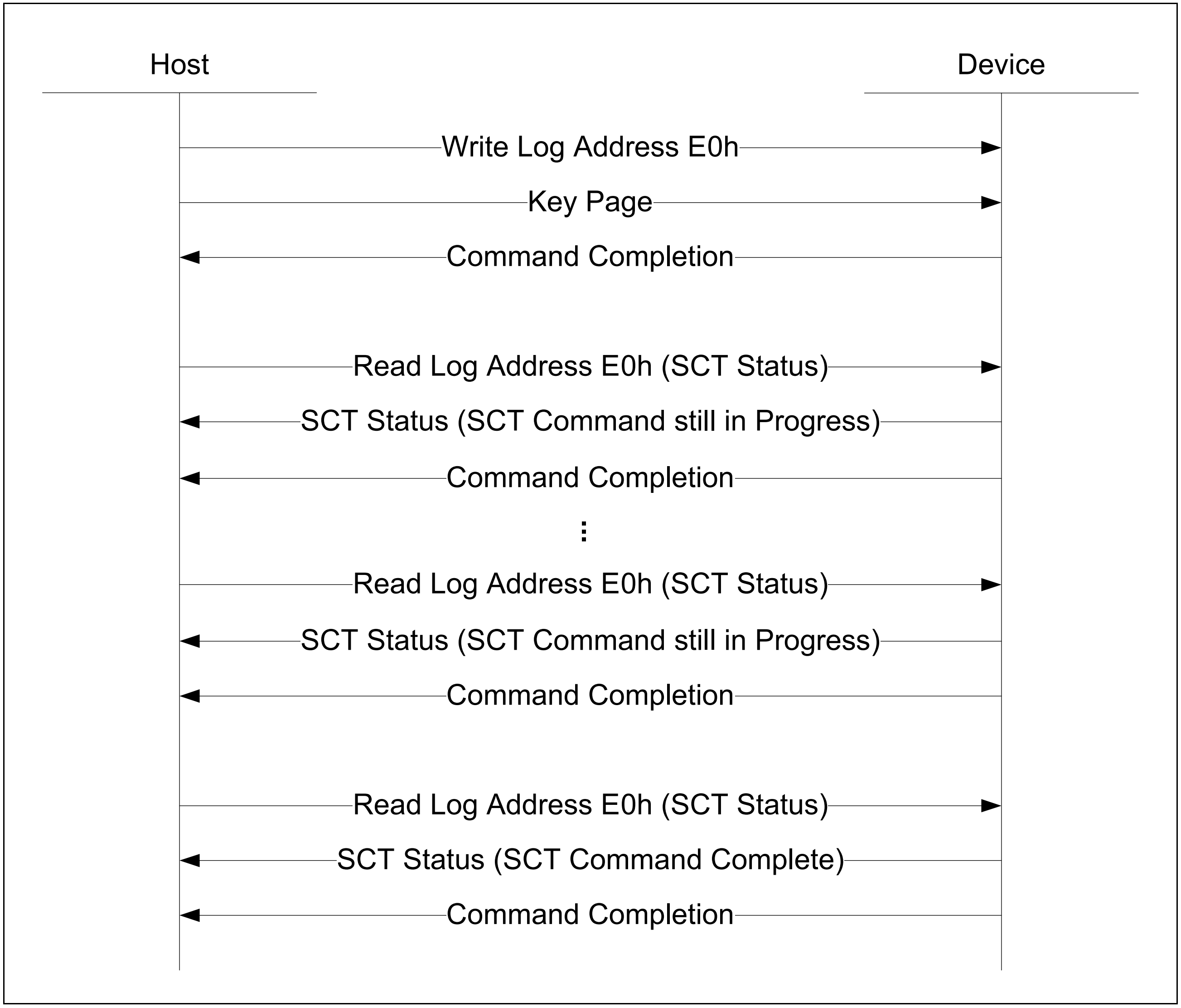

Figure D.8 — Example sequence for a Non-Data SCT command with background activity

D.3 Issuing an SCT command to a device

D.3.1 Step 1 - Build a Key Page

The host builds the key page 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 D.1 or table D.2), and sends the key page to the device.

Table D.1 — SCT command using SMART WRITE LOG command

Name	Description
Feature	D6h (e.g., SMART WRITE LOG)
Count	01h
LBA	**Bit Description** 27:24 N/A 23:8 C24Fh 7:0 E0h (e.g., SCT Command/Status log address)
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 B0h

Table D.2 — SCT command using WRITE LOG EXT command

Name	Description
Feature	Reserved
Count	0001h (e.g., one sector for SCT commands)
LBA	**Bit Description** 47:40 Reserved 39:32 00h 31:16 Reserved 15:8 00h 7:0 E0h (e.g., SCT Command/Status log address)
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent - See 6.2.12 3:0 Reserved
Command	7:0 3Fh (e.g., WRITE LOG EXT) 57h (e.g., WRITE LOG DMA EXT)

If the SCT command is successful, then the device responds with successful status (see table 156). If the command is aborted (i.e., Status = 51h and Error = 04h), then either the key page format is invalid, the command structure contains an invalid value or the command encountered a processing error. The host checks the Count field and LBA (7:0) field for the error code (see table 157 and table 158). 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 may be partial output available (e.g., on a sector read command, the data up to and including the sector in error is available) and the host may proceed to Step 3 to get the partial data. In some cases the error is not fatal and serves only as a warning.

If the status is 50h, then the host checks LBA (23:8). If LBA (23:8) is cleared to 0000h, 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 command, READ LOG DMA EXT command, or READ LOG EXT command to the SCT Data Transfer log (see table 159 and table 160). To transfer data from the host to the device, the host issues a SMART WRITE LOG command, WRITE LOG DMA EXT command, or WRITE LOG EXT command to the SCT Data Transfer log (see table 159 and table 160). The transfer request is in the range of one sector up to the total number of sectors not yet transferred. The number of sectors remaining was posted in the LBA (23:8) field 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 than 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 (23:8) field the number of sectors remaining to be transferred. If the Number of Sectors Transferred field and the LBA (23:8) field are set to 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. If the number of sectors to be transferred is greater than or equal to FFFFh, the device sets LBA (23:8) 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 (e.g., SCT Write Same command) 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 161, table 162, and table 163) to determine how the command completed. If the command has not completed (i.e., by reporting FFFFh in table 163 byte 14), then the host waits a vendor specific 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.

Annex E

(Informative)

Implementation Guidelines For 1 024 and 4 096 Byte Sector Sizes

E.1 Scope

This annex provides guidelines for implementing a media format that incorporates sector sizes greater than 512 bytes.

The information provided in this annex enables sector sizes that are a binary multiple greater than 512 bytes. This standard also specifies methods to report sector sizes that are not a binary multiple. Common sector sizes that are not binary multiples include 520, 524, 528 and 532 byte sectors. Non-binary multiples are beyond the scope of this annex.

E.2 Overview

Figure E.1 shows major system components that are affected by a change in sector size.

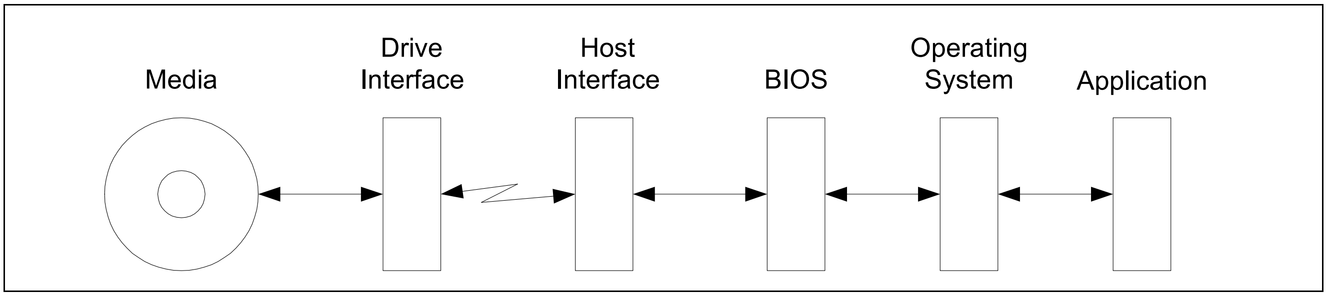

Figure E.1 — System Dependency Chain

The following methods may be used to expand the sector size:

a) Native Physical Sector Size method (i.e., the physical sector size is seen at the drive interface); or
b) 512-byte Emulation method (i.e., keeps the 512-byte logical sector size at the drive interface). Figure E.2 illustrates these methods.

	Today	512-Byte LB[a]	Physical Sector Size LB [a]	512-Byte LB[a]	Physical Sector Size LB[a]
Interface Sector Size	512 Bytes	512 Bytes	1 024 Bytes	512 Bytes	4 096 Bytes
		Requires RMW, is compatible with the System Dependency Chain [b] chain	Incompatible with the System Dependency Chain [b], does not require RMW	Requires RMW, is compatible with the System Dependency Chain [b] chain	Incompatible with the System Dependency Chain [b], does not require RMW
Media Sector Size	512 Bytes	1 024 Bytes	1 024 Bytes	4 096 Bytes	4 096 Bytes

[a] Logical Block
[b] See figure E.1. The system dependency chain is evolving and may change to support logical sector sizes larger than 512 bytes.

Figure E.2 — Mapping Proposals

Using the 512-byte Logical Block method, the Drive Interface, Host Interface, BIOS, Operating System, and Applications still function. Optimal performance is achieved if the OS were modified to properly align the disk accesses. The 512-byte Logical Block method also allows a drive manufacturer to ship a utility with the unit that optimizes performance. If the Physical Sector Size Logical Block method is employed, the existing Drive Interface, Host Interface, BIOS, OS, and Applications may not function. The reason they may not function is that many components in the System Dependency Chain (see figure E.1) only support 512-byte logical blocks. If the host interface is able to transfer the data, it is likely that the BIOS is only implemented to handle 512-byte logical blocks. If the BIOS does support the larger logical block size, it is likely the operating system is written to only handle 512-byte logical sectors. In the case where the BIOS or host interface only supports 512-byte logical blocks, no code may reasonably be used to fix the problem.

This standard specifies a method of aligning 512-byte logical sectors with larger physical sectors by specifying LBA alignment requirements using the IDENTIFY DEVICE command (see 7.16), the Long Logical feature set (see 4.10), and Long Physical Sector feature set (see 4.11). Figure E.3 is an example of the capability specified in this standard.

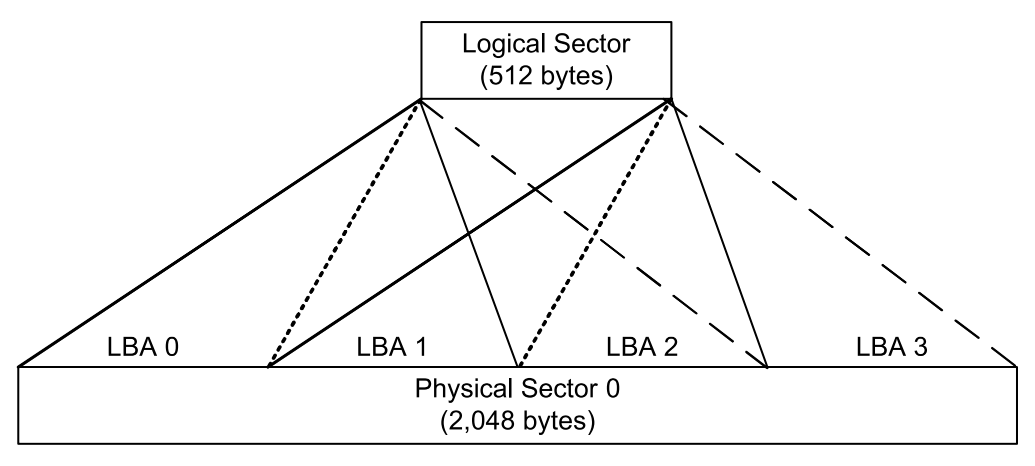

Figure E.3 — Logical Sector to Physical Mapping

In this example, the interface sector size (i.e., logical sector size) is 512 bytes, and the physical sector size is 2 048 bytes. This allows an ATA device to both implement a larger physical sector and maintain compatibility with existing systems, interfaces, and software. One of the drawbacks of this method is that drive performance may suffer if the host writes data starting or ending on an LBA that is misaligned with respect to the physical sector boundaries. When misalignment occurs, the drive is forced to perform a Read-Modify-Write (RMW) operation in order to satisfy the host request.

This standard also allows the ATA device to report that a Logical Sector size is the same as a physical sector size. This allows an ATA device to implement a native 4 096-byte sector on the media and requires that transfers be 4 096 bytes of data for each logical block requested. This method avoids RMWs. The main drawback of this implementation is that existing systems, interfaces, BIOS and system software, OS and otherwise, have to change in order to accommodate the device.

E.3 Implementation

E.3.1 4 096-Byte Sector Size Implementation

The 4 096-byte physical sector size allows for greater format efficiencies, however, 4 096-byte physical sectors causes alignment issues.

The device indicates a 4 096-byte sector size to the host by:

a) returning 6003h in IDENTIFY DEVICE data word 106 (see 7.16.7.56) indicating that the device has eight 512-byte logical sectors to compose a 4 096-byte physical sector. The host may use this information to know that transfers should start with an LBA where the low order 3 bits are zero and the transfer ends on an LBA where the low order 3 bits are one; or
b) returning 5000h in IDENTIFY DEVICE data word 106 and 0800h in IDENTIFY DEVICE data words 117..118 (see 7.16.7.61) indicating that the device has one 4 096-byte logical sector per 4 096-byte physical sector. The host may use this information to know that transfers require 4 096 bytes per logical block requested.

E.3.2 Reporting Alignment (512-Byte LBA Only)

This standard defines the ability to report alignment by placing the sector number of the first alignment point in IDENTIFY DEVICE data word 209 (see 7.16.7.76).

If the drive reports a 4 096-byte physical sector and a 512-byte logical sector, the following IDENTIFY DEVICE data word 209 values report the alignment:

a) if word 209 = 4000h, then LBA 0 is aligned to the beginning for the first physical sector;
b) if word 209 = 4001h, then LBA 0 is offset from the start of the first physical sector by 512 bytes (i.e., 1 sector);
c) if word 209 = 4002h, then LBA 0 is offset from the start of the first physical sector by 1 024 bytes (i.e., 2 sectors);
d) if word 209 = 4003h, then LBA 0 is offset from the start of the first physical sector by 1 536 bytes (i.e., 3 sectors);
e) if word 209 = 4004h, then LBA 0 is offset from the start of the first physical sector by 2 048 bytes (i.e., 4 sectors);
f) if word 209 = 4005h, then LBA 0 is offset from the start of the first physical sector by 2 560 bytes (i.e., 5 sectors);
g) if word 209 = 4006h, then LBA 0 is offset from the start of the first physical sector by 3 072 bytes (i.e., 6 sectors); and
h) if word 209 = 4007h, then LBA 0 is offset from the start of the first physical sector by 3 584 bytes (i.e., 7 sectors).

For systems that use Windows® XP and earlier, and have devices formatted with a single partition, the optimal value is 4001h.

Windows® XP and earlier do not check the Logical Sector size field or Physical Sector size field reported in IDENTIFY DEVICE data (see table 46).

E.3.3 Read-Modify-Write (RMW) (512-Byte LBA Only)

For devices with a logical sector size of 512 bytes, the drive may be forced to perform RMW when it receives an unaligned transfer. Write commands do not provide a way to return an error other than an Abort (see 6.3.2) or a Device Fault (see 6.2.7). If there is an uncorrectable error encountered during the initial read operation, the Write command has no way to report the issue. This error may affect logical sectors not accessed by the Write command. There are several possible solutions to choose from in providing the information to the host. Figure E.4 shows the issue.

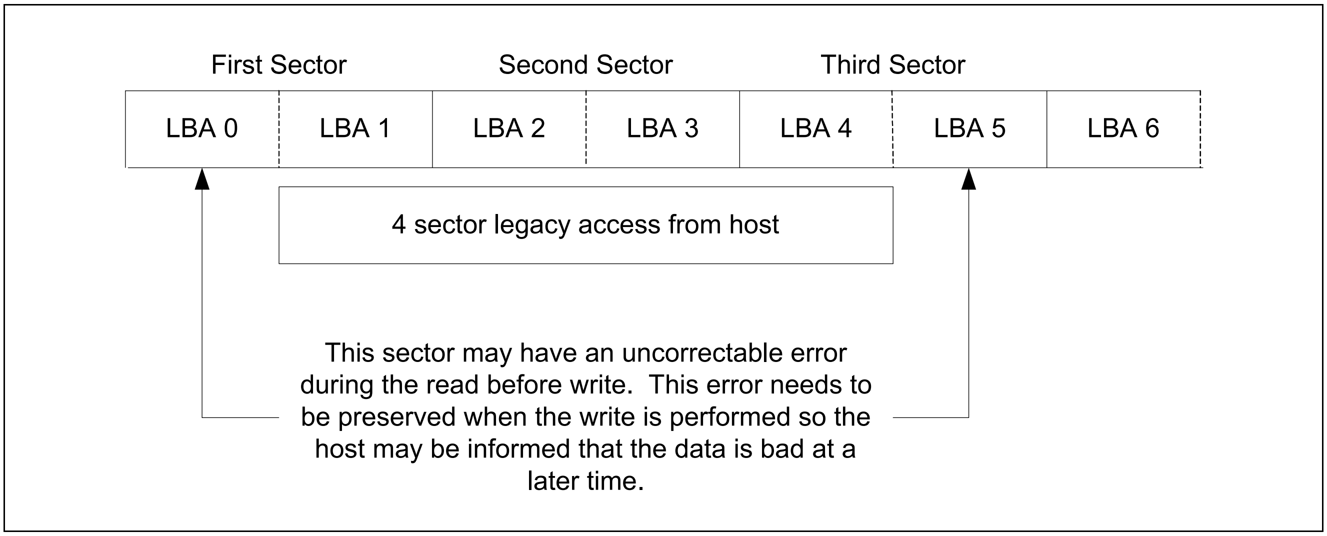

Figure E.4 — Uncorrectable Error Handling

E.4 Implementation Issues (512-Byte LBA Only)

E.4.1 Overview

Although the implementation described here allows a drive to function in a legacy system without modification, there are some issues that are critical in allowing the drive to perform at peak efficiency. Figure E.5 describes a typical device media layout showing the positions of the Master Boot Record (i.e., MBR), BIOS Parameter Block, and the remainder of a File Allocation Table based file system. This layout varies based on the type of File Allocation Table file system used, but all the elements described here are generally present. The sector numbers on the left hand side of Figure E.5 show typical and/or legacy locations for the various data structures on the media.

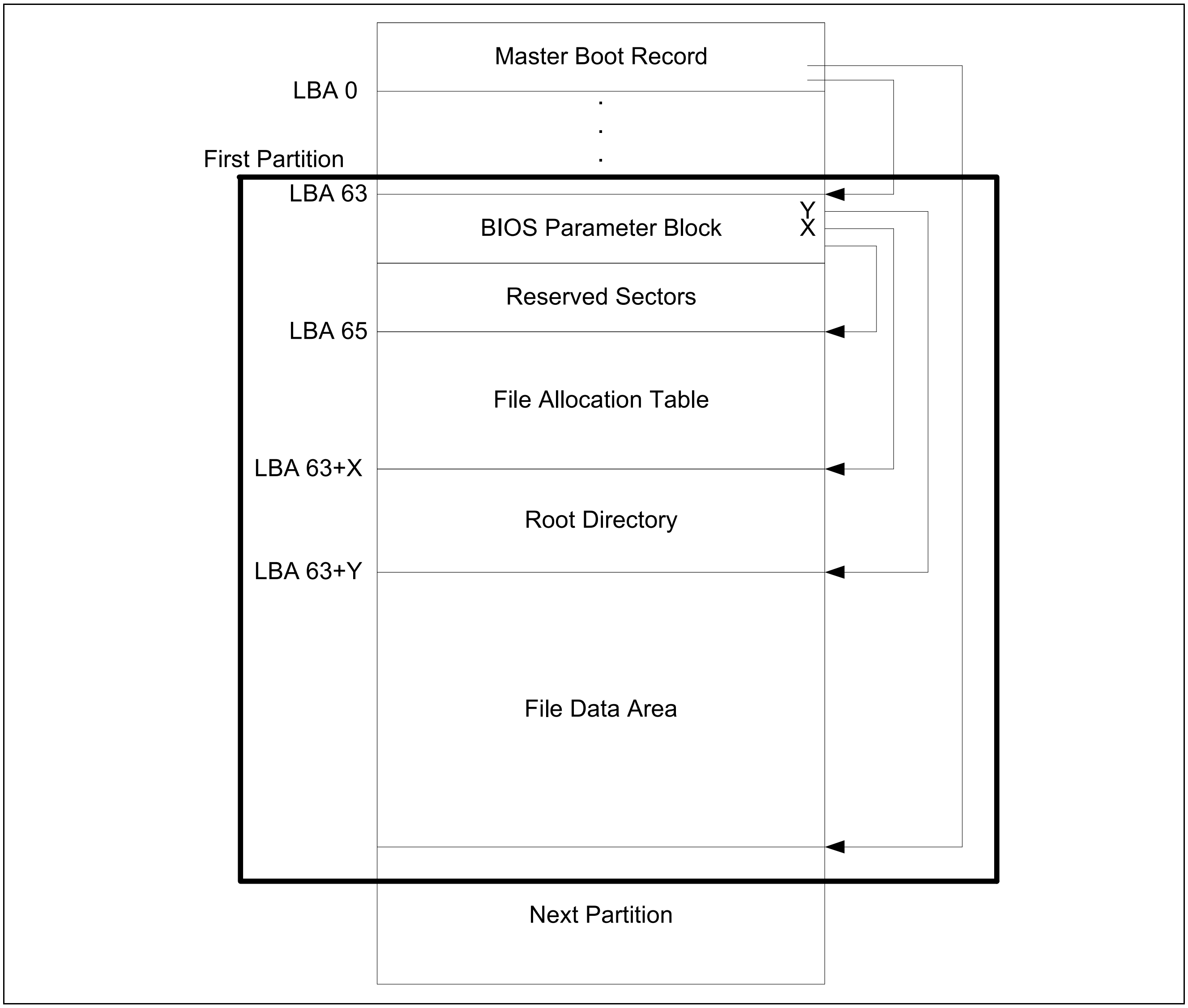

Figure E.5 — Typical HDD Layout Using A Master Boot Record

E.4.2 Drive Partitioning

Prior to the year 1994, typical disk partitioning software placed the Master Boot Record at Cylinder 0, Head 0, and sector 1 (i.e., LBA 0). The Master Boot Record contains a pointer to the first partition. The common practice was to place first partition at Cylinder 0 Head 1, sector 1 (i.e., the LBA value of the first sector in the first partition varied). Once the sectors per track standardized on 63, the LBA value of the first sector in the first partition standardized on LBA 63. In the year 2010, there are some applications that check to make sure that partitions start on a track boundary, even though there is no meaning for cylinders heads and sectors.

As larger sectors occur, partition alignment becomes an important issue that affects applications that check if the first partition starts on sector 63 (e.g., on a 512-byte sector device, all the partitions should start on an LBA that is aligned with the start of a physical sector on the media, on a 1 024-byte sector device, the partitions should start on an even numbered sector and end on an odd numbered sector, and on a 4 096-byte sector device, the partitions should start on an LBA where the low order three bits are zero).

For drives that use 512-byte LBA, all partitions should start on an LBA that is aligned with the start of a physical sector on the media. This affects some applications that check to make sure the first partition starts on sector 63, but a change is required to implement larger sectors on the media.

E.4.3 File System Formatting

There are many file systems that cluster sectors together to create an allocation unit larger than a single 512-byte sector. These file systems generally implement a table to associate clusters with files, commonly called a File Allocation Table. A typical cluster size is 4 096 bytes (i.e., eight 512-byte sectors). Even if the Partition is properly aligned, there is an issue where the size of the File Allocation Table may cause the individual clusters in the File Data Area to be unaligned relative to the physical sectors on the media resulting in performance degradation.

If the clusters in the file system are properly aligned, file accesses are naturally aligned resulting in optimum performance.

E.4.4 Virtual Memory accessing

Once the clusters in the file system are aligned, the OS memory manager needs to be modified to prevent unaligned accesses. When a device has alignment requirements, device performance tests may show acceptable performance, but if the virtual memory activity is not aligned, CPU performance tests may provide unacceptable results.

E.4.5 Booting

The devices with alignment requirements should not show significant performance degradation on unaligned reads. Since booting is mainly a reading process, an impact on system boot times in an unaligned environment is not expected.