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Subject:	Public Review and Comments Register for the Approval of:
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Due Date:	**The public review is from April 2, 2021 to June 1, 2021.**

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Working Draft American National Standard

Project T13/BSR INCITS 558

Revision 10
March 3, 2021

Information technology - ATA Command Set - 5 (ACS-5)

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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. This standard maintains a high degree of compatibility with the ATA/ATAPI Command Set - 4 (ACS-4).

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Foreword

(This foreword is not part of this standard.)

This standard is designed to maintain a high degree of compatibility with the ACS-4 standard.

Requests for interpretation, suggestions for improvement and addenda, or defect reports are welcome. They should be sent to the INCITS Secretariat, ITI, 700 K Street NW, Suite 600, Washington, DC 20001.

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 INCITS approved this standard, INCITS had the following members:

Name	Company
TBD	

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

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Company	Name
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 feature set definitions.
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 logs.
Clause 10 describes command normal and error outputs.
Annex A provides command summaries.
Annex B provides a tutorial on how to use SCT.
Annex C provides implementation guidelines for 1 024/4 096 byte sectors.
Annex D provides a tutorial on how to use the DATA SET MANAGEMENT command with Trim.
Annex E provides a tutorial on how to use repurposing depopulation.
Bibliography is the bibliography for this standard.

American National Standard
for Information Technology –

ATA Command Set - 5 (ACS-5)

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). This standard specifies the command set that host systems use to access storage devices. This standard 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 other ATA standards as well as related device and host standards and specifications (e.g., SCSI standards and SATA-IO specifications).

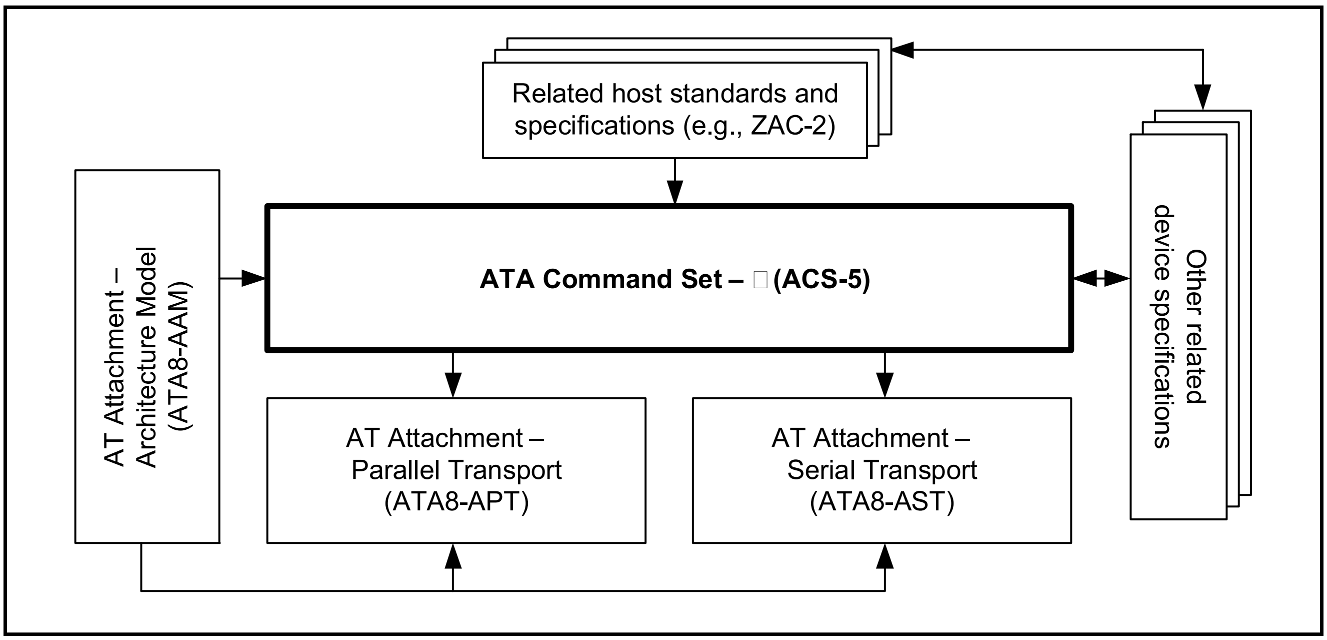

Figure 1 — ATA document relationships

This standard maintains compatibility with the ACS-4 standard, INCITS 529-2018, while providing additional functions.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

INCITS 4-1986 (R2012), *Information Systems – Coded Character Sets – 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII)*

ISO 7779:1999, *Acoustics – Measurement of airborne noise emitted by information technology and telecommunications equipment*

INCITS 451-2008, *AT Attachment-8 – ATA/ATAPI Architecture Model (ATA8-AAM)*

INCITS 493-2012, *AT Attachment-8 – Serial Transport (ATA8-AST)*

INCITS 502-2019, SCSI Primary Commands – 5 (SPC-5)

T10/INCITS BSR 506, *SCSI Block Commands – 4 (SBC-4)* (under consideration)

INCITS 524-2016, *AT Attachment-8 – Parallel Transport (ATA8-APT)*

T13/INCITS BSR 549, *Zoned-device ATA Command Set - 2 (ZAC-2)* (under consideration)

Serial ATA revision 3.5 (SATA 3.5) [1]

RFC 3280, *Internet X.509 Public Key Infrastructure: Certificate and Certificate Revocation List (CRL) Profile, IETF, 2002* [2]

RFC 3281, *An Internet Attribute Certificate: Profile for Authorization, IETF, 2002* [2]

FIPS PUB 140-2, *Security Requirements For Cryptographic Modules, May 25, 2001* [3]

FIPS PUB 140-3, *Security Requirements for Cryptographic Modules, March 23, 2019* [3]

SFF-8447 LBA Count for Disk Drives [4]

SFF-8609 Specification for Management Interface for Drive Conditions, Rev 1.0, July 07, 2017 [4]

1. For more information on Serial ATA international Organization, see http://www.sata-io.org/.
2. For more information on IETF publications, see http://www.ietf.org/.
3. For more information on National Institute of Standards and Technology publications, see http://www.nist.gov/.
4. For more information on SFF specifications contact the SFF committee at http://www.snia.org/sff/specifications.

3 Definitions, abbreviations, and conventions

3.1 Definitions

3.1.1 28-bit command
command that uses the FEATURE field (7:0), COUNT field (7:0), LBA field (27:0), ICC field (7:0), AUXILIARY field (31:0), DEVICE field (15:8), and COMMAND field (7:0) to specify its arguments

3.1.2 48-bit command
command that uses the FEATURE field (15:0), COUNT field (15:0), LBA field (47:0), ICC field (7:0), AUXILIARY field (31:0), DEVICE field (15:8), and COMMAND field (7:0) to specify its arguments

3.1.3 accessible max address
maximum LBA that is accessible by read commands and write commands that return command completion without error

3.1.4 Active mode
power condition specified by the PM0: Active state

Note 1 to entry: See 4.17.4.

3.1.5 additional sense code
combination of the ADDITIONAL SENSE CODE field and the ADDITIONAL SENSE CODE QUALIFIER field

Note 1 to entry: See 7.34 and 9.14.

3.1.6 administrator
person who is responsible for the administration of one or more devices

Note 1 to entry: For example, the person who establishes passwords in the Security feature set (see 4.22).

3.1.7 advanced background operations
background processing that may impact device response time to affected LBAs and may include garbage collection operations

3.1.8 AOI (Administered Organizational Identifier)
24-bit organizational identifier that is administered by the IEEE

Note 1 to entry: The IEEE Administered Organizational Identifier is described in https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/tutorials/eui.pdf.

Note 2 to entry: The IEEE defines multiple formats of AOI values, including 24-bit AOI values. Only 24-bit AOI values are used by this standard (i.e., the MA-L values and CID values described by the document referenced in note 1 to entry).

Note 3 to entry: The IEEE administration of the MA-L and CID values is defined such that values in each group are mutually unique with respect to each other as described by the document referenced in note 1 to entry.

Note 4 to entry: AOI values are available from the IEEE-SA Registration Authority (see https://standards.ieee.org/products-services/regauth/index.html).

3.1.9 ASCII character
byte containing a 7-bit ASCII pattern in bits 6:0 with bit 7 cleared to zero

Note 1 to entry: See INCITS 4-1986.

3.1.10 ATA device
device that supports the General feature set

Note 1 to entry: See 4.2.

3.1.11 ATA string
set of ASCII characters in the format specified in 3.4.9

3.1.12 background activity
activity initiated by a command that occurs after command completion has been reported

3.1.13 BIOS (Basic Input/Output System)
application client that is run when power is applied whose primary function is to initialize various components (e.g., storage devices)

3.1.14 byte
sequence of eight contiguous bits considered as a unit

Note 1 to entry: See 3.4.8.

3.1.15 cache
data storage area outside the area accessible by hosts

Note 1 to entry: The cache may contain a subset of the data stored in the non-volatile media.

3.1.16 caching priority level
a measure of the relative importance of keeping a copy of user data in non-volatile cache

3.1.17 CFA-APT device
device that supports the CFA feature set (see ACS-3), the ATA8-APT transport, and not the ATA8-AST transport

3.1.18 circular buffer
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

3.1.19 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

3.1.20 command acceptance
positive acknowledgement of a command being received by a device

3.1.21 command completion
completion by the device of processing the command

Note 1 to entry: As part of command completion the device:

a) completes the action requested by the command or terminates the command with an error; and
b) sets the appropriate bits in the ERROR field and the STATUS field.

3.1.22 COMRESET
commanded hardware reset in the Serial ATA transport

Note 1 to entry: See ATA8-AST.

3.1.23 depopulate
process by which a device removes the capability of a storage element to store logical block data

3.1.24 depopulated
property associated with a physical element that results in the element being unable to store logical block data

3.1.25 depopulation operation
process by which a device removes the capability of a storage element to store user data

3.1.26 device
data storage peripheral

Note 1 to entry: An example of a device is a disk drive.

Note 2 to entry: see 3.1.10.

3.1.27 device configuration changing command
command that is able to change the configuration of the logical sector to physical sector mapping

Note 1 to entry: The following commands are the device configuration changing commands: MUTATE EXT (see 7.16), SET SECTOR CONFIGURATION EXT (see 7.46), REMOVE ELEMENT AND TRUNCATE (see 7.33), and RESTORE ELEMENTS AND REBUILD (see 7.35).

3.1.28 dirty data
user data in a non-volatile cache that is newer than the corresponding data in the primary medium

3.1.29 DMA data transfer
means of data transfer between device and host memory without application client intervention

3.1.30 DRQ data block
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 DQWord
sequence of 16 contiguous bytes considered as a unit

Note 1 to entry: See 3.4.8

3.1.32 DWord
sequence of four contiguous bytes considered as a unit

Note 1 to entry: See 3.4.8

3.1.33 evict
a process within the device to remove user data from the non-volatile cache

3.1.34 FIS
frame structure used by the Serial ATA transport

Note 1 to entry: See ATA8-AST.

3.1.35 flush command
command that flushes the volatile write cache

Note 1 to entry: The following commands are the flush commands: the FLUSH CACHE (see 7.10) command and the FLUSH CACHE EXT (see 7.11) command.

3.1.36 free-fall
vendor specific condition of acceleration

3.1.37 garbage collection operation
process that prepares resources for future allocation

3.1.38 GPL command
command that is associate with the General Purpose Logging feature set

Note 1 to entry: The following commands are the GPL commands: READ LOG EXT, READ LOG DMA EXT, WRITE LOG EXT, and WRITE LOG DMA EXT.

3.1.39 hardware reset
routine performed by a device after a hardware reset event

Note 1 to entry: See the Device Management protocol in ATA8-AAM.

3.1.40 host
object that originates commands and device management functions

Note 1 to entry: See ATA8-AAM.

3.1.41 host interface
service delivery subsystem

Note 1 to entry: See ATA8-AAM.

3.1.42 hybrid device
a device that contains a primary medium and a non-volatile cache

3.1.43 ID Not Found error
command completion with the ID NOT FOUND bit set to one (see 6.3.4)

3.1.44 Idle mode
one or all of the power conditions associated with the PM1: Idle state (see 4.17.4)

3.1.45 LBA
value used to reference a logical sector

3.1.46 LBA mapping resource
resource (e.g., a physical block or a data structure associated with tracking resource usage) that enables storage upon media

3.1.47 LBA resource
resource (e.g., a physical block) used for storing user data

3.1.48 log
named sequence of one or more log pages

Note 1 to entry: See clause 9.

3.1.49 log address
numeric value that a log command uses to identify a specific log

3.1.50 log command
SMART READ LOG command (see 7.48.2), SMART WRITE LOG command (see 7.48.4), or GPL feature set (see 4.11) command

3.1.51 log page
512-byte block of data associated with a log

Note 1 to entry: See clause 9.

3.1.52 logical block
synonym for logical sector

Note 1 to entry: See 3.1.53.

3.1.53 logical sector
set of words accessed and referenced as a unit (see 9.10.4.4) that contain user data and are referenced by LBA (see 3.1.45)

3.1.54 logical sector size
size in words of logical sectors on the device

Note 1 to entry: If the LOGICAL SECTOR SIZE SUPPORTED bit (see 9.10.4.3.2) is cleared to zero, the device logical sector size is 256 words. If the LOGICAL SECTOR SIZE SUPPORTED bit is set to one, the device logical sector size is indicated by the contents of the LOGICAL SECTOR SIZE field (see 9.10.4.4).

3.1.55 mapping resource
a vendor specific mechanism that may be used by the device internally to describe the physical location and attributes of user data

3.1.56 media
material on which user data is stored

3.1.57 media access command
command that causes the device to access non-volatile media

3.1.58 native max address
LBA that a device reports by GET NATIVE MAX ADDRESS EXT command (see 7.2.2) and the maximum LBA accepted by a device using the SET ACCESSIBLE MAX ADDRESS EXT command (see 7.2.3)

3.1.59 NCQ command
command in the NCQ feature set

Note 1 to entry: See 4.15.

3.1.60 non-volatile media
physical storage media that retains user data written to it through all reset events (e.g., power-on reset)

3.1.61 partition
range of LBAs specified by an application client

3.1.62 PATA device
device that implements the parallel ATA transport

Note 1 to entry: See ATA8-APT.

3.1.63 physical element
subcomponent of an ATA device

3.1.64 physical sector
one or more contiguous logical sectors that are read from or written to the device media in a single operation

3.1.65 PIO
data transfers performed using PIO commands and protocol

3.1.66 power condition
one of the following power management substates: Idle_a, Idle_b, Idle_c, Standby_y or Standby_z

Note 1 to entry: See 4.9.

3.1.67 power cycle
when power is removed from a host or device until the subsequent power-on event

Note 1 to entry: See the Device Power-on protocol in ATA8-AAM.

3.1.68 power-on reset
routine performed by a device after detecting a power-on event

Note 1 to entry: See ATA8-AAM.

3.1.69 primary medium
the medium to which all user data is synchronized

3.1.70 queued command
NCQ command that has reported command acceptance but not command completion

3.1.71 QWord
sequence of eight contiguous bytes considered as a unit

Note 1 to entry: See 3.4.8.

3.1.72 read command
command that causes the device to retrieve user data

Note 1 to entry: The following commands are the read commands: the READ DMA command, READ DMA EXT command, READ FPDMA QUEUED command, READ SECTOR(S) command, READ SECTOR(S) EXT command, READ STREAM EXT command, READ STREAM DMA EXT command, READ VERIFY SECTOR(S) command, and READ VERIFY SECTOR(S) EXT command.

3.1.73 read stream command
command that causes the device to transfer user data from the device to the host

Note 1 to entry: The following commands are the read stream commands: the READ STREAM EXT command and READ STREAM DMA EXT command.

3.1.74 SATA device
device implementing the serial ATA transport

Note 1 to entry: See ATA8-AST.

3.1.75 SCT Command
command that writes to the SCT command/status log

Note 1 to entry: See clause 8.

3.1.76 SCT Status
command that reads from the SCT command/status log

Note 1 to entry: See clause 8.

3.1.77 Secure Content Storage Association
organization that develops specifications for protecting digital media content

Note 1 to entry: See https://www.vidity.com/ for information on the Secure Content Storage Association.

3.1.78 sense data
combination of the DEFERRED ERROR bit (see 4.24.2), sense key (see 3.1.79), and additional sense code (see 3.1.5)

3.1.79 sense key
contents of the SENSE KEY field in the sense data

Note 1 to entry: See SPC-5.

3.1.80 signature
unique set of values placed in the return parameters used to distinguish device types (e.g., ATA device)

Note 1 to entry: See table 349.

3.1.81 signed
value that is encoded using two's complement

3.1.82 Sleep mode
power condition specified by the PM3: Sleep state

Note 1 to entry: See 4.17.4.

3.1.83 software reset
routine performed by a device after a software reset event

Note 1 to entry: See the Device Management protocol in ATA8-AAM.

3.1.84 solid state device
a device which uses non-volatile memory to store user data

3.1.85 spin-down
process of bringing a rotating media device's media to a stop

3.1.86 spin-up
process of bringing a rotating media device's media to operational speed

3.1.87 Standby mode
one or all of the power conditions associated with the PM2: Standby state

Note 1 to entry: See 4.17.4.

3.1.88 storage depopulation command
command associated with the storage element depopulation feature set (see 4.26)

Note 1 to entry: The following commands are the storage depopulation commands: the REMOVE ELEMENT AND TRUNCATE command and the RESTORE ELEMENTS AND REBUILD command.

3.1.89 storage element
physical element that provides non-volatile storage for an associated group of logical blocks (see 4.19)

3.1.90 stream
set of operating parameters specified by a host using the CONFIGURE STREAM command (see 7.4) to be used for subsequent read stream commands and write stream commands

3.1.91 sync
a process within the device where dirty data in the non-volatile cache is written to the primary medium

3.1.92 transport
mechanism used to communicate with a device

Note 1 to entry: See ATA8-APT and ATA8-AST.

3.1.93 trim command
DATA SET MANAGEMENT command with the TRIM bit set to one or DATA SET MANAGEMENT XL command with the TRIM bit set to one

3.1.94 trimmed
property associated with a logical sector that affects the data returned by read commands

3.1.95 trimmed logical sector
logical sector that has been affected by a command that has the TRIM bit set to one

Note 1 to entry: Commands that request logical sectors to be trimmed may not affect all specified logical sectors.

3.1.96 truncate operation
process by which a device reduces its native capacity

3.1.97 unaligned write
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

3.1.98 unrecoverable error
error for which a device is unable to read a logical block or write a logical block

3.1.99 user data
data that is transferred between the host and the device using read commands and write commands

3.1.100 user data area
area of the media that is addressable from LBA 0 to the native max address if the Accessible Max Address Configuration feature set is supported, or LBA 0 to the maximum value defined in table 5 if the Accessible Max Address Configuration feature set is not supported

3.1.101 volatile cache
cache that does not retain data through power cycles

3.1.102 word
sequence of two contiguous bytes considered as a unit

Note 1 to entry: See 3.4.8.

3.1.103 write FUA command
write command that specifies that the device store user data to non-volatile media before reporting command completion

Note 1 to entry: The WRITE FPDMA QUEUED command with the FUA bit set to one, and the WRITE DMA FUA EXT command are the write FUA commands.

3.1.104 write command
command that causes the device to store user data

Note 1 to entry: The following commands are the write commands: the SCT Write Same command, WRITE DMA command, WRITE DMA EXT command, WRITE DMA FUA EXT command, WRITE FPDMA QUEUED command, WRITE SECTOR(S) command, WRITE SECTOR(S) EXT command, WRITE STREAM DMA EXT command, WRITE STREAM EXT command, and ZERO EXT command.

3.1.105 write stream command
command that causes the device to transfer user data from the host to the device

Note 1 to entry: The following commands are the write stream commands: the WRITE STREAM DMA EXT command and WRITE STREAM EXT command.

3.1.106 WWN (World Wide Name)
64 bit worldwide unique name based upon a company's IEEE AOI

Note 1 to entry: See 9.10.5.8.

Note 2 to entry: The WWNs defined by this standard are based on the Name_Identifiers defined in FC-FS-6 (see Bibliography).

3.2 Symbols and abbreviations

3.2.1 Abbreviations

Abbreviations used in this standard:

Abbreviation	Meaning
ABO	Advanced Background Operation
ACS	ATA Command Set
AOI	Administered Organizational Identifier
APM	Advanced Power Management
ASC	Additional Sense Code

Abbreviation	Meaning
ASCII	American Standard Code for Information Interchange
ASCQ	Additional Sense Code Qualifier
ASR	Asynchronous Signal Recovery (see SATA 3.5)
ATA	AT Attachment
ATA8-AAM	AT Attachment-8 - ATA/ATAPI Architecture Model (see clause 2)
ATA8-ACS	AT Attachment-8 - ATA/ATAPI Command Set (see Bibliography)
ATA8-APT	AT Attachment-8 - Parallel Transport (see clause 2)
ATA8-AST	AT Attachment-8 - Serial Transport (see clause 2)
BIOS	Basic Input/Output System
CCTL	Command Completion Time Limit (see 7.4.3.4 and 7.28.3.2)
CFA	CompactFlash Association (see www.compactflash.org)
CFast	CompactFlash ATA Serial Transport (see clause 2)
CRC	Cyclic Redundancy Check
DAS	Device Activity Signal (see SATA 3.5)
DMA	Direct Memory Access
DRQ	Data ReQuest (see ATA8-APT)
DSN	Device Statistics Notification
DSS	Disable Staggered Spinup (see SATA 3.5)
EPC	Extended Power Conditions
EXT	Command that uses the extended (48-bit LBA) format parameters
FC-FS-6	Fibre Channel Framing and Signaling - 6 (see Bibliography)
FIS	Frame Information Structure
FUA	Forced Unit Access
GPL	General Purpose Logging
ISO	Organization for International Standards
LBA	Logical Block Address
LLS	Long Logical Sector
LPS	Long Physical Sector
LSB	Least Significant Bit
MSB	Most Significant Bit
NVM	Non-Volatile Memory
NCQ	Native Command Queueing
PATA	Parallel ATA
PCIe	PCI Express®
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)
SBC-4	SCSI Block Commands - 4
SCSA	Secure Content Storage Association
SMART	Self-Monitoring Analysis and Reporting Technology
SPC-5	SCSI Primary Commands - 5 (see clause 2)
SSP	Software Settings Preservation
T10	INCITS Technical Committee T10
TCG	Trusted Computing Group (see www.trustedcomputinggroup.org)
VS	Vendor Specific
WWN	World Wide Name
ZAC-2	Zoned Device ATA Command Set - 2 (see clause 2)

3.2.2 Units

Units used in this standard:

Unit	Meaning
h	hour (unit of time)
min	minute (unit of time)
ma	milliampere
ms	millisecond (i.e., 10^{-3} seconds)
ns	nanosecond (i.e., 10^{-9} seconds)
s	second (unit of time)
μs	microsecond (i.e., 10^{-6} seconds)
V	volt

3.2.3 Symbols

Symbols used in this standard:

Symbol	Meaning
©	copyright
®	registered trademark
™	unregistered trademark

3.2.4 Mathematical operators

Mathematical operators used in this standard:

Mathematical Operator	Meaning
+	added to
×	multiplied by
/	divided by
^	power of
<	less than
≤	less than or equal to
>	greater than
≥	greater than or equal to

3.3 Keywords

3.3.1 expected

keyword used to describe the behavior of the hardware or software in the design models assumed by this standard

Note 1 to entry: Other hardware and software design models may also be implemented.

3.3.2 mandatory

keyword indicating items to be implemented as defined by this standard

3.3.3 may

keyword that indicates flexibility of choice with no implied preference

3.3.4 N/A

keyword that indicates a field is not applicable and has no defined value

Note 1 to entry: A field defined as N/A should not be checked by the host or device.

3.3.5 obsolete

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

Note 1 to entry: Some degree of functionality may be required for items designated as “obsolete” to provide for backward compatibility.

Note 2 to entry: Obsolete commands should not be used by the host.

Note 3 to entry: 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, the device shall return command completion for the command.

3.3.6 optional

keyword that describes features that are not required by this standard

Note 1 to entry: If any optional feature defined by the standard is implemented, the feature shall be implemented in the way defined by the standard.

3.3.7 prohibited

keyword indicating that an item shall not be supported by an implementation

3.3.8 reserved

keyword indicating reserved bits, bytes, words, fields, and code values that are set aside for future standardization

Note 1 to entry: The use and interpretation of reserved bits, bytes, words, fields, and code values may be specified by future extensions to this or other standards.

Note 2 to entry: A reserved bit, byte, word, or field shall be cleared to zero, or set in accordance with a future extension to this standard.

Note 3 to entry: The recipient shall not check reserved bits, bytes, words, or fields.

Note 4 to entry: Receipt of reserved code values in defined fields shall be considered a command parameter error and reported by returning command aborted.

3.3.9 retired

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

Note 1 to entry: 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.

3.3.10 shall

keyword indicating a mandatory requirement

Note 1 to entry: Designers are required to implement all such mandatory requirements to ensure interoperability with other products that conform to this standard.

3.3.11 should

keyword indicating flexibility of choice with a strongly preferred alternative

Note 1 to entry: This keyword is equivalent to the phrase “it is recommended”.

3.3.12 vendor specific

something (e.g., a bit, field, code value) that is not defined by this standard

Note 1 to entry: Specification of the referenced item is determined by the device vendor and may be used differently in various implementations.

3.4 Conventions

3.4.1 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 3.4.5 for the naming convention used for naming bits.)

Names of fields are in small uppercase (e.g., DRAT SUPPORTED). Normal case is used when the contents of a field are being discussed. Fields containing only one bit are usually referred to as the NAME bit instead of the NAME field.

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

3.4.2 Precedence

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

3.4.3 Lists

3.4.3.1 Lists overview

Lists are associated with an introductory paragraph or phrase, and are numbered relative to that paragraph or phrase (i.e., all lists begin with an a) or 1) entry).

Each item in a list is 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, the first word in the item is not capitalized. If the item in a list is a complete sentence, the first word in the item is capitalized.

Each item in a list ends with a semicolon, except the last item, which ends in a period. The next to the last entry in the list ends 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.

3.4.3.2 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:

EXAMPLE - 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.

3.4.3.3 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 a 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:

EXAMPLE - 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.

3.4.4 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 1 shows some examples of decimal numbers using various numbering conventions.

Table 1 — 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).

3.4.5 Bit conventions

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

3.4.6 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).

3.4.7 State diagram conventions

All state diagrams use the notation shown in Figure 2.

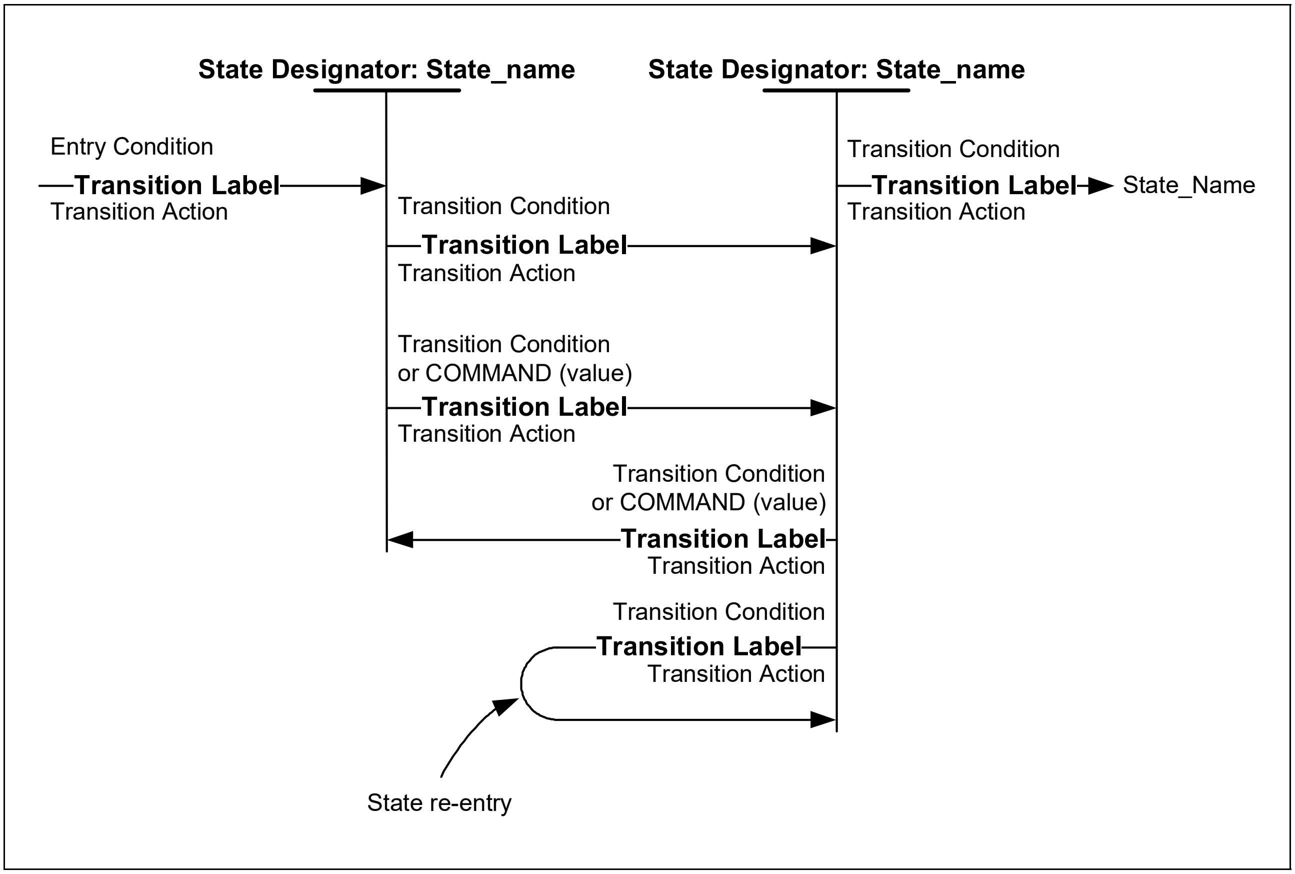

Figure 2 — State diagram convention

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) CRYPTO SCRAMBLE EXT (failure exit allowed) means the device processes a CRYPTO SCRAMBLE EXT command with the FAILURE MODE bit set to one; or
b) CRYPTO SCRAMBLE EXT (hard failure required) means the device processes CRYPTO SCRAMBLE EXT command with the FAILURE MODE bit cleared to zero.

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

3.4.8 Byte, word, DWord, QWord, and DQWord Relationships

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

Byte

Byte							
7	6	5	4	3	2	1	0
MSB							LSB

Word at offset n

Word n															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MSB															LSB

Byte 2n+1	Byte 2n

DWord at word offset n

DWord n/2																															
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MSB																															LSB

Byte 2n+3	Byte 2n+2	Byte 2n+1	Byte 2n
Word n+1		Word n	

QWord at word offset n

QWord n/4																							
63	...	56	55	...	48	47	...	40	39	...	32	31	...	24	23	...	16	15	...	8	7	...	0
MSB																							LSB

Byte 2n+7	Byte 2n+6	Byte 2n+5	Byte 2n+4	Byte 2n+3	Byte 2n+2	Byte 2n+1	Byte 2n
Word n+3		Word n+2		Word n+1		Word n	
DWord n/2+1				DWord n/2			

DQWord at word offset n

DQWord n/8																							
127	...	112	111	...	96	95	...	80	79	...	64	63	...	48	47	...	32	31	...	16	15	...	0
MSB																							LSB

Word n+7	Word n+6	Word n+5	Word n+4	Word n+3	Word n+2	Word n+1	Word n
DWord n/2+3		DWord n/2+2		DWord n/2+1		DWord n/2	
QWord n/4+1				QWord n/4			

Figure 3 — Byte, word, DWord, QWord, and DQWord 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.

EXAMPLE 1 - If the two-byte field (i.e., word) in SCT command (see table 203) word 0 contains 0007h, then:

a) byte 0 contains 07h; and
b) byte 1 contains 00h.

EXAMPLE 2 - If the four-byte field (i.e., DWord) at IDENTIFY DEVICE data words 60..61 (see table 57) 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.

EXAMPLE 3 - If an eight-byte field (i.e., QWord) in the SCT Write Same command words 2..5 (see table 205) 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., fields in the ATA Strings log page (see 9.10.7)) is considered to be an array of bytes, not a multi-byte value, and is handled as described in 3.4.9;
b) the IDENTIFY DEVICE data World Wide Name field consists of four word fields rather than one QWord field and is handled as described in 7.13.6.58; and
c) 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 subclauses or in the standard defining the security protocol.

3.4.9 ATA string convention

ATA strings (e.g., the MODEL NUMBER field (see 9.10.7.4)) 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.

Each pair of bytes in an ATA string is swapped as shown in table 2.

Table 2 — 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

Using the ATA string that contains firmware revision information as an example, table 3 shows the contents of the FIRMWARE REVISION field (see 9.10.7.3) in the Strings page (see 9.10.7) in IDENTIFY DEVICE data log (see 9.10). In this example, the firmware revision string is “abcdefg ”, including one padding space character at the end of the string. Table 3 also shows the copy of the FIRMWARE REVISION field that uses the word format of the IDENTIFY DEVICE input from device to host data structure (see 7.13.6).

Table 3 — FIRMWARE REVISION field example

Strings page [a] offset	Value	Copy of FIRMWARE REVISION field in IDENTIFY DEVICE data [b]		
		Offset	Word	Value
32	62h (i.e., “b”)	46	23	6162h (i.e., “ba”)
33	61h (i.e., “a”)	47		
34	64h (i.e., “d”)	48	24	6364h (i.e., “dc”)
35	63h (i.e., “c”)	49		
36	66h (i.e., “f”)	50	25	6566h (i.e., “fe”)
37	65h (i.e., “e”)	51		
38	20h (i.e., “ “, the space character)	52	26	6720h (i.e., “ g”)
39	67h (i.e., “g”)	53		

[a] See Strings page (see 9.10.7) in IDENTIFY DEVICE data log (see 9.10).
[b] See table 57.

3.4.10 Offset Convention

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

4 Feature set definitions

4.1 Overview

4.1.1 Feature set summary

Table 4 lists the feature sets in alphabetical order and shows whether a feature set is mandatory, optional, or prohibited for ATA devices.

Table 4 — Feature set summary

Feature set	ATA devices
48-bit Address feature set (see 4.3)	O
Accessible Max Address Configuration feature set (see 4.4)	O
Advanced Background Operation feature set (ABO) (see 4.5)	O
Advanced Power Management (APM) feature set (see 4.6)	O
Command Duration Limits feature set (see 4.7)	O
Device Statistics Notifications (DSN) feature set (see 4.8)	O
Extended Power Conditions (EPC) feature set (see 4.9)	O
Free-fall Control feature set (see 4.10)	O
General feature set (see 4.2)	M
General Purpose Logging (GPL) feature set (see 4.11)	M
Hybrid Information feature set (see 4.12)	O
Long Logical Sector (LLS) feature set (see 4.13)	O
Long Physical Sector (LPS) feature set (see 4.14)	O
Native Command Queuing (NCQ) feature set (see 4.15)	O
Out Of Band Management Interface (see 4.16)	O
Power Management feature set (see 4.17)	M
Power-Up In Standby (PUIS) feature set (see 4.18)	O
Rebuild Assist feature set (see 4.19)	O
Sanitize Device feature set (see 4.20)	O
SATA Hardware Feature Control feature set (see 4.21)	O
Security feature set (see 4.22)	O
Self-Monitoring, Analysis, and Reporting Technology (SMART) feature set (see 4.23)	O
Sense Data Reporting feature set (see 4.24)	O
Software Settings Preservation (SSP) feature set (see 4.25)	O
Storage Element Depopulation feature set (see 4.26)	O
Streaming feature set (see 4.27)	O
Trusted Computing feature set (see 4.28)	O
User Data Initialization feature set (see 4.29)	O
Write-Read-Verify feature set (see 4.30)	O
Key: M – Mandatory, O – Optional	

4.1.2 Capacity reporting

If the ATA device supports the Accessible Max Address Configuration feature set (see 4.4) and the host issues a SET ACCESSIBLE MAX ADDRESS EXT command (see 7.2.3), then IDENTIFY DEVICE data words and the Capacity page (see 9.10.4) of the IDENTIFY DEVICE data log may be affected as shown in table 5.

Table 5 — IDENTIFY DEVICE capacity reporting

Device Settings		Current Capacity Settings		Reported Capacities			
IDENTIFY DEVICE data word 83 bit 10 (48-bit support)	IDENTIFY DEVICE data word 69 bit 3	accessible max address ≤ 0FFF_ FFFFh	accessible max address ≤ FFFF_ FFFFh	IDENTIFY DEVICE data words 60..61	IDENTIFY DEVICE data words 100..103	IDENTIFY DEVICE data words 230..233	ACCESSIBLE CAPACITY field [a]
0	N/A	N/A	N/A	accessible max address + 1	reserved	reserved	accessible max address + 1
1	0	yes	yes	accessible max address + 1	accessible max address + 1	reserved	accessible max address + 1
1	0	no	no	0000_0000_ 0FFF_FFFFh	accessible max address + 1	reserved	accessible max address + 1
1	0	no	yes	0000_0000_ 0FFF_FFFFh	accessible max address + 1	reserved	accessible max address + 1
1	1	yes	yes	accessible max address + 1	accessible max address + 1	accessible max address + 1	accessible max address + 1
1	1	no	no	0000_0000_ 0FFF_FFFFh	less than or equal to accessible max address + 1 [b]	accessible max address + 1	accessible max address + 1
1	1	no	yes	0000_0000_ 0FFF_FFFFh	less than or equal to accessible max address + 1 [b]	accessible max address + 1	accessible max address + 1

[a] The ACCESSIBLE CAPACITY field is defined in 9.10.4.2.
[b] IDENTIFY DEVICE data words 100..103 may be limited to ≤ 0000_0000_FFFF_FFFFh

A device shall not change the content in the ACCESSIBLE CAPACITY field (see 9.10.4.2), IDENTIFY DEVICE data words 60..61, or IDENTIFY DEVICE data words 230..233, during the processing of all resets (e.g., a power-on reset).

The native max address of the device may change as the result of processing a device configuration changing command.

The SET SECTOR CONFIGURATION EXT command:

a) increases the native max address if the logical block size is decreased; and
b) decreases the native max address if the logical block size is increased.

The MUTATE EXT command may modify the native max address.

The REMOVE ELEMENT AND TRUNCATE command may decrease the native max address. The RESTORE ELEMENTS AND REBUILD command may increase the native max address.

4.2 General feature set

4.2.1 Overview

The General feature set is the base feature set for ATA devices that conform to this standard.

The following commands are mandatory for devices that support the General feature set:

a) EXECUTE DEVICE DIAGNOSTIC (see 7.9);
b) IDENTIFY DEVICE (see 7.13); and
c) SET FEATURES (see 7.45).

The following commands are optional for devices that support the General feature set:

a) DATA SET MANAGEMENT (see 7.5);
b) DATA SET MANAGEMENT XL (see 7.6);
c) DOWNLOAD MICROCODE (see 7.7);
d) DOWNLOAD MICROCODE DMA (see 7.8);
e) FLUSH CACHE (see 7.10);
f) NOP (see 7.18);
g) READ BUFFER (see 7.19);
h) READ BUFFER DMA (see 7.20);
i) READ DMA (see 7.21);
j) READ SECTOR(S) (see 7.26);
k) READ VERIFY SECTOR(S) (see 7.30);
l) SET DATE & TIME (see 7.44);
m) WRITE BUFFER (see 7.56);
n) WRITE BUFFER DMA (see 7.57);
o) WRITE DMA (see 7.58);
p) WRITE SECTOR(S) (see 7.63);
q) WRITE UNCORRECTABLE EXT (see 7.68); and
r) ZERO EXT (see 7.69).

The following logs are mandatory for devices that support the General feature set:

a) IDENTIFY DEVICE data log (see 9.10).

See also subclauses 4.2.2 and 4.2.3.

4.2.2 Unexpected power removal

If power is removed from an ATA device and:

a) there are commands for which the device has not reported command completion; or
b) there is user data in a volatile write cache that has not been written to non-volatile media,

then an unexpected power removal condition has occurred.

If:

1) the device has non-volatile media;
2) all write cache is non-volatile (i.e., the NON-VOLATILE WRITE CACHE ENABLED bit is set to one) or the volatile write cache is disabled (i.e., the VOLATILE WRITE CACHE ENABLED bit is cleared to zero);
3) a write command completes without error; and
4) an unexpected power removal occurs,

then, after power is restored, a read command that completes without error for any LBA included in that write command shall return the user data that was written by that write command before the unexpected power removal.

If:

1) the device has non-volatile media;
2) a write FUA command completes without error; and
3) an unexpected power removal occurs,

then, after power is restored, a read command that completes without error for any LBA included in that write FUA command shall return the user data that was written by that write FUA command before the unexpected power removal.

If:

1) the device has non-volatile media;
2) a write command completes without error;
3) a subsequent flush command completes without error; and
4) an unexpected power removal occurs,

then, after power is restored, a read command that completes without error for any LBA included in that write command shall return the user data that was written by that write command before the unexpected power removal.

4.2.3 Interactions with volatile caches

While processing write commands, as a result of using volatile write cache, there is a period of time during which the user data may be lost if:

a) an unexpected power removal occurs (see 4.2.2); or
b) a hardware failure occurs.

If an error occurs while the device is writing to the medium and that error is reported as a deferred error, then the device may invalidate cached user data. This invalidation may occur for data cached in both volatile and non-volatile caches.

If volatile write cache is enabled and the device processes:

a) a flush command;
b) a STANDBY IMMEDIATE command; or
c) a write stream command with the FLUSH bit set to one,

then all user data in volatile write cache becomes non-volatile before returning command completion without error.

If the device processes a SET FEATURES disable volatile write cache subcommand, then the device initiates a sequence to flush volatile cache to non-volatile media before command completion (see 7.45.3).

If volatile write cache is enabled and a transition to a power condition that prevents access to the media is requested (e.g., before a hard drive stops its spindle motor during a transition to the Standby_z power condition), then all user data in volatile write cache becomes non-volatile.

If:

a) the write-read-verify feature set is enabled; and
b) the processing of a write command requires the device to read from the media before returning command completion without error,

then all user data in volatile write cache for that write command shall become non-volatile before returning command completion without error for that write command.

If volatile write cache is enabled and the device returns command completion without error for an IDLE IMMEDIATE command with the Unload feature, then all user data in volatile write cache may remain volatile.

4.3 48-bit Address feature set

The 48-bit Address feature set allows devices:

a) with capacities up to 281 474 976 710 655 (i.e., (2^48)-1) 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 support the 48-bit Address feature set:

a) FLUSH CACHE EXT (see 7.11);
b) READ DMA EXT (see 7.22);
c) READ SECTOR(S) EXT (see 7.27);
d) READ VERIFY SECTOR(S) EXT (see 7.31);
e) WRITE DMA EXT (see 7.59);
f) WRITE DMA FUA EXT (see 7.60); and
g) WRITE SECTOR(S) EXT (see 7.65).

Devices that support the 48-bit Address feature set may also support commands that use 28-bit addressing. 28-bit commands and 48-bit commands may be intermixed.

Devices that support the 48-bit feature set shall indicate support of the 48-bit Address feature set by setting the 48-BIT SUPPORTED bit (see 9.10.5.2.16) to one.

4.4 Accessible Max Address Configuration feature set

4.4.1 Overview

The Accessible Max Address Configuration feature set provides a method for a host to discover the native max address and control the accessible max address.

The following commands are mandatory for devices that support the Accessible Max Address Configuration feature set:

a) GET NATIVE MAX ADDRESS EXT (see 7.2.2);
b) SET ACCESSIBLE MAX ADDRESS EXT (see 7.2.3); and
c) FREEZE ACCESSIBLE MAX ADDRESS EXT (see 7.2.4).

ATA devices indicate support for this feature set by setting the AMAX ADDR SUPPORTED bit (see 9.10.5.2.34) to one.

4.4.2 SET ACCESSIBLE MAX ADDRESS EXT description

The SET ACCESSIBLE MAX ADDRESS EXT command (see 7.2.3) limits read commands and write commands to LBAs from zero to the LBA specified by the most recent SET ACCESSIBLE MAX ADDRESS EXT command that returned command completion without error. The results of a SET ACCESSIBLE MAX ADDRESS EXT command that returns command completion without error shall persist across all resets (e.g., power-on resets). The accessible max address is the native max address unless a SET ACCESSIBLE MAX ADDRESS EXT command has been completed without error.

The contents of a user data area made not accessible through the use of the SET ACCESSIBLE MAX ADDRESS EXT command are indeterminate if that user data area is made accessible again.

4.4.3 Interactions with device statistics data

ATA devices supporting this feature set may alter device statistics (see 9.5) as a result of processing a successful SET ACCESSIBLE MAX ADDRESS EXT command (see 7.2.3).

4.5 Advanced Background Operation feature set (ABO)

4.5.1 Overview

The Advanced Background Operation feature set allows the host to indicate when advanced background operations may be performed while limiting impact to other host initiated activities.

Advanced background operations include both host-initiated (see 4.5.2) and device-initiated advanced background operations (see 4.5.3).

EXAMPLE - Advanced background operations may include NAND block erase operations, media read operations, and media write operations (e.g., garbage collection), that may impact response time for normal read requests or write requests from the host.

If the device supports the Advanced Background Operation feature set, then the device shall:

a) set the ADVANCED BACKGROUND OPERATION SUPPORTED bit (see 9.10.5.2.48) to one;
b) support the SET FEATURES subcommand Advanced Background Operation Control (see 7.45.22);
c) support the DSN feature set (see 4.8);
d) implement the abo_timer;
e) support the FRACTION OF DEVICE RESOURCES AVAILABLE field (see 9.5.6.13); and
f) support these fields in the IDENTIFY DEVICE data log:
   A) ABO STATUS field (see 9.10.6.11.1);
   B) ABO MINIMUM FRACTION field (see 9.10.5.13.3);
   C) ABO MIN TIMELIMIT field (see 9.10.5.13.4);
   D) ABO MAX TIMELIMIT field (see 9.10.5.13.5);
   E) TIME SCHEDULED FOR DEVICE MAINTENANCE field (see 9.10.6.10.1);
   F) TIME TO PERFORMANCE DEGRADATION field (see 9.10.6.10.2);
   G) MINIMUM INACTIVE TIME field (see 9.10.6.10.3); and
   H) MINIMUM INACTIVE TIME IN MILLISECONDS field (see 9.10.6.10.3).

4.5.2 Host-initiated advanced background operations

If the host is able to predict idle time when there are few read requests and few write requests to the device, then the host may notify the device about this idle time so that the device may perform advanced background operations. As a result, advanced background operations are minimally overlapped with normal read commands and normal write commands from the host.

The SET FEATURES subcommand Advanced Background Operation Control (see 7.45.22) is used to:

a) start host-initiated advanced background operations;
b) stop host-initiated advanced background operations;
c) specify an optional maximum time limit for processing advanced background operations; and
d) specify that the advanced background operations be processed for a maximum amount of time before returning command completion (i.e., foreground mode) or that the advanced background operation start after returning command completion (i.e., immediate response mode).

The host should use the Device Maintenance Schedule (see 9.10.6.10) to determine how much time the device indicates that the device needs to perform maintenance activities. If the DEVICE MAINTENANCE POLLING TIME field (see 9.10.5.14.1) is non-zero, then the device recommends how often the host should read the Device Maintenance schedule (see 9.10.6.10).

If the ABO RECOMMENDED ABO START INTERVAL field (see 9.10.5.14.2) is non-zero, then the host should send the SET FEATURES subcommand Advanced Background Operation Control (see 7.45.22) to start host-initiated advanced background operations to the device on a regular basis.

If a read command or a write command is processed while host-initiated advanced background operations are active, then the device may:

a) suspend ABO when that command is processed and resume after returning command completion; or
b) continue ABO while processing that command.

4.5.3 Device-initiated advanced background operations

If the value of the FRACTION OF DEVICE RESOURCES AVAILABLE field (see 9.5.6.13) is less than or equal to the value of the ABO MINIMUM FRACTION field (see 9.10.5.13.3), then the device may initiate advanced background operations without a request from the host.

The device notifies the host when device initiated advanced background operations are imminent using the Device Statistics Notification feature (see 4.8).

The host should set the threshold for the FRACTION OF DEVICE RESOURCES AVAILABLE field sufficiently high to allow the host to receive a notification and specify to the device to perform host initiated advanced background operations before the device reaches the minimum fraction.

4.6 Advanced Power Management (APM) feature set

The APM feature set is a feature set that allows the host to select a power management level in a device. The power management level (see table 126) 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). 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 mandatory enable APM subcommand of the SET FEATURES command (see 7.45.5) that allows the host to set the APM level; and
b) an optional disable APM subcommand of the SET FEATURES command (see 7.45.5).

The APM feature set is independent of the Standby timer (see 4.17.3). If the APM feature set is enabled and the Standby timer is enabled, then the device shall go to the PM:2 Standby state if:

a) the Standby timer expires; or
b) a vendor specific APM algorithm indicates that the PM:2 Standby state should be entered.

The device shall indicate:

a) feature set support in the APM SUPPORTED bit (see 9.10.5.2.19);
b) feature set enabled in the APM ENABLED bit (see 9.10.6.2.17); and
c) APM level in the APM LEVEL field (see 9.10.6.3.2).

See 4.9.4 for interactions between the APM and EPC feature sets.

4.7 Command Duration Limits feature set

4.7.1 Overview

The inactive time for a command (e.g., time spent in the queue) begins at command acceptance and ends when the device initiates actions to access, transfer, or act upon the specified data. The active time for a command begins when the device initiates actions to access, transfer, or act upon the specified data and ends at command completion.The total time from command acceptance to command completion is the sum of the inactive command time and the active command time.

The Command Duration Limits feature set defines separate and independent time limits for these active and inactive periods of a command: active time limit for a command and inactive time limit for a command. The active time limit for a command is the maximum time that an individual command is allowed to be active. The inactive time limit for a command is the maximum time that an individual command is allowed to be inactive.

For NCQ commands, the Command Duration Limits feature set defines guidelines that the device uses to complete commands with greater throughput efficiency while maintaining host preferences.

The Command Duration Limits log (see 9.11) is a readable and writable log that defines an array of limit descriptors that the host may use, indexed by a Command Duration Limits index value as described in 4.7.2. Each Command Duration Limits Descriptor contains:

a) an active time limit for a command;
b) an inactive time limit for a command;
c) policies for what the device does if either time limit is exceeded;
d) a guideline for processing NCQ commands; and
e) policies for using the guideline to process NCQ commands.

If the Command Duration Limits feature set is supported (i.e., the COMMAND DURATION LIMITS SUPPORTED bit (see 9.10.5.19.3) is set to one), then:

a) the SET FEATURES Enable/Disable Command Duration Limits feature set (see 7.45.10) subcommand shall be supported; and
b) the Command Duration Limits log shall be supported.

Command Duration Limits Statistics log page (see 9.5.4):

a) should be supported if the Command Duration Limits feature set is supported (i.e., the COMMAND DURATION LIMITS SUPPORTED bit (see 9.10.5.19.3) is set to one); and
b) shall be supported if the Command Duration Limits feature set is supported and command duration guidelines are supported (i.e., the COMMAND DURATION GUIDELINES SUPPORTED bit (see 9.10.5.19.2) is set to one).

If the Command Duration Limits feature set is:

a) enabled (i.e., the COMMAND DURATION LIMITS ENABLED bit (see 9.10.6.2.3) is set to one), then:
   A) the device shall return command aborted with the additional sense code set to COMMAND SEQUENCE ERROR (see 6.8.3) in response to the following commands:
      a) the READ STREAM DMA EXT command (see 7.28);
      b) the READ STREAM EXT command (see 7.29);
      c) the WRITE STREAM DMA EXT command (see 7.66);
      d) the WRITE STREAM EXT command (see 7.67); and
      e) the DEADLINE HANDLING command (see 7.17.12);

      and

   B) if the device shall process the SCT Error Recovery Control command (see 8.3.3), then the device shall:
      a) set the Extended Status Code (see table 189) to 0004h (i.e., Invalid function code in SCT Error Recovery command); and
      b) return command aborted with the additional sense code set to COMMAND SEQUENCE ERROR;

   and

b) disabled (i.e., the COMMAND DURATION LIMITS ENABLED bit is cleared to zero), then the device shall process the following commands as defined in this standard:
   A) the READ STREAM DMA EXT command;
   B) the READ STREAM EXT command;
   C) the WRITE STREAM DMA EXT command;
   D) the WRITE STREAM EXT command; and
   E) the DEADLINE HANDLING command; and
   F) the SCT Error Recovery Control command.

If the Command Duration Limits feature set is supported and command duration guidelines are supported (i.e., the COMMAND DURATION GUIDELINES SUPPORTED bit (see 9.10.5.19.2) is set to one), then:

a) the Lowest Achievable Command Duration device statistic (see 9.5.4.3) shall be supported; and
b) the following fields shall be supported in at least one Command Duration Limits Descriptor (see 9.11.2):
   A) the COMMAND DURATION GUIDELINE POLICY field (see 9.11.2.4); and
   B) the COMMAND DURATION GUIDELINE field (see 9.11.2.9).

4.7.2 COMMAND DURATION LIMITS INDEX field

The COMMAND DURATION LIMITS INDEX field is an index that is used to select a Command Duration Limits Descriptor in the Command Duration Limits log.

If the Command Duration Limits feature set is disabled (i.e., the COMMAND DURATION LIMITS ENABLED bit (see 9.10.6.2.3) is cleared to zero), then the device shall ignore the COMMAND DURATION LIMITS INDEX field.

If the Command Duration Limits feature set is enabled (i.e., the COMMAND DURATION LIMITS ENABLED bit is set to one) and the device processes a command with a non-zero value in the COMMAND DURATION LIMITS INDEX field, then the device:

1) uses the contents of the COMMAND DURATION LIMITS INDEX field to select a Command Duration Limits Descriptor (see 9.11.2) as described in table 6; and
2) associates the non-zero duration limits and guidlines information, if any, and applicable information in the specified Command Duration Limits Descriptor with the command being processed.

Table 6 — Command Duration Limits descriptor selection

COMMAND DURATION LIMITS INDEX field	Command Duration Limits descriptor for read commands	Command Duration Limits descriptor for write commands
1	r1	w1
2	r2	w2
3	r3	w3
4	r4	w4
5	r5	w5
6	r6	w6
7	r7	w7

4.7.3 Command duration limits operation

The results of associating the contents of a Command Duration Limits Descriptor with the processing of a command depend on the contents of the Command Duration Limits Descriptor.

EXAMPLE - A host may associate two or more Command Duration Limits Descriptors with host-defined command priorities and use the COMMAND DURATION LIMITS INDEX field values that select those descriptors as priority numbers. The differences between the host-defined command priorities are represented to the device through the specification of different field values in each Command Duration Limits Descriptor. In this way, the host's interpretation of command priorities is disassociated from the processing performed by the device. If the Command Duration Limits Descriptors are specified appropriately, then the device processing remains the same even if one host specifies higher valued command priorities (i.e., larger COMMAND DURATION LIMITS INDEX field values) as resulting in faster command processing, while another host specifies lower valued command priorities as resulting in faster command processing.

If the Command Duration Limits feature is enabled and the device processes a command that contains the COMMAND DURATION LIMITS INDEX field, then the processing of that command shall not be altered by the Command Duration Limits feature set, if:

a) the COMMAND DURATION LIMITS INDEX field is cleared to zero; or
b) the device is able to process that command such that:
   A) the inactive time for that command is less than or equal to the non-zero INACTIVE TIME LIMIT field (see 9.11.2.6), if any, in the Command Duration Limits Descriptor selected by that COMMAND DURATION LIMITS INDEX field;
   B) the active time for that command is less than or equal to the non-zero ACTIVE TIME LIMIT field (see 9.11.2.5), if any, in the Command Duration Limits Descriptor selected by that COMMAND DURATION LIMITS INDEX field; and
   C) the COMMAND DURATION GUIDELINES SUPPORTED bit (see 9.10.5.19.2) is cleared to zero or the COMMAND DURATION GUIDELINE field (see 9.11.2.9) is cleared to zero in the Command Duration Limits Descriptor selected by that COMMAND DURATION LIMITS INDEX field.

If the Command Duration Limits feature is enabled and the device processes a command that contains a COMMAND DURATION LIMITS INDEX field where:

a) the inactive time for that command is greater than the non-zero INACTIVE TIME LIMIT field (see 9.11.2.6), if any, in the Command Duration Limits Descriptor selected by that COMMAND DURATION LIMITS INDEX field, if any, in the INACTIVE TIME LIMIT POLICY field (see 9.11.2.2) in the Command Duration Limits Descriptor selected by that COMMAND DURATION LIMITS INDEX field is set to:
   A) Dh, then the device shall return command complete with no error with the additional sense code set to DATA CURRENTLY UNAVAILABLE (see 6.8.6); and
   B) Fh, then the device shall return command aborted with the additional sense code set to COMMAND TIMEOUT BEFORE PROCESSING (see 6.8.4);
b) the active time for this command is greater than the non-zero ACTIVE TIME LIMIT field (see 9.11.2.5), if any, in the Command Duration Limits Descriptor selected by that COMMAND DURATION LIMITS INDEX field, and the ACTIVE TIME LIMIT POLICY field (see 9.11.2.3) in the Command Duration Limits Descriptor selected by that COMMAND DURATION LIMITS INDEX field is set to:
   A) Dh, then the device shall return command complete with no error with the additional sense code set to DATA CURRENTLY UNAVAILABLE (see 6.8.6); and
   B) Fh, then the device shall return command aborted with the additional sense code set to COMMAND TIMEOUT BEFORE PROCESSING (see 6.8.4);

   and
c) that command is an NCQ command and the COMMAND DURATION GUIDELINE field (see 9.11.2.9) in the Command Duration Limits Descriptor selected by that COMMAND DURATION LIMITS INDEX field contains a non-zero value, then the device should modify the queued processing of that command based on the contents of the following fields in that Command Duration Limits Descriptor:
   A) the COMMAND DURATION GUIDELINE field; and
   B) the COMMAND DURATION GUIDELINE POLICY field (see 9.11.2.4).

4.7.4 High Priority Enhancement feature

The High Priority Enhancement feature of the Command Duration Limits feature set uses fields in the Command Duration Limits log (see 9.11) for the host to provide guidance to the device regarding processing of the READ FPDMA QUEUED command (see 7.23) and the WRITE FPDMA QUEUED command (see 7.61) that have the PRIO field (see 4.15.2) set to 10b (i.e., High priority (see table 10)).

If the High Priority Enhancement feature is supported (i.e., if the HIGH PRIORITY ENHANCEMENT SUPPORTED bit (see 9.10.5.19.1) is set to one), then the device shall support:

a) the NCQ feature set (see 4.15); and
b) the Command Duration Limits log (see 9.11).

If the High Priority Enhancement feature is enabled (i.e., if HIGH PRIORITY ENHANCEMENT ENABLED bit (see 9.10.6.2.2) is set to one), then READ FPDMA QUEUED commands and WRITE FPDMA QUEUED commands with the PRIO field set to 10b (i.e., the affected commands) shall be processed by the device as follows:

a) the contents of the PERFORMANCE VERSUS COMMAND DURATION GUIDELINES field shall affect the processing of all affected commands as described in 9.11.1.2; and
b) the contents of the COMMAND DURATION GUIDELINE field (see 9.11.2.9) in:
   A) Command Duration Limits Descriptor r1 (see 9.11.1) shall affect the processing of all READ FPDMA QUEUED commands that are affected commands as described in 9.11.2.9; and
   B) Command Duration Limits Descriptor w1 (see 9.11.1) shall affect the processing of all WRITE FPDMA QUEUED commands that are affected commands as described in 9.11.2.9.

If the High Priority Enhancement feature is enabled, the device shall ignore the following Command Duration Limits log fields:

a) in Command Duration Limits Descriptor r1, and Command Duration Limits Descriptor w1, all fields except the COMMAND DURATION GUIDELINE field; and
b) all fields in the following Command Duration Limits Descriptors:
   A) r2;
   B) r3;
   C) r4;
   D) r5;
   E) r6;
   F) r7;
   G) w2;
   H) w3;
   I) w4;
   J) w5;
   K) w6; and
   L) w7.

If the Command Duration Limits feature set is enabled, then the High Priority Enhancement feature is disabled (see 7.45.10).

4.8 Device Statistics Notification (DSN) feature set

4.8.1 Overview

The DSN feature set allows the host to configure a device to monitor device statistics and allows a device to notify the host that a change in a device statistic has met a configured DSN Condition Definition.

Each device statistic in the Device Statistics log (see 9.5) indicates support for device statistics notifications and if the monitored DSN Condition Definition for that device statistic is met (see table 224).

In the Device Statistics Notifications log (see 9.26), the Definition log pages (see table 319) allow the setting of the DSN CONDITION FLAGS field (see table 320) (e.g., include device statistic threshold comparison conditions and device statistic validity conditions). Device statistic threshold comparison values are specified in the same format and units as the referenced device statistic.

The Summary log page (see table 317) of the Device Statistics Notifications log contains a list of the active device statistics notifications (i.e., notifications of monitored device statistics with test conditions that are met when the page is read).

The Definition log pages of the Device Statistics Notifications log are not affected by the processing of a power-on reset (see ATA8-AAM).

The DSN feature set is enabled by a SET FEATURES Enable DSN function (see 7.45.21) that returns command completion without error. This feature set may be disabled by a SET FEATURES Disable DSN function (see 7.45.21) that returns command completion without error.

Devices that support this feature set shall support the:

a) General Purpose Logging feature set (see 4.11);
b) Sense Data Reporting feature set (see 4.24);
c) Device Statistics Notifications log (see 9.26);
d) Device Statistics log (see 9.5); and
e) SET FEATURES Enable/Disable the DSN feature set (see 7.45.21).

If the DSN feature set is enabled, then the DSN feature set shall:

a) be disabled upon processing a power-on reset (see ATA8-AAM); and
b) remain enabled across all other resets (e.g., hardware reset, software reset).

If the DSN feature set is supported and disabled, then:

a) commands that read the Summary page of the Device Statistics Notifications log (i.e., page 00h):
   A) should return command complete without an error; and
   B) if the command completes without an error, then all the DSN Match Entries shall be cleared to zeros;
   C) if the command completes without an error and the command is an NCQ command and the SUCCESSFUL NCQ COMMAND SENSE DATA ENABLED bit (see 9.10.6.2.6) is cleared to zero;
   and
b) commands that read or write the Definition pages of the Device Statistics Notifications log (e.g., pages 01h..07h) should return command complete without an error.

4.8.2 DSN notifications

Device statistics are evaluated against the DSN Condition Definition during updates of the device statistic. Each DSN Condition Definition is evaluated independently. Each DSN Condition Definition is evaluated on updates to the monitored device statistic.

The device sets the SENSE DATA AVAILABLE bit (see 6.2.9) in the STATUS field to one in the normal outputs and error outputs for a command, if:

a) the command is being completed:
   A) with an error; or
   B) without an error and the command is not an NCQ command (see 4.15);
b) the Sense Data Reporting feature set (see 4.24) is enabled; and
c) for a specific device statistic, the following conditions exist:
   A) DSN is supported;

B) a DSN Condition Definition (see table 319) is configured; and
C) the DSN Condition Definition is met.

The device sets the DEVICE STATISTICS NOTIFICATION ACTIVE bit (see 9.28.2.3.2) to one in the Sense Data for Successful NCQ Commands log (see 9.28), if:

a) an NCQ command (see 4.15) is being completed without an error;
b) the Sense Data Reporting feature set (see 4.24) is enabled; and
c) the SUCCESSFUL NCQ COMMAND SENSE DATA ENABLED bit (see 9.10.6.2.6) is set to one; and
d) for a specific device statistic, the following conditions exist:
   A) DSN is supported;
   B) a DSN Condition Definition (see table 319) is configured; and
   C) the DSN Condition Definition is met.

The DEVICE STATISTICS NOTIFICATION ACTIVE bit is cleared to zero by a command that reads the Sense Data for Successful NCQ Commands log (see 4.15.7).

If the device is reporting changes based on DSN Condition Definitions that have been met in response to a REQUEST SENSE EXT command, then the normal outputs shall contain the additional sense code set to WARNING – DEVICE STATISTICS NOTIFICATION ACTIVE (see 6.8.34).

The contents of the Summary page (i.e., 00h) of the Device Statistics Notifications log (see 9.26) are always valid while the DSN ENABLED bit (see 9.10.6.2.8) is set to one. The validity of the Device Statistics Notifications log is not affected by the value of the SENSE DATA ENABLED bit (see 9.10.6.2.12) or the value of the NCQ AUTOSENSE SUPPORTED bit (see 9.10.10.2.21). The host may read the Summary page to check for notification status changes. The Summary page shall not be changed by:

a) a READ LOG EXT command (see 7.24) or READ LOG DMA EXT (see 7.25) command addressing the:
   A) Summary page of the Device Statistics Notifications log (see 9.26); or
   B) NCQ Command Error log (see 9.14);

   or
b) a REQUEST SENSE DATA EXT command (see 7.34).

4.8.3 DSN notifications setup

The host requests specific device statistics notifications by writing to the Definition pages (see table 319) of the Device Statistics Notifications log (see 9.26). In each Definition page, the host may write one or more pairs of QWords with each pair forming one device statistic notification entry as follows:

1) a Device Statistics Location QWord that specifies a device statistic in the Device Statistics log (see 9.5) that is to be tested for the device statistics notification; and
2) a Device Statistics Condition Definition QWord that specifies the test to be made.

Each device statistic notification entry is independent of other device statistic notification entries.

If any Definition page being written to the Device Statistics Notifications log contains a device statistic notification entry that:

a) refers to a device statistic that is not supported (see table 224);
b) refers to a device statistic that does not support device statistic notification (see table 224);
c) contains a threshold value that is out of range for the referenced device statistic (see table 320); or
d) contains a Comparison Type that is reserved (see table 320),

then:

1) none of the Definition pages being written to the Device Statistics Notifications log shall be saved by the device; and
2) the command shall return command aborted (see table 372).

4.9 Extended Power Conditions (EPC) feature set

4.9.1 Overview

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

a) defining power conditions (i.e., Idle_a, Idle_b and Idle_c) within the PM1: Idle state in the Power Management feature set (see 4.17);
b) defining power conditions (i.e., Standby_y and Standby_z) within the PM2: Standby state in the Power Management feature set;
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 command Extended Power Conditions subcommand (see 7.45.20);
b) the Power Conditions log (see 9.8);
c) the additional status values returned by the CHECK POWER MODE command (see 7.3);
d) the EPC SUPPORTED bit (see 9.10.5.2.27); and
e) the EPC ENABLED bit (see 9.10.6.2.9).

4.9.2 Power conditions

Idle_a, Idle_b, and Idle_c are power conditions within the PM1: Idle state (see 4.17.4). Standby_y and Standby_z are power conditions within the PM2: Standby state (see 4.17.4). 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

In this ordering, a power condition:

a) on the right side of the relationship is a lower power condition than any power condition to its left (e.g., Standby_y is a lower power condition than Idle_c); and
b) on the left side of the relationship is a higher power condition than any power condition to its right (e.g., Standby_y is a higher power condition than Standby_z).

The Standby timer (see 4.17.3) is controlled using:

a) the SET FEATURES command Extended Power Conditions subcommand (see 7.45.20);
b) the IDLE command (see 7.14); and
c) the STANDBY command (see 7.49).

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

Each of these power conditions has a set of current, saved and default settings (see 9.8). Default settings are not changeable. Default and saved settings shall persist across all resets (e.g., power-on resets). The current settings shall not persist across power cycles.

4.9.3 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 command Extended Power Conditions subcommand (see 7.45.20). Configured settings for the timers are readable in the Power Conditions log (see 9.8).

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

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

If a command is accepted that requires a transition to PM0: Active state (see 4.17.4), all enabled power condition timers shall be stopped. If a command is accepted that does not require a transition to PM0: Active state (e.g., a CHECK POWER MODE command), then the timers shall continue to run.

On command completion, all power condition timers that were stopped shall be initialized with their current timer values (see 9.8) and started.

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

If an enabled timer expires and that timer is associated with a lower power condition (see 4.9.2) than the device's current power condition, then the device shall transition to the power condition associated with the expired timer. The device shall not transition to a higher power condition as the result of a timer expiring. If the timers associated with multiple enabled power conditions expire at the same time, the device shall transition to the lowest of the lower power conditions associated with expired timers.

If volatile write cache is enabled (i.e., if the VOLATILE WRITE CACHE ENABLED bit (see 9.10.6.2.10) is set to one), then prior to entering into any power condition that prevents access to the media (e.g., before a hard drive stops its spindle motor during a transition to the Standby_z power condition), the device shall write all cached data to the media for the device (e.g., as a device does in response to a flush command).

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

If the device processes a power-on reset or the Enable the EPC feature set subcommand (see 7.45.20.6), the device shall:

1) stop all power condition timers (see 4.9.3);
2) copy the SAVED TIMER ENABLED bit to the CURRENT TIMER ENABLED bit in the power conditions descriptors (see 9.8.4) for all supported power conditions;
3) copy the contents of the SAVED TIMER SETTING field to the CURRENT TIMER SETTING field in the power conditions descriptors for all supported power conditions; and
4) initialize and restart all enabled power condition timers with the values in the CURRENT TIMER SETTING fields in the associated power conditions descriptors.

If the device processes a hardware reset or a software reset, the device shall:

1) stop all power condition timers;
2) remain in the current power condition; and
3) initialize and restart all enabled power condition timers with the values in the CURRENT TIMER SETTING fields in the associated power conditions descriptors.

If the device processes an IDLE command (see 7.14) without error, then:

1) in the Standby_z power condition descriptor of the Standby power conditions page (see 9.8.3) in the Power Conditions log, if the specified Standby timer period (see table 61) in the IDLE command is set to:
   A) a nonzero value, then the device shall set the CURRENT TIMER ENABLED bit to one, convert the specified timer period to units of 100 ms, and set the CURRENT TIMER SETTING field to the converted value; or
   B) zero, then the device shall clear the CURRENT TIMER ENABLED bit to zero and clear the CURRENT TIMER SETTING field to zero;
2) the device shall transition to the PM1: Idle state (see 4.17.4); and
3) the device shall enter the Idle_a power condition.

If the device processes an IDLE IMMEDIATE command (see 7.15) without error, then:

1) if the Unload feature (see 7.15.2.2) was selected, then:
   A) the device shall perform the operations described in 7.15.2.2; and
   B) if volatile write cache is enabled (i.e., if the VOLATILE WRITE CACHE ENABLED bit (see 9.10.6.2.10) is set to one), 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 (see 7.49) without error, then:

1) in the Standby_z power condition descriptor of the Standby power conditions page (see 9.8.3) in the Power Conditions log, if the specified Standby timer period (see table 151) in the STANDBY command is set to:

   A) a nonzero value, then the device shall set the CURRENT TIMER ENABLED bit to one, convert the specified timer period to units of 100 ms, and set the CURRENT TIMER SETTING field to the converted value; or
   B) zero, then the device shall clear the CURRENT TIMER ENABLED bit to zero and clear the CURRENT TIMER SETTING field to zero;
2) the device shall transition to the PM2: Standby state (see 4.17.4); and
3) the device shall enter the Standby_z power condition.

If the device processes a STANDBY IMMEDIATE command (see 7.50) without error, then the device shall:

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

The EPC feature set and the APM feature set (see 4.6) are mutually exclusive. If the EPC feature set is disabled (i.e., the EPC ENABLED bit (see 9.10.6.2.9) is cleared to zero), the device:

a) shall process the Enable the EPC feature set subcommand (see 7.45.20.6);
b) may process the Set EPC Power Source subcommand (see 7.45.20.8); and
c) shall return command aborted for all other EPC feature set subcommands.

If the device processes a SET FEATURES Enable APM subcommand without error and the EPC ENABLED bit (see 9.10.6.2.9) is set to one, then the device shall disable the EPC feature set.

During background activities:

a) all power condition timers may be stopped; and
b) on completion of the background activity, the power condition timers that were stopped shall be restarted from where they were stopped.

4.10 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. If this feature is enabled, upon detecting a free-fall event the device should protect the user data on the media from damage. The implementation of free-fall detection and protection is vendor specific.

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

a) the SET FEATURES subcommand to Enable the Free-fall Control feature set (see 7.45.15); and
b) the SET FEATURES subcommand to Disable the Free-fall Control feature set.

The settings controlled by the Enable/Disable Free-fall Control subcommands shall persist across all resets.

The FREE-FALL ENABLED bit (see 9.10.6.2.18) indicates whether the Free-fall Control feature set is enabled.

4.11 General Purpose Logging (GPL) feature set

The General Purpose Logging (GPL) feature set provides access to the logs in a device. These logs may be associated with specific feature sets (e.g., the SMART feature set (see 4.23) and the Streaming feature set (see 4.27)). Support requirements for individual logs are summarized in table 218. Some logs are documented as mandatory in their feature set description.

If the feature set associated with a requested log (see table 218) is disabled, the device shall return command aborted.

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

a) READ LOG EXT (see 7.24); and
b) WRITE LOG EXT (see 7.62).

If the GPL feature set is supported, the following commands are optional:

a) READ LOG DMA EXT (see 7.25); and
b) WRITE LOG DMA EXT (see 7.63).

If the GPL feature set is supported, all Host Specific logs shall be supported (see 9.9).

4.12 Hybrid Information feature set

4.12.1 Hybrid Information feature overview

A hybrid device contains both a primary medium (e.g., rotating magnetic) and a non-volatile cache (e.g., flash memory).

The Hybrid Information feature allows the host to provide information to the device that the device uses for various purposes (e.g., to decide the medium to which the user data is to be saved for optimal performance in retrieval).

Devices may determine data to be cached based on:

a) observed access patterns of LBAs and length of requests; or
b) information provided by the host using this feature set.

Caching priority specifies the relative caching importance of the data associated with a command in relation to other commands being processed by the device. Caching priority is a value in the range of 1h to max (see table 7).

The Hybrid Information feature set provides a method for the host to indicate the caching priority of incoming requests to the device.

Table 7 — Caching Priority

Caching Priority Value	Description
0	No information provided
1..(max-1)	Intermediate caching priority levels
max	Maximum supported caching priority level (see 9.19.2.8)

If the MAX PRIORITY BEHAVIOR bit (see 9.19.2.11.3) is set to one and the host specifies the highest caching priority, then the device shall place the data in the non-volatile cache until explicitly evicted by the host.

If the MAX PRIORITY BEHAVIOR bit is cleared to zero, then the highest caching priority passed to the device instructs the hybrid device that the associated data should:

a) be placed in non-volatile cache; and
b) remain in the non-volatile cache.

Intermediate caching priority levels inform the device of the priority of placing the data in the non-volatile cache. The device should make a choice based on the caching priority provided by the host and other device knowledge (e.g., rotational position optimizations).

The host may specify a dirty high threshold (see 7.17.10.3.4) and a dirty low threshold (see 7.17.10.3.3) to ensure that the device does not consume too much internal bandwidth syncing logical sectors between the non-volatile cache and the primary medium, while still leaving room to absorb new writes.

The caching priority values hints are specified in the HYBRID INFORMATION field (see 7.17.8.4) for the following commands:

a) the HYBRID DEMOTE BY SIZE command (see 7.17.8);
b) the HYBRID CHANGE BY LBA RANGE command (see 7.17.9);
c) the HYBRID CONTROL command (see 7.17.10);
d) the READ DMA EXT command (see 7.22);
e) the READ FPDMA QUEUED command (see 7.23);
f) the WRITE DMA EXT command (see 7.59);
g) the WRITE DMA FUA EXT command (see 7.60); and
h) the WRITE FPDMA QUEUED command (see 7.61).

The host may request that the device evict logical sectors from the non-volatile cache using the HYBRID EVICT command (see 7.43.8).

If the device processes a read command, then each logical sector specified in that read command should be read from the medium with the shortest latency that contains the most recent copy of the specified logical sectors.

If the Hybrid Information feature set is not supported (i.e., the HYBRID INFORMATION SUPPORTED bit is cleared to zero), then the device shall:

a) ignore the HYBRID INFORMATION field for any command; and
b) indicate that the following are not supported:
   A) the SET FEATURES Enable/Disable Hybrid Information subcommand (see 7.45.16.10);
   B) the Hybrid Information log (see 9.19);
   C) the HYBRID EVICT command (see 7.43.8);
   D) the HYBRID DEMOTE BY SIZE command (see 7.17.8);
   E) the HYBRID CHANGE BY LBA RANGE command (see 7.17.9); and
   F) the HYBRID CONTROL command (see 7.17.10).

If the Hybrid Information feature set is supported (i.e., the HYBRID INFORMATION SUPPORTED bit (see 9.10.10.2.23) is set to one), then:

a) the device shall support:
   A) the following:
      a) NCQ Autosense feature (i.e., the NCQ AUTOSENSE SUPPORTED bit (see 9.10.10.2.21) shall be set to one); and
      b) Power-Up In Standby feature set (see 4.18);
   B) the following SET FEATURES subcommands:
      a) Enable/disable the PUIS feature set (see 7.45.6); and
      b) Enable/Disable Hybrid Information (see 7.45.16.10);
   C) the HYBRID DEMOTE BY SIZE command (see 7.17.8);
   D) the HYBRID CONTROL command (see 7.17.10); and
   E) the following logs:
      a) SATA NCQ Non-Data (see 9.17);
      b) SATA NCQ Send and Receive (see 9.18);
      c) IDENTIFY DEVICE data (see 9.10); and
      d) Hybrid Information (see 9.19);
b) the device should support Device Sleep (i.e., the DEVICE SLEEP SUPPORTED bit (see 9.10.10.2.22) should be set to one);
c) the device shall not support the SET FEATURES PUIS feature set device spin-up subcommand (see 7.45.7);
d) the following commands, if supported, shall be able to return command completion without error while in the PM2: Standby (see 4.15.4) state or in the PM5: PUIS and spin-up subcommand not supported state (see 4.15.4):
   A) all read commands, if the requested logical sectors are in the non-volatile cache all read commands that return all user data from the non-volatile cache;
   B) all write commands, if the device stores all of the data for the command in the non-volatile cache all write commands that store all the specified user data in the non-volatile cache;
   C) commands to read the following logs:
      a) Identify Device data;
      b) Hybrid Information;
      c) Power Conditions;
      d) NCQ Command Queued Error;
      e) SATA NCQ Non-Data; and
      f) SATA NCQ Send and Receive;
   D) IDENTIFY DEVICE command;
   E) CHECK POWER MODE command;
   F) SMART RETURN STATUS command; and
   G) SECURITY UNLOCK command;
e) if the Hybrid Information feature is enabled (i.e., the HYBRID INFORMATION ENABLED bit (see 9.10.10.3.12), then the device shall:
   A) process the HYBRID INFORMATION field (see 7.17.8.4) as described in this subclause for a:

a) HYBRID DEMOTE BY SIZE command (see 7.17.8);
b) HYBRID CHANGE BY LBA RANGE command (see 7.17.9);
c) HYBRID CONTROL command (see 7.17.10);
d) READ DMA EXT command (see 7.22);
e) READ FPDMA QUEUED command (see 7.23);
f) WRITE DMA EXT command (see 7.59);
g) WRITE DMA FUA EXT command (see 7.60); and
h) WRITE FPDMA QUEUED command (see 7.61);

and

B) ignore the HYBRID INFORMATION field for all other commands;

and

f) if the Hybrid Information feature is disabled (i.e., the HYBRID INFORMATION ENABLED bit (see 9.10.10.3.12) is cleared to zero), then the device shall ignore the HYBRID INFORMATION field as described in this subclause.

4.12.2 Syncing

The Hybrid Information log contains the following fields related to syncing:

a) DIRTY LOW THRESHOLD field (see 7.17.10.3.3); and
b) DIRTY HIGH THRESHOLD field (see 7.17.10.3.4).

The device should prioritize the logical sectors contained in the non-volatile cache to be synced as follows:

1) starting from the requested caching priority level of zero, up to the maximum caching priority level;
2) within each requested caching priority level, sync the least recently used logical sectors first and then the most recently used logical sectors.

4.12.3 Interactions with ATA power management

If:

a) the Hybrid Information feature is enabled;
b) the device processes a read command or a write command; and
c) the requested logical sectors are not accessible in the current power condition,

then:

a) the device shall return command aborted; and
b) if the failing command is READ FPDMA QUEUED or WRITE FPDMA QUEUED, then the device shall set the additional sense code to LOGICAL UNIT NOT READY, INITIALIZING COMMAND REQUIRED (see 6.8.13) in the NCQ Command Error log (see 9.14).

If the device indicates an additional sense code of LOGICAL UNIT NOT READY, INITIALIZING COMMAND REQUIRED (see 6.8.13), then the device should be explicitly spun up before the host reissues the command.

If the power condition was entered as a result of processing the EPC Go To Power Condition command (see 7.45.20.3) with the HOLD POWER CONDITION bit (see 7.45.20.2.1) cleared to zero, then table 8 describes interactions with the power source reported by the device.

Table 8 — Power Source interactions

POWER SOURCE field [a]	Description
0h	Vendor specific
1h	The device should not go to a power condition that consumes more power in order to sync logical sectors.
2h	Syncing operations should not adversely affect performance. The device should be more aggressive about syncing than when on battery. If the device changed power condition in order to process syncing, then the device should return to the previous power condition on completion of the syncing operation.

[a] The POWER SOURCE field is in the IDENTIFY DEVICE data log (see 9.10.6.3.1).

4.12.4 Other Hybrid conditions

4.12.4.1 NVM Size changed

The device may reduce the NVM Size of the non-volatile cache. If the device reduces the NVM size of the non-volatile cache, then

a) the device shall set the NVM SIZE CHANGED bit (see 9.19.2.4.4) in the Hybrid Information log (see 9.19); and
b) if the Hybrid Information feature is enabled and the device processes a SMART RETURN STATUS command (see 7.48.3), then the device shall:
   A) set the value of LBA(23:8) to 2CF4h (i.e., the device has detected a threshold exceeded condition); and
   B) return command complete without error.

If the host reads the Hybrid Information log, then the device shall clear the NVM SIZE CHANGED bit after returning the log data to the host.

4.12.4.2 Read Only

The device may change the non-volatile cache to read-only access. If the device changes the non-volatile cache to read-only access, then the device shall set the READ ONLY bit (see 9.19.2.4.3) to one.

4.12.4.3 Data Loss

If the device encounters conditions such that some logical sectors in the non-volatile cache is no longer accessible, then:

a) the device shall set the DATA LOSS bit (see 9.19.2.4.2) to one; and
b) if the Hybrid Information feature is enabled and the device processes a SMART RETURN STATUS command (see 7.48.3), then the device shall:
   A) set the value of LBA(23:8) to 2CF4h (i.e., the device has detected a threshold exceeded condition); and
   B) return command complete without error.

If the host reads the Hybrid Information log, then the device shall clear the DATA LOSS bit (see 9.19.2.4.2) after returning the log data to the host.

4.12.4.4 Unusable

If the device encounters conditions such that the non-volatile cache has become unusable, then:

a) the device shall set the UNUSABLE bit (see 9.19.2.4.5) to one;
b) the device shall disable the Hybrid Information feature (i.e., the HYBRID INFORMATION ENABLED bit (see 9.10.10.3.12) is cleared to zero);
c) the device shall remove indication of support for the Hybrid Information feature (i.e., HYBRID INFORMATION SUPPORTED bit shall be cleared to zero); and
d) if the device processes a SMART RETURN STATUS command (see 7.48.3), then the device shall:

A) set the value of LBA(23:8) to 2CF4h (i.e., the device has detected a threshold exceeded condition); and
B) return command complete without error.

The device may clear the UNUSABLE bit under vendor specific conditions.

4.12.4.5 Automatic Disable

If:

a) the Hybrid Information feature is currently enabled; and
b) the device has not processed any command to read the Hybrid Information log for 25 consecutive power cycles,

then the device shall:

1) clear the REQUESTED CACHING PRIORITY LEVEL field for all logical sectors in the non-volatile cache to zero;
2) clear the ENABLED field (see 9.19.2.3) to zero; and
3) disable the Hybrid Information feature (i.e., clear the HYBRID INFORMATION ENABLED bit (see 9.10.10.3.12) to zero).

4.13 Long Logical Sector (LLS) feature set

The LLS feature set provides a method for a device to indicate that it has more than 256 words per logical sector (e.g., logical sectors with 520 or 528 bytes). Devices with logical sectors longer than 256 words shall set the LOGICAL SECTOR SIZE SUPPORTED bit (see 9.10.4.3.2) to one. The logical sector size is indicated in the LOGICAL SECTOR SIZE field (see 9.10.4.4).

Table 9 describes the number of words transferred per COUNT field unit for ATA devices that support the LLS feature set. Data transfer commands transfer either the logical sector size (see 9.10.4.4) or 256 words depending on the command.

EXAMPLE - The READ DMA EXT command and the WRITE DMA EXT command transfer data in units of logical sectors each of which has a size in words that is indicated by the contents of the LOGICAL SECTOR SIZE field (see 9.10.4.4) while the READ LOG EXT command and the WRITE LOG EXT command transfer 256 words per DRQ data block, regardless of the logical sector size.

In figure 4, the long logical sector example shows a device formatted with long logical sectors.

The Long Physical Sector (LPS) feature set (see 4.14) and the LLS feature set are not mutually exclusive. In figure 4, the long logical and long physical sector example shows a device that supports both the LPS feature set and the LLS feature set.

Table 9 — Words transferred per COUNT field unit by command (Sheet 1 of 2)

Command	Words transferred
DATA SET MANAGEMENT	256
DATA SET MANAGEMENT XL	256
DOWNLOAD MICROCODE	256
DOWNLOAD MICROCODE DMA	256
GET PHYSICAL ELEMENT STATUS	256
IDENTIFY DEVICE	256
READ BUFFER	256
READ BUFFER DMA	256
READ DMA	logical sector size (see 9.10.4.4)
READ DMA EXT	logical sector size (see 9.10.4.4)
READ FPDMA QUEUED	logical sector size (see 9.10.4.4)
READ LOG EXT	256
READ LOG DMA EXT	256
READ SECTOR(S)	logical sector size (see 9.10.4.4)
READ SECTOR(S) EXT	logical sector size (see 9.10.4.4)
READ STREAM DMA EXT	logical sector size (see 9.10.4.4)
READ STREAM EXT	logical sector size (see 9.10.4.4)
READ VERIFY SECTOR(S)	logical sector size (see 9.10.4.4)
RECEIVE FPDMA QUEUED	256
SECURITY DISABLE PASSWORD	256
SECURITY ERASE UNIT	256
SECURITY SET PASSWORD	256
SECURITY UNLOCK	256

Table 9 — Words transferred per COUNT field unit by command (Sheet 2 of 2)

Command	Words transferred
SEND FPDMA QUEUED	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	logical sector size (see 9.10.4.4)
WRITE DMA EXT	logical sector size (see 9.10.4.4)
WRITE DMA FUA EXT	logical sector size (see 9.10.4.4)
WRITE FPDMA QUEUED	logical sector size (see 9.10.4.4)
WRITE LOG EXT	256
WRITE LOG DMA EXT	256
WRITE SECTOR(S)	logical sector size (see 9.10.4.4)
WRITE SECTOR(S) EXT	logical sector size (see 9.10.4.4)
WRITE STREAM DMA EXT	logical sector size (see 9.10.4.4)
WRITE STREAM EXT	logical sector size (see 9.10.4.4)
ZAC MANAGEMENT IN	256
ZAC MANAGEMENT OUT	256

4.14 Long Physical Sector (LPS) feature set

The 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 7.45.19) and the LPS Mis-alignment log (see 9.13) are optional for devices that support the LPS feature set.

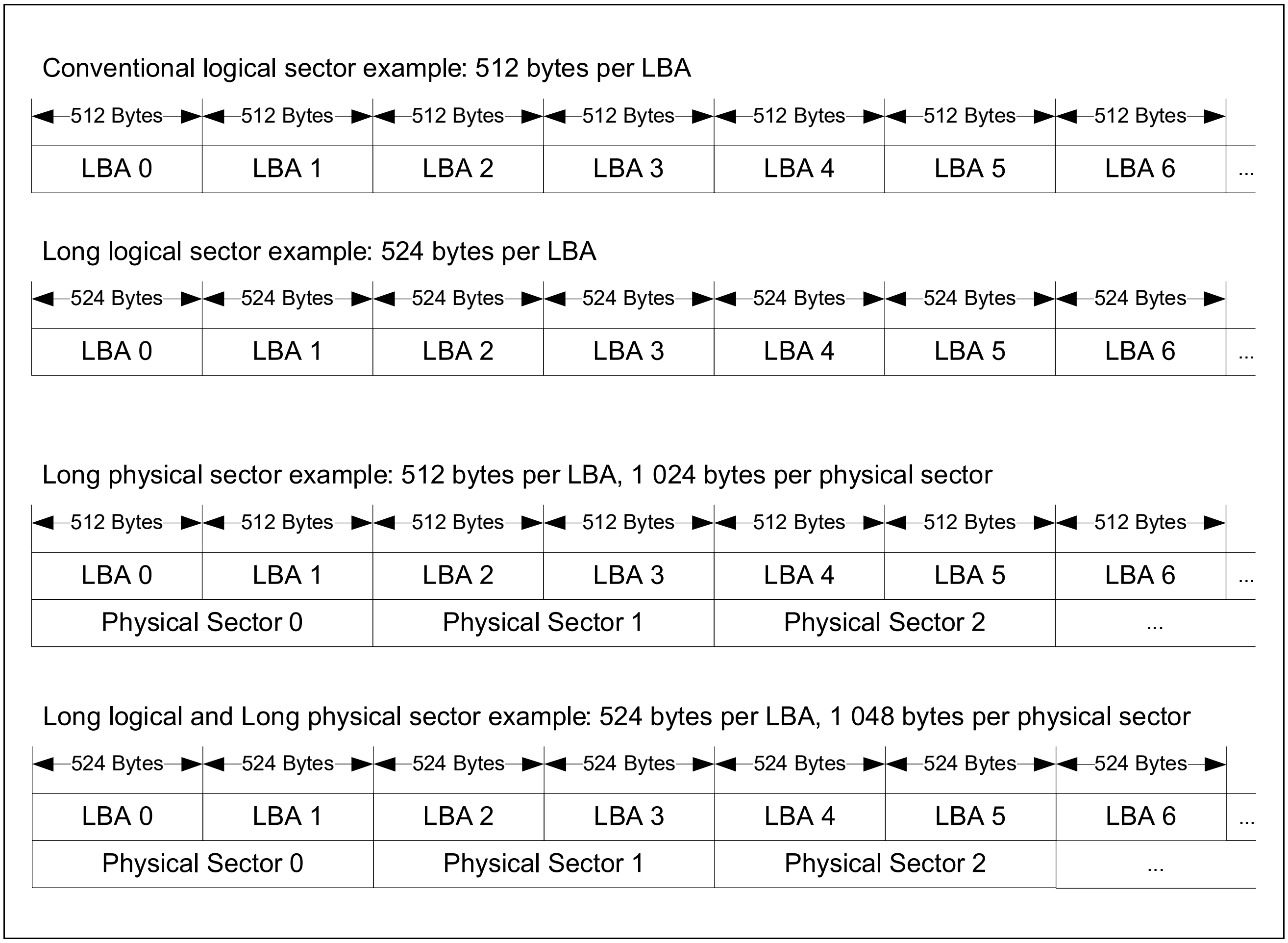

Figure 4 — LLS and LPS Example

If the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP SUPPORTED bit (see 9.10.4.3.1) is set to one and the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP field (see 9.10.4.3.4) is cleared to zero, then the device may report the alignment of the first logical sector (LBA 0) within the first physical sector in the LOGICAL SECTOR OFFSET field (see 9.10.4.3.5).

Examples of logical/physical sector alignments follow.

EXAMPLE 1 - In Figure 5, there are two logical sectors within one physical sector, and the first logical sector is in the first half. The offset is zero, and the LOGICAL SECTOR OFFSET field (see 9.10.4.3.5) is set to 0000h.

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 two logical sectors within one physical sector, and the first logical sector is in the second half. The offset is one, and the LOGICAL SECTOR OFFSET field (see 9.10.4.3.5) is set to 0001h.

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 four logical sectors within one physical sector, and the first logical sector is in the second half. The offset is three, and the LOGICAL SECTOR OFFSET field (see 9.10.4.3.5) is set to 0003h.

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

Figure 7 — Alignment 3

4.15 Native Command Queuing (NCQ) feature set

4.15.1 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).

If the device supports the NCQ feature set, then the device shall support the:

a) READ FPDMA QUEUED command (see 7.23);
b) WRITE FPDMA QUEUED command (see 7.61);
c) GPL feature set (see 4.11);
d) General Purpose Log Directory log (see 9.2);
e) NCQ Command Error log (see 9.14); and
f) serial ATA page of the IDENTIFY DEVICE data log (see 9.10.10).

The following commands are optional for devices that support the NCQ feature set:

a) NCQ NON-DATA (see 7.17);
b) RECEIVE FPDMA QUEUED (see 7.32); and
c) SEND FPDMA QUEUED (see 7.43).

The following logs are optional for devices that support the NCQ feature set:

a) SATA Phy Event Counters log (see 9.16);
b) SATA NCQ Non-Data log (see 9.17); and
c) SATA NCQ Send and Receive log (see 9.18).

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 include an NCQ Tag. If an NCQ Tag value (i.e., the value in an NCQ TAG field (see 7.17.3.3)) exceeds the value returned in IDENTIFY DEVICE data word 75 (see 7.13.6.33), 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 an 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 1 — The NCQ Tag identifies return information (e.g., 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 subsequent commands, except a command from the GPL feature set (see 4.11) that reads the NCQ Command Error log (see 9.14), until the device completes that command without error.

4.15.2 Priority

If the Command Duration Limits feature set (see 4.7) is not supported or not enabled, then the priority is specified in the PRIO field (see table 10) for some NCQ commands (i.e., the READ FPDMA QUEUED command, the WRITE FPDMA QUEUED command, the RECEIVE FPDMA QUEUED command, the SEND FPDMA QUEUED command, and the DURABLE/ORDERED WRITE NOTIFICATION command).

If the Command Duration Limits feature set is supported and enabled, then the device shall ignore the PRIO field for the READ FPDMA QUEUED command and the WRITE FPDMA QUEUED command.

Table 10 — PRIO field

Code	Description
00b	Normal priority
01b	Isochronous deadline-dependent priority The device should complete isochronous requests prior to their associated deadline.
10b	High priority The device should attempt to provide better quality of service for the command. The device should complete high priority requests in a more timely fashion than normal and isochronous requests.
11b	Reserved

4.15.3 Unload with NCQ commands outstanding

If NCQ commands are outstanding and the IDLE IMMEDIATE command is accepted, then the device shall:

1) move the heads to a safe position;
2) return command aborted as described in 4.15.1.

After receiving the error indication, the host should read the NCQ Command Error log (see 9.14). In the log, the device indicates whether the error was due to accepting an IDLE IMMEDIATE command with the Unload feature and whether the Unload was processed using the UNL bit (see 9.14.4). The device shall not load the heads to the media when processing the read command for the NCQ Command Error log.

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

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

such that if the unload process completes without errors, then:

a) the IDLE IMMEDIATE command with the Unload feature should be processed normally; and
b) a non-error status should be returned.

There may be a delay in transferring an IDLE IMMEDIATE command with the Unload feature to the device due to active data transfers for previously received NCQ commands. The delay may be reduced by decreasing the size of the data transfers requested by the NCQ commands.

4.15.4 Command Phases

4.15.4.1 Command Acceptance

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

4.15.4.2 Data transmission

Data transfer should occur after command acceptance.

4.15.4.3 Command completion

If 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 as described in 4.15.1. The condition of the data for any NCQ command for which a device reports command aborted is indeterminate.

4.15.5 NCQ command processing order requirements

The following types of NCQ command processing order requirements are defined:

a) **none:** this NCQ command is processed in any order chosen by the device;
b) **immediate:** this immediate NCQ command is processed before the processing of as many other NCQ commands as possible;
c) **sequential:** this sequential NCQ command is processed in order of command acceptance (see 4.15.4.1) with respect to any other sequential NCQ commands in the queue; and
d) **ordered:** this ordered NCQ command is processed in order of command acceptance with respect to all other NCQ commands in the queue.

SATA 3.5 defines:

a) the requirements for immediate NCQ commands, sequential NCQ commands, and ordered NCQ commands; and
b) which NCQ commands are affected by these requirements.

4.15.6 ATA device commands encapsulated in NCQ feature set commands

ATA device commands are commands that are not in the NCQ feature set (see 4.15.1). An ATA device may process some ATA device commands (e.g., the SET FEATURES command (see 7.45)) within the NCQ feature set if the ATA command inputs are encapsulated in the inputs to an NCQ NON-DATA command (see 7.17), a RECEIVE FPDMA QUEUED command (see 7.32), or a SEND FPDMA QUEUED command (see 7.43). This is accomplished by:

a) defining a subcommand code for a specific NCQ feature set command that identifies the presence of an encapsulated ATA command; and
b) defining how the inputs associated with the ATA command are encapsulated in the inputs of the NCQ feature set command.

SATA 3.5 defines both the subcommand code and the encapsulation.

This standard replicates these definitions to integrate the encapsulation information with the definition of the ATA command being encapsulated as follows:

a) the SATA 3.5 subcommand assignments are replicated in the definitions of the NCQ NON-DATA command, the RECEIVE FPDMA QUEUED command, and the SEND FPDMA QUEUED command; and
b) the input encapsulation details are included in the subclauses that define the ATA commands that are encapsulated.

4.15.7 Returning sense data for successful NCQ feature set commands

If the SUCCESSFUL NCQ COMMAND SENSE DATA SUPPORTED bit (see 9.10.5.2.40) is set to one, the device supports returning sense data for successful NCQ commands using the Sense Data for Successful NCQ Commands log (see 9.28).

If the SENSE DATA ENABLED bit (see 9.10.6.2.12) is cleared to zero, the device shall not return sense data for successful NCQ commands. The SET FEATURES subcommand Enable/Disable the Sense Data Reporting feature set (see 7.45.17) controls the value of the SENSE DATA ENABLED bit.

If:

a) the SUCCESSFUL NCQ COMMAND SENSE DATA ENABLED bit is set to one (see 9.10.6.2.6);
b) the SENSE DATA ENABLED bit is set to one (see 9.10.6.2.12);
c) an NCQ command completes without an error; and
d) the processing of that command detected the availability of sense data,

then, based on the contents of the NCQ TAG field (see 7.17.3.3) input for that command, the device shall modify the contents of the Sense Data for Successful NCQ Commands log (see 9.28) by:

a) setting to one the bit in the SENSE DATA VALID field (see 9.28.2.2) whose bit number is equal to the command's tag; and
b) copying the sense data to the Successful Sense Data descriptor (see 9.28.3) that is associated with the command's tag.

The device shall set the SENSE DATA AVAILABLE bit to one (see 6.2.9) in the normal NCQ outputs (see table 354) if:

a) an NCQ command completes without an error; and
b) one or more bits in the SENSE DATA VALID field (see 9.28.2) is set to one.

The device shall clear the SENSE DATA VALID field (see 9.28.2) to zero as part of processing any read log command that reads any page in the Sense Data for Successful NCQ Commands log (see 9.28). Clearing bits 31:0 to zero in the SENSE DATA VALID field may result in other bytes in the Sense Data for Successful NCQ Commands log being cleared to zero (see 9.28.2.2).

4.16 Out Of Band Management Interface

The out of band management interface provides the ability to report attribute information about the SATA device using the methods defined in SFF-8609. The attribute information is defined in the Out Of Band Management Control log (see 9.33) and corresponds to the Data Code values in the Data Type Definition in SFF-8609. Support for the out of band management interface is indicated by the OUT OF BAND MANAGEMENT INTERFACE SUPPORTED bit (see 9.10.10.2.30). The out of band management interface is enabled if the REPORTING ENABLED (see 9.33.3) bit is set to one in Out Of Band Management Control log (see 9.33). If the REPORTING ENABLED SUPPORTED bit is set to one, then the device shall support the Out Of Band Management Control log.

The behavior of the out of band management interface when the device is in the DevSleep interface power state (see SATA 3.5) is vendor specific.

The attribute information is transferred as described in SFF-8609. Fields in the Out Of Band Management Control log specify and control the frequency at which attribute information is transferred. The device transfers the enabled attribute information over the out of band management interface.

For each enabled attribute, the device should transfer the attribute information based on the reporting interval and other fields in the attribute control descriptor.

If

a) multiple attributes are enabled; and
b) multiple attributes should be transferred at the same time based on the reporting interval of the enabled attributes,

then the device chooses the attribute to be transferred next based on a vendor specific algorithm.

If:

1) the REPORTING ENABLED bit (see 9.33.3) is cleared to zero (i.e., the out of band management interface is disabled); and
2) the device processes a General Purpose Logging feature set command that causes the REPORTING ENABLED bit to change from zero to one (i.e., enabling the out of band management interface),

then the device shall transfer the protocol revision code packet (see SFF-8609) five times at a one second interval, before transferring any enabled attribute information.

If the out of band management interface is enabled (i.e., the REPORTING ENABLED bit is set to one), then after a:

a) power-on reset;
b) hardware reset; or
c) download microcode activation,

the device shall transfer the protocol revision code packet five times at a one second interval, before transferring any enabled attribute information.

If the REPORTING ENABLED bit is set to one and the device is going to the:

a) standby mode; or
b) sleep mode,

then the device should transfer the stopping transmission packet (see SFF-8609), twice with no more than one second from the start of the first packet transfer to the start of the second, prior to entry into this mode.

If the stopping transmission packet was transferred as part of entry into the PM2: Standby (see 4.17.4.4) state or the PM3: Sleep (see 4.17.4.5) state, then the device should stop transferring the attribute information over the out of band management interface until the device goes back to the:

a) PM0: Active (see 4.17.4.2) state; or
b) PM1: Idle (see 4.17.4.3) state.

If the device processes a General Purpose Logging feature set command that causes:

a) the REPORTING ENABLED bit to change from one to zero; or
b) the attribute enable bit (e.g., TEMPERATURE REPORTING ENABLED bit (see 9.33.7.2) in all attribute control descriptors (see 9.33.7)) to become or remain zero when the REPORTING ENABLED bit is set to one,

then the device should transfer the stopping transmission packet twice with no more than one second from the start of the first packet transfer to the start of the second, prior to stopping transmission of the attribute information over the out of band management interface.

4.17 Power Management feature set

4.17.1 Overview

An ATA device shall support the Power Management feature set.

The Power Management feature set allows a host to modify the behavior of a device in a manner that reduces the power required to operate. The Power Management feature set provides a set of commands and a timer that enable a device to implement low power consumption modes. The Power Management feature set supported by an ATA device shall include the following (see 4.6 and 4.18):

a) the Standby timer (see 4.17.3);
b) CHECK POWER MODE command (see 7.3);
c) IDLE command (see 7.14);
d) IDLE IMMEDIATE command (see 7.15);
e) SLEEP command (see 7.47);
f) STANDBY command (see 7.49); and
g) STANDBY IMMEDIATE command (see 7.50).

4.17.2 Power management commands

The CHECK POWER MODE command (see 7.3) allows a host to determine if a device is in, going to, or leaving Active mode, Standby mode, 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 (see 7.14) and IDLE IMMEDIATE command (see 7.15) move a device to Idle mode immediately from the Active mode or Standby mode. The IDLE command also sets the Standby timer count (i.e., enables or disables the Standby timer).

The STANDBY command (see 7.49) and STANDBY IMMEDIATE command (see 7.50) move a device to Standby mode immediately from the Active mode or Idle mode. The STANDBY command also sets the Standby timer count.

The SLEEP command (see 7.47) moves a device to Sleep mode. The device's interface becomes inactive (see the applicable transport standard) after the device reports command completion for the SLEEP command. A device only transitions from Sleep mode after processing a hardware reset or a software reset.

4.17.3 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, the Standby timer is:

a) reinitialized to the value specified by the most recent IDLE command (see 7.14) or STANDBY command (see 7.49); and
b) started.

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

4.17.4 Power Management states and transitions

4.17.4.1 Power Management state machine

Figure 8 shows the Power Management states and state transitions.

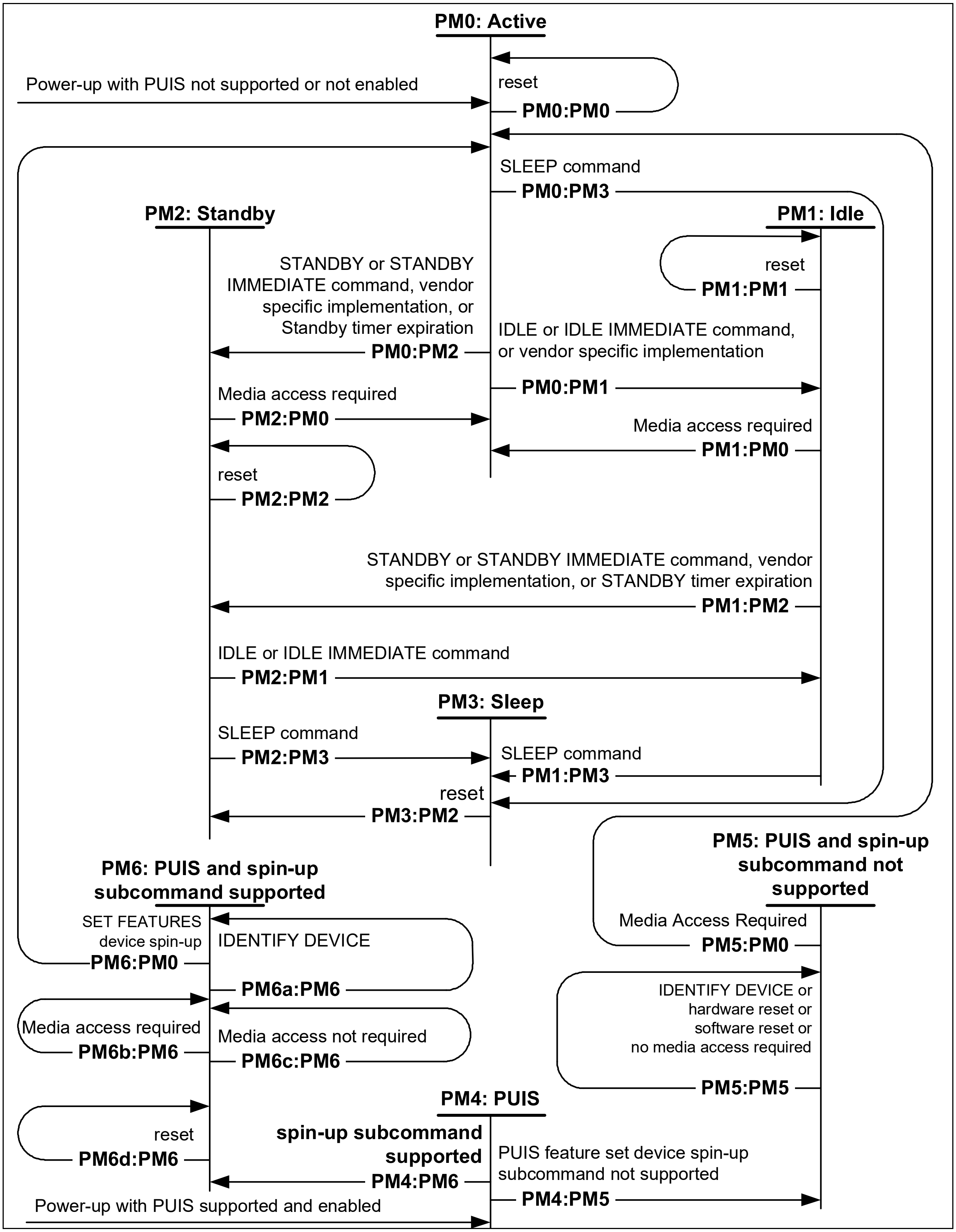

Figure 8 — Power management state diagram

4.17.4.2 PM0: Active

This state shall be entered if the device processes 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 set is not supported or is not enabled (see 4.18).

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 mode. Power consumption is greatest in this mode.

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

Transition PM0:PM1: The device shall transition to the PM1: Idle state if:

a) an IDLE command (see 7.14) is processed without error;
b) an IDLE IMMEDIATE command (see 7.15) is processed without error; or
c) a vendor specific implementation determines a transition to the PM1: Idle state is required.

Transition PM0:PM2: The device shall transition to the PM2: Standby state if:

a) a STANDBY command (see 7.49) is processed without error;
b) a STANDBY IMMEDIATE command (see 7.50) is processed without error;
c) the Standby timer expires (see 4.17.3); or
d) a vendor specific implementation determines a transition to the PM2: Standby state is required.

Transition PM0:PM3: If a SLEEP command (see 7.47) is processed, the device shall transition to the PM3: Sleep state.

4.17.4.3 PM1: Idle

This state shall be entered if the device processes an IDLE command or IDLE IMMEDIATE command without error. 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 processing 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, 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 or software reset.

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

a) a STANDBY command is processed without error;
b) a STANDBY IMMEDIATE command is processed without error;
c) the Standby timer expires; or
d) a vendor specific implementation determines a transition to the PM2: Standby state is required.

Transition PM1:PM3: If a SLEEP command is processed without error, the device shall transition to the PM3: Sleep state.

4.17.4.4 PM2: Standby

This state shall be entered if:

a) the device returns completion for a STANDBY command without error;
b) the device returns completion for a STANDBY IMMEDIATE command without error;
c) the Standby timer expires;
d) a device performs a vendor specific power management function; or
e) the device processes a hardware reset or a software reset while in PM2: Standby or PM3: Sleep.

In Standby mode, the device is capable of processing commands but the device may take longer (e.g., 30 s) 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, the device shall transition to the PM0: Active state.

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

a) an IDLE command is processed without error; or
b) an IDLE IMMEDIATE command is processed without error.

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

Transition PM2:PM3: If a SLEEP command is processed without error, the device shall transition to the PM3: Sleep state.

4.17.4.5 PM3: Sleep

This state shall be entered if the device processes a SLEEP command without error.

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

In Sleep mode, 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 or a software reset.

4.17.4.6 PM4: PUIS

This state shall be entered after processing a power-on reset if the PUIS feature set (see 4.18) is supported and is enabled.

If deferred microcode data is available to be activated and the device is waiting for access to the media, then the FW ACTIVATION PENDING bit (see 9.10.6.2.5) should be set to one.

Transition PM4:PM5: A device shall transition to the PM5: PUIS and spin-up subcommand not supported state if the device does not support the PUIS feature set device spin-up subcommand (see 7.45.7).

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

4.17.4.7 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 support the PUIS feature set device spin-up subcommand.

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

Transition PM5:PM0: If the device processes a media access command, 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:

a) an IDENTIFY DEVICE command;
b) any hardware reset;
c) any software reset; or
d) any command that does not require media access.

4.17.4.8 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, is enabled, and the device supports the PUIS feature set device spin-up command.

In this state, the device is capable of processing commands but the device may take longer (e.g., 30 s) 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 PUIS feature set 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.

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, 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, 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 or a software reset.

4.18 Power-Up In Standby (PUIS) feature set

4.18.1 Overview

The PUIS feature set allows devices to be powered-up into the PM4: PUIS state (see 4.17.4) 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 Enable the PUIS feature set subcommand of the SET FEATURES command (see 7.45.6); or
b) a jumper or similar means.

The PUIS SUPPORTED bit (see 9.10.5.2.18) indicates whether the PUIS feature set is supported. The PUIS ENABLED bit (see 9.10.6.2.16) indicates whether the PUIS feature set is enabled.

If enabled by a jumper, the PUIS feature set shall not be disabled by the processing of a Disable the PUIS feature set subcommand (see 7.45.6).

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

If the device does not support the PUIS feature set device spin-up subcommand (see 4.18.3) and the device has powered-up into the PM4: PUIS state (see 4.17.4), then the device shall spin-up upon receipt of the first command that requires the device to access the media, except the IDENTIFY DEVICE command (see 4.18.2).

4.18.2 Interactions with the IDENTIFY DEVICE command

If the device:

a) implements the Enable/Disable PUIS subcommand (see 7.45.6);
b) has the PUIS ENABLED bit (see 9.10.6.2.16) set to one; and
c) receives an IDENTIFY DEVICE command while the device is in the Standby mode as a result of powering up in that mode,

then the device shall respond to the IDENTIFY DEVICE command without spinning up the media.

If the device is unable to return complete response data without accessing the media, for the IDENTIFY DEVICE data the device shall set:

a) word 0 bit 2 (see 7.13.6.2) to one to indicate that the response is incomplete;
b) all other bits of word 0 to valid values; and
c) word 2 (see 7.13.6.4) to a valid value.

Those fields in the IDENTIFY DEVICE data that are not set to valid values shall be cleared to zero.

After a device is able to return all data for an IDENTIFY DEVICE command, the device shall return all data for those commands until the next power-on reset is processed.

4.18.3 PUIS feature set device spin-up subcommand

A device may support the PUIS feature set device spin-up subcommand (see 7.45.7) that requests the device to spin-up to the Active mode after the device has powered-up into Standby mode.

If the device supports the PUIS feature set device spin-up subcommand and PUIS feature set is enabled, the device shall remain in the PM6: PUIS and spin-up subcommand supported state until the PUIS feature set device spin-up subcommand is processed.

If the device supports the PUIS feature set device spin-up subcommand, the SPIN-UP SUPPORTED bit (see 9.10.5.2.17) shall be set to one.

4.19 Rebuild Assist feature set

4.19.1 Overview

The Rebuild Assist feature set allows a host that is processing a storage array rebuild to determine which logical sectors on the failed device are unreadable without having to read every LBA (i.e., the read command is terminated with an error and failed LBA information is reported in the sense data). This information may be used to reconstruct the failed logical sectors.

Enabling the Rebuild Assist feature set (see 4.19.2):

a) allows the NCQ Command Error log (see 9.14) to indicate the location of multiple failing LBAs on READ FPDMA QUEUED commands (see 7.23) and WRITE FPDMA QUEUED commands (see 7.61);
b) if the NON-NCQ REBUILD ASSIST SUPPORTED bit (see 9.10.5.2.50) is set to one, then allows the Sense Data log (see 9.32) to indicate the location of multiple failing LBAs on READ DMA EXT commands (see 7.22), WRITE DMA EXT commands (see 7.59), and WRITE DMA FUA EXT commands (see 7.60);
c) may cause the device to initiate a self test to identify the scope of failures, if any; and
d) modifies read command recovery behavior based on the setting of the RARC bit (see 7.22.3.2).

As a result of processing a power on reset, the Rebuild Assist feature set shall be disabled (i.e., the REBUILD ASSIST ENABLED bit shall be cleared to zero (see 9.10.10.3.11). All other resets shall not affect the Rebuild Assist feature set.

If the Rebuild Assist feature set is supported (i.e., the REBUILD ASSIST SUPPORTED bit is set to one (see 9.10.10.2.27)), then the device shall support the NCQ Autosense feature.

Self-test routines performed while the Rebuild Assist feature set is enabled may result in detection of failed physical elements.

A predicted unrecovered error (see 4.19.3.3 and 4.19.3.5) is an unrecovered error that is the result of an attempt to access an LBA associated with a failed physical element.

An unpredicted unrecovered error (see 4.19.3.2 and 4.19.3.4) is an unrecovered error that is the result of accessing an LBA that is not associated with a failed physical element.

4.19.2 Enabling the Rebuild Assist feature set

If the host writes to the Rebuild Assist log (see 9.20) and sets the MANAGE REBUILD ASSIST bit to one (see 9.20.2), then the device:

a) may initiate a self test of the physical elements contained within the device and should disable any physical elements that are not functioning correctly;
b) shall initialize the DISABLED PHYSICAL ELEMENTS field (see 9.20.5) based on the results of a self-test;
c) shall minimize device-initiated background activities; and
d) shall enable the Rebuild Assist feature set.

The host may verify that Rebuild Assist feature set is enabled by reading:

a) the Rebuild Assist log and verifying that the MANAGE REBUILD ASSIST bit is set to one; or
b) the Serial ATA page of the IDENTIFY DEVICE data log (see 9.10.10) and verifying that the REBUILD ASSIST ENABLED bit is set to one.

4.19.3 Using the Rebuild Assist feature set

4.19.3.1 Overview

If the Rebuild Assist feature set is enabled and the NON-NCQ REBUILD ASSIST SUPPORTED bit (see 9.10.5.2.50) is:

a) cleared to zero, then the host should send READ FPDMA QUEUED commands (see 7.23) to read the available data from the device; and
b) set to one, then the host should send READ FPDMA QUEUED commands (see 7.23) or READ DMA EXT commands (see 7.22) to read the available data from the device.

If a READ FPDMA QUEUED command or READ DMA EXT command does not detect an unrecovered error, the command should complete without error.

The Rebuild Assist feature set allows reporting of an unrecovered read error or an unrecovered write error that is:

c) a predicted unrecovered error (see 4.19.3.3, 4.19.3.5, and 4.19.3.7); or
d) an unpredicted unrecovered error (see 4.19.3.2, 4.19.3.4, and 4.19.3.6).

If a device processes a READ FPDMA QUEUED command or a READ DMA EXT command with the RARC bit (see 7.22.3.2) set to one, then the Rebuild Assist feature set shall not affect processing of that command.

4.19.3.2 Unpredicted unrecovered read error processing

If the device processes a READ FPDMA QUEUED command with the RARC bit (see 7.22.3.2) cleared to zero or a READ DMA EXT command with the RARC bit cleared to zero, and detects an unpredicted unrecovered error, then the device:

a) shall perform limited read recovery that is vendor specific;
b) shall transfer the data for all recovered logical sectors, if any, from the starting LBA of that command up to the unrecovered logical sector;
c) shall terminate that command with an error and return information as described in 4.19.3.6; and
d) may use the detection of an unpredicted unrecovered error in a vendor specific manner to:
    A) detect additional logical sectors that have unpredicted unrecovered errors or predicted unrecovered errors; and
    B) report that detection, if any, by replacing the return information described in step c) with the information described in 4.19.3.7.

If the host receives sense data with the additional sense code set to MULTIPLE READ ERRORS (see 6.8.27), then the host should issue the next read command with the starting LBA set to the contents of the FINAL LBA IN ERROR field plus one.

4.19.3.3 Predicted unrecovered read error processing

If the device processes a READ FPDMA QUEUED command with the RARC bit cleared to zero (see 7.22.3.2) or a READ DMA EXT command with the RARC bit cleared to zero and detects a predicted unrecovered error, then the device shall:

a) perform limited read recovery that is vendor specific;
b) transfer the data for all recovered logical sectors, if any, from the starting LBA of that command up to the first unrecovered logical sector; and
c) terminate that command with an error, and return information as described in 4.19.3.7.

If the host receives sense data with the additional sense code set to MULTIPLE READ ERRORS (see 6.8.27), then the host should issue the next read command with the starting LBA set to the contents of the FINAL LBA IN ERROR field plus one.

4.19.3.4 Unpredicted unrecovered write error processing

If the device processes a WRITE FPDMA QUEUED command, a WRITE DMA EXT command, or a WRITE DMA FUA EXT command and detects an unpredicted unrecovered error, then the device shall terminate that command with an error and return information as described in 4.19.3.6.

4.19.3.5 Predicted unrecovered write error processing

If the device processes a WRITE FPDMA QUEUED command, a WRITE DMA EXT command, or a WRITE DMA FUA EXT command and detects a predicted unrecovered error, then the device shall terminate that command with an error and return information as described in 4.19.3.7.

If the host receives sense data with the additional sense code set to MULTIPLE WRITE ERRORS (see 6.8.28), then the host should issue the next write command with the starting LBA set to the contents of the FINAL LBA IN ERROR field plus one.

4.19.3.6 Unpredicted unrecovered error information reporting

If an unpredicted unrecovered error is detected (see 4.19.3.2 and 4.19.3.4), then the device shall return the following information:

a) the additional sense code set to:
    A) UNRECOVERED READ ERROR (see 6.8.33), if the command is a read command; or
    B) WRITE ERROR (see 6.8.35), if the command is a write command;

and

b) the LBA field set to the LBA of the first unrecovered logical sector.

If the device is processing:

a) a READ FPDMA QUEUED command (see 7.23) or a WRITE FPDMA QUEUED command (see 7.61), then the information described in this subclause (i.e., 4.19.3.6) shall be returned in the NCQ Command Error log (see 9.14); and
b) a READ DMA EXT command (see 7.22), a WRITE DMA EXT command (see 7.59), or a WRITE DMA FUA EXT command (see 7.60), then the information described in this subclause (i.e., 4.19.3.6) shall be returned in the applicable error outputs (see table 367 or table 373).

4.19.3.7 Predicted unrecovered error information reporting

If a predicted unrecovered error is detected (see 4.19.3.2, 4.19.3.4, and 4.19.3.5), then the device shall return the following information:

a) the additional sense code set to:
   A) MULTIPLE READ ERRORS (see 6.8.27), if the command is a read command; or
   B) MULTIPLE WRITE ERRORS (see 6.8.28), if the command is a write command;
b) the LBA field set to the LBA of the first unrecovered logical sector; and
c) the FINAL LBA IN ERROR field set to the LBA of the highest numbered predicted unrecovered logical sector in a sequence of contiguous unrecovered logical sectors that starts with the first LBA in error.

If the device is processing:

a) a READ FPDMA QUEUED command (see 7.23) or a WRITE FPDMA QUEUED command (see 7.61), then the information described in this subclause (i.e., 4.19.3.7) shall be returned in the NCQ Command Error log (see 9.14); and
b) a READ DMA EXT command (see 7.22), a WRITE DMA EXT command (see 7.59), or a WRITE DMA FUA EXT command (see 7.60), then the information described in this subclause (i.e., 4.19.3.7) shall be returned in:
   A) the applicable error outputs (see table 367 or table 373); and
   B) the Sense Data log (see 9.32).

4.19.4 Disabling the Rebuild Assist feature set

The Rebuild Assist feature set shall be disabled if:

a) the device processes a power-on reset; or
b) the device processes a command that writes to the Rebuild Assist log (see 9.20) with the MANAGE REBUILD ASSIST bit cleared to zero (see 9.20.2).

4.19.5 Testing the Rebuild Assist feature set

The Rebuild Assist log (see 9.20) provides a method to test the host's rebuild process.

A device is requested to simulate a failing condition by writing to the Rebuild Assist log with the MANAGE REBUILD ASSIST bit set to one (see 9.20.2) and the DISABLED PHYSICAL ELEMENTS field with one or more bits set to one (see 9.20.5). The host may write to the Rebuild Assist log more than once to simulate additional failing physical elements.

Each bit in the DISABLED PHYSICAL ELEMENTS field represents a physical element that is associated with a group of LBAs that are treated as predicted unrecovered read errors and predicted unrecovered write errors. The correlation of bits in the DISABLED PHYSICAL ELEMENTS field to LBAs in the device is vendor specific.

To end this test, the host should disable the Rebuild Assist feature set (see 4.19.4).

4.20 Sanitize Device feature set

4.20.1 Overview

The Sanitize Device feature set allows hosts to request that devices modify the content of all user data areas in the device in a way that results in previously existing data in these areas becoming unretrievable. Sanitize operations (see 4.20.4) are initiated using one of the sanitize operation commands.

For zoned devices (see ZAC-2):

a) the ZONED NO RESET bit (see 7.36.2.3.2) controls how each write pointer zone (see ZAC-2) is processed after successful completion of a sanitize operation (see 4.20.4);
b) ZAC-2 describes zone related extensions to how sanitize operations are performed; and
c) none of the requirements for the Sanitize feature set in this standard are removed by ZAC-2.

Devices that support the Sanitize Device feature set shall indicate support of the Sanitize Device feature set by setting the SANITIZE SUPPORTED bit (see 9.10.8.7.4) to one.

4.20.2 Sanitize operation scope

Sanitize operations shall affect user data areas that are currently allocated and user data areas that are not currently allocated (e.g., previously allocated areas and physical sectors that have become inaccessible).

Sanitize operations shall:

a) remove all descriptors from the Pending Defects log (see 9.27); and
b) not affect other non-user data areas (e.g., the IDENTIFY DEVICE data log (see 9.10)).

Sanitize operations shall cause previously existing data in caches to be unable to be accessed. The method used to modify the caches and the existing User password, if any, is outside the scope of this standard.

Other than the effects described in this subclause, sanitize operations shall not affect non-user data areas (e.g., logs (see clause 9)).

4.20.3 Sanitize commands

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

a) SANITIZE STATUS EXT (see 7.36.7); and
b) SANITIZE FREEZE LOCK EXT (see 7.36.6).

If the Sanitize Device feature set is supported, the SANITIZE ANTIFREEZE LOCK EXT command (see 7.36.5) may be supported.

If the Sanitize Device feature set is supported, at least one of the following commands shall be supported:

a) CRYPTO SCRAMBLE EXT (see 7.36.3);
b) BLOCK ERASE EXT (see 7.36.2); or
c) OVERWRITE EXT (see 7.36.4).

Until a power-on reset is processed, the SANITIZE FREEZE LOCK EXT command (see 7.36.6) causes the device to return command aborted for any subsequent sanitize command except SANITIZE STATUS EXT.

Until a power-on reset is processed, the SANITIZE ANTIFREEZE LOCK EXT command (see 7.36.5) causes the device to return command aborted for any subsequent SANITIZE FREEZE LOCK EXT command or SANITIZE ANTIFREEZE LOCK EXT command.

4.20.4 Sanitize operations

To initiate a sanitize operation the host issues one of the following sanitize operation commands:

a) CRYPTO SCRAMBLE EXT command (see 7.36.3);
b) BLOCK ERASE EXT command (see 7.36.2); or
c) OVERWRITE EXT command (see 7.36.4).

The sanitize operation may continue after the command that initiated the sanitize operation returns command completion without error.

The sanitize operation shall resume after any interruption (e.g., a power-on reset) as specified in 4.20.10.

The normal outputs of the SANITIZE STATUS EXT command (see table 357) report progress of an active sanitize operation or a successful completion of the most recent sanitize operation.

In the absence of other errors, the error outputs of the SANITIZE STATUS EXT command (see table 385) report the status of the most recent sanitize operation.

A crypto scramble sanitize operation (i.e., a sanitize operation that is initiated by a CRYPTO SCRAMBLE EXT command (see 7.36.3)) or block erase sanitize operation (i.e., a sanitize operation that is initiated by a BLOCK ERASE EXT command (see 7.36.2)) make previously written contents in the user data area unretrievable (e.g., read commands may return command complete with error).

An overwrite sanitize operation (i.e., a sanitize operation that is initiated by an OVERWRITE EXT command (see 7.36.4) fills all user data 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 whether to invert the four byte pattern between consecutive overwrite passes.

Sector reallocation is allowed during sanitize operations.

If deferred microcode data (see 7.7) exists, then sanitize operation commands shall return command aborted with the additional sense code set to LOGICAL UNIT NOT READY, MICROCODE ACTIVATION REQUIRED (see 6.8.23).

4.20.5 Interactions of the Sanitize Device feature set and Security feature set

If the RESTRICTED SANITIZE OVERRIDES SECURITY bit (see 9.10.8.7.8) is set to one, then a successful sanitize operation shall:

a) cause the existing User password (see 4.22.3.2), if any, to be unable to be accessed; and
b) clear the SECURITY ENABLED bit (see 9.10.8.3.7) to zero.

If the security state machine is in a state that does not block access to user data (e.g., the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5) state), then for all sanitize commands, the device may return command complete without error.

If the security state machine is in the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8) state and:

a) the RESTRICTED SANITIZE OVERRIDES SECURITY bit is cleared to zero, then:
   A) for SANITIZE STATUS EXT commands (see 7.36.7), the device may return command complete without error; and
   B) for other sanitize commands, the device shall return command aborted;
   and
b) the RESTRICTED SANITIZE OVERRIDES SECURITY bit is set to one, then:
   A) for sanitize operation commands with the FAILURE MODE bit (see 7.36.2.3.3) set to one, the device shall return command aborted as described in the Error Output subclause of each sanitize operation command; and
   B) for sanitize commands that do not define a FAILURE MODE bit or sanitize commands that specify a FAILURE MODE bit cleared to zero, the device may return command complete without error.

4.20.6 Command processing during sanitize operations

After a device has started processing a Sanitize operation and until the device transitions to the SD0: Sanitize Idle state (see 4.20.10.2) state, the device shall abort all commands other than the:

a) IDENTIFY DEVICE command;
b) IDLE IMMEDIATE command with UNLOAD;
c) READ LOG EXT command or READ LOG DMA EXT command if one of the following log addresses is requested:
   A) 10h (i.e., NCQ Command Error log);
   B) 30h (i.e., IDENTIFY DEVICE data log); or
   C) E0h (i.e., SCT Command/Status log);
d) REPORT ZONES EXT command (see ZAC-2) with:
   A) the ZONE LOCATOR field cleared to zero;
   B) the REPORTING OPTIONS field set to 3Fh (i.e., conventional zones);
   C) the RETURN PAGE COUNT field set to 0001h; and

    D) the PARTIAL bit set to one;
- e) REQUEST SENSE DATA EXT command;
- f) SANITIZE ANTIFREEZE LOCK EXT command;
- g) SANITIZE STATUS EXT command;
- h) SECURITY UNLOCK command;
- i) SET FEATURES PUIS feature set device spin-up subcommand;
- j) SMART READ LOG command if one of the following log addresses is requested:
    - A) 30h (i.e., IDENTIFY DEVICE data log); or
    - B) E0h (i.e., SCT Command/Status log);
- k) SMART RETURN STATUS command; and
- l) supported sanitize operations commands (see 4.20.4), if the device is in the SD3: Sanitize Operation Failed state (see 4.20.10.5) state or the SD4: Sanitize Operation Succeeded state (see 4.20.10.6) state.

If:

- a) the device is unable to report command completion without error to a processed command because a sanitize operation is in process; and
- b) the Sense Data Reporting feature set is enabled,

then the device should set the additional sense code to LOGICAL UNIT NOT READY, SANITIZE IN PROGRESS (see 6.8.25).

If the device processes an IDLE IMMEDIATE command with UNLOAD (see 7.15.2.2) that returns command completion without error, then the sanitize operation shall be suspended. The sanitize operation shall be resumed after the processing of a software reset, a hardware reset, or any new command except IDLE IMMEDIATE command with UNLOAD.

If the device processes a power-on reset and enters the PM5: PUIS and spin-up subcommand not supported state (see figure 8), then the device shall resume processing the sanitize operation after receiving a media access command, even though the media access command returns command aborted.

4.20.7 Sanitize Operation Completed Without Error value

The Sanitize Operation Completed Without Error value is an indication of the success of the most recently completed sanitize operation. The value shall be maintained in non-volatile storage. The Sanitize Operation Completed Without Error value is:

- a) cleared to zero when the Sanitize Device state machine transitions to the SD2: Sanitize Operation In Progress state (see 4.20.10.4) state;
- b) set to one when the Sanitize Device state machine transitions to the SD4: Sanitize Operation Succeeded state (see 4.20.10.6) state; and
- c) preserved over all resets (e.g., power-on reset).

The Sanitize Operation Completed Without Error value is reported in the SANITIZE OPERATION COMPLETED WITHOUT ERROR bit (see table 357).

4.20.8 Failure Mode Policy value

The Failure Mode Policy value is an indication of how the FAILURE MODE bit (see 7.36.2.3.3) was set in the sanitize operation command that caused the transition SD0:SD2 (see 4.20.10.2). The value shall be maintained in non-volatile storage.

If the Failure Mode Policy value is cleared to zero and the FAILURE MODE bit is set to one in a sanitize operation command processed while in the SD3: Sanitize Operation Failed state (see 4.20.10.5) state or in the SD4: Sanitize Operation Succeeded state (see 4.20.10.6) state, then the sanitize operation command returns command aborted.

The Failure Mode Policy value is:

- a) cleared to zero when the Sanitize Device state machine enters the SD0: Sanitize Idle state (see 4.20.10.2) state; and
- b) preserved over all resets (e.g., power-on reset).

4.20.9 Sanitize Antifreeze value

The Sanitize Antifreeze value is an indication of whether a SANITIZE ANTIFREEZE LOCK EXT command (see 7.36.5) returned command completion without error.

The Sanitize Antifreeze value is:

a) set to one if a SANITIZE ANTIFREEZE LOCK EXT command returns command completion without error; and
b) cleared to zero by the processing of:
   A) a power-on reset; or
   B) a hardware reset with the SSP feature disabled (see 4.25).

4.20.10 Sanitize Device state machine

4.20.10.1 Overview

Figure 9 describes the operation of the Sanitize Device state machine.

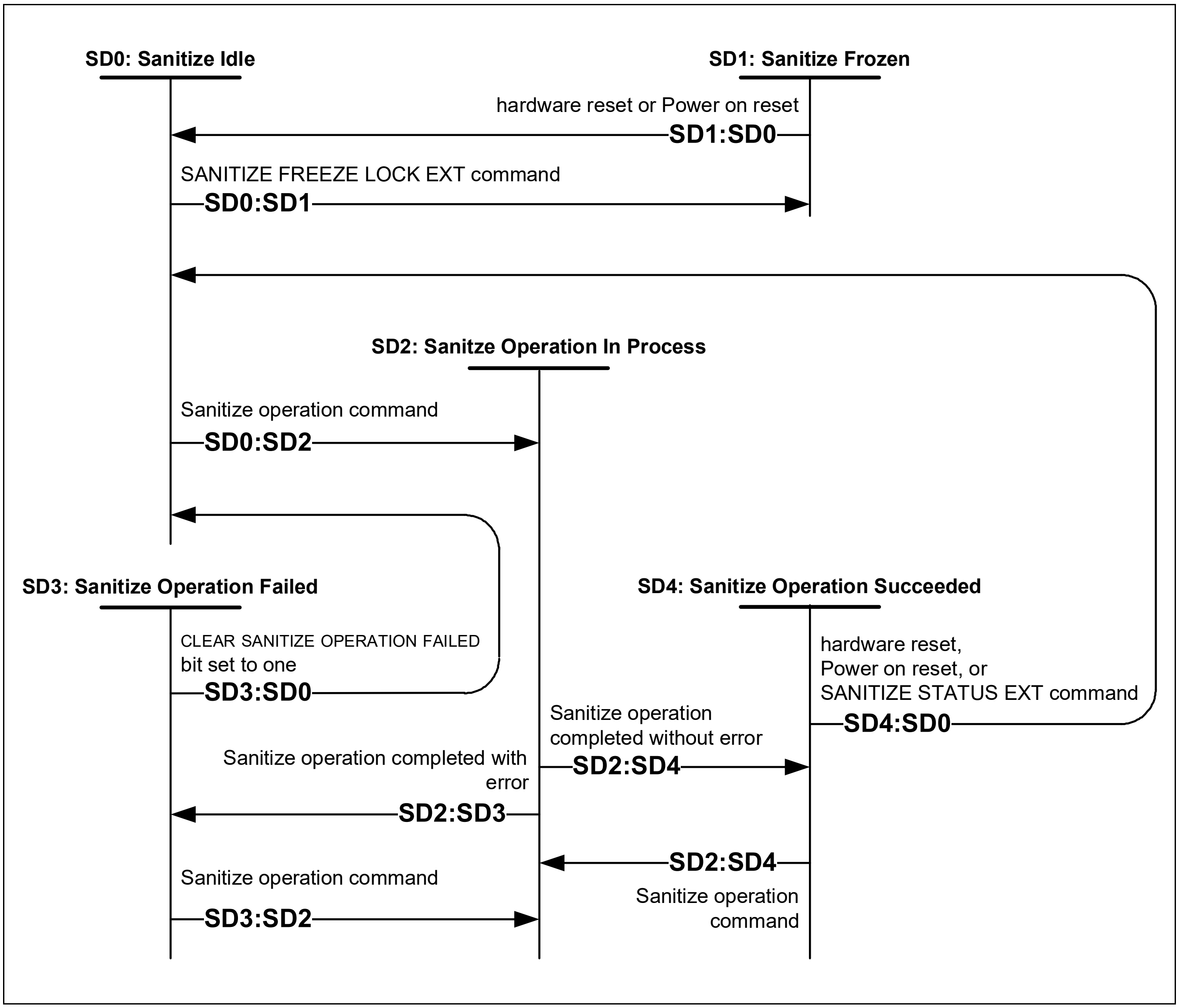

Figure 9 — Sanitize Device state machine

4.20.10.2 SD0: Sanitize Idle state

While in the SD0: Sanitize Idle state, the device is ready for a sanitize operation command (see 4.20.4) or a SANITIZE FREEZE LOCK EXT command (see 7.36.6).

While in this state, the device shall not transition from this state as a result of processing:

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

Upon entry to this state, the device shall clear the Failure Mode Policy value (see 4.20.8) to zero.

Transition SD0:SD1: If the device processes a SANITIZE FREEZE LOCK EXT command (see 7.36.6) that returns command completion without error, then the device shall transition to the SD1: Sanitize Frozen state (see 4.20.10.3) state.

Transition SD0:SD2: If the device processes a supported sanitize operation command (see 4.20.4) that returns command completion without error, then the device shall transition to the SD2: Sanitize Operation In Progress state (see 4.20.10.4) state.

4.20.10.3 SD1: Sanitize Frozen state

While in the SD1: Sanitize Frozen state, the device shall:

a) abort Sanitize Device feature set commands except SANITIZE STATUS EXT (see 7.36.7); and
b) not transition from this state as a result of processing a SANITIZE STATUS EXT command.

Transition SD1:SD0: If the device processes a hardware reset or a power-on reset, the device shall transition to the SD0: Sanitize Idle state (see 4.20.10.2) state.

4.20.10.4 SD2: Sanitize Operation In Progress state

While in the SD2: Sanitize Operation In Progress state, the device is processing a sanitize operation.

While in this state, the device shall not transition from this state as a result of processing:

a) a hardware reset;
b) a power-on reset; or
c) a SANITIZE STATUS EXT command (see 7.36.7).

While in this state, the device shall process commands as described in 4.20.6. Sector reallocation is allowed while in this state.

Upon entry to this state, the device shall clear the Sanitize Operation Completed Without Error value (see 4.20.7) to zero.

Transition SD2:SD3: After completion of a sanitize operation, the device shall transition to SD3: Sanitize Operation Failed state (see 4.20.10.5) state if:

a) any physical sectors that are allocated for user data have not been successfully sanitized; or
b) any physical areas that are available to be allocated for user data were not successfully sanitized.

Transition SD2:SD4: After completion of a sanitize operation, the device shall transition to SD4: Sanitize Operation Succeeded state (see 4.20.10.6) state if:

a) all physical sectors that are allocated for user data have been successfully sanitized; and
b) all physical areas that are available to be allocated for user data have been successfully sanitized.

4.20.10.5 SD3: Sanitize Operation Failed state

While in the SD3: Sanitize Operation Failed state, the device has failed the sanitize operation.

While in this state, the device shall process a SANITIZE STATUS EXT command (see 7.36.7) by returning command aborted with the SANITIZE DEVICE ERROR REASON field set to Sanitize Command Unsuccessful (see table 385).

While in this state, the device shall process commands as described in 4.20.6, with the exception that sanitize operation commands shall be processed in this state.

While in this state, the device shall not transition from this state as a result of processing:

a) a hardware reset;
b) a power-on reset; or
c) a SANITIZE STATUS EXT command (see 7.36.7) with the CLEAR SANITIZE OPERATION FAILED bit cleared to zero.

Transition SD3:SD0: The device shall transition to the SD0: Sanitize Idle state (see 4.20.10.2) state if:

a) the Failure Mode Policy value (see 4.20.8) is set to one; and
b) a SANITIZE STATUS EXT command with the CLEAR SANITIZE OPERATION FAILED bit set to one returns command completion without error.

Transition SD3:SD2: If the device processes a supported sanitize operation command (see 4.20.4) that returns command completion without error, then the device shall transition to the SD2: Sanitize Operation In Progress state (see 4.20.10.4) state.

4.20.10.6 SD4: Sanitize Operation Succeeded state

While in the SD4: Sanitize Operation Succeeded state, the device has completed processing a successful sanitize operation.

While in this state, in addition to processing commands as described in 4.20.6, the device shall process sanitize operation commands as described in 4.20.4, with the exception that sanitize operation commands shall be processed in this state.

Upon entry to this state, the device shall set the Sanitize Operation Completed Without Error value (see 4.20.7) to one.

Transition SD4:SD0: The device shall transition to the SD0: Sanitize Idle state (see 4.20.10.2) state if the device processes:

a) a hardware reset;
b) a power-on reset; or
c) a SANITIZE STATUS EXT command (see 7.36.7).

Transition SD4:SD2: If the device processes a supported sanitize operation command (see 4.20.4) that returns command completion without error, then the device shall transition to the SD2: Sanitize Operation In Progress state (see 4.20.10.4) state.

4.21 SATA Hardware Feature Control feature set

A device may support DSS or DAS (see SATA 3.5). A device may support extended capabilities by supporting SATA Hardware Feature Control.

If Hardware Feature Control is supported, then:

a) the IDENTIFY DEVICE data log HARDWARE FEATURE CONTROL IS SUPPORTED bit (see 9.10.10.2.19) shall be set to one;
b) the SET FEATURES Enable Hardware Feature Control subcommand (see 7.45.16.8) shall be supported;
c) page 08h of the IDENTIFY DEVICE data log (see 9.10) shall be supported;
d) if the device processes a power on reset, then the device shall clear to zero:
   A) the IDENTIFY DEVICE data log HARDWARE FEATURE CONTROL IS ENABLED bit (see 9.10.10.3.6);
   B) the IDENTIFY DEVICE data log CURRENT HARDWARE FEATURE CONTROL IDENTIFIER field (see 9.10.10.4); and
   C) the IDENTIFY DEVICE data log SUPPORTED HARDWARE FEATURE CONTROL IDENTIFIER field (see 9.10.10.5);

   and
e) if the device processes a SET FEATURES Enable Hardware Feature Control subcommand without error, then:
   A) the device shall set the IDENTIFY DEVICE data log HARDWARE FEATURE CONTROL IS ENABLED bit (see 9.10.10.3.6) to one;
   B) the device shall set the IDENTIFY DEVICE data log CURRENT HARDWARE FEATURE CONTROL IDENTIFIER field (see 9.10.10.4) to a nonzero value;
   C) the device shall set the IDENTIFY DEVICE data log SUPPORTED HARDWARE FEATURE CONTROL IDENTIFIER field (see 9.10.10.5) to a nonzero value; and
   D) the behavior of the SATA Hardware Feature Control feature set is specified by the SET FEATURES Enable Hardware Feature Control subcommand (see 7.45.16.8).

If SATA Hardware Feature Control feature set is not supported, then:

a) the IDENTIFY DEVICE data log HARDWARE FEATURE CONTROL IS SUPPORTED bit (see 9.10.10.2.19) shall be cleared to zero;
b) the IDENTIFY DEVICE data log HARDWARE FEATURE CONTROL IS ENABLED bit (see 9.10.10.3.6) shall be cleared to zero;
c) the SET FEATURES Enable Hardware Feature Control subcommand (see 7.45.16.8) shall not be supported;
d) the IDENTIFY DEVICE data log SUPPORTED HARDWARE FEATURE CONTROL IDENTIFIER field (see 9.10.10.5) shall be cleared to zero; and
e) the IDENTIFY DEVICE data log CURRENT HARDWARE FEATURE CONTROL IDENTIFIER field (see 9.10.10.4) shall be cleared to zero.

4.22 Security feature set

4.22.1 Overview

The Security feature set is a password system that restricts access to:

a) user data on the device; and
b) specific configuration capabilities.

The Master Password Identifier feature (see 4.22.10) extends the Security feature set.

The Security page of the IDENTIFY DEVICE data log (see 9.10.8) contains information about supported security capabilities, current security status, and security settings.

4.22.2 Disabling and enabling the Security feature set

If the Security feature set is supported and there is no User password (see 4.22.3.2), the Security feature set is disabled.

If the Security feature set is disabled, then:

a) the SECURITY ENABLED bit (see 9.10.8.3.7) is cleared to zero; and
b) the MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2) is cleared to zero (i.e., High (see 4.22.4)).

If the Security feature set is supported and there is a User password, the Security feature set is enabled.

If the Security feature set is enabled, the SECURITY ENABLED bit is set to one.

4.22.3 Passwords

4.22.3.1 Overview

The system has two types of passwords:

a) User; and
b) Master.

4.22.3.2 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 is used to unlock the device to allow access.

Security is enabled by setting a User password with the SECURITY SET PASSWORD command (see 7.41). If security is enabled and a power-on reset is processed, then access is denied to user data on the device from the time the power-on reset is processed until a SECURITY UNLOCK command (see 7.42) returns command completion without error.

4.22.3.3 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).

4.22.4 Master password capability

If security is enabled on the device, the use of the Master password is indicated by the MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2). The MASTER PASSWORD CAPABILITY bit represents High or Maximum as described in this subclause.

The MASTER PASSWORD CAPABILITY bit is modified during the processing of a SECURITY SET PASSWORD command (see 7.41) that specifies a User password.

If the MASTER PASSWORD CAPABILITY bit is set to High (i.e., zero), either the User password or Master password are used interchangeably.

If the MASTER PASSWORD CAPABILITY bit is set to Maximum (i.e., one), the Master password is not used with the SECURITY DISABLE PASSWORD (see 7.37) command and SECURITY UNLOCK command. The SECURITY ERASE UNIT (see 7.39) command, however, uses either a valid User password or Master password.

4.22.5 Frozen mode

The SECURITY FREEZE LOCK (see 7.40) command prevents changes to all Security states (see 4.22.11.6 and 4.22.11.10) until:

a) a subsequent power-on reset or hardware reset; or
b) the device transitions to the SD4: Sanitize Operation Succeeded state (see 4.20.10.6).

Use of the SECURITY FREEZE LOCK command prevents password setting attacks on the security system.

4.22.6 Commands

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

a) SECURITY SET PASSWORD (see 7.41);
b) SECURITY UNLOCK (see 7.42);
c) SECURITY ERASE PREPARE (see 7.38);
d) SECURITY ERASE UNIT (see 7.39);
e) SECURITY FREEZE LOCK (see 7.40); and
f) SECURITY DISABLE PASSWORD (see 7.37).

4.22.7 Security initial setting

At the time of manufacture of the device, the security feature set shall be disabled (see 4.22.2).

The value of the Master password at the time of manufacture is outside the scope of this standard.

4.22.8 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 (see 7.40) command without error.

The SECURITY ERASE UNIT command (see 7.39) ignores the MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2) when comparing passwords, and accepts 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 (see 7.41), then the device returns command aborted.

If the MASTER PASSWORD CAPABILITY bit was set to High (see 4.22.4) during the most recent SECURITY SET PASSWORD command that set the User password, then the device accepts the Master password and complete the command without error.

If the MASTER PASSWORD CAPABILITY bit was set to Maximum (see 4.22.4) during the most recent SECURITY SET PASSWORD command that set the User password, then the device returns command aborted for a SECURITY UNLOCK command (see 7.42) or a SECURITY DISABLE PASSWORD command (see 7.37) if the Master password is supplied.

4.22.9 Password attempt counter and SECURITY COUNT EXPIRED bit

The device shall maintain a password attempt counter and a SECURITY COUNT EXPIRED bit (see 9.10.8.3.4).

The password attempt counter shall be decremented if:

a) the device is in the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8);
b) the SECURITY COUNT EXPIRED bit is cleared to zero; and
c) a SECURITY UNLOCK command (see 7.42) fails as a result of an invalid User password or Master password.

If the password attempt counter reaches zero, the device shall set the SECURITY COUNT EXPIRED bit to one.

If the SECURITY COUNT EXPIRED bit is set to one, the device shall return command aborted for all SECURITY UNLOCK commands and SECURITY ERASE UNIT commands (see 7.39).

If the device processes a power-on reset or a hardware reset, then the device shall:

a) clear the SECURITY COUNT EXPIRED bit to zero; and
b) set the password attempt counter to five.

4.22.10 Master Password Identifier feature

The Master Password Identifier feature associates a 16-bit non-volatile value with the Master password. The master password identifier does not indicate whether a Master password exists or is valid.

Support for this feature is reported in the MASTER PASSWORD IDENTIFIER field (see 9.10.8.2). Valid identifiers are 0001h through FFFEh. A value of 0000h or FFFFh indicates that this feature is not supported.

If the Master Password Identifier feature is supported, then:

a) the host may specify the value of the master password identifier using the SECURITY SET PASSWORD command (see 7.41);
b) the MASTER PASSWORD IDENTIFIER field shall not be modified by the device except in response to the SECURITY SET PASSWORD command; and
c) the MASTER PASSWORD IDENTIFIER field shall be set to FFFEh at the time of manufacture.

If supported, the Master Password Identifier feature allows an administrator to use several sets of Master passwords (e.g., for use in different deployments of devices). The administrator may:

a) maintain a mapping of actual Master passwords to corresponding Master Password Identifiers;
b) set the corresponding Master Password Identifier at the same time the Master password is set using a SECURITY SET PASSWORD command in which the Master password is specified (i.e., the IDENTIFIER bit is set to one); and
c) retrieve the most recently set Master Password Identifier from the MASTER PASSWORD IDENTIFIER field in the Security page of the IDENTIFY DEVICE data log.

If a User password had been set and lost, an administrator may read the MASTER PASSWORD IDENTIFIER field to obtain a hint as to which Master password was previously set.

4.22.11 Security states

4.22.11.1 Overview

Table 11 is a summary of the security states. If the power is off, the security characteristics are as in table 11, but are not reportable.

Table 11 — Summary of Security States and Security Characteristics

Security state	Reference	Security Characteristics				
		Power	Enabled [a]	Locked [b]	Frozen [c]	Password Attempts Exceeded [d]
SEC0	4.22.11.4	off	0	N/A	N/A	N/A
SEC1	4.22.11.5	on	0	0	0	0
SEC2	4.22.11.6	on	0	0	1	Varies
SEC3	4.22.11.7	off	1	N/A	N/A	N/A
SEC4	4.22.11.8	on	1	1	0	Varies
SEC5	4.22.11.9	on	1	0	0	Varies
SEC6	4.22.11.10	on	1	0	1	Varies

[a] See the SECURITY ENABLED bit (see 9.10.8.3.7).
[b] See the SECURITY LOCKED bit (see 9.10.8.3.6).
[c] See the SECURITY FROZEN bit (see 9.10.8.3.5).
[d] See the SECURITY COUNT EXPIRED bit (see 9.10.8.3.4).

4.22.11.2 Security command actions

Table 12 describes the effect of the security state on commands.

Table 12 — Security Command Actions (Sheet 1 of 4)

Command [a]	Locked [b]	Unlocked or Disabled [c f]	Frozen [d]
BLOCK ERASE EXT	see 4.20.5	Executable	Executable
CHECK POWER MODE	Executable	Executable	Executable
CLOSE ZONE EXT [e]	Command aborted	Executable	Executable
CONFIGURE STREAM	Command aborted	Executable	Executable
CRYPTO SCRAMBLE EXT	see 4.20.5	Executable	Executable
DATA SET MANAGEMENT	Command aborted	Executable	Executable
DATA SET MANAGEMENT XL	Command aborted	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
FINISH ZONE EXT [e]	Command aborted	Executable	Executable
FLUSH CACHE	Command aborted	Executable	Executable
FLUSH CACHE EXT	Command aborted	Executable	Executable
FREEZE ACCESSIBLE MAX ADDRESS EXT	Command aborted	Executable	Executable
GET NATIVE MAX ADDRESS EXT	Executable	Executable	Executable
GET PHYSICAL ELEMENT STATUS	Executable	Executable	Executable
IDENTIFY 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
MUTATE EXT	Command aborted	Executable	Executable
NCQ NON-DATA - ABORT NCQ QUEUE	Executable	Executable	Executable
NCQ NON-DATA - DEADLINE HANDLING	Executable	Executable	Executable
NCQ NON-DATA- HYBRID DEMOTE BY SIZE	Command aborted	Executable	Executable
NCQ NON-DATA- HYBRID CHANGE BY LBA RANGE	Command aborted	Executable	Executable

[a] All commands not listed in this table are not addressed by the Security feature set.
[b] Locked indicates that the device is in the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8).
[c] Unlocked or disabled indicates that the device is in the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5) or the SEC5: Security Enabled/Not Locked/Not Frozen state (see 4.22.11.9).
[d] Frozen indicates that the device is in the SEC2: Security Disabled/Not Locked/Frozen state (see 4.22.11.6) or the SEC6: Security Enabled/Not Locked/Frozen state (see 4.22.11.10).
[e] xxxxxxxxxxxSee ZAC-2.
[f] If the device processes a command for which table 12 specifies ‘Command aborted’, then the device should return the additional sense code set to ACCESS DENIED - NO ACCESS RIGHTS (see 6.8.2).

Table 12 — Security Command Actions (Sheet 2 of 4)

Command [a]	Locked [b]	Unlocked or Disabled [c f]	Frozen [d]
NCQ NON-DATA - HYBRID CONTROL	Command aborted	Executable	Executable
NCQ NON-DATA - SET FEATURES	Executable	Executable	Executable
NCQ NON-DATA - ZERO EXT	Command aborted	Executable	Executable
NCQ NON-DATA - ZAC Management Out	Command aborted	Executable	Executable
NOP	Executable	Executable	Executable
OPEN ZONE EXT [e]	Command aborted	Executable	Executable
OVERWRITE EXT	see 4.20.5	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
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
RECEIVE FPDMA QUEUED - READ LOG DMA EXT	Executable	Executable	Executable
RECEIVE FPDMA QUEUED - ZAC Management In - REPORT REALMS [e]	Executable	Executable	Executable
RECEIVE FPDMA QUEUED - ZAC Management In - REPORT ZONES [e]	Executable	Executable	Executable
RECEIVE FPDMA QUEUED - ZAC Management In - REPORT ZONE DOMAINS [e]	Executable	Executable	Executable
RECEIVE FPDMA QUEUED - ZAC Management In - ZONE ACTIVATE [e]	Executable [e]	Executable	Executable
RECEIVE FPDMA QUEUED - ZAC Management In - ZONE QUERY [e]	Executable	Executable	Executable
REMOVE ELEMENT AND MODIFY ZONES [e]	Command aborted	Executable	Executable

[a] All commands not listed in this table are not addressed by the Security feature set.
[b] Locked indicates that the device is in the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8).
[c] Unlocked or disabled indicates that the device is in the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5) or the SEC5: Security Enabled/Not Locked/Not Frozen state (see 4.22.11.9).
[d] Frozen indicates that the device is in the SEC2: Security Disabled/Not Locked/Frozen state (see 4.22.11.6) or the SEC6: Security Enabled/Not Locked/Frozen state (see 4.22.11.10).
[e] xxxxxxxxxxxSee ZAC-2.
[f] If the device processes a command for which table 12 specifies ‘Command aborted’, then the device should return the additional sense code set to ACCESS DENIED - NO ACCESS RIGHTS (see 6.8.2).

Table 12 — Security Command Actions (Sheet 3 of 4)

Command [a]	Locked [b]	Unlocked or Disabled [c f]	Frozen [d]
REMOVE ELEMENT AND TRUNCATE	Command aborted	Executable	Executable
REPORT REALMS [e]	Executable	Executable	Executable
REPORT ZONE DOMAINS [e]	Executable	Executable	Executable
REPORT ZONES EXT [e]	Executable	Executable	Executable
REQUEST SENSE DATA EXT	Executable	Executable	Executable
RESET WRITE POINTER EXT [e]	Command aborted	Executable	Executable
RESTORE ELEMENTS AND REBUILD	Command aborted	Executable	Executable
SANITIZE ANTIFREEZE LOCK EXT	see 4.20.5	Executable	Executable
SANITIZE FREEZE LOCK EXT	see 4.20.5	Executable	Executable
SANITIZE STATUS EXT	Executable	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
SEND FPDMA QUEUED	Command aborted	Executable	Executable
SEQUENTIALIZE ZONE EXT [e]	Command aborted	Executable	Executable
SERVICE	Command aborted	Executable	Executable
SET ACCESSIBLE MAX ADDRESS EXT	Command aborted	Executable	Executable
SET FEATURES	Executable	Executable	Executable
SET SECTOR CONFIGURATION EXT	Command aborted	Executable	Executable
SLEEP	Executable	Executable	Executable
SMART READ LOG	Executable	Executable	Executable
SMART RETURN STATUS	Executable	Executable	Executable
SMART WRITE LOG	Executable	Executable	Executable
STANDBY	Executable	Executable	Executable
STANDBY IMMEDIATE	Executable	Executable	Executable

[a] All commands not listed in this table are not addressed by the Security feature set.
[b] Locked indicates that the device is in the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8).
[c] Unlocked or disabled indicates that the device is in the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5) or the SEC5: Security Enabled/Not Locked/Not Frozen state (see 4.22.11.9).
[d] Frozen indicates that the device is in the SEC2: Security Disabled/Not Locked/Frozen state (see 4.22.11.6) or the SEC6: Security Enabled/Not Locked/Frozen state (see 4.22.11.10).
[e] xxxxxxxxxxxSee ZAC-2.
[f] If the device processes a command for which table 12 specifies ‘Command aborted’, then the device should return the additional sense code set to ACCESS DENIED - NO ACCESS RIGHTS (see 6.8.2).

Table 12 — Security Command Actions (Sheet 4 of 4)

Command [a]	Locked [b]	Unlocked or Disabled [c f]	Frozen [d]
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 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
ZONE ACTIVATE EXT [e]	Executable	Executable	Executable
ZONE QUERY EXT [e]	Executable	Executable	Executable
ZERO EXT	Command aborted	Executable	Executable

[a] All commands not listed in this table are not addressed by the Security feature set.
[b] Locked indicates that the device is in the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8).
[c] Unlocked or disabled indicates that the device is in the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5) or the SEC5: Security Enabled/Not Locked/Not Frozen state (see 4.22.11.9).
[d] Frozen indicates that the device is in the SEC2: Security Disabled/Not Locked/Frozen state (see 4.22.11.6) or the SEC6: Security Enabled/Not Locked/Frozen state (see 4.22.11.10).
[e] xxxxxxxxxxxSee ZAC-2.
[f] If the device processes a command for which table 12 specifies ‘Command aborted’, then the device should return the additional sense code set to ACCESS DENIED - NO ACCESS RIGHTS (see 6.8.2).

4.22.11.3 Security state machine

Figure 10 describes security states and state transitions.

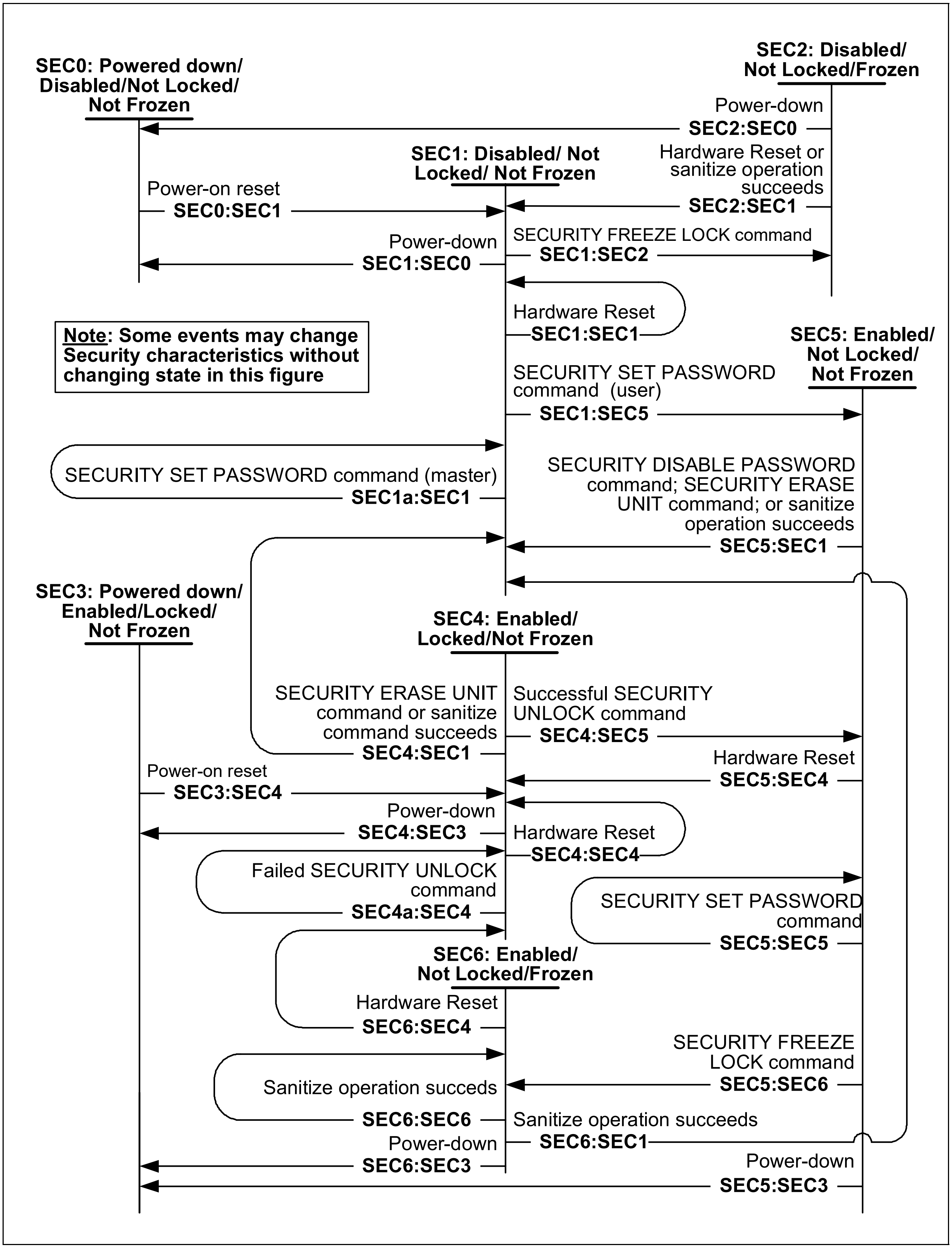

Figure 10 — Security state diagram

4.22.11.4 SEC0: Powered down/Security Disabled/Not Locked/Not Frozen state

The SEC0: Powered down/Security Disabled/Not Locked/Not Frozen state shall be entered if 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: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5) state.

4.22.11.5 SEC1: Security Disabled/Not Locked/Not Frozen state

The SEC1: Security Disabled/Not Locked/Not Frozen state shall be entered if:

a) the Security feature set is disabled and:
   A) the device processes a power-on reset; or
   B) the device processes a hardware reset;
b) the device processes a SECURITY DISABLE PASSWORD command (see 7.37);
c) the device processes a SECURITY ERASE UNIT command (see 7.39);
d) the device processes a SECURITY SET PASSWORD command (see 7.41) that sets the Master password while in this state; and
e) the device transitions to the SD4: Sanitize Operation Succeeded state (see 4.20.10.6).

If this state is entered as a result of processing a power-on reset or hardware reset, the device shall set the password attempt counter and the SECURITY COUNT EXPIRED bit (see 9.10.8.3.4) as described in 4.22.9.

In this state, the device shall respond to commands as specified in the Unlocked or Disabled column of table 12. With the exception of the commands in the Security feature set, processing of commands shall not cause a transition from this state.

In this state, the device shall set the bits in the Security page (see 9.10.8) of the IDENTIFY DEVICE data log as described in table 13.

Table 13 — Security page settings for the SEC1: Security Disabled/Not Locked/Not Frozen state

Bit name	Value	Description
SECURITY SUPPORTED bit (see 9.10.8.3.1)	1	Security feature set is supported
SECURITY ENABLED bit (see 9.10.8.3.7)	0	There is no active User password
SECURITY LOCKED bit (see 9.10.8.3.6)	0	device is not locked
SECURITY FROZEN bit (see 9.10.8.3.5)	0	device is not frozen
SECURITY COUNT EXPIRED bit (see 9.10.8.3.4)	Varies	Password Attempt Counter Exceeded 1= counter exceeded 0= counter not exceeded
MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2)	0	Master Password Capability is not Maximum

Transition SEC1:SEC0: If the device is powered-down, the device shall transition to the SEC0: Powered down/Security Disabled/Not Locked/Not Frozen state (see 4.22.11.4) state.

Transition SEC1:SEC1: If the device processes a hardware reset, the device shall transition to the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5) state.

Transition SEC1a:SEC1: If a SECURITY SET PASSWORD command (see 7.41) in which the Master password is specified (i.e., the IDENTIFIER bit is set to one) returns command completion without error, then the device shall:

a) save the Master password and the optional Master Password Identifier;
b) transition to the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5) state; and
c) not change the MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2).

Transition SEC1:SEC2: If a SECURITY FREEZE LOCK command (see 7.40) returns command completion without error, then the device shall transition to the SEC2: Security Disabled/Not Locked/Frozen state (see 4.22.11.6) state.

Transition SEC1:SEC5: If a SECURITY SET PASSWORD command (see 7.41) in which the User password is specified (i.e, the IDENTIFIER bit is cleared to zero) returns command completion without error, then the device shall:

a) save the User password;
b) update the MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2); and
c) transition to the SEC5: Security Enabled/Not Locked/Not Frozen state (see 4.22.11.9) state.

4.22.11.6 SEC2: Security Disabled/Not Locked/Frozen state

The SEC2: Security Disabled/Not Locked/Frozen state shall be entered when the device processes a SECURITY FREEZE LOCK command while in the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5) state.

In this state, the device shall respond to commands as specified in the Frozen column of table 12.

The processing of commands shall not cause a transition from this state, except for:

a) the processing of commands in the Security feature set; or
b) the transition of the Sanitize state machine to the SD4: Sanitize Operation Succeeded state (see 4.20.10.6) state.

In this state, the device shall set the bits in the Security page (see 9.10.8) of the IDENTIFY DEVICE data log as described in table 14.

Table 14 — Security page settings for the SEC2: Security Disabled/Not Locked/Frozen state

Bit name	Value	Description
SECURITY SUPPORTED bit (see 9.10.8.3.1)	1	Security feature set is supported
SECURITY ENABLED bit (see 9.10.8.3.7)	0	There is no active User password
SECURITY LOCKED bit (see 9.10.8.3.6)	0	device is not locked
SECURITY FROZEN bit (see 9.10.8.3.5)	1	device is frozen
SECURITY COUNT EXPIRED bit (see 9.10.8.3.4)	Varies	Password Attempt Counter Exceeded 1= counter exceeded 0= counter not exceeded
MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2)	Varies	Master Password Capability (see 4.22.4) 0=High (i.e., Master password enabled) 1=Maximum (i.e., Master password disabled)

Transition SEC2:SEC0: If the device is powered-down, the device shall transition to the SEC0: Powered down/Security Disabled/Not Locked/Not Frozen state (see 4.22.11.4) state.

Transition SEC2:SEC1: If the device:

a) receives a hardware reset; or
b) transitions to the SD4: Sanitize Operation Succeeded state (see 4.20.10.6) state,

then the device shall transition to the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5) state.

4.22.11.7 SEC3: Powered down/Security Enabled/Locked/Not Frozen state

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

Transition SEC3:SEC4: If the device processes a power-on reset, the device shall transition to the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8) state.

4.22.11.8 SEC4: Security Enabled/Locked/Not Frozen state

The SEC4: Security Enabled/Locked/Not Frozen state shall be entered if:

a) the Security feature set is enabled and:

A) the device processes a power-on reset; or
B) the device processes a hardware reset;

or

b) while in this state, the device processes a SECURITY ERASE PREPARE command (see 7.38) or a SECURITY UNLOCK command (see 7.42) and:
   A) the SECURITY COUNT EXPIRED bit (see 9.10.8.3.4) is set to one; or
   B) the password supplied is incorrect.

In this state, the device shall respond to commands as specified in the Locked column of table 12.

The processing of commands shall not cause a transition from this state, except for:

a) the processing of commands in the Security feature set; or
b) the transition of the Sanitize state machine to the SD4: Sanitize Operation Succeeded state (see 4.20.10.6) state.

If this state is entered due to power-on reset or hardware reset, the device shall set the password attempt counter and the SECURITY COUNT EXPIRED bit as described in 4.22.9.

In this state, the device shall set the bits in the Security page (see 9.10.8) of the IDENTIFY DEVICE data log as described in table 15.

Table 15 — Security page settings for the SEC4: Security Enabled/Locked/Not Frozen state

Bit name	Value	Description
SECURITY SUPPORTED bit (see 9.10.8.3.1)	1	Security feature set is supported
SECURITY ENABLED bit (see 9.10.8.3.7)	1	There is an active User password
SECURITY LOCKED bit (see 9.10.8.3.6)	1	device is locked
SECURITY FROZEN bit (see 9.10.8.3.5)	0	device is not frozen
SECURITY COUNT EXPIRED bit (see 9.10.8.3.4)	Varies	Password Attempt Counter Exceeded 1= counter exceeded 0= counter not exceeded
MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2)	Varies	Master Password Capability (see 4.22.4) 0=High (i.e., Master password enabled) 1=Maximum (i.e., Master password disabled)

Transition SEC4:SEC1: If:

a) a SECURITY ERASE UNIT command (see 7.39) returns command completion without error; or
b) transitions to the SD4: Sanitize Operation Succeeded state (see 4.20.10.6) state,

then the device shall transition to the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5) state.

Transition SEC4:SEC3: If the device is powered-down, the device shall transition to the SEC3: Powered down/Security Enabled/Locked/Not Frozen state (see 4.22.11.7) state.

Transition SEC4:SEC4: If the device processes a hardware reset, the device shall transition to the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8) state.

Transition SEC4a:SEC4: If a SECURITY UNLOCK command (see 7.42) is processed with an incorrect password, then the device shall:

a) process the password attempt counter as described in 4.22.9; and
b) transition to the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8) state.

After processing of the SECURITY ERASE PREPARE command (see 7.38), the device shall transition to the SEC4: Security Enabled/Locked/Not Frozen state.

Transition SEC4:SEC5: If a SECURITY UNLOCK command (see 7.42) returns command completion without error, the device shall transition to the SEC5: Security Enabled/Not Locked/Not Frozen state (see 4.22.11.9) state.

4.22.11.9 SEC5: Security Enabled/Not Locked/Not Frozen state

The SEC5: Security Enabled/Not Locked/Not Frozen state shall be entered if the device processes one of the following commands that returns command completion without error:

a) while in the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5) state, the device processes a SECURITY SET PASSWORD command (see 7.41) in which the User password is specified (i.e., the IDENTIFIER bit is cleared to zero);
b) while in the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8) state, the device processes a SECURITY UNLOCK command (see 7.42); or
c) while in the SEC5: Security Enabled/Not Locked/Not Frozen state (see 4.22.11.9) state, the device processes a:
    A) SECURITY SET PASSWORD command; or
    B) SECURITY ERASE PREPARE command (see 7.38).

In this state, the device shall respond to commands as specified in the Unlocked or Disabled column of table 12.

The processing of commands shall not cause a transition from this state, except for:

a) the processing of commands in the Security feature set; or
b) the transition of the Sanitize state machine to the SD4: Sanitize Operation Succeeded state (see 4.20.10.6) state.

In this state, the device shall set the bits in the Security page (see 9.10.8) of the IDENTIFY DEVICE data log as described in table 16.

Table 16 — Security page settings for the SEC5: Security Enabled/Not Locked/Not Frozen state

Bit name	Value	Description
SECURITY SUPPORTED bit (see 9.10.8.3.1)	1	Security feature set is supported
SECURITY ENABLED bit (see 9.10.8.3.7)	1	There is an active User password
SECURITY LOCKED bit (see 9.10.8.3.6)	0	device is not locked
SECURITY FROZEN bit (see 9.10.8.3.5)	0	device is not frozen
SECURITY COUNT EXPIRED bit (see 9.10.8.3.4)	Varies	Password Attempt Counter Exceeded 1= counter exceeded 0= counter not exceeded
MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2)	Varies	Master Password Capability (see 4.22.4) 0=High (i.e., Master password enabled) 1=Maximum (i.e., Master password disabled)

Transition SEC5:SEC1: If:

a) a SECURITY DISABLE PASSWORD command (see 7.37) or a SECURITY ERASE UNIT command (see 7.39) returns command completion without error; or
b) transitions to the SD4: Sanitize Operation Succeeded state (see 4.20.10.6) state,

then the device shall transition to the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5) state.

Transition SEC5:SEC3: If the device is powered-down, the device shall transition to the SEC3: Powered down/Security Enabled/Locked/Not Frozen state (see 4.22.11.7) state.

Transition SEC5:SEC4: If the device processes a hardware reset, the device shall transition to the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8) state.

Transition SEC5:SEC5: If a SECURITY SET PASSWORD command (see 7.41) in which the Master password is specified (i.e., the IDENTIFIER bit is set to one) returns command completion without error, then the device shall:

a) save the Master password and the optional Master Password Identifier;
b) not change the MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2); and
c) transition to the SEC5: Security Enabled/Not Locked/Not Frozen state (see 4.22.11.9) state.

If a SECURITY SET PASSWORD command in which the User password is specified (i.e., the IDENTIFIER bit is cleared to zero) or a SECURITY UNLOCK command (see 7.42) returns command completion without error, then the device shall:

a) save the User password;
b) update the MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2); and
c) transition to the SEC5: Security Enabled/Not Locked/Not Frozen state.

If a SECURITY ERASE PREPARE command (see 7.38) returns command completion without error, then the device shall transition to the SEC5: Security Enabled/Not Locked/Not Frozen state.

Transition SEC5:SEC6: If a SECURITY FREEZE LOCK command (see 7.40) returns command completion without error, the device shall transition to the SEC6: Security Enabled/Not Locked/Frozen state (see 4.22.11.10) state.

4.22.11.10 SEC6: Security Enabled/Not Locked/Frozen state

The SEC6: Security Enabled/Not Locked/Frozen state shall be entered when the device receives a SECURITY FREEZE LOCK command (see 7.40) while in the SEC5: Security Enabled/Not Locked/Not Frozen state (see 4.22.11.9) state.

In this state, the device shall respond to commands as specified in the Frozen column of table 12.

The processing of commands shall not cause a transition from this state, except for:

a) the processing of commands in the Security feature set; or
b) the transition of the Sanitize state machine to the SD4: Sanitize Operation Succeeded state (see 4.20.10.6) state.

In this state, the device shall set the bits in the Security page (see 9.10.8) of the IDENTIFY DEVICE data log as described in table 17.

Table 17 — Security page settings for the SEC6: Security Enabled/Not Locked/Frozen state

Bit name	Value	Description
SECURITY SUPPORTED bit (see 9.10.8.3.1)	1	Security feature set is supported
SECURITY ENABLED bit (see 9.10.8.3.7)	1	There is an active User password
SECURITY LOCKED bit (see 9.10.8.3.6)	0	device is not locked
SECURITY FROZEN bit (see 9.10.8.3.5)	1	device is frozen
SECURITY COUNT EXPIRED bit (see 9.10.8.3.4)	Varies	Password Attempt Counter Exceeded 1= counter exceeded 0= counter not exceeded
MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2)	Varies	Master Password Capability (see 4.22.4) 0=High (i.e., Master password enabled) 1=Maximum (i.e., Master password disabled)

Transition SEC6:SEC1: If the device transitions to the SD4: Sanitize Operation Succeeded state (see 4.20.10.6) state and the RESTRICTED SANITIZE OVERRIDES SECURITY bit is:

a) set to one, then the device shall transition to the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5) state; and
b) cleared to zero, then the device may transition to the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5) state.

Transition SEC6:SEC3: If the device is powered-down, the device shall transition to the SEC3: Powered down/Security Enabled/Locked/Not Frozen state (see 4.22.11.7) state.

Transition SEC6:SEC4: If the device processes a hardware reset, the device shall transition to the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8) state.

Transition SEC6:SEC6: If the RESTRICTED SANITIZE OVERRIDES SECURITY bit is cleared to zero and the device transitions to the SD4: Sanitize Operation Succeeded state (see 4.20.10.6) state, then the device may transition to the SEC6: Security Enabled/Not Locked/Frozen state (see 4.22.11.10) state.

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

4.23.1 Overview

The SMART feature set allows for the protection of user data on the device 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.

4.23.2 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.

4.23.3 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.

4.23.4 Threshold exceeded condition

If the device's SMART reliability status indicates an impending degrading or fault condition (see 7.48.3), a threshold exceeded condition occurs.

4.23.5 SMART feature set commands

SMART feature set 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 supported, the SMART RETURN STATUS command (see 7.48.3) shall be supported.

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

a) SMART READ LOG (see 7.48.2); and
b) SMART WRITE LOG (see 7.48.4).

4.23.6 SMART operation with power management modes

If the SMART feature set is enabled (i.e., if the SMART ENABLED bit (see 9.10.6.2.15) is set to one), 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 mode or Idle mode from a Standby mode.

If a SMART feature set enabled device has been set to use the Standby timer (see 4.17.3), the device should save the device accumulated SMART data prior to going from an Idle mode to the Standby mode or upon return to an Active mode or Idle mode from a Standby mode.

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

4.23.7 SMART device error log reporting

The logging of reported errors is an optional SMART feature. If error logging is supported by a device, support for error logging is indicated in SMART ERROR LOGGING SUPPORTED bit (see 9.10.5.2.26). If error logging is supported, the device shall provide information on the most recent five errors that the device reported as described in the SMART READ LOG command (see 7.48.2). The device may also provide additional vendor specific information on these reported errors.

If error logging is supported, error logging shall not be disabled when SMART is disabled. Error log information shall be gathered while the device is powered-on and in a normal power mode. The logging of errors while in a reduced power mode is optional. If errors are logged while in a reduced power mode, the reduced power mode shall not change. If the SMART feature set (see 4.23) is disabled, the delivering of error log information via the SMART READ LOG command is also disabled.

The SMART error logs are:

a) the Summary SMART Error Log (see 9.22);
b) the Comprehensive SMART Error Log (see 9.4); and
c) the Extended Comprehensive SMART Error Log (see 9.7).

4.24 Sense Data Reporting feature set

4.24.1 General

The Sense Data Reporting feature set allows devices to report that additional error or non-error informational status (i.e., sense data) is available from the device and may be retrieved by the host. The sense keys, additional sense codes, and additional sense code qualifiers described by this standard use code values defined in SPC-5.

The following are mandatory for devices implementing the Sense Data Reporting feature set:

a) the REQUEST SENSE DATA EXT command (see 7.34);
b) the SET FEATURES subcommand Enable/Disable the Sense Data Reporting feature set (see 7.45.17);
c) the SENSE DATA AVAILABLE bit (see 6.2.9);
d) the SENSE DATA ENABLED bit (see 9.10.6.2.12); and
e) the SENSE DATA SUPPORTED bit (see 9.10.5.2.28).

The following are optional for devices implementing the Sense Data Reporting feature set:

a) setting the NON-NCQ REBUILD ASSIST SUPPORTED bit (see 9.10.5.2.50) to one;
b) support for the Sense Data log (see 9.32);
c) support for the REQUEST SENSE DEVICE FAULT SUPPORTED bit (see 9.10.5.2.38); and
d) support for the PERSISTENT SENSE DATA REPORTING bit (see 9.10.5.2.47).

This feature is enabled by issuing a SET FEATURES subcommand Enable/Disable the Sense Data Reporting feature set (see 7.45.17) to the device. The host may disable this capability by issuing a SET FEATURES subcommand Enable/Disable the Sense Data Reporting feature set (see 7.45.17) to the device.

If the Sense Data Reporting feature set is enabled (see 7.45.17), the device notifies the host of available sense data by setting the SENSE DATA AVAILABLE bit to one (see 6.2.9) in the STATUS field. The ERROR field shall comply with the requirements in clause 6.

The host retrieves the sense data:

a) described in table 355 by issuing a REQUEST SENSE DATA EXT command (see 7.34) to the device; or
b) by reading the Sense Data log (see 9.32).

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 returned completion without an error and the sense data is available (e.g., a correctable error occurred).

If the Sense Data Reporting feature set is supported and is not enabled, then:

a) if the REQUEST SENSE DEVICE FAULT SUPPORTED bit (see 9.10.5.2.38) is set to one, then the device shall make the sense data described in table 355 available through the REQUEST SENSE DATA EXT command; and
b) if the REQUEST SENSE DEVICE FAULT SUPPORTED bit is cleared to zero, then the device may make the sense data described in table 355 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 stop being available to be returned by the REQUEST SENSE EXT command after:

a) receiving any reset;
b) acceptance of a command that:
   A) is not a REQUEST SENSE DATA EXT command; or
   B) does not read the NCQ Command Error log or the Sense Data log;

   or

c) completion of a REQUEST SENSE DATA EXT command.

The SENSE DATA ENABLED bit shall not be changed as a result of the device processing a hardware or software reset. See 9.10.5.2.47 for a description of the device behavior as a result of processing a Power-on reset on the Sense Data Reporting feature set.

4.24.2 Current information sense data and deferred error sense data

Sense data may be:

a) current information sense data (i.e., with the DEFERRED ERROR bit cleared to zero); or
b) deferred error sense data (i.e., with the DEFERRED ERROR bit set to one).

Current information sense data is sense data associated with the command for which the device has:

a) returned command completion with an error; and
b) set the SENSE DATA AVAILABLE bit to one (see 6.2.9).

Deferred error sense data is sense data not associated with the command for which the device has:

a) returned command completion with an error; and
b) set the SENSE DATA AVAILABLE bit to one (see 6.2.9).

Deferred error sense data may be sense data:

a) for a previous command for which the device returned command completion without error; or
b) associated with:
   A) multiple commands for which the device returned command completion without error; or
   B) no specific command.

4.25 Software Settings Preservation (SSP) feature set

The SSP feature set provides a method for a host 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 18. The device is only required to preserve the indicated software setting if the device supports the particular feature/command with which the setting is associated.

Table 18 — Preserved Feature Sets and Settings

Capability	Preserved Setting
Security Mode	Current Security State as defined in the security state transition diagram (see 4.22.11)
Standby Timer	Setting for the Standby timer (see 4.17.3)
Read/Write Stream Error Logs	Contents of these logs (see 9.15 and 9.23)
Password Attempt Counter	Value of the Password Attempt Counter (see 4.22.9)
Volatile Write Cache	Enabled or disabled (see 7.45.3)
Transfer Mode	PIO, DMA, and UDMA transfer mode settings (see 7.45.4)
APM feature set	Enabled or disabled (see 7.45.5)
Read look-ahead	Enabled or disabled (see 7.45.13)
Reverting to defaults mode	Enabled or disabled (see 7.45.14)
Sanitize Device state machine	Whether the device is in the SD1: Sanitize Frozen state (see 4.20.10.3) state
Write-Read-Verify	Settings of the Write-Read-Verify feature set (i.e., the contents of the WRV ENABLED bit (see 9.10.6.2.19), the WRV MODE 3 COUNT field (see 9.10.5.6), and IDENTIFY DEVICE data word 220 bits 7:0). The device shall not return to the Write-Read-Verify factory default setting after processing a COMRESET.
NCQ Streaming commands processing	The state of the WDNC bit (see 7.17.12.3) and the RDNC bit (see 7.17.12.3)
Device Sleep	Enabled or disabled (see 7.45.16.9)
Device Initiated Power Management	Enabled or disabled (see 7.45.16.4)

4.26 Storage Element Depopulation feature set

4.26.1 Overview

The Storage Element Depopulation feature set provides a mechanism for a host to manage the depopulation of storage elements from a device.

The media in a device may consist of a number of storage elements. Each of these storage elements:

a) is associated with some number of physical sectors; and
b) has a health status (see 7.12).

A storage element is a type of physical element. Physical elements are associated with a unique element identifier that is assigned by the device. The element identifier shall be non-zero. The association of element identifiers to physical elements shall persist across all resets. Activating microcode may change the association between element identifiers and physical elements.

The health status of a given element may become degraded (i.e., outside manufacturer's specification limit). Such degradation may affect the overall performance of the device as seen by the host.

A storage element that has been depopulated provides:

a) no LBA resources; and
b) no LBA mapping resources.

Storage element depopulation may:

a) change the associations between LBAs and physical sectors (e.g., the REMOVE ELEMENT AND TRUNCATE command (see 7.33)); or
b) not change the associations between LBAs and physical sectors (e.g., the REMOVE ELEMENT AND MODIFY ACCESS command (see ZAC-2)).

After a storage element has been depopulated, it may be restored to normal operation using the RESTORE ELEMENTS AND REBUILD command (see 7.35), if the RESTORE ELEMENTS AND REBUILD SUPPORTED bit (see 9.10.5.17.1) is set to one.

Devices that support the Storage Element Depopulation feature set shall:

a) support the GET PHYSICAL ELEMENT STATUS command (see 7.12);
b) set the GET PHYSICAL ELEMENT STATUS SUPPORTED bit (see 9.10.5.17.2) to one;
c) support the REMOVE ELEMENT AND TRUNCATE command (see 7.33);
d) set the REMOVE ELEMENT AND TRUNCATE SUPPORTED bit (see 9.10.5.17.3) to one;
e) support the General Purpose Logging feature set (see 4.11);
f) support the Sense Data Reporting feature set (see 4.24);
g) enable the Sense Data Reporting feature set during the processing of any reset;
h) support NCQ autosense (i.e., set the NCQ AUTOSENSE SUPPORTED bit to one in the Serial ATA page of the IDENTIFY DEVICE data log (see 9.10.10.2.21)), if the NCQ feature set is supported (see 4.15);
i) support the DSN feature set (see 4.8); and
j) support the Physical Element Status Changed device statistic (see 9.5.7.5).

Devices that support the Storage Element Depopulation feature set may:

a) support the RESTORE ELEMENTS AND REBUILD command (see 7.35); and
b) set the RESTORE ELEMENTS AND REBUILD SUPPORTED bit (see 9.10.5.17.1) to one.

4.26.2 Status change notification

The device may monitor the status of storage elements as a background operation. The device may notify the host that the status of one or more storage elements is not within manufacturer's specification limit (see 9.20). The specific mechanism for detection of this condition is outside the scope of this standard. The device notifies the host of the change in status of a storage element by incrementing the value in the PHYSICAL ELEMENT STATUS CHANGED field (see 9.5.7.5).

To determine the status of storage elements, the host requests physical element status (see 7.12).

4.26.3 Repurposing Depopulation

4.26.3.1 Overview

Repurposing depopulation uses the REMOVE ELEMENT AND TRUNCATE command to perform the actions specified in 4.26.3.2 to reduce the capacity of the device.

Upon completion of the REMOVE ELEMENT AND TRUNCATE command, the actions performed by repurposing depopulation (see 4.26.3.2) may continue as background processes. Upon the completion of the actions performed by repurposing depopulation, the contents of the user data area may have no relation to the contents of the user data area before the processing of the REMOVE ELEMENT AND TRUNCATE command.

A REMOVE ELEMENT AND TRUNCATE command may be issued for each storage element that is to be removed from the current operating configuration. The effect of processing multiple REMOVE ELEMENT AND TRUNCATE commands (see 7.33) shall be cumulative.

A device may have a limit on the number of storage elements that may be depopulated. If the device is requested to depopulate a storage element in excess of this limit, the device may return command aborted with the additional sense code set to INVALID FIELD IN CDB (see 6.8.17).

The capacity values reported by the IDENTIFY DEVICE command and the IDENTIFY DEVICE data log are described in table 5.

4.26.3.2 Actions performed by repurposing depopulation

Repurposing depopulation uses the REMOVE ELEMENT AND TRUNCATE command (see 7.33), that specifies that the device:

a) shall perform a depopulation operation (see 4.26.3.3);
b) shall perform a truncate operation (see 4.26.3.4); and
c) may perform a user data initialization operation (see 4.29.2) with inputs (see 4.29.2.2) that do not change:
    A) the logical sector size;
    B) logical to physical sector relationship; or
    C) any zoning information (see ZAC-2).

A depopulation operation, a truncate operation, or a user data initialization operation shall not be terminated by a COMRESET, hardware reset, or software reset.

If a depopulation operation, a truncate operation, or a user data initialization operation:

a) detects an error that prevents successful completion of that operation; or
b) is interrupted by a power-on reset,

then the device:

a) shall terminate that operation; and
b) may abort subsequent media access commands with the additional sense code set to DEPOPULATION FAILED (see 6.8.7) until a subsequent REMOVE ELEMENT AND TRUNCATE command or a RESTORE ELEMENTS AND REBUILD command (see 7.35) completes without error.

4.26.3.3 Depopulation operations

To initiate a depopulation operation the host issues a REMOVE ELEMENT AND TRUNCATE command.

The depopulation operation may continue after the command that initiated the depopulation operation returns command completion without error.

Sector reallocation may occur during depopulation operations.

4.26.3.4 Truncate operations

The REQUESTED MAX LBA field in the REMOVE ELEMENT AND TRUNCATE command (see 7.33):

a) specifies the native max address and the accessible max address (see 7.33.3.3); and
b) should be no larger than the native max address at the time of command acceptance minus the ASSOCIATED CAPACITY field (see 7.12.6.5.6) for the storage element being depopulated.

The processing of a REMOVE ELEMENT AND TRUNCATE command shall not change the LOGICAL SECTOR SIZE field (see 9.10.4.4) or the LOGICAL SECTOR OFFSET field (see 9.10.4.3.5).

4.26.4 Repurposing Depopulation Restoration

4.26.4.1 Overview

Repurposing depopulation restoration uses the RESTORE ELEMENTS AND REBULD command (see 7.35) to perform the actions specified in 4.26.4.2 to restore some or all the capacity of the device that was reduced by previous:

a) depopulation operations (see 4.26.3.3); and
b) REMOVE ELEMENT AND MODIFY ZONES commands (see ZAC-2).

Upon completion of the RESTORE ELEMENTS AND REBUILD command, the actions performed by depopulation revocation operations (see 4.26.4.3) may continue as background processes. Upon the completion of the actions performed by depopulation revocation operations, the contents of the user data area may have no relation to the contents of the user data area before the processing of the RESTORE ELEMENTS AND REBUILD command.

To process a RESTORE ELEMENTS AND REBUILD command, the device:

a) should attempt to restore to the current operating configuration every storage element that has been affected by a previous depopulation operation as described in 4.26.3.3; and
b) may or may not restore one or more storage elements to the current operating configuration for reasons that include:
   A) since the processing of a depopulation operation (see 4.26.3.3), the processing of a command (e.g., a sanitize command (see 7.36), a SET SECTOR CONFIGURATON EXT command (see 7.46), a ZONE ACTIVATE command (see ZAC-2)) has changed the current configuration in a way that the device is unable to restore during the processing of a depopulation revocation operation; or
   B) a storage element is unable to provide normal operational capabilities.

The capacity values reported by the IDENTIFY DEVICE command and the IDENTIFY DEVICE data log are described in table 5.

4.26.4.2 Actions performed by repurposing depopulation restorations

Repurposing depopulation restorations use the RESTORE ELEMENTS AND REBUILD command (see 7.35), that specifies that, if depopulated storage elements are available for repurposing depopulation restoration, then the device:

a) shall perform a depopulation revocation operation (see 4.26.4.3);
b) shall perform a rebuild operation (see 4.26.4.4); and
c) may perform a user data initialization operation (see 4.29.2) with inputs (see 4.29.2.2) that do not change:
   A) the logical sector size;
   B) logical to physical sector relationship; or
   C) any zoning information (see ZAC-2).

A depopulation revocation operation, a rebuild operation, or a user data initialization operation shall not be terminated by a COMRESET, hardware reset, or software reset.

If a depopulation revocation operation, a rebuild operation, or a user data initialization operation:

a) detects an error that prevents successful completion of that operation; or
b) is interrupted by a power-on reset,

then the device:

a) shall terminate that operation; and
b) may abort subsequent media access commands with the additional sense code set to DEPOPULATION RESTORATION FAILED (see 6.8.9) until a subsequent RESTORE ELEMENTS AND REBUILD command or a REMOVE ELEMENT AND TRUNCATE command (see 7.33) completes without error.

4.26.4.3 Depopulation revocation operations

To initiate a depopulation revocation operation the host issues a RESTORE ELEMENTS AND REBUILD command.

The depopulation revocation operation may continue after the command that initiated the depopulation revocation operation returns command completion without error.

Sector reallocation may occur during depopulation revocation operations.

4.26.4.4 Rebuild operations

A rebuild operation may change the native max address and the accessible max address.

After a rebuild operation completes all logical sectors on the device shall have the device logical block length and number of logical sectors per physical sector in effect at the time of the processing of the RESTORE ELEMENTS AND REBUILD command.

The processing of a RESTORE ELEMENTS AND REBUILD command shall not change the LOGICAL SECTOR SIZE field (see 9.10.4.4) or the LOGICAL SECTOR OFFSET field (see 9.10.4.3.5).

4.26.5 Effects of storage depopulation commands on other commands

4.26.5.1 Allowed commands

While the device is performing the actions specified in 4.26.3.2 (i.e., for repurposing depopulation) or 4.26.4.2 (i.e., for repurposing depopulation restorations), the device shall abort all commands other than the:

a) IDENTIFY DEVICE;
b) IDLE IMMEDIATE with the Unload feature;
c) READ LOG EXT or READ LOG DMA EXT, if one of the following log addresses is requested:
   A) 04h (i.e., Device Statistics log);
   B) 0Ah (i.e., Device Statistics Notification log);
   C) 10h (i.e., NCQ Command Error log);
   D) 30h (i.e., IDENTIFY DEVICE data log); or
   E) E0h (i.e., SCT Command/Status log);
d) REPORT ZONES EXT (see ZAC-2) with:
   A) the ZONE LOCATOR field cleared to zero;
   B) the REPORTING OPTIONS field set to 3Fh (i.e., conventional zones);
   C) the RETURN PAGE COUNT field set to 0001h; and
   D) the PARTIAL bit set to one;
e) REQUEST SENSE DATA EXT;
f) SANITIZE ANTIFREEZE LOCK EXT;
g) GET PHYSICAL ELEMENT STATUS;
h) SECURITY UNLOCK;
i) SET FEATURES PUIS feature set device spin-up;
j) SMART READ LOG, if one of the following log addresses is requested:
   A) 04h (i.e., Device Statistics log);
   B) 0Ah (i.e., Device Statistics Notification log);
   C) 30h (i.e., IDENTIFY DEVICE data log); or
   D) E0h (i.e., SCT Command/Status log);

   and
k) SMART RETURN STATUS.

If a command is aborted as described in this subclause, the additional sense code shall be set to:

a) DEPOPULATION IN PROGRESS (see 6.8.8), if a repurposing depopulation is in progress; and
b) DEPOPULATION RESTORATION IN PROGRESS (see 6.8.10), if a repurposing depopulation restoration is in progress.

4.26.5.2 Progress checking

If a REQUEST SENSE DATA EXT command (see 7.34) is processed while a repurposing depopulation (see 4.26.3.2) is in progress, then the additional sense code shall be set to DEPOPULATION IN PROGRESS (see 6.8.8).

If a REQUEST SENSE DATA EXT command (see 7.34) is processed while a repurposing depopulation restoration (see 4.26.4.2) is in progress, then the additional sense code shall be set to DEPOPULATION RESTORATION IN PROGRESS (see 6.8.10).

4.26.6 Interactions with logs

While a device is performing the actions specified in 4.26.3.2 (i.e., for repurposing depopulation) or 4.26.4.2 (i.e., for repurposing depopulation restorations), the device may change the following logs:

a) the Pending Defects log (see 9.27);
b) the LBA Status log (see 9.12);
c) the Device Statistics log (see 9.5) (e.g., to the General Errors Statistics log page (see 9.5.7)); and
d) the Mutate Configuration log (see 9.30).

If a user data initialization operation (see 4.29.2) is performed, then that operation shall not change:

a) the Power Conditions log (see 9.8); and
b) the Host Specific log (see 9.9).

4.26.7 Interactions with caches

Successful completion of a REMOVE ELEMENT AND TRUNCATE command or a RESTORE ELEMENTS AND REBUILD command shall invalidate all cached user data.

4.27 Streaming feature set

4.27.1 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 support the Streaming feature set shall implement the:

a) GPL feature set (see 4.11);
b) CONFIGURE STREAM command (see 7.4);
c) READ STREAM EXT command (see 7.29);
d) READ STREAM DMA EXT command (see 7.28);
e) WRITE STREAM EXT command (see 7.67); and
f) WRITE STREAM DMA EXT command (see 7.66).

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

Support of the Streaming feature set is indicated STREAMING SUPPORTED bit (see 9.10.5.2.24).

4.27.2 Streaming commands

4.27.2.1 Streaming command overview

The CONFIGURE STREAM command (see 7.4) is used by a host to define the properties of a stream to assist the device in configuring for best caching performance. The STREAM ID field 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 value in the STREAM ID field may be used by the device to configure the available resources to support the streaming requirements of the Audio/Video content.

A host may use read stream commands and write stream commands to access any stream.

The CONFIGURE STREAM command DEFAULT CCTL field (see 7.4.3.4) 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 CCTL field (see 7.28.3.2) in each read stream command or write stream command, where the time limit is effective for that command only. 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 the device. These commands may be interspersed with commands not in the Streaming feature set. However, 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 the STREAM MIN REQUEST SIZE field (see 9.10.6.6).

4.27.2.2 FLUSH bit

The FLUSH bit when set to one in the write stream commands (see 7.66.3.3) 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 7.4.3.5), streaming performance may be degraded. The SET FEATURES Enable/Disable Volatile Write Cache subcommand (see 7.45.3) may affect caching for commands in the Streaming feature set.

4.27.2.3 NOT SEQUENTIAL bit

The NOT SEQUENTIAL bit in the read stream commands (see 7.28.3.4) specifies that the next read stream command with the same Stream ID may or may not start with the next LBA following the highest numbered LBA of the previous read stream command.

NOTE 2 — The NOT SEQUENTIAL bit provides information for the device to optimize pre-fetching decisions.

4.27.2.4 READ CONTINUOUS bit

The READ CONTINUOUS bit in the read stream commands (see 7.28.3.3) specifies that the device shall transfer the requested amount of data to the host within the time specified by the DEFAULT CCTL field (see 7.4.3.4) or the COMMAND CCTL field (see 7.28.3.2) even if an error occurs. The data sent to the host by the device in an error condition is vendor specific.

4.27.2.5 WRITE CONTINUOUS bit

The WRITE CONTINUOUS bit in the write stream commands (see 7.66.3.2) specifies that the device shall transfer the requested amount of data from the host within the time specified by the DEFAULT CCTL field (see 7.4.3.4) or the COMMAND CCTL field (see 7.28.3.2) even if an error occurs. If the device is unable to resolve an error within the time specified by the DEFAULT CCTL field or the COMMAND CCTL field, 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.

4.27.2.6 Streaming Logs

A device supporting the Streaming feature set shall implement the Read Stream Error Log (see 9.15) and the Write Stream Error Log (see 9.23). These logs are accessed using any supported read log command in the GPL feature set (see 4.11).

4.28 Trusted Computing feature set

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

The following commands are mandatory for devices that support 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).

The TRUSTED COMPUTING SUPPORTED bit (see 9.10.8.6) 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 Security Protocols are defined in table 155 and table 165.

4.29 User Data Initialization feature set

4.29.1 Overview

The User Data Initialization feature set is associated with the following methods for changing how user data is accessed:

a) the user data initialization operation (see 4.29.2); and
b) the MUTATE EXT command (see 4.29.3 and 7.16).

4.29.2 User data initialization operation

4.29.2.1 Overview

Based on the user data initialization operation inputs (see 4.29.2.2), a user data initialization operation may return the device to the equivalent of its manufactured accessibility. Performing a user data initialization operation may:

a) be limited to modifying information that the device uses to associate an LBA with a logical sector; or
b) include:
    A) verifying the accessibility of every logical sector;
    B) detecting and processing defects; and
    C) performing actions necessary to configure a zone device (see ZAC-2).

If the inputs are the same as those for the current device configuration, then the user data initialization operation shall make no changes. This shall not be considered an error.

The successful processing of a user data initialization operation may result in the device changing:

a) the ACCESSIBLE CAPACITY field (see 9.10.4.2) to the new native max address;
b) the association between LBAs and user data;
c) the user data;
d) trimmed logical sectors (see 7.5.3.3);
e) markup LBA ranges (see 7.5.3.4);
f) IDENTIFY DEVICE data (see 7.13.6); and
g) settings managed by the SET FEATURES command (see 7.45).

During the successful processing of a user data initialization operation, the device may recalculate the following device statistics:

a) Logical Sectors Written (see 9.5.6.5);
b) Logical Sectors Read (see 9.5.6.7);
c) Number of Reallocated Logical Sectors (see 9.5.8.6);
d) Number of Reallocation Candidate Logical Sectors (see 9.5.8.9); and
e) Read Recovery Attempts (see 9.5.8.7).

The processing of a user data initialization operation shall not affect:

a) the Power Conditions log (see 9.8); and
b) the Host Specific log (see 9.9).

During the successful processing of a user data initialization operation, the device may change the following logs:

a) the IDENTIFY DEVICE data log (see 9.10);
b) the Summary SMART Error log (see 9.22);
c) the Comprehensive SMART Error log (see 9.4);
d) the Extended Comprehensive SMART Error log (see 9.7);
e) the Selective Self-Test log (see 9.21);
f) the Pending Defects log (see 9.27);
g) the LPS Mis-alignment log (see 9.13);
h) the LBA Status log (see 9.12);
i) the Write Stream Error log (see 9.23); and
j) the Read Stream Error log (see 9.15).

While a user data initialization operation is being performed:

a) the device shall return command aborted with the additional sense code set to LOGICAL UNIT NOT READY, FORMAT IN PROGRESS (see 6.8.21) for all commands other than:
   A) CHECK POWER MODE;
   B) IDENTIFY DEVICE;
   C) IDLE IMMEDIATE with the Unload feature;
   D) READ LOG EXT or READ LOG DMA EXT, if one of the following log addresses is requested:
      a) 10h (i.e., NCQ Command Error log);
      b) 30h (i.e., IDENTIFY DEVICE data log); or
      c) E0h (i.e., SCT Command/Status log);
   E) REQUEST SENSE DATA EXT;
   F) SANITIZE ANTIFREEZE LOCK EXT;
   G) SECURITY UNLOCK;
   H) SET FEATURES PUIS feature set device spin-up;
   I) SMART READ LOG, if one of the following log addresses is requested:
      a) 30h (i.e., IDENTIFY DEVICE data log); or
      b) E0h (i.e., SCT Command/Status log);
      and
   J) SMART RETURN STATUS;
   and
b) if the device processes a power-on reset, then the device shall process subsequent commands as if the user data initialization operation completed with an error.

As a result of completing a user data initialization operation without error, the device:

a) based on the user data initialization operation inputs, shall modify the following pages in the IDENTIFY DEVICE data log (see 9.10):
   A) the Capacity page (see 9.10.4); and
   B) the Zoned Device Information page (see ZAC-2), if appropriate;
b) shall set the device signature (see table 349) based on the schema type (see 9.30.4.3); and
c) may return command aborted with the additional sense code set to LOGICAL UNIT NOT READY, POWER CYCLE REQUIRED (see 6.8.24) in response to any command until the device processes a power-on reset.

If a user data initialization operation completes with an error, then until a subsequent user data initialization operation completes without error, the device shall return command aborted with the additional sense code set to:

a) MEDIUM FORMAT CORRUPTED (see 6.8.26), if a MUTATE EXT command (see 7.16) is performing the user data initialization operation;
b) DEPOPULATION FAILED (see 6.8.7), if a REMOVE ELEMENT AND TRUNCATE command (see 7.33) is performing the user data initialization operation; or
c) DEPOPULATION RESTORATION FAILED (see 6.8.9), if a RESTORE ELEMENTS AND REBUILD command (see 7.35) is performing the user data initialization operation,

for all commands other than:

a) any command that performs a user data initialization operation;
b) CHECK POWER MODE;
c) IDENTIFY DEVICE;
d) IDLE IMMEDIATE with the Unload feature;
e) READ LOG EXT or READ LOG DMA EXT, if one of the following log addresses is requested:
   A) 10h (i.e., NCQ Command Error log);
   B) 30h (i.e., IDENTIFY DEVICE data log); or
   C) E0h (i.e., SCT Command/Status log);
f) REQUEST SENSE DATA EXT;
g) SANITIZE ANTIFREEZE LOCK EXT;
h) SECURITY UNLOCK;
i) SET FEATURES PUIS feature set device spin-up;

j) SMART READ LOG, if one of the following log addresses is requested:
   A) 30h (i.e., IDENTIFY DEVICE data log); or
   B) E0h (i.e., SCT Command/Status log);

   and

k) SMART RETURN STATUS.

4.29.2.2 User data initialization operation inputs

The inputs to a user data initialization operation specify the new:

a) logical sector size;
b) logical to physical sector relationship;
c) accessible capacity; and
d) the following zoning information (see ZAC-2), if any;
   A) applicable ZAC-2 feature set (e.g., the host aware zones feature set);
   B) extents to be configured with conventional zones;
   C) extents to be configured with write pointer zones; and
   D) number of logical sectors per zone.

4.29.3 MUTATE EXT command

The MUTATE EXT command (see 7.16) allows the host to request that the device perform a user data initialization operation (see 4.29.2) that changes device specified aspects of how the device accesses user data.

The contents of the Mutate Configurations log (see 9.30) specify the changes that a host is allowed to request. The current configuration of the device may affect the allowed changes as follows, devices that:

a) do not support ZAC-2 features may limit the allowed changes to specific changes that affect logical sector size (e.g., changes between eight 512 byte logical sectors and one 4 096 byte logical sector in a 4 096 byte physical block); and
b) support ZAC-2 features may limit the allowed changes to those that affect the number of logical sectors per zone.

The processing of a MUTATE EXT command may result in changes to the contents of the Mutate Configuration log (e.g., the Mutate Configuration descriptor processed by that command may be removed).

4.30 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 Write-Read-Verify feature set, the host may send a SET FEATURES Enable/Disable Write-Read-Verify feature set subcommand (see 7.45.8).

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

These commands are affected by the Write-Read-Verify feature set:

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 SECTOR(S) (see 7.64); and
f) WRITE SECTOR(S) EXT (see 7.65).

See 7.45.8 for a description of device behavior if this feature set is supported and enabled.

The WRV SUPPORTED bit (see 9.10.5.2.33) shall indicate whether this feature set is supported. The WRV ENABLED bit (see 9.10.6.2.19) indicates the supported and enabled or disabled state of this feature set.

If the device's volatile write cache is enabled, the device may return command completion without 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 command is processed by the device,

then the device shall only return 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 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 logical 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 6.2.6) to one.

5 ATA protocols

ATA Protocols are described in the transport standards (e.g., ATA8-APT and ATA8-AST). The protocols listed in this clause shall be implemented by all transports that use the commands defined in this standard. 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) DMA Queued Command Protocol; and
f) Execute Device Diagnostic 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 10.2) and error outputs (see 10.3) for each command include:

a) a one byte STATUS field (see 6.2);
b) a one byte ERROR field (see 6.3);
c) a COUNT field (see 6.4), SACTIVE field (see 6.5), and SATA STATUS field (see 6.6), if required, for certain commands (e.g., the READ FPDMA QUEUED command, Sanitize Device feature set commands, and WRITE FPDMA QUEUED command); and
d) an LBA field (see 6.7) that may contain the LBA of First Unrecoverable Error (see 6.7.2).

6.2 STATUS field

6.2.1 Overview

The STATUS field is one byte and is conveyed as an output from the device to the host (see applicable transport standard). Each bit, when valid, is defined in table 19. Details about individual normal outputs are defined in 10.2. Details about individual error outputs are defined in 10.3.

Table 19 — STATUS field

Name	Reference
BUSY bit	6.2.3
DEVICE READY bit	6.2.7
DEVICE FAULT bit	6.2.6
STREAM ERROR bit	6.2.10
DEFERRED WRITE ERROR bit	6.2.5
DATA REQUEST bit	6.2.4
ALIGNMENT ERROR bit	6.2.2
SENSE DATA AVAILABLE bit	6.2.9
ERROR bit	6.2.8

6.2.2 ALIGNMENT ERROR bit

The ALIGNMENT ERROR bit shall be set to one if:

a) the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP SUPPORTED bit (see 9.10.4.3.1) is set to one;
b) the LPS MISALIGNMENT REPORTING SUPPORTED bit (see 9.10.5.2.3) is set to one;
c) the ALIGNMENT ERROR REPORTING field (see 9.10.4.3.3) contains 01b or 10b; and
d) the device returns completion for a write command without an error where:
   A) the first byte of data does not begin at the first byte of a physical sector (see the LOGICAL SECTOR OFFSET field (see 9.10.4.3.5)); or
   B) the last byte of data does not end at the last byte of a physical sector (see the LOGICAL SECTOR OFFSET field).

Otherwise, the ALIGNMENT ERROR bit shall be cleared to zero.

If an alignment error and another error occur during the processing of a write command, the other error is returned and the alignment error is not reported in the STATUS field (i.e., the ALIGNMENT ERROR bit shall be cleared to zero). If an alignment error occurs, whether or not its reported in the STATUS field, and there is space remaining in the LPS Mis-alignment log (see 9.13), then an entry shall be made in the log.

6.2.3 BUSY bit

The BUSY bit is transport dependent (see 6.2.11). Refer to the applicable transport standard for the usage of the BUSY bit.

6.2.4 DATA REQUEST bit

The DATA REQUEST bit is transport dependent (see 6.2.11). Refer to the appropriate transport standard for the usage of the DATA REQUEST bit.

6.2.5 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 7.66) or WRITE STREAM EXT command (see 7.67). Otherwise, the DEFERRED WRITE ERROR bit shall be cleared to zero.

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 9.23).

6.2.6 DEVICE FAULT bit

If the device is in a condition where continued operation may affect the integrity of user data on the device (e.g., failure to spin-up without error, or no spares remaining for reallocation), then the device shall:

a) return command aborted with the DEVICE FAULT bit set to one in response to all commands (e.g., IDENTIFY DEVICE commands) except REQUEST SENSE DATA EXT commands;
b) complete a REQUEST SENSE DATA EXT command without error with an additional sense code of INTERNAL TARGET FAILURE (see 6.8.15), if:
   A) the SENSE DATA SUPPORTED bit (see 9.10.5.2.28) is set to one; and
   B) the REQUEST SENSE DEVICE FAULT SUPPORTED bit (see 9.10.5.2.38) is set to one;

   or
c) return command aborted with the DEVICE FAULT bit set to one in response to a REQUEST SENSE DATA EXT command, if:
   A) the SENSE DATA SUPPORTED bit (see 9.10.5.2.28) is cleared to zero; or
   B) the SENSE DATA SUPPORTED bit is set to one and the REQUEST SENSE DEVICE FAULT SUPPORTED bit (see 9.10.5.2.38) is cleared to zero.

Power cycling the device is the only mechanism that may clear the DEVICE FAULT bit to zero.

If the DEVICE FAULT bit has been cleared to zero, then it may remain clear until a command that affects user data integrity is received by the device.

6.2.7 DEVICE READY bit

The DEVICE READY bit is transport dependent (see 6.2.11). Refer to the applicable transport standard for the usage of the DEVICE READY bit.

6.2.8 ERROR bit

An ATA device shall set the ERROR bit to one if any bit in the ERROR field (see 6.3) is set to one. Otherwise, an ATA device shall clear the ERROR bit to zero.

6.2.9 SENSE DATA AVAILABLE bit

The SENSE DATA AVAILABLE bit shall be set to one if:

a) the SENSE DATA SUPPORTED bit (see 9.10.5.2.28) is set to one;
b) the SENSE DATA ENABLED bit (see 9.10.6.2.12) is set to one; and
c) the device has sense data to report (see 4.24) after processing any command.

Otherwise, the SENSE DATA AVAILABLE bit shall be cleared to zero.

The ERROR bit and the SENSE DATA AVAILABLE bit may both be set to one.

Bit 1 of the STATUS field is obsolete if:

a) the SENSE DATA SUPPORTED bit (see 9.10.5.2.28) is cleared to zero; or
b) the SENSE DATA ENABLED bit (see 9.10.6.2.12) is cleared to zero.

6.2.10 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 4.27) and the:

a) READ CONTINUOUS bit is set to one in a read stream command (see 7.28.3.3); or
b) WRITE CONTINUOUS bit is set to one in a write stream command (see 7.66.3.2).

Otherwise, the STREAM ERROR bit shall be cleared to zero.

If the STREAM ERROR bit is set to one, the value returned in the LBA field (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:

a) the READ CONTINUOUS bit is set to one in a read stream command or the WRITE CONTINUOUS bit is set to one in a write stream command; and
b) 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:
   A) Read Stream Error Log (see 9.15); or
   B) Write Stream Error log (see 9.23).

6.2.11 Transport Dependent bits and fields

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 and is conveyed as an output from the device to the host (see applicable transport standard). Each bit, when valid, is defined in table 20. Details about individual normal outputs are defined in 10.2. Details about individual error outputs are defined in 10.3.

Table 20 — ERROR field

Name	Reference
INTERFACE CRC bit	6.3.5
UNCORRECTABLE ERROR bit	6.3.6
ID NOT FOUND bit	6.3.4
ABORT bit	6.3.2
COMMAND COMPLETION TIME OUT bit	6.3.3

6.3.2 ABORT bit

The ABORT bit shall be set to one if the device aborts the command. The ABORT bit shall be cleared to zero if the device does not abort the command.

If the host requested an address outside of the range of user addressable addresses, then:

a) the ID NOT FOUND bit (see 6.3.4) shall be set to one and the ABORT bit shall be cleared to zero; or
b) the ID NOT FOUND bit shall be cleared to zero and the ABORT bit shall be set to one.

If a user addressable address was not found (see 6.3.4), the ABORT bit shall be cleared to zero.

If the INTERFACE CRC bit (see 6.3.5) is set to one, the ABORT bit shall be set to one.

6.3.3 COMMAND COMPLETION TIME OUT bit

The COMMAND COMPLETION TIME OUT bit shall be set to one if:

a) the STREAMING SUPPORTED bit (see 9.10.5.2.23) is set to one (i.e., the Streaming feature set (see 4.27) is supported); and
b) a command completion time out has occurred in response to a Streaming feature set command.

Otherwise, an ATA device shall clear the COMMAND COMPLETION TIME OUT bit to zero.

6.3.4 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 (see 6.3.2) is cleared to zero.

Otherwise, the ID NOT FOUND bit shall be cleared to zero.

If the ID NOT FOUND bit is set to one and the SENSE DATA ENABLED bit (see 9.10.6.2.12) is set to one, then the device shall return the additional sense code set to LOGICAL BLOCK ADDRESS OUT OF RANGE (see 6.8.19).

6.3.5 INTERFACE CRC bit

The INTERFACE CRC bit shall be set to one if an interface CRC error occurred during an Ultra DMA data transfer. The INTERFACE CRC bit shall be cleared to zero if an interface CRC error did not occur during an Ultra DMA data transfer.

The value of the INTERFACE CRC bit may be applicable to Multiword DMA transfers and PIO data transfers. If the INTERFACE CRC bit is set to one, the ABORT bit is set to one.

6.3.6 UNCORRECTABLE ERROR bit

The UNCORRECTABLE ERROR bit shall be set to one if the data contains an uncorrectable error. The UNCORRECTABLE ERROR bit shall be cleared to zero if the data does not contain an uncorrectable error.

6.4 COUNT field

6.4.1 Overview

The COUNT field is an output from the device to the host. The uses of the COUNT field depend on the command being processed (see clause 10). Commands may use the COUNT field to indicate the:

a) number of contiguous logical sectors that contain potentially bad data (see 6.4.2) for commands in the Streaming feature set; or
b) the tag of an NCQ command (see 6.4.3) for commands in the NCQ feature set.

6.4.2 Contiguous stream logical sectors that contain potentially bad data

For commands in the Streaming feature set (see 4.27), the COUNT field may be used to indicate the number of contiguous logical sectors that contain potentially bad data.

6.4.3 NCQ Tag

For commands in the NCQ feature set (see 4.15), the COUNT field may be used to indicate the tag of an NCQ command that caused an error as shown in table 21.

Table 21 — COUNT field use for NCQ Tag

Bit	Description
7:3	NCQ TAG field (see 7.17.3.3)
2:0	Reserved

6.5 SACTIVE field

See ATA8-AST for a description of the SACTIVE field.

6.6 SATA STATUS field

See ATA8-AST for a description of the SATA STATUS field (i.e., word 0 of the Set Device Bits FIS).

6.7 LBA field

6.7.1 Overview

The LBA field is an output from the device to the host. The uses of the LBA field depend on the command being processed (see clause 10). Commands may use the LBA field to indicate the LBA of the first unrecovered error (see 6.7.2).

6.7.2 LBA of First Unrecoverable Error

For commands that return LBA of the first unrecoverable error, if an unrecoverable error was encountered prior to or during the processing of that command, then the LBA field contains the LBA of the first unrecoverable error. This value does not provide any status information regarding any data transferred by the command that returned the error. The value may be outside the LBA range of the command that returned the error.

6.8 Sense code definitions

6.8.1 Overview

This subclause describes the recommended sense data specified in the Error outputs in clause 7. The methods for retrieving the sense data are described in the following subclauses:

a) Sense data reporting feature set (see 4.24);
b) Returning sense data for successful NCQ feature set commands (see 4.15.7);
c) NCQ Command Error log (see 9.14); and
d) NCQ Autosense (see 9.14.6).

The sense keys and additional sense code values are found in SPC-5.

Table 22 shows the additional sense codes described in this standard.

Table 22 — Sense Codes

Additional sense code	Reference
ACCESS DENIED - NO ACCESS RIGHTS	6.8.2
COMMAND SEQUENCE ERROR	6.8.3
COMMAND TIMEOUT BEFORE PROCESSING	6.8.4
COMMAND TIMEOUT DURING PROCESSING	6.8.5
DATA CURRENTLY UNAVAILABLE	6.8.6
DEPOPULATION FAILED	6.8.7
DEPOPULATION IN PROGRESS	6.8.8
DEPOPULATION RESTORATION FAILED	6.8.9
DEPOPULATION RESTORATION IN PROGRESS	6.8.10
FAILURE PREDICTION THRESHOLD EXCEEDED	6.8.11
INFORMATION UNIT iuCRC ERROR DETECTED	6.8.12
INITIATOR RESPONSE TIMEOUT	6.8.13
INSUFFICIENT RESOURCES	6.8.14
INTERNAL TARGET FAILURE	6.8.15
INVALID COMMAND OPERATION CODE	6.8.16
INVALID FIELD IN CDB	6.8.17
INVALID FIELD IN PARAMETER LIST	6.8.18
LOGICAL BLOCK ADDRESS OUT OF RANGE	6.8.19
LOGICAL UNIT FAILED SELF-TEST	6.8.20
LOGICAL UNIT NOT READY, FORMAT IN PROGRESS	6.8.21
LOGICAL UNIT NOT READY, INITIALIZING COMMAND REQUIRED	6.8.22
LOGICAL UNIT NOT READY, MICROCODE ACTIVATION REQUIRED	6.8.23
LOGICAL UNIT NOT READY, POWER CYCLE REQUIRED	6.8.24
LOGICAL UNIT NOT READY, SANITIZE IN PROGRESS	6.8.25
MEDIUM FORMAT CORRUPTED	6.8.26
MULTIPLE READ ERRORS	6.8.27
MULTIPLE WRITE ERRORS	6.8.28
NO ADDITIONAL SENSE INFORMATION	6.8.29
NO DEFECT SPARE LOCATION AVAILABLE	6.8.30
OVERLAPPED COMMANDS ATTEMPTED	6.8.31
READ ERROR - LBA MARKED BAD BY APPLICATION CLIENT	6.8.32
UNRECOVERED READ ERROR	6.8.33
WARNING – DEVICE STATISTICS NOTIFICATION ACTIVE	6.8.34
WRITE ERROR	6.8.35

6.8.2 ACCESS DENIED - NO ACCESS RIGHTS

If the device returns the additional sense code set to ACCESS DENIED - NO ACCESS RIGHTS, then the device should return the sense key set to DATA PROTECT.

6.8.3 COMMAND SEQUENCE ERROR

The device should return the sense key set to ILLEGAL REQUEST with the additional sense code set to COMMAND SEQUENCE ERROR, if the device accepts a command which is out of sequence with respect to other required commands or events (e.g., the device accepts a subsequent SET ACCESSIBLE MAX ADDRESS EXT command without processing a power-on reset).

6.8.4 COMMAND TIMEOUT BEFORE PROCESSING

If the device returns the additional sense code set to COMMAND TIMEOUT BEFORE PROCESSING, then the device shall return the sense key set to ABORTED COMMAND.

6.8.5 COMMAND TIMEOUT DURING PROCESSING

If the device returns the additional sense code set to COMMAND TIMEOUT DURING PROCESSING, then the device shall return the sense key set to ABORTED COMMAND.

6.8.6 DATA CURRENTLY UNAVAILABLE

If the device returns the additional sense code set to DATA CURRENTLY UNAVAILABLE, then the device shall return the sense key set to COMPLETED.

6.8.7 DEPOPULATION FAILED

If the device returns the additional sense code set to DEPOPULATION FAILED, then the device should return the sense key set to MEDIUM ERROR.

6.8.8 DEPOPULATION IN PROGRESS

If the device returns the additional sense code set to DEPOPULATION IN PROGRESS, then the device should return the sense key set to NOT READY.

6.8.9 DEPOPULATION RESTORATION FAILED

If the device returns the additional sense code set to DEPOPULATION RESTORATION FAILED, then the device should return the sense key set to MEDIUM ERROR.

6.8.10 DEPOPULATION RESTORATION IN PROGRESS

If the device returns the additional sense code set to DEPOPULATION RESTORATION IN PROGRESS, then the device should return the sense key set to NOT READY.

6.8.11 FAILURE PREDICTION THRESHOLD EXCEEDED

The device should return the sense key set to UNIT ATTENTION with the additional sense code set to FAILURE PREDICTION THRESHOLD EXCEEDED, if the device encounters a threshold exceeded condition. In response to this UNIT ATTENTION, the host may issue an SCT Status command (see 8.2.5) to return the current smart status.

6.8.12 INFORMATION UNIT iuCRC ERROR DETECTED

The device should return the sense key set to ILLEGAL REQUEST with the additional sense code set to INFORMATION UNIT iuCRC ERROR DETECTED, if the device receives an invalid information unit. The device sets the INTERFACE CRC bit in the ERROR field to one as described in 6.3.5 as part of reporting command completion for that write command.

6.8.13 INITIATOR RESPONSE TIMEOUT

The device should return the sense key set to ABORTED COMMAND with the additional sense code set to INITIATOR RESPONSE TIMEOUT, if the device times out on receiving a response from the host (e.g., the device processes a write command and the host takes too long to provide the write data).

6.8.14 INSUFFICIENT RESOURCES

The device should return the sense key set to ABORTED COMMAND with the additional sense code set to INSUFFICIENT RESOURCES, if the device is unable to report command completion without error due to internal resource issues.

6.8.15 INTERNAL TARGET FAILURE

The device should return the sense key set to HARDWARE ERROR with the additional sense code set to INTERNAL TARGET FAILURE, if a fatal hardware error occurs.

6.8.16 INVALID COMMAND OPERATION CODE

The device should return the sense key set to ILLEGAL REQUEST with the additional sense code set to INVALID COMMAND OPERATION CODE, if the device receives an invalid value in the COMMAND field (see 7.1.9).

6.8.17 INVALID FIELD IN CDB

The device should return the sense key set to ILLEGAL REQUEST with the additional sense code set to INVALID FIELD IN CDB, if the device receives a command with an invalid value in a field in the inputs other than the COMMAND field.

6.8.18 INVALID FIELD IN PARAMETER LIST

The device should return the sense key set to ILLEGAL REQUEST with the additional sense code set to INVALID FIELD IN PARAMETER LIST, if the device receives a command that has an Output from the Host to the Device Data Structure with an invalid value in any field within the data structure.

6.8.19 LOGICAL BLOCK ADDRESS OUT OF RANGE

The device should return the sense key set to ILLEGAL REQUEST with the additional sense code set to LOGICAL BLOCK ADDRESS OUT OF RANGE, if the device receives an invalid logical block address.

6.8.20 LOGICAL UNIT FAILED SELF-TEST

The device should return the sense key set to HARDWARE ERROR with the additional sense code set to LOGICAL UNIT FAILED SELF-TEST, if the device is unable to process commands (e.g., device sets the DEVICE FAULT bit to one when power is applied) except the REQUEST SENSE EXT command.

6.8.21 LOGICAL UNIT NOT READY, FORMAT IN PROGRESS

The device should return the sense key set to NOT READY with the additional sense code set to LOGICAL UNIT NOT READY, FORMAT IN PROGRESS.

6.8.22 LOGICAL UNIT NOT READY, INITIALIZING COMMAND REQUIRED

The device should return the sense key set to NOT READY with the additional sense code set to LOGICAL UNIT NOT READY, INITIALIZING COMMAND REQUIRED, if an initializing command is required (e.g., a SET FEATURES command with the PUIS feature set device spin-up subcommand (see 7.45.7) is required to exit the PM6: PUIS and spin-up subcommand supported state (see 4.15.4)).

6.8.23 LOGICAL UNIT NOT READY, MICROCODE ACTIVATION REQUIRED

The device should return the sense key set to NOT READY with the additional sense code set to LOGICAL UNIT NOT READY, MICROCODE ACTIVATION REQUIRED, if the FW ACTIVATION PENDING bit (see 9.10.6.2.5) is set to one.

6.8.24 LOGICAL UNIT NOT READY, POWER CYCLE REQUIRED

The device should return the sense key set to NOT READY with the additional sense code set to LOGICAL UNIT NOT READY, POWER CYCLE REQUIRED.

6.8.25 LOGICAL UNIT NOT READY, SANITIZE IN PROGRESS

The device should return the sense key set to NOT READY with the additional sense code set to LOGICAL UNIT NOT READY, SANITIZE IN PROGRESS, if the device is unable to report command completion without error due to a sanitize operation in progress.

6.8.26 MEDIUM FORMAT CORRUPTED

The device should return the sense key set to MEDIUM ERROR with the additional sense code set to MEDIUM FORMAT CORRUPTED.

6.8.27 MULTIPLE READ ERRORS

The device should return the sense key set to ABORTED COMMAND with the additional sense code set to MULTIPLE READ ERRORS, if the device encounters a predicted unrecovered read error (see 4.19.3.3).

6.8.28 MULTIPLE WRITE ERRORS

The device should return the sense key set to ABORTED COMMAND with the additional sense code set to MULTIPLE WRITE ERRORS, if the device encounters a predicted unrecovered read error (see 4.19.3.5).

6.8.29 NO ADDITIONAL SENSE INFORMATION

The device should return the sense key set to NO SENSE with the additional sense code set to NO ADDITIONAL SENSE INFORMATION, if the device has no additional sense information to report.

6.8.30 NO DEFECT SPARE LOCATION AVAILABLE

The device should return the sense key set to HARDWARE ERROR with the additional sense code set to NO DEFECT SPARE LOCATION AVAILABLE, if the device receives a write command that causes a relocation operation and the device is unable to relocate the data. The device sets the DEVICE FAULT bit in the STATUS field to one as described in (see 6.2.6) as part of reporting command completion for that write command.

6.8.31 OVERLAPPED COMMANDS ATTEMPTED

The device should return the sense key set to ABORTED COMMAND with the additional sense code set to OVERLAPPED COMMANDS ATTEMPTED, if the device receives an NCQ command with a value in the NCQ TAG field (see 7.17.3.3) that is the same as the value in the NCQ TAG field of an outstanding NCQ command.

6.8.32 READ ERROR - LBA MARKED BAD BY APPLICATION CLIENT

The device should return the sense key set to MEDIUM ERROR with the additional sense code set to READ ERROR - LBA MARKED BAD BY APPLICATION CLIENT, if a read command requests an LBA that has a flagged uncorrectable media error (see 7.68.2.3).

6.8.33 UNRECOVERED READ ERROR

The device should return the sense key set to MEDIUM ERROR with the additional sense code set to UNRECOVERED READ ERROR, if the device has an uncorrected error (see 6.3.6) in a read command.

6.8.34 WARNING – DEVICE STATISTICS NOTIFICATION ACTIVE

The device should return the sense key set to UNIT ATTENTION with the additional sense code set to WARNING – DEVICE STATISTICS NOTIFICATION ACTIVE, if the device encounters a DSN notification available (see 4.8.2).

6.8.35 WRITE ERROR

The device should return the sense key set to MEDIUM ERROR with the additional sense code set to WRITE ERROR, if a write command completes with unrecovered write error.

7 Command descriptions

7.1 Command description introduction

7.1.1 Overview

ATA commands are delivered using the following fields (see table 23):

a) FEATURE;
b) COUNT;
c) LBA;
d) DEVICE; and
e) COMMAND.

ATA commands may use the ICC field and the AUXILIARY field (see table 23).

Field lengths are different 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.

EXAMPLE - A 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 each eight 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 are each eight bits in length;
b) the FEATURE field and COUNT field are 16 bits in length; and
c) the LBA field is 48 bits in length.

EXAMPLE - A feature set subclause reads:

Feature Set

This 28-bit command is for all ATA devices.

7.1.4 Inputs

The Inputs subclause describes possible inputs for a command (e.g., as shown in table 23).

Table 23 — Example Command Structure

Field	Description
FEATURE	Each transport standard defines how the FEATURE field is mapped for proper functionality. Each transport standard also defines how 28-bit commands are mapped differently than 48-bit commands.
COUNT	Each transport standard defines how the COUNT field is mapped for proper functionality. Each transport standard also defines how 28-bit commands are mapped differently than 48-bit commands.
LBA	For many commands, the LBA field contains the LBA of the first logical sector to be transferred. Each transport standard defines how the LBA field is mapped to the appropriate fields or registers.
ICC [a]	Each transport standard defines how the ICC field, if present, is mapped to the appropriate fields or registers. The ICC field is not present in all commands.
AUXILIARY [a]	Each transport standard defines how the AUXILIARY field, if present, is mapped to the appropriate fields or registers. The AUXILIARY field is not present in all commands.
DEVICE	Each transport standard defines 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 field contains the command code.

[a] Commands that depend on the transport of this field are defined by this standard in a way that prevents the operation codes from being valid on devices that implement a transport standard that does not define a mapping for this field.

7.1.5 Normal Outputs

The Normal Outputs subclause describes normal outputs (e.g., as shown in table 24). A command with Normal Outputs does not return command completion with an error. Therefore, the ERROR field in the Normal Outputs is reserved in every command. The COUNT field and LBA field may be reserved. However, in some commands the COUNT field and LBA field may have return parameters in Normal Outputs. The STATUS field shows the DEVICE FAULT bit, the ALIGNMENT ERROR bit, the SENSE DATA AVAILABLE bit, and the ERROR bit. Bit 7, bit 6, and bit 3 of the STATUS field are marked Transport Dependent in many of the Normal Outputs.

Table 24 — Example Normal Output

Field	Description
ERROR	Reserved
COUNT	Reserved
LBA	Reserved
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit** **Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A or ALIGNMENT ERROR bit – See 6.2.2 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

7.1.6 Error Outputs

The Error Outputs subclause shows the ERROR field, COUNT field, LBA field, and STATUS field (e.g., as shown in table 25). An Error Output occurs when any 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 25 — Example Error Output

Field	Description
ERROR	**Bit Description** 7 INTERFACE CRC bit – See 6.3.5 6 UNCORRECTABLE ERROR bit – See 6.3.6 5 Obsolete 4 ID NOT FOUND bit – See 6.3.4 3 Obsolete 2 ABORT bit – See 6.3.2 1 Obsolete 0 Obsolete
COUNT	Reserved
LBA	LBA of First Unrecoverable Error – See 6.7.2
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2:1 N/A 0 ERROR bit – See 6.2.8

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 defined in the associated 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 using the Error Outputs shown in table 359.

7.1.10 Commands summary

The commands defined by this standard are listed in table 26.

Table 26 — Summary of commands (Sheet 1 of 3)

Command	Reference
ABORT NCQ QUEUE	7.17.11
BLOCK ERASE EXT	7.36.2
CHECK POWER MODE	7.3
CONFIGURE STREAM	7.4
CRYPTO SCRAMBLE EXT	7.36.3
DATA SET MANAGEMENT	7.5
DATA SET MANAGEMENT XL	7.6
DEADLINE HANDLING	7.17.12
DOWNLOAD MICROCODE	7.7
DOWNLOAD MICROCODE DMA	7.8
EXECUTE DEVICE DIAGNOSTIC	7.9
FLUSH CACHE	7.10
FLUSH CACHE EXT	7.11
FREEZE ACCESSIBLE MAX ADDRESS EXT	7.2.4
GET NATIVE MAX ADDRESS EXT	7.2.2
GET PHYSICAL ELEMENT STATUS	7.12
HYBRID CHANGE BY LBA RANGE	7.17.9
HYBRID CONTROL	7.17.10
HYBRID DEMOTE BY SIZE	7.17.8
HYBRID EVICT	7.43.8
IDENTIFY DEVICE	7.13
IDLE	7.14
IDLE IMMEDIATE	7.15
MUTATE EXT	7.16
NCQ NON-DATA	7.17
NOP	7.18
OVERWRITE EXT	7.36.4
READ BUFFER	7.19
READ BUFFER DMA	7.20
READ DMA	7.21

Table 26 — Summary of commands (Sheet 2 of 3)

Command	Reference
READ DMA EXT	7.22
READ FPDMA QUEUED	7.23
READ LOG DMA EXT	7.25
READ LOG EXT	7.24
READ SECTOR(S)	7.26
READ SECTOR(S) EXT	7.27
READ STREAM DMA EXT	7.28
READ STREAM EXT	7.29
READ VERIFY SECTOR(S)	7.30
READ VERIFY SECTOR(S) EXT	7.31
RECEIVE FPDMA QUEUED	7.32
REMOVE ELEMENT AND TRUNCATE	7.33
REQUEST SENSE DATA EXT	7.34
RESTORE ELEMENTS AND REBUILD	7.35
SANITIZE ANTIFREEZE LOCK EXT	7.36.5
SANITIZE FREEZE LOCK EXT	7.36.6
SANITIZE STATUS EXT	7.36.7
SECURITY DISABLE PASSWORD	7.37
SECURITY ERASE PREPARE	7.38
SECURITY ERASE UNIT	7.39
SECURITY FREEZE LOCK	7.40
SECURITY SET PASSWORD	7.41
SECURITY UNLOCK	7.42
SEND FPDMA QUEUED	7.43
SET ACCESSIBLE MAX ADDRESS EXT	7.2.3
SET DATE & TIME EXT	7.44
SET FEATURES	7.45
SET SECTOR CONFIGURATON EXT	7.46
SLEEP	7.47
SMART READ LOG	7.48.2
SMART RETURN STATUS	7.48.3
SMART WRITE LOG	7.48.4
STANDBY	7.49

Table 26 — Summary of commands (Sheet 3 of 3)

Command	Reference
STANDBY IMMEDIATE	7.50
TRUSTED NON-DATA	7.51
TRUSTED RECEIVE	7.52
TRUSTED RECEIVE DMA	7.53
TRUSTED SEND	7.54
TRUSTED SEND DMA	7.55
WRITE BUFFER	7.56
WRITE BUFFER DMA	7.57
WRITE DMA	7.58
WRITE DMA EXT	7.59
WRITE DMA FUA EXT	7.60
WRITE FPDMA QUEUED	7.61
WRITE LOG DMA EXT	7.63
WRITE LOG EXT	7.62
WRITE SECTOR(S)	7.64
WRITE SECTOR(S) EXT	7.65
WRITE STREAM DMA EXT	7.66
WRITE STREAM EXT	7.67
WRITE UNCORRECTABLE EXT	7.68
ZERO EXT	7.69

7.2 Accessible Max Address Configuration

7.2.1 Accessible Max Address Configuration overview

Individual Accessible Max Address Configuration commands are identified by the value placed in the FEATURE field. Table 27 defines these FEATURE field values.

Table 27 — Accessible Max Address Configuration FEATURE field values

Value	Command
0000h	GET NATIVE MAX ADDRESS EXT (see 7.2.2)
0001h	SET ACCESSIBLE MAX ADDRESS EXT (see 7.2.3)
0002h	FREEZE ACCESSIBLE MAX ADDRESS EXT (see 7.2.4)
0003h..FFFFh	Reserved

7.2.2 GET NATIVE MAX ADDRESS EXT – 78h/0000h, Non-Data

7.2.2.1 Feature Set

This 48-bit command is for devices that support the Accessible Max Address Configuration feature set (see 4.4).

7.2.2.2 Description

The GET NATIVE MAX ADDRESS EXT command returns the maximum LBA that is available to be accessible for the physical device.

7.2.2.3 Inputs

See table 28 for the GET NATIVE MAX ADDRESS EXT command inputs.

Table 28 — GET NATIVE MAX ADDRESS EXT command inputs

Field	Description
FEATURE	0000h
COUNT	Reserved
LBA	Reserved
DEVICE	**Bit Description** 7 Obsolete 6 N/A 7:5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 78h

7.2.2.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 356.

7.2.2.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 361.

7.2.3 SET ACCESSIBLE MAX ADDRESS EXT – 78h/0001h, Non-Data

7.2.3.1 Feature Set

This 48-bit command is for devices that support the Accessible Max Address Configuration feature set (see 4.4).

7.2.3.2 Description

The SET ACCESSIBLE MAX ADDRESS EXT command sets the accessible max address to the value contained in the LBA field.

The capacity values reported by the IDENTIFY DEVICE command and the IDENTIFY DEVICE data log are described in table 5.

If a SET ACCESSIBLE MAX ADDRESS EXT command has completed without error, a subsequent SET ACCESSIBLE MAX EXT command that is received before a power-on reset is processed shall return command aborted.

After a SET ACCESSIBLE MAX ADDRESS EXT command using a new maximum LBA returns command completion without error, the content of all IDENTIFY DEVICE data words shall comply with subclause 4.1.2.

The contents of IDENTIFY DEVICE data (see 7.13.6) and the maximum LBA shall not be changed if a SET ACCESSIBLE MAX ADDRESS EXT command returns command aborted.

See 7.68.2.1 for a description of the interactions between the SET ACCESSIBLE MAX ADDRESS EXT command and the WRITE UNCORRECTABLE EXT command.

7.2.3.3 Inputs

See table 29 for the SET ACCESSIBLE MAX ADDRESS EXT command inputs.

Table 29 — SET ACCESSIBLE MAX ADDRESS EXT command inputs

Field	Description
FEATURE	0001h
COUNT	Reserved
LBA	Requested maximum LBA value
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 7:5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 78h

7.2.3.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 352.

7.2.3.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

If the value in the LBA field is greater than the native max address, the device shall return an ID Not Found error.

The device shall return command aborted, if the most recent power-on reset:

a) a SET ACCESSIBLE MAX ADDRESS EXT command has returned command completion without error; or
b) a FREEZE ACCESSIBLE MAX ADDRESS EXT command (see 7.2.4) has returned command completion without error.

See table 379.

7.2.4 FREEZE ACCESSIBLE MAX ADDRESS EXT – 78h/0002h, Non-Data

7.2.4.1 Feature Set

This 48-bit command is for devices that support the Accessible Max Address Configuration feature set (see 4.4).

7.2.4.2 Description

If the device returns command completion for a FREEZE ACCESSIBLE MAX ADDRESS EXT command without an error, then the device shall return command aborted for any subsequent SET ACCESSIBLE MAX ADDRESS EXT commands (see 7.2.3) until a power-on reset has been processed by the device. A device shall not exit this mode of operation as the result of processing a hardware reset or a software reset.

7.2.4.3 Inputs

See table 30 for the FREEZE ACCESSIBLE MAX ADDRESS EXT command inputs.

Table 30 — FREEZE ACCESSIBLE MAX ADDRESS EXT command inputs

Field	Description
FEATURE	0002h
COUNT	Reserved
LBA	Reserved
DEVICE	**Bit Description** 7 Obsolete 6 N/A 7:5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 78h

7.2.4.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 352.

7.2.4.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 361.

7.3 CHECK POWER MODE – E5h, Non-Data

7.3.1 Feature Set

This 28-bit command is for devices that support the Power Management feature set (see 4.17).

7.3.2 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 the power management state or affect the operation of the Standby timer.

NOTE 3 — The device may be in transition to the reported state.

7.3.3 Inputs

See table 31 for the CHECK POWER MODE command inputs.

Table 31 — CHECK POWER MODE command inputs.

Field	Description
FEATURE	N/A
COUNT	N/A
LBA	N/A
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 E5h

7.3.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 347.

7.3.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 360.

7.4 CONFIGURE STREAM – 51h, Non-Data

7.4.1 Feature Set

This 48-bit command is for devices that support the Streaming feature set (see 4.27).

7.4.2 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.

7.4.3 Inputs

7.4.3.1 Overview

See table 32 for the CONFIGURE STREAM command inputs.

Table 32 — CONFIGURE STREAM command inputs

Field	Description
FEATURE	**Bit Description** 15:8 DEFAULT CCTL field – See 7.4.3.4 7 ADD/REMOVE STREAM bit – See 7.4.3.2 6 Obsolete 5:3 Reserved 2:0 STREAM ID field – See 7.4.3.3
COUNT	Allocation Unit – See 7.4.3.5
LBA	Reserved
DEVICE	**Bit Description** 7:5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 51h

7.4.3.2 ADD/REMOVE STREAM bit

If the ADD/REMOVE STREAM bit is set to one (i.e., the host is adding a stream), then the device shall set the operating parameters for the stream specified by the STREAM ID field. If the stream specified by the STREAM ID field was configured by a previous CONFIGURE STREAM command, and the current CONFIGURE STREAM command returns command completion without error, then the operating parameters specified by the current CONFIGURE STREAM command shall have replaced the operating parameters specified by the previous CONFIGURE STREAM command for the stream.

If the ADD/REMOVE STREAM bit is cleared to zero (i.e., the host is removing a stream), then the device shall clear the operating characteristics for the stream specified by the STREAM ID field in this command.

7.4.3.3 STREAM ID field

The STREAM ID field specifies the stream to which the operating parameters apply.

7.4.3.4 DEFAULT CCTL field

The DEFAULT CCTL field indicates the time in which the device shall return command completion for a read stream command or a write stream command for this stream with the COMMAND CCTL field cleared to zero (see 7.28.3.2) according to the following formula:

maximum command completion time = ((DEFAULT CCTL field) × (STREAM GRANULARITY field (see 9.10.6.8)) microseconds

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

If the ADD/REMOVE STREAM bit is cleared to zero (see 7.4.3.2), the DEFAULT CCTL field is reserved.

7.4.3.5 ALLOCATION UNIT field

The ALLOCATION UNIT field 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 4 — Setting the ALLOCATION UNIT field does not restrict or change command behavior.

7.4.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 348.

7.4.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

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) the ADD/REMOVE STREAM bit is cleared to zero and the STREAM ID field specifies the stream that has not been configured by a previous CONFIGURE STREAM command; or
c) the device does not support the value requested in the DEFAULT CCTL field.

If the ABORT bit is set to one, then the previous parameters configured for all streams shall remain in effect. See table 364 for the definition of Error Outputs.

7.5 DATA SET MANAGEMENT – 06h, DMA

7.5.1 Feature Set

This 48-bit command is for ATA devices (see 4.2).

7.5.2 Description

The DATA SET MANAGEMENT command provides information (e.g., file system information) that the device may or may not use to optimize device operation (e.g., the device may ignore the information if that information is received faster than the device is able to process). The results from successful processing of a DATA SET MANAGEMENT command may not be detectable by the host.

The device processes the DATA SET MANAGEMENT command in the NCQ feature set environment (see 4.15.6) if the DATA SET MANAGEMENT command is encapsulated in a SEND FPDMA QUEUED command (see 7.43) with the inputs encapsulated as shown in 7.5.7.

7.5.3 Inputs

7.5.3.1 Overview

See table 33 for the DATA SET MANAGEMENT command inputs.

Table 33 — DATA SET MANAGEMENT command inputs

Field	Description
FEATURE	**Bit Description** 15:8 DSM FUNCTION field – See 7.5.3.2 7:1 Reserved 0 TRIM bit – See 7.5.3.3
COUNT	Number of 512-byte blocks to be transferred (see 7.5.6). The value zero is reserved.
LBA	If the TRIM bit is set to one, reserved If the TRIM bit is cleared to zero, defined by the DSM FUNCTION field (see 7.5.3.2)
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 06h

7.5.3.2 DSM FUNCTION field

If the TRIM bit is set to one, the DSM FUNCTION field is reserved.

If the TRIM bit is cleared to zero, the DSM FUNCTION field (see table 34) specifies the data set management function to be performed.

Table 34 — DSM FUNCTION field

Code	Description
00h	Reserved
01h	Markup LBA Ranges function (see 7.5.3.4)
02h..FFh	Reserved

7.5.3.3 TRIM bit

A trim command requests that the specified LBAs (see 7.5.6) become trimmed logical sectors. A trim command results in some, none, or all of the LBAs specified by that command becoming trimmed logical sectors, see Annex D.

EXAMPLE 1 - Examples of properties associated with trimmed logical sectors are:

a) no storage resources; and
b) read commands return:
   A) a nondeterministic value that is independent of the previously written value;
   B) a deterministic value that is independent of the previously written value; or
   C) zero.

EXAMPLE 2 - Examples of ways that logical sectors may become trimmed are as follows:

a) as established at time of manufacture;
b) the DATA SET MANAGEMENT command (see 7.5);
c) the ZERO EXT command (see 7.69); and
d) sanitize operation commands (see 4.20.4).

Table 35 shows the data that is returned for trimmed logical sectors based on the values of the TRIM SUPPORTED bit (see 9.10.5.9.2), the DRAT SUPPORTED bit (see 9.10.5.2.2), and the RZAT SUPPORTED bit (see 9.10.5.2.8).

Table 35 — Data returned for trimmed logical sectors

Bit			Data returned for a trimmed logical sector specified by a read command
TRIM SUPPORTED	DRAT SUPPORTED	RZAT SUPPORTED	
0	see 9.10.5.9.2	see 9.10.5.9.2	N/A
1	0	see 9.10.5.2.8	Different data may be returned for each read command.
	1	0	The same data returned by the first read of that logical sector processed after that logical sector became a trimmed logical sector.
	1	1	The returned data is zeros.

The data read from a trimmed logical sector shall not be retrieved from data that was previously received from a host addressed to any other LBA.

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

If a write to a trimmed logical sector returns command completion with an error, that logical sector may or may not be a trimmed logical sector.

See 7.68.2.1 for a description of the interactions between the DATA SET MANAGEMENT command with the TRIM bit set to one and the WRITE UNCORRECTABLE EXT command.

7.5.3.4 Markup LBA Ranges data set management function

If the DSM FUNCTION field is set to 01h (i.e., Markup LBA Ranges), then:

a) the LBA field (47:32) is reserved; and
b) processing of the Logical Block Markup Descriptor specified by the LBA field (31:0) is defined by the LOGICAL BLOCK MARKUPS SUPPORTED field (see 9.10.5.9.1).

7.5.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 352.

7.5.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

If the TRIM bit is set to one and:

a) the device detects an invalid LBA Range Entry (see 7.5.6); or
b) count is greater than the MAX PAGES PER DSM COMMAND field (see 9.10.5.9.3),

then the device shall return command aborted.

One or more specified logical sectors may become trimmed logical sectors before the device returns command aborted.

See table 372.

If the DATA SET MANAGEMENT command or DATA SET MANAGEMENT XL command is NCQ encapsulated (see 7.6.7), then:

a) the device sets the ERROR bit to one and aborts the command in response to an LBA out of range, a duplicate tag number, an invalid tag number, or an Interface CRC error (see table 382); and
b) errors that occur during the processing of this command are reported by returning a transport dependent indicator (see table 383) with additional information available in the NCQ Command Error log (see 9.14).

7.5.6 Output from the Host to the Device Data Structure

7.5.6.1 Overview

DATA SET MANAGEMENT Request Data is a list of one or more LBA Range Entry pages (see table 36). If the TRIM bit is set to one (see 7.5.3.3), individual LBA Range Entries may overlap and are not required to be sorted. Table 36 is the format for each change sent.

Table 36 — LBA Range Entry page format

Offset	Type	Description
0..7	QWord	Entry 0 63:48 RANGE LENGTH field (see 7.5.6.2) 47:0 LBA VALUE field (see 7.5.6.3)
8..15	QWord	Entry 1 63:48 RANGE LENGTH field 47:0 LBA VALUE field
…		…
504..511	QWord	Entry 63 63:48 RANGE LENGTH field 47:0 LBA VALUE field

7.5.6.2 RANGE LENGTH field

The RANGE LENGTH field specifies the number of logical sectors in the LBA range. If the RANGE LENGTH field is set to 0000h, the LBA Range Entry shall be ignored.

7.5.6.3 LBA VALUE field

The LBA VALUE field specifies the starting LBA of the LBA range. If the LBA value plus the range length is greater than the accessible capacity (see 9.10.4.2), the device shall return command aborted.

7.5.6.4 Examples

Examples of how to combine LBA values and range lengths to form a LBA Range Entry follow.

EXAMPLE 1 - If logical blocks 11 through 18 are represented in an LBA Range Entry, then the LBA VALUE field is set to 11 and the RANGE LENGTH field is set to 8 ((i.e., the LBA Range Entry is 0008_0000_0000_000Bh).

EXAMPLE 2 - If only logical block 20 is represented in an LBA Range Entry, then the LBA VALUE field is set to 20 and the RANGE LENGTH field is set to 1 (i.e., the LBA Range Entry is 0001_0000_0000_0014h).

7.5.7 NCQ encapsulation

If a DATA SET MANAGEMENT command is processed in an NCQ environment as subcommand 00h of a SEND FPDMA QUEUED command (see 7.43), the ATA command inputs are encapsulated as:

a) defined by the SEND FPDMA QUEUED command for some inputs (e.g., the COUNT field); and
b) shown in table 37 for subcommand specific inputs.

Table 37 — SEND FPDMA QUEUED command encapsulation for the subcommand specific inputs from a DATA SET MANAGEMENT command

SEND FPDMA QUEUED field (see table 117)	DATA SET MANAGMENT field (see table 33), if any
LBA	LBA
AUXILIARY (15:0)	FEATURE
AUXILIARY (31:16)	Reserved

7.6 DATA SET MANAGEMENT XL – 07h, DMA

7.6.1 Feature Set

This 48-bit command is for ATA devices (see 4.2).

7.6.2 Description

The DATA SET MANAGEMENT XL command provides the same functions as the DATA SET MANAGEMENT command (see 7.5) using an Output from the Host to the Device Data Structure with larger XL LBA Range Entries (see 7.6.6).

The device processes the DATA SET MANAGEMENT XL command in the NCQ feature set environment (see 4.15.6) if the DATA SET MANAGEMENT XL command is encapsulated in a SEND FPDMA QUEUED command (see 7.43) with the inputs encapsulated as shown in 7.6.7.

7.6.3 Inputs

See table 38 for the DATA SET MANAGEMENT XL command inputs.

Table 38 — DATA SET MANAGEMENT XL command inputs

Field	Description
FEATURE	**Bit Description** 15:8 DSM FUNCTION field – See 7.5.3.2 7:1 Reserved 0 TRIM bit – See 7.5.3.3
COUNT	Number of 512-byte blocks to be transferred (see 7.6.6). The value zero is reserved.
LBA	If the TRIM bit is set to one, reserved If the TRIM bit is cleared to zero, defined by the DSM FUNCTION field (see 7.5.3.2)
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 07h

7.6.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See 7.5.4.

7.6.5 Error Outputs

See 7.5.5.

7.6.6 Output from the Host to the Device Data Structure

DATA SET MANAGEMENT XL Request Data is a list of one or more XL LBA Range Entry pages (see table 39). If the TRIM bit is set to one (see 7.5.3.3), individual XL LBA Range Entries may specify LBA ranges that overlap and are not required to be sorted. Table 39 is the format for each change sent.

Table 39 — XL LBA Range Entry page format

Offset	Type	Description
0..15	DQWord	Entry 0 127:64 RANGE LENGTH field (see 7.5.6.2) 63:48 Reserved 47:0 LBA VALUE field (see 7.5.6.3)
16..31	DQWord	Entry 1 127:64 RANGE LENGTH field 63:48 Reserved 47:0 LBA VALUE field
…		…
496..511	DQWord	Entry 31 127:64 RANGE LENGTH field 63:48 Reserved 47:0 LBA VALUE field

7.6.7 NCQ encapsulation

If a DATA SET MANAGEMENT XL command is processed in an NCQ environment as subcommand 04h of a SEND FPDMA QUEUED command (see 7.43), the ATA command inputs are encapsulated as:

a) defined by the SEND FPDMA QUEUED command for some inputs (e.g., the COUNT field); and
b) shown in table 40 for subcommand specific inputs.

Table 40 — SEND FPDMA QUEUED command encapsulation for the subcommand specific inputs from a DATA SET MANAGEMENT XL command

SEND FPDMA QUEUED field (see table 117)	DATA SET MANAGMENT XL field (see table 38), if any
LBA	LBA
AUXILIARY (15:0)	FEATURE
AUXILIARY (31:16)	Reserved

7.7 DOWNLOAD MICROCODE – 92h, PIO Data-Out/Non-Data

7.7.1 Feature Set

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

7.7.2 Description

7.7.2.1 Overview

The DOWNLOAD MICROCODE command and the DOWNLOAD MICROCODE DMA command allow 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.

The following terms describe microcode data conditions:

a) active microcode: the microcode that the device is currently running;
b) updated microcode: the microcode that the device is in the process of receiving from the host;
c) saved microcode: updated microcode that has been completely downloaded, validated, and saved to non-volatile storage; and
d) deferred microcode: saved microcode 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, then 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 field specifies the number of 512-byte data blocks that shall be transferred. The BLOCK COUNT field is specified in the COUNT field and the LBA field (see table 42).

Activation may change device feature configuration (e.g., 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.

If the Security feature set (see 4.22) is supported, then:

a) activation as a result of any DOWNLOAD MICROCODE command or DOWNLOAD MICROCODE DMA command shall not change the Security feature set Frozen Mode; and
b) activation as a result of a power-on reset shall set the Security feature set Frozen Mode to not frozen (see 4.22.5).

After successful activation, any deferred microcode shall be discarded.

Table 41 lists the SUBCOMMAND field definitions.

The state machine (see 7.7.2.6) for the DOWNLOAD MICROCODE command or DOWNLOAD MICROCODE DMA command describes additional requirements.

Table 41 — SUBCOMMAND field

Code	Subcommand Name	Phases Included		
		Download	Save	Activate
01h	Obsolete			
02h	Reserved			
03h	Download with offsets and save microcode for immediate and future use (see 7.7.2.2)	one or more segments	Yes	Yes [a]
04h..06h	Reserved			
07h	Download and save microcode for immediate and future use (see 7.7.2.3)	one segment only	Yes	Yes
08h..0Dh	Reserved			
0Eh	Download with offsets and save microcode for future use (see 7.7.2.4)	one or more segments	Yes	No [b]
0Fh	Activate downloaded microcode (see 7.7.2.5)	No	No	Yes
10h..FFh	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).

7.7.2.2 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 7.7.4).

If 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 cleared 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.

7.7.2.3 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:

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

7.7.2.4 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 7.7.4).

If 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 7.7.2.5). The activation of deferred microcode data may be delayed until the device has access to the media.

The processing of commands other than the DOWNLOAD MICROCODE command and the DOWNLOAD MICROCODE DMA command shall not affect any:

a) updated microcode; and
b) saved microcode.

7.7.2.5 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 7.7.2.4).

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, the device shall return command aborted.

7.7.2.6 DOWNLOAD MICROCODE state machine

7.7.2.6.1 Overview

Subclause 7.7.2.6 and figure 11 describe the DOWNLOAD MICROCODE state machine for all subcommands of the DOWNLOAD MICROCODE command and the DOWNLOAD MICROCODE DMA command.

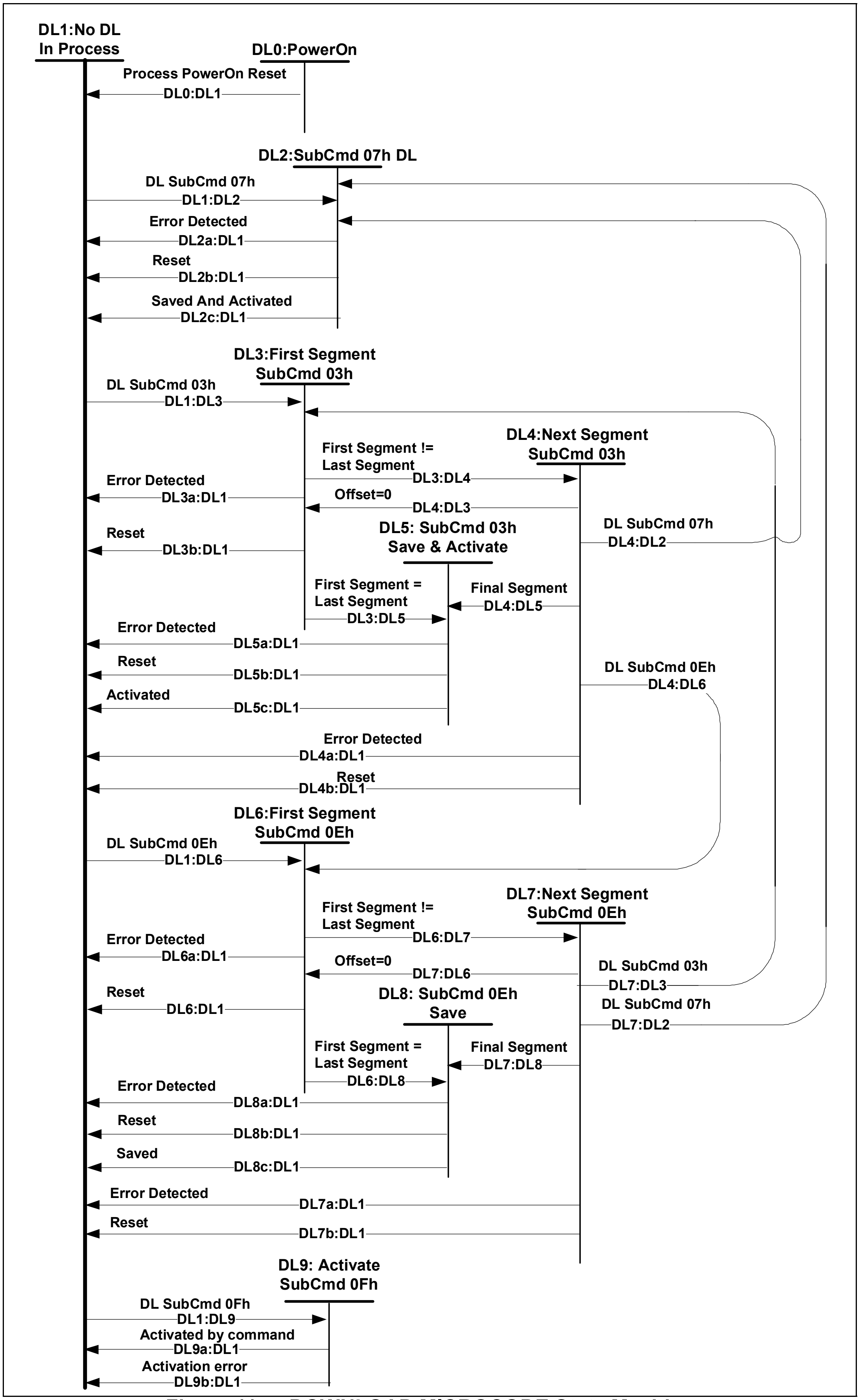

Figure 11 — DOWNLOAD MICROCODE State Machine

7.7.2.6.2 DL0: Power On state

In the DL0: Power On state, 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:

1) clear the FW ACTIVATION PENDING bit (see 9.10.6.2.5) to zero; and
2) transition to the DL1: No DL In Process (see 7.7.2.6.3) state.

7.7.2.6.3 DL1: No DL In Process state

In the DL1: No DL In Process state, there is no download microcode command sequence in process. In this state, any ATA command for which command acceptance occurs shall be processed.

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

If a download microcode 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 nonzero; or
c) the Download with offsets and save microcode for future use subcommand is processed and the value of the BUFFER OFFSET field is nonzero,

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: SubCmd 07h DL (see 7.7.2.6.4) 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 cleared to zero, then the device shall transition to the DL3: First Segment SubCmd 03h (see 7.7.2.6.5) 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 cleared to zero, then the device shall transition to the DL6: First Segment SubCmd 0Eh (see 7.7.2.6.8) state.

Transition DL1:DL9: If the device processes an Activate downloaded microcode subcommand, then the device shall transition to the DL9: Activate SubCmd 0Fh (see 7.7.2.6.11) state.

7.7.2.6.4 DL2: SubCmd 07h DL state

In the DL2: SubCmd 07h DL state, 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) retain all deferred microcode data;
3) return command aborted; and
4) transition to the DL1: No DL In Process (see 7.7.2.6.3) 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;
2) retain all deferred microcode data; and
3) transition to the DL1: No DL In Process (see 7.7.2.6.3) 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 without error;
2) shall activate the updated microcode data if the device returned command completion without error first;
3) shall return command completion without error if the device has not previously returned command completion; and
4) shall transition to the DL1: No DL In Process (see 7.7.2.6.3) state.

7.7.2.6.5 DL3: First Segment SubCmd 03h state

In the DL3: First Segment SubCmd 03h state, 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 cleared 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 cleared 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 processes a Download with offsets and save microcode for immediate and future use subcommand and:

a) the value of the DM MINIMUM TRANSFER SIZE field (see 9.10.5.3.6) is:
   A) not 0000h;
   B) not FFFFh; and
   C) greater than the BLOCK COUNT field of the Download with offsets and save microcode for immediate and future use subcommand;
b) the value of the DM MAXIMUM TRANSFER SIZE field (see 9.10.5.3.5) is:
   A) not 0000h;
   B) not FFFFh; and
   C) less than the value of the BLOCK COUNT field of the Download with offsets and save microcode for immediate and future use subcommand;

   or
c) 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: No DL In Process (see 7.7.2.6.3) 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: No DL In Process (see 7.7.2.6.3) 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 expected final segment), then the device:

1) shall retain all deferred microcode data;
2) shall return command completion without error;
3) may set the COUNT field to 01h (see 7.7.4); and
4) shall transition to the DL4: Next Segment SubCmd 03h (see 7.7.2.6.6) state.

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: SubCmd 03h Save & Activate (see 7.7.2.6.7) state.

7.7.2.6.6 DL4: Next Segment SubCmd 03h state

In the DL4: Next Segment SubCmd 03h state, the device waits for and processes additional Download with offsets and save microcode for immediate and future use subcommands. In this state, 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 cleared 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 cleared to zero, then the device shall:

1) ignore the BUFFER OFFSET field; and
2) return command completion without error

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

a) the segment does not complete the microcode data;
b) the value of the BLOCK COUNT field is nonzero; and
c) the value of the BUFFER OFFSET field is nonzero 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 7.7.4); and
3) shall return command completion without error.

If the device processes a command that is not a download microcode 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 nonzero; 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;
3) return command aborted; and
4) transition to the DL1: No DL In Process (see 7.7.2.6.3) state.

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

a) the value of the DM MINIMUM TRANSFER SIZE field (see 9.10.5.3.6) is:
   A) not 0000h;
   B) not FFFFh; and
   C) greater than the BLOCK COUNT field of the Download with offsets and save microcode for immediate and future use subcommand;

   or
b) the value of the DM MAXIMUM TRANSFER SIZE field (see 9.10.5.3.5) is:
   A) not 0000h;

   B) not FFFFh; and
   C) less than the value of the BLOCK COUNT field of the 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;
3) return command aborted; and
4) transition to the DL1: No DL In Process (see 7.7.2.6.3) state.

If the device processes an Activate downloaded microcode subcommand, 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 the DL1: No DL In Process (see 7.7.2.6.3) state.

Transition DL4b:DL1: If the device processes a hardware reset or a software reset, 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: No DL In Process (see 7.7.2.6.3) state.

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

1) retain all deferred microcode data; and
2) transition to the DL1: No DL In Process (see 7.7.2.6.3) state.

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 DL1: No DL In Process (see 7.7.2.6.3) state.

Transition DL4:DL3: If the device processes a Download with offsets and save microcode for immediate and future use subcommand (i.e., 03h) and the value of the BUFFER OFFSET field is cleared to zero, then the device shall:

1) discard all updated microcode data that has not been saved;
2) if the DM CLEARS NONACTIVATED DEFERRED DATA bit (see 9.10.5.3.1) is:
   A) cleared to zero, then retain all deferred microcode data; or
   B) set to one, then discard all deferred microcode data;
   and
3) transition to the DL3: First Segment SubCmd 03h (see 7.7.2.6.5) 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: SubCmd 03h Save & Activate (see 7.7.2.6.7) state.

Transition DL4:DL6: If the device processes a Download with offsets and save microcode for future use subcommand (i.e., 0Eh) and the value of the BUFFER OFFSET field is cleared to zero, then the device shall:

1) discard all updated microcode data that has not been saved;
2) if the DM CLEARS NONACTIVATED DEFERRED DATA bit (see 9.10.5.3.1) is:
   A) cleared to zero, then retain all deferred microcode data; or
   B) set to one, then discard all deferred microcode data;
   and
3) transition to the DL6: First Segment SubCmd 0Eh (see 7.7.2.6.8) state.

7.7.2.6.7 DL5: SubCmd 03h Save & Activate state

In the DL5: SubCmd 03h Save & Activate state, the device has received all of the updated microcode data. The device shall perform any verification required by the device. The device shall save the updated microcode data in a non-volatile location, replacing any deferred microcode data.

Transition DL5a: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: No DL In Process (see 7.7.2.6.3) state.

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: No DL In Process (see 7.7.2.6.3) 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 7.7.4);
4) shall return command completion without error; and
5) shall transition to DL1: No DL In Process (see 7.7.2.6.3) state.

7.7.2.6.8 DL6: First Segment SubCmd 0Eh state

In the DL6: First Segment SubCmd 0Eh state, 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 cleared 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 processes a Download with offsets and save microcode for future use subcommand and:

a) the value of the DM MINIMUM TRANSFER SIZE field (see 9.10.5.3.6) is:
   A) not 0000h;
   B) not FFFFh; and
   C) greater than the BLOCK COUNT field of the Download with offsets and save microcode for future use subcommand;

   or
b) the value of the DM MAXIMUM TRANSFER SIZE field (see 9.10.5.3.5) is:
   A) not 0000h;
   B) not FFFFh; and
   C) less than the value of the BLOCK COUNT field of the Download with offsets and save microcode for future use subcommand,

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: No DL In Process (see 7.7.2.6.3) 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: No DL In Process (see 7.7.2.6.3) 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 segment does not complete the microcode data), then the device shall:

1) discard all updated microcode data that has not been saved;
2) retain all deferred microcode data;
3) return command completion without error;
4) set the COUNT field to 01h (see 7.7.4); and
5) transition to the DL7: Next Segment SubCmd 0Eh (see 7.7.2.6.9) 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: SubCmd 0Eh Save (see 7.7.2.6.10) state.

7.7.2.6.9 DL7: Next Segment SubCmd 0Eh state

In the DL7: Next Segment SubCmd 0Eh state, 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 this state, 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 cleared 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 does not complete the microcode data;
b) the value of the BLOCK COUNT field is nonzero; and
c) the value of the BUFFER OFFSET field is nonzero and is equal to the sum of:
   A) the value of the BUFFER OFFSET field of the previous download microcode command; and
   B) the value of the BLOCK COUNT field of the previous download microcode command,

then the device:

1) shall set the COUNT field to 01h (see 7.7.4); and
2) shall return command completion without error.

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

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

If the device processes an Activate downloaded microcode subcommand (i.e. 0Fh), 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 the DL1: No DL In Process (see 7.7.2.6.3) state.

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

a) the value of the BLOCK COUNT field is nonzero;
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 microcode command; and
   B) the value of the BLOCK COUNT field of the previous download microcode command,

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: No DL In Process (see 7.7.2.6.3) state.

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

a) the value of the DM MINIMUM TRANSFER SIZE field (see 9.10.5.3.6) is:
   A) not 0000h;
   B) not FFFFh; and
   C) greater than the BLOCK COUNT field of the Download with offsets and save microcode for future use subcommand;

   or
b) the value of the DM MAXIMUM TRANSFER SIZE field (see 9.10.5.3.5) is:
   A) not 0000h;
   B) not FFFFh; and
   C) less than the value of the BLOCK COUNT field of the Download with offsets and save microcode for future use subcommand,

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: No DL In Process (see 7.7.2.6.3) state.

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: No DL In Process (see 7.7.2.6.3) state.

Transition DL7:DL2: If the device processes a Download and save microcode for immediate and future use subcommand, then:

1) the device shall discard all updated microcode data that has not been saved;
2) if the DM CLEARS NONACTIVATED DEFERRED DATA bit (see 9.10.5.3.1) is:
   A) cleared to zero, then the device shall retain all deferred microcode data; or
   B) set to one, then the device shall:
      a) discard all deferred microcode data; and
      b) clear the FW ACTIVATION PENDING bit (see 9.10.6.2.5) to zero;

   and
3) the device shall transition to the DL2: SubCmd 07h DL (see 7.7.2.6.4) state.

Transition DL7:DL3: If the device processes a Download with offsets and save microcode for immediate and future use subcommand (i.e., 03h) and the value of the BUFFER OFFSET field is cleared to zero, then:

1) the device shall discard all updated microcode data that has not been saved;
2) if the DM CLEARS NONACTIVATED DEFERRED DATA bit (see 9.10.5.3.1) is:
   A) cleared to zero, then retain all deferred microcode data; or
   B) set to one, then the device shall:
      a) discard all deferred microcode data; and
      b) clear the FW ACTIVATION PENDING bit (see 9.10.6.2.5) to zero;

   and
3) device shall transition to the DL3: First Segment SubCmd 03h (see 7.7.2.6.5) state.

Transition DL7:DL6: If the device processes a Download with offsets and save microcode for future use subcommand (i.e., 0Eh) and the value of the BUFFER OFFSET field is cleared to zero, then:

1) the device shall discard all updated microcode data that has not been saved;
2) if the DM CLEARS NONACTIVATED DEFERRED DATA bit (see 9.10.5.3.1) is:
   A) cleared to zero, then retain all deferred microcode data; or
   B) set to one, then the device shall:
      a) discard all deferred microcode data; and
      b) clear the FW ACTIVATION PENDING bit (see 9.10.6.2.5) to zero;

   and
3) the device shall transition to the DL6: First Segment SubCmd 0Eh (see 7.7.2.6.8) 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: SubCmd 0Eh Save (see 7.7.2.6.10) state.

7.7.2.6.10 DL8: SubCmd 0Eh Save state

In the DL8: SubCmd 0Eh Save state, 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: No DL In Process (see 7.7.2.6.3) 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: No DL In Process (see 7.7.2.6.3) state.

Transition DL8c:DL1: If the device does not detect an error, then the device shall:

1) set the COUNT field to 03h (see 7.7.4);
2) set the FW ACTIVATION PENDING bit (see 9.10.6.2.5) to one;
3) return command completion without error; and
4) transition to DL1: No DL In Process (see 7.7.2.6.3) state.

7.7.2.6.11 DL9: Activate SubCmd 0Fh state

In the DL9: Activate SubCmd 0Fh state, 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 02h (see 7.7.4);
4) clear the FW ACTIVATION PENDING bit (see 9.10.6.2.5) to zero;
5) return command completion without error; and
6) transition to DL1: No DL In Process (see 7.7.2.6.3) state.

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) clear the FW ACTIVATION PENDING bit (see 9.10.6.2.5) to zero;
3) discard all deferred microcode data;
4) return command aborted; and
5) transition to DL1: No DL In Process (see 7.7.2.6.3) state.

7.7.3 Inputs

7.7.3.1 Overview

See table 42 for the DOWNLOAD MICROCODE command inputs.

Table 42 — DOWNLOAD MICROCODE command inputs

Field	Description
FEATURE	SUBCOMMAND field – See 7.7.3.2
COUNT	BLOCK COUNT field (7:0) – See 7.7.3.3
LBA	**Bit Description** 27:24 Reserved 23:8 BUFFER OFFSET field – See 7.7.3.4 7:0 BLOCK COUNT field (15:8) – See 7.7.3.3
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 92h

7.7.3.2 SUBCOMMAND field

See table 41.

7.7.3.3 BLOCK COUNT field

The BLOCK COUNT field contains the number of 512-byte data blocks that shall be transferred. The BLOCK COUNT field is specified in the COUNT field and the LBA field. The BLOCK COUNT field is only valid if the SUBCOMMAND field is 03h, 07h, or 0Eh, and is reserved for all other subcommands.

7.7.3.4 BUFFER OFFSET field

The BUFFER OFFSET field specifies the offset into the updated microcode data that the data transferred by this download microcode command contains. The BUFFER OFFSET field is only valid if the SUBCOMMAND field is 03h or 0Eh, and is reserved for all other subcommands.

7.7.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

If the subcommand is Download with offsets and save microcode for future use, then table 43 describes the indicator returned in the COUNT field.

If the subcommand is Download with offsets and save microcode for immediate and future use and the:

a) DM MINIMUM TRANSFER SIZE field (see 9.10.5.3.6) has a value other than 0000h or FFFFh; or
b) DM MAXIMUM TRANSFER SIZE field (see 9.10.5.3.5) has a value other than 0000h or FFFFh,

then table 43 describes the indicator returned in the COUNT field.

Table 43 — 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	None	Reserved

For additional returns, see table 346.

7.7.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

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 362.

7.8 DOWNLOAD MICROCODE DMA – 93h, DMA/Non-Data

7.8.1 Feature Set

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

7.8.2 Description

See 7.7.2.

7.8.3 Inputs

See table 44 for the DOWNLOAD MICROCODE DMA command inputs.

Table 44 — DOWNLOAD MICROCODE DMA command inputs

Field	Description
FEATURE	See the SUBCOMMAND field in 7.7.3.2
COUNT	See the BLOCK COUNT field in 7.7.3.3
LBA	See the LBA field in 7.7.3
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 93h

7.8.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See 7.7.4.

7.8.5 Error Outputs

See 7.7.5.

7.9 EXECUTE DEVICE DIAGNOSTIC – 90h, Execute Device Diagnostic

7.9.1 Feature Set

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

7.9.2 Description

The EXECUTE DEVICE DIAGNOSTIC command causes the device to perform internal diagnostic tests.

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.

7.9.3 Inputs

See table 45 for the EXECUTE DEVICE DIAGNOSTIC command inputs.

Table 45 — EXECUTE DEVICE DIAGNOSTIC command inputs

Field	Description
FEATURE	N/A
COUNT	N/A
LBA	N/A
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 90h

7.9.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The diagnostic code written into the ERROR field is an eight-bit code defined in table 46. See table 349.

Table 46 — Diagnostic codes

Code [a]	Description
When this code is in the Device 0 [b] ERROR field	
01h	Device 0 [b] passed, Device 1 [b] passed or not present
00h, 02h..7Fh	Device 0 [b] failed, Device 1 [b] passed or not present
81h	Device 0 [b] passed, Device 1 [b] failed
80h, 82h..FFh	Device 0 [b] failed, Device 1 [b] failed
When this code is in the Device 1 [b] ERROR field	
01h	Device 1 [b] passed [c]
00h, 02h..7Fh	Device 1 [b] failed [c]
80h..FFh	Reserved

[a] Codes other than 01h and 81h may indicate additional information about the failure(s).
[b] See the appropriate transport standard for the definition of device 0 and device 1.
[c] If Device 1 is not present, the host may see the information from Device 0 even though Device 1 is selected.

7.9.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

This command shall complete without setting the ERROR bit to one (see 7.9.4).

7.10 FLUSH CACHE – E7h, Non-Data

7.10.1 Feature Set

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

7.10.2 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 write cache. If the volatile write cache is disabled or no volatile write cache is present, the device shall indicate command completion without error.

NOTE 5 — This command may take longer than 30 s to complete.

7.10.3 Inputs

See table 47 for the FLUSH CACHE command inputs.

Table 47 — FLUSH CACHE command inputs

Field	Description
FEATURE	N/A
COUNT	N/A
LBA	N/A
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 E7h

7.10.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.10.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

If an unrecoverable error occurs while the device is writing data to the media, the device shall terminate processing the command and report the error, including the LBA of First Unrecoverable Error (see 6.7.2). If the device receives a subsequent FLUSH CACHE command, the device shall continue the process of flushing the cache. See table 365.

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 7.11).

7.11 FLUSH CACHE EXT – EAh, Non-Data

7.11.1 Feature Set

This 48-bit command is for devices that support the 48-bit Address feature set (see 4.3).

7.11.2 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 6 — This command may take longer than 30 s to complete.

7.11.3 Inputs

See table 48 for the FLUSH CACHE EXT command inputs.

Table 48 — FLUSH CACHE EXT command inputs

Field	Description
FEATURE	Reserved
COUNT	Reserved
LBA	Reserved
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 EAh

7.11.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 352.

7.11.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

If an unrecoverable error occurs while the device is writing data to the media, the device shall terminate processing the command and report the error, including the LBA of First Unrecoverable Error (see 6.7.2). If a device receives a subsequent FLUSH CACHE EXT command, then the device shall continue the process of flushing the cache. See table 366.

7.12 GET PHYSICAL ELEMENT STATUS – 12h, DMA

7.12.1 Feature Set

This 48-bit command is for devices that support the Storage Element Depopulation feature set (see 4.26).

7.12.2 Description

The GET PHYSICAL ELEMENT STATUS command requests that the device return status information for physical elements within the device.

7.12.3 Inputs

7.12.3.1 Overview

See table 49 for the GET PHYSICAL ELEMENT STATUS command inputs.

Table 49 — GET PHYSICAL ELEMENT STATUS command inputs

Field	Description
FEATURE	**Bit Description** 15:14 FILTER field – See 7.12.3.2 13:12 Reserved 11:8 REPORT TYPE field – See 7.12.3.3 7:0 Reserved
COUNT	REQUESTED PAGE COUNT field - See 7.12.3.4
LBA	STARTING ELEMENT field – See 7.12.3.5
DEVICE	**Bit Description** 7 Obsolete 6 Reserved 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 12h

7.12.3.2 FILTER field

The FILTER field (see table 50) specifies the information to be returned by the GET PHYSICAL ELEMENT STATUS command.

Table 50 — FILTER field

Code	Description
00b	Return descriptors for all elements matching the REPORT TYPE field
01b	Return descriptors for all elements matching the REPORT TYPE field for which the value of the PHYSICAL ELEMENT HEALTH field (see table 55) is: a) greater than or equal to 65h and less than or equal to CFh (i.e., outside manufacturer's specification limit); b) equal to FBh (i.e., depopulation revocation has completed with error); c) equal to FCh (i.e., depopulation revocation has been initiated and not completed); d) equal to FDh (i.e., depopulation has completed with error); e) equal to FEh (i.e., depopulation has been initiated and not completed); or f) equal to FFh (i.e., depopulation has been successfully completed)
All others	Reserved

7.12.3.3 REPORT TYPE field

The REPORT TYPE field (see table 51) specifies the information to be returned by the GET PHYSICAL ELEMENT STATUS command.

Table 51 — REPORT TYPE field

Code	Description
0h	Return descriptors for physical elements, based on the FILTER field
1h	Return descriptors for storage elements, based on the FILTER field
2h..Fh	Reserved

7.12.3.4 REQUESTED PAGE COUNT field

The REQUESTED PAGE COUNT field specifies the number of pages of data requested to be returned. The device shall return the number of 512-byte pages specified in the REQUESTED PAGE COUNT field. Pad bytes are appended as needed to meet this requirement. Pad bytes shall have a value of 00h.

Unless otherwise specified, if the REQUESTED PAGE COUNT field specifies fewer 512-byte pages than the device has available to return, then the device:

a) shall truncate the returned data to the specified number of 512-byte pages; and
b) shall not modify any of the returned physical element status descriptor data as a result of the truncation.

If the REQUESTED PAGE COUNT field specifies more 512-byte pages than the device has available to return, then 512 bytes of all zeros shall be returned for those pages for which the device has no data to return.

The value 0000h is reserved in the REQUESTED PAGE COUNT field.

7.12.3.5 STARTING ELEMENT field

The STARTING ELEMENT field specifies the element identifier of the first physical element addressed by this command as described in (see 7.12.6.2).

7.12.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.12.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 362.

7.12.6 Input from the Device to the Host Data Structure

7.12.6.1 Overview

The format of the data input from the device to the host (see table 52) includes header information followed by a physical element descriptor list consisting of physical element status descriptor 0 through physical element status descriptor N.

Table 52 — GET PHYSICAL ELEMENT STATUS input from device to host

Offset	Type	Description
0..3	DWord	NUMBER OF DESCRIPTORS field (see 7.12.6.2)
4..7	DWord	NUMBER OF DESCRIPTORS RETURNED field (see 7.12.6.3)
8..11	DWord	IDENTIFIER OF ELEMENT BEING DEPOPULATED field (see 7.12.6.4)
12..31		Reserved
32..63	Bytes	Physical element status descriptor 0 (see 7.12.6.5)
64..95	Bytes	Physical element status descriptor 1
...		
s-31..s	Bytes	Physical element status descriptor N
s+1..((512 x (pc - 1)))	Bytes	Zero padding

Where:

s is the offset of the highest numbered byte of the final physical element status descriptor; and
pc is the requested page count
Zero padding shall be cleared to zero.

7.12.6.2 NUMBER OF DESCRIPTORS field

The NUMBER OF DESCRIPTORS field shall contain the number of descriptors in the element descriptors list. The element descriptors list is a list of physical elements that:

a) meet the requirements of the REPORTING OPTIONS field;
b) meet the requirements of the FILTER field; and
c) have an element identifier that is greater than or equal to the element identifier specified by the STARTING ELEMENT field in the command.

Due to processing considerations outside the scope of this standard, two GET PHYSICAL ELEMENT STATUS commands with identical values in all command fields may result in two different values in the NUMBER OF DESCRIPTORS field.

7.12.6.3 NUMBER OF DESCRIPTORS RETURNED field

The NUMBER OF DESCRIPTORS RETURNED field contains the number of physical element status descriptors in the input from the device to host data (see table 52).

7.12.6.4 IDENTIFIER OF ELEMENT BEING DEPOPULATED field

The IDENTIFIER OF ELEMENT BEING DEPOPULATED field contains the element identifier of the element that is in the process of being depopulated. If the value of this field is cleared to zero, then no action specified in 4.26.3.2 as a result of repurposing depopulation is in progress.

7.12.6.5 Physical element status descriptor

7.12.6.5.1 Overview

The physical element status descriptor (see table 53) contains status information for a physical element. The physical element status descriptors shall be sorted in ascending order of the element identifier.

Table 53 — Physical element status descriptor

Offset	Type	Description
0..3		Reserved
4..7	DWord	ELEMENT IDENTIFIER field (see 7.12.6.5.2)
8..12		Reserved
13	Byte	Depopulation flags **Bit Description** 7:1 Reserved 0 RESTORATION ALLOWED bit (see 7.12.6.5.3)
14	Byte	PHYSICAL ELEMENT TYPE field (see 7.12.6.5.4)
15	Byte	PHYSICAL ELEMENT HEALTH field (see 7.12.6.5.5)
16..23	QWord	ASSOCIATED CAPACITY field (see 7.12.6.5.6)
24..31		Reserved

7.12.6.5.2 ELEMENT IDENTIFIER field

The ELEMENT IDENTIFIER field contains the non-zero identifier of the physical element (e.g., storage element) associated with this physical element status descriptor.

7.12.6.5.3 RESTORATION ALLOWED bit

If the RESTORATION ALLOWED bit is cleared to zero, then this physical element:

a) has not been depopulated (see 4.26.1); or
b) has been depopulated and is not a candidate for being restored.

If the RESTORATION ALLOWED bit is set to one, then this physical element has been depopulated and is a candidate for being restored.

7.12.6.5.4 PHYSICAL ELEMENT TYPE field

The PHYSICAL ELEMENT TYPE field indicates the type of the physical element associated with this physical element status descriptor, as described by table 54.

Table 54 — PHYSICAL ELEMENT TYPE field

Code	Description
00h	Reserved
01h	Storage element
02h..FFh	Reserved

7.12.6.5.5 PHYSICAL ELEMENT HEALTH field

The PHYSICAL ELEMENT HEALTH field indicates the health of the physical element associated with this physical element status descriptor, as described by table 55.

Table 55 — PHYSICAL ELEMENT HEALTH field

Code	Description
00h	Not reported
01h..63h [a]	Within manufacturer's specification limit
64h	At manufacturer's specification limit
65h..CFh [a]	Outside manufacturer's specification limit
D0h..FAh	Reserved
FBh	Depopulation revocation has completed with error
FCh	Depopulation revocation has been initiated and not completed
FDh	Depopulation has completed with error
FEh	Depopulation has been initiated and not completed
FFh	Depopulation has been successfully completed

[a] The device may implement a subset of values.

7.12.6.5.6 ASSOCIATED CAPACITY field

The ASSOCIATED CAPACITY field indicates the estimated number of logical blocks by which the capacity of the device is reduced if the physical element associated with this physical element status descriptor becomes depopulated. A value of FFFF_FFFF_FFFF_FFFFh indicates that the number of logical blocks by which the capacity of the device is reduced is not reported.

7.13 IDENTIFY DEVICE – ECh, PIO Data-In

7.13.1 Feature Set

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

7.13.2 Description

The IDENTIFY DEVICE command specifies that the device shall send a 512-byte block of data to the host. See 7.13.6 for a description of the return data.

Incomplete data may be returned by this command (see 7.13.6.2).

The IDENTIFY DEVICE data contains information regarding optional features and command support. If the host issues a command that is indicated as not supported in the IDENTIFY DEVICE data, the device shall respond as if an unsupported command has been received (see 7.1.9).

7.13.3 Inputs

See table 56 for the IDENTIFY DEVICE command inputs.

Table 56 — IDENTIFY DEVICE command inputs

Field	Description
FEATURE	N/A
COUNT	N/A
LBA	N/A
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 ECh

7.13.4 Normal Outputs

See table 345.

7.13.5 Error Outputs

ATA devices shall not report an error, except:

a) while an NCQ command is outstanding;
b) after an NCQ Feature Set command error and before the NCQ Command Error Log is read;
c) if the device is in device fault condition (see 6.2.6); or
d) if an Interface CRC error has occurred.

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 362.

7.13.6 Input from the Device to the Host Data Structure

7.13.6.1 Overview

Table 57 specifies the format of the IDENTIFY DEVICE data.

Table 57 — IDENTIFY DEVICE data (Sheet 1 of 17)

Word	O M	S P	F V	Description
0	M	B		General configuration (see 7.13.6.2)
			F	15 0 = ATA device
			X	14:8 Retired
			X	7:6 Obsolete
			X	5:3 Retired
			V	2 Incomplete response
			X	1 Retired
				0 Reserved
1			X	Obsolete
2	O	B	V	Specific configuration (see 7.13.6.4)
3			X	Obsolete
4..5			X	Retired
6			X	Obsolete
7..8		N		Reserved for CFA (see 7.13.6.8)
9			X	Retired
10..19	M	B	F	Serial number (see 7.13.6.10)
20..21			X	Retired
22			X	Obsolete
23..26	M	B	F	Firmware revision (see 7.13.6.13)
27..46	M	B	F	Model number (see 7.13.6.14)
47			X	Obsolete
48	O	B		Trusted Computing feature set options (see 7.13.6.16)
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
				13:1 Reserved for the Trusted Computing Group
			F	0 Trusted Computing feature set is supported

Key:
F/V – Fixed/variable content
- F – The content of the field does not change except following a download microcode or power-on reset.
- 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 57 — IDENTIFY DEVICE data (Sheet 2 of 17)

Word	O M	S P	F V	Description
49	M			Capabilities (see 7.13.6.17)
				15:14 Obsolete
		B	F	13 Standardized Standby Timer Values
				1 = Standby timer values as specified in this standard are supported.
				0 = Standby timer values are vendor specific.
				12 Obsolete
		P	F	11 1 = IORDY (see ATA8-APT) supported
				0 = IORDY (see ATA8-APT) may be supported
		P	F	10 IORDY (see ATA8-APT) may be disabled
		B	F	9 Shall be set to one (i.e., LBA is supported).
		P	F	8 DMA supported
				7:2 Reserved
		B	V	1:0 Long Physical Sector Alignment Error reporting
50	M			Capabilities (see 7.13.6.17)
		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 1 = There is a minimum Standby time value that is vendor specific.
				0 = There is no minimum Standby timer value.
51..52			X	Obsolete
53	M			See 7.13.6.19
		B	V	15:8 Free-fall Control Sensitivity
				7:3 Reserved
		B	F	2 the fields reported in word 88 are valid
		B	F	1 the fields reported in words 64..70 are valid
			X	0 Obsolete
54..58			X	Obsolete

Key:
F/V – Fixed/variable content
- F – The content of the field does not change except following a download microcode or power-on reset.
- 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 57 — IDENTIFY DEVICE data (Sheet 3 of 17)

Word	O M	S P	F V	Description
59	M			See 7.13.6.21
		B	F	15 The BLOCK ERASE EXT command is supported (see 7.36.2)
		B	F	14 The OVERWRITE EXT command is supported (see 7.36.4)
		B	F	13 The CRYPTO SCRAMBLE EXT command is supported (see 7.36.3)
		B	F	12 The Sanitize feature set is supported (see 4.20)
		B	F	11 Shall be set to one 0 = The commands allowed during a sanitize operation are as specified by ACS-2
		B	F	10 The SANITIZE ANTIFREEZE LOCK EXT command is supported (see 7.36.5)
				9 Reserved
			X	8:0 Obsolete
60..61	M	B	F	Total number of user addressable logical sectors for 28-bit commands (DWord) (see 7.13.6.22)
62			X	Obsolete
63	M			Multiword DMA modes (see 7.13.6.24)
				15:11 Reserved
		P	V	10 Multiword DMA mode 2 is selected
		P	V	9 Multiword DMA mode 1 is selected
		P	V	8 Multiword DMA mode 0 is selected
				7:3 Reserved
		P	F	2 Multiword DMA mode 2 and below are supported
		P	F	1 Multiword DMA mode 1 and below are supported
		P	F	0 Multiword DMA mode 0 is supported
64	M			See 7.13.6.25
				15:2 Reserved
		P	F	1:0 PIO mode 3 and mode 4 supported
65	M	P	F	Minimum Multiword DMA transfer cycle time per word (see 7.13.6.26)
66	M	P	F	Manufacturer’s recommended Multiword DMA transfer cycle time (see 7.13.6.27)
67	M	P	F	Minimum PIO transfer cycle time without flow control (see 7.13.6.28)
68	M	P	F	Minimum PIO transfer cycle time with IORDY (see ATA8-APT) flow control (see 7.13.6.29)

Key:
F/V – Fixed/variable content
- F – The content of the field does not change except following a download microcode or power-on reset.
- 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 57 — IDENTIFY DEVICE data (Sheet 4 of 17)

Word	O M	S P	F V	Description
69	M			Additional Supported (see 7.13.6.30)
		N		15 Reserved for CFA
		B	F	14 Deterministic data in trimmed LBA range(s) is supported
		B	F	13 Long Physical Sector Alignment Error Reporting Control is supported
			X	12 Obsolete
		B	F	11 READ BUFFER DMA is supported
		B	F	10 WRITE BUFFER DMA is supported
			X	9 Obsolete
		B	F	8 DOWNLOAD MICROCODE DMA is supported
				7 Reserved for IEEE 1667
		B	F	6 0 = Optional ATA device 28-bit commands supported
		B	F	5 Trimmed LBA range(s) returning zeroed data is supported
		B	F	4 Device Encrypts All User Data on the device
		B	F	3 Extended Number of User Addressable Sectors is supported
		B	V	2 All write cache is non-volatile
			X	1:0 Obsolete
70				Reserved
71..74				Obsolete
75	O			Queue depth (see 7.13.6.33)
				15:5 Reserved
		S	F	4:0 Maximum queue depth – 1

Key:
F/V – Fixed/variable content
- F – The content of the field does not change except following a download microcode or power-on reset.
- 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 57 — IDENTIFY DEVICE data (Sheet 5 of 17)

Word	O M	S P	F V	Description
76	O			Serial ATA Capabilities (see 7.13.6.34)
		S	F	15 Supports READ LOG DMA EXT as equivalent to READ LOG EXT
		S	F	14 Supports Device Automatic Partial to Slumber transitions
		S	F	13 Supports Host Automatic Partial to Slumber transitions
		S	F	12 Supports NCQ priority information
		S	F	11 Supports Unload while NCQ commands are outstanding
		S	F	10 Supports the SATA Phy Event Counters log
		S	F	9 Supports receipt of host initiated power management requests
		S	F	8 Supports the NCQ feature set
				7:4 Reserved for Serial ATA
		S	F	3 Supports SATA Gen3 Signaling Speed (6.0Gb/s)
		S	F	2 Supports SATA Gen2 Signaling Speed (3.0Gb/s)
		S	F	1 Supports SATA Gen1 Signaling Speed (1.5Gb/s)
		S	F	0 Shall be cleared to zero
77	O			Serial ATA Additional Capabilities (see 7.13.6.35)
				15:10 Reserved for Serial ATA
				9 Supports Out Of Band Management Interface
		S	F	8 Power Disable feature always enabled
		S	F	7 Supports DevSleep to ReducedPwrState
		S	F	6 Supports RECEIVE FPDMA QUEUED and SEND FPDMA QUEUED commands
		S	F	5 Supports NCQ NON-DATA Command
		S	F	4 Supports NCQ Streaming
		S	V	3:1 Coded value indicating current negotiated Serial ATA signal speed
		S	F	0 Shall be cleared to zero

Key:
F/V – Fixed/variable content
- F – The content of the field does not change except following a download microcode or power-on reset.
- 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 57 — IDENTIFY DEVICE data (Sheet 6 of 17)

Word	O M	S P	F V	Description
78	O			Serial ATA features supported (see 7.13.6.36)
				15:13 Reserved for Serial ATA
		S	F	12 Power Disable feature supported
		S	F	11 Device supports Rebuild Assist feature set
				10 Reserved for Serial ATA
				9 Device supports Hybrid Information
		S	F	8 Device Sleep feature supported
		S	F	7 Device supports NCQ Autosense
		S	F	6 Device supports Software Settings Preservation
		S	F	5 Device supports Hardware Feature Control
		S	F	4 Device supports in-order data delivery
		S	F	3 Device supports initiating power management
		S	F	2 Device supports DMA Setup auto-activation
		S	F	1 Device supports nonzero buffer offsets
		S	F	0 Shall be cleared to zero
79	O			Serial ATA features enabled (see 7.13.6.37)
				15:12 Reserved for Serial ATA
		S	V	11 Rebuild Assist feature set enabled
		S	V	10 Power Disable feature enabled
				9 Hybrid Information enabled
		S	V	8 Device Sleep feature enabled
		S	V	7 Automatic Partial to Slumber transitions enabled
		S	V	6 Software Settings Preservation enabled
		S	V	5 Hardware Feature Control is enabled
		S	V	4 In-order data delivery enabled
		S	V	3 Device initiated power management enabled
		S	V	2 DMA Setup auto-activation enabled
		S	V	1 Nonzero buffer offsets enabled
		S	F	0 Shall be cleared to zero

Key:
F/V – Fixed/variable content
- F – The content of the field does not change except following a download microcode or power-on reset.
- 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 57 — IDENTIFY DEVICE data (Sheet 7 of 17)

Word	O M	S P	F V	Description
80	M			Major version number (see 7.13.6.38)
				15:13 Reserved
		B	F	12 Supports ACS-5
		B	F	11 supports ACS-4
		B	F	10 supports ACS-3
		B	F	9 supports ACS-2
		B	F	8 supports ATA8-ACS
		B	F	7 Obsolete
		B	F	6 Obsolete
		B	F	5 Obsolete
			X	4 Obsolete
			X	3 Obsolete
			X	2 Obsolete
			X	1 Obsolete
				0 Reserved
81	M	B	F	Minor version number (see 7.13.6.39)
82	M			Commands and feature sets supported (see 7.13.6.40)
			X	15 Obsolete
		B	F	14 The NOP command is supported.
		B	F	13 The READ BUFFER command is supported.
		B	F	12 The WRITE BUFFER command is supported.
			X	11:7 Obsolete
		B	F	6 Read look-ahead is supported.
		B	F	5 The volatile write cache is supported.
		B	F	4 Obsolete
		B	F	3 Shall be set to one (i.e., the Power Management feature set is supported)
			X	2 Obsolete
		B	F	1 The Security feature set is supported.
		B	F	0 The SMART feature set is supported.

Key:
F/V – Fixed/variable content
- F – The content of the field does not change except following a download microcode or power-on reset.
- 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 57 — IDENTIFY DEVICE data (Sheet 8 of 17)

Word	O M	S P	F V	Description
83	M			Commands and feature sets supported (see 7.13.6.40)
		B	F	15 Shall be cleared to zero
		B	F	14 Shall be set to one
		B	F	13 The FLUSH CACHE EXT command is supported.
		B	F	12 Shall be set to one (i.e., the FLUSH CACHE command is supported).
			X	11 Obsolete
		B	F	10 The 48-bit Address feature set is supported.
			X	9:7 Obsolete
		B	F	6 SET FEATURES subcommand is required to spin-up after power-up.
		B	F	5 The PUIS feature set is supported.
			X	4 Obsolete
		B	F	3 The APM feature set is supported.
		N		2 Reserved for CFA
			X	1 Obsolete
		B	F	0 The DOWNLOAD MICROCODE command is supported.
84	M			Commands and feature sets supported (see 7.13.6.40)
		B	F	15 Shall be cleared to zero
		B	F	14 Shall be set to one
		B	F	13 The IDLE IMMEDIATE command with UNLOAD feature is supported.
			X	12:9 Obsolete
		B	F	8 Shall be set to one (i.e., the World Wide Name is supported)
			X	7 Obsolete
		B	F	6 The WRITE DMA FUA EXT command is supported.
		B	F	5 The GPL feature set is supported
		B	F	4 The Streaming feature set is supported
			X	3 Obsolete
				2 Reserved
		B	F	1 The SMART self-test is supported.
		B	F	0 SMART error logging is supported.

Key:
F/V – Fixed/variable content
- F – The content of the field does not change except following a download microcode or power-on reset.
- 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 57 — IDENTIFY DEVICE data (Sheet 9 of 17)

Word	O M	S P	F V	Description
85	M			Commands and feature sets supported or enabled (see 7.13.6.41)
			X	15 Obsolete
		B	F	14 The NOP command is supported.
		B	F	13 The READ BUFFER command is supported.
		B	F	12 The WRITE BUFFER command is supported.
			X	11:7 Obsolete
		B	V	6 Read look-ahead is enabled.
		B	V	5 The volatile write cache is enabled.
		B	F	4 Obsolete
		B	F	3 Shall be set to one (i.e., the Power Management feature set is supported)
			X	2 Obsolete
		B	V	1 The Security feature set is enabled.
		B	V	0 The SMART feature set is enabled.
86	M			Commands and feature sets supported or enabled (see 7.13.6.41)
		B	F	15 Words 119..120 are valid.
				14 Reserved
		B	F	13 FLUSH CACHE EXT command supported.
		B	F	12 FLUSH CACHE command supported.
			X	11 Obsolete
		B	F	10 The 48-bit Address features set is supported.
			X	9:7 Obsolete
		B	F	6 SET FEATURES subcommand is required to spin-up after power-up.
		B	V	5 The PUIS feature set is enabled.
			X	4 Obsolete
		B	V	3 The APM feature set is enabled.
		N		2 Reserved for CFA
			X	1 Obsolete
		B	F	0 The DOWNLOAD MICROCODE command is supported.

Key:
F/V – Fixed/variable content
- F – The content of the field does not change except following a download microcode or power-on reset.
- 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 57 — IDENTIFY DEVICE data (Sheet 10 of 17)

Word	O M	S P	F V	Description
87	M			Commands and feature sets supported or enabled (see 7.13.6.41)
		B	F	15 Shall be cleared to zero
		B	F	14 Shall be set to one
		B	F	13 The IDLE IMMEDIATE command with Unload feature is supported.
			X	12:9 Obsolete
		B	F	8 Shall be set to one (i.e., the World Wide Name is supported)
			X	7 Obsolete
		B	F	6 The WRITE DMA FUA EXT command is supported.
		B	F	5 The GPL feature set is supported.
			X	4:3 Obsolete
		B	V	2 Media serial number is valid.
		B	F	1 SMART self-test is supported.
		B	F	0 SMART error logging is supported.
88	O			Ultra DMA modes (see 7.13.6.42)
				15 Reserved
		P	V	14 Ultra DMA mode 6 is selected.
		P	V	13 Ultra DMA mode 5 is selected.
		P	V	12 Ultra DMA mode 4 is selected.
		P	V	11 Ultra DMA mode 3 is selected.
		P	V	10 Ultra DMA mode 2 is selected.
		P	V	9 Ultra DMA mode 1 is selected.
		P	V	8 Ultra DMA mode 0 is selected.
				7 Reserved
		P	F	6 Ultra DMA mode 6 and below are supported.
		P	F	5 Ultra DMA mode 5 and below are supported.
		P	F	4 Ultra DMA mode 4 and below are supported.
		P	F	3 Ultra DMA mode 3 and below are supported.
		P	F	2 Ultra DMA mode 2 and below are supported.
		P	F	1 Ultra DMA mode 1 and below are supported.
		P	F	0 Ultra DMA mode 0 is supported.

Key:
F/V – Fixed/variable content
- F – The content of the field does not change except following a download microcode or power-on reset.
- 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 57 — IDENTIFY DEVICE data (Sheet 11 of 17)

Word	O M	S P	F V	Description
89	O	B	F	Time required for a Normal Erase mode SECURITY ERASE UNIT command (see 7.13.6.43)
90	O	B	F	Time required for an Enhanced Erase mode SECURITY ERASE UNIT command (see 7.13.6.44)
91				15:8 Reserved
	O	B	V	7:0 Current APM level value (see 7.13.6.45)
92	O	B	V	Master Password Identifier (see 7.13.6.46)

Key:

F/V – Fixed/variable content
- F – The content of the field does not change except following a download microcode or power-on reset.
- 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 57 — IDENTIFY DEVICE data (Sheet 12 of 17)

Word	O M	S P	F V	Description
93	M			Hardware reset results (see 7.13.6.47) For SATA devices, word 93 shall be set to the value 0000h.
		B	F	15 Shall be cleared to zero
		B	F	14 Shall be set to one for PATA devices
		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 Device 1 asserted PDIAG-.
			V	10:9 These bits indicate how Device 1 determined the device number: 00 = Reserved 01 = a jumper was used. 10 = the CSEL signal was used. 11 = some other method was used or the method is unknown.
			F	8 Shall be set to one
		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 Device 0 responds when Device 1 is selected.
			V	5 Device 0 detected the assertion of DASP-.
			V	4 Device 0 detected the assertion of PDIAG-.
			V	3 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 for PATA devices
94			X	Obsolete

Key:
F/V – Fixed/variable content
- F – The content of the field does not change except following a download microcode or power-on reset.
- 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 57 — IDENTIFY DEVICE data (Sheet 13 of 17)

Word	O M	S P	F V	Description
95	O	B	F	Stream Minimum Request Size (see 7.13.6.49)
96	O	B	V	Streaming Transfer Time – DMA (see 7.13.6.50)
97	O	B	V	Streaming Access Latency – DMA and PIO (see 7.13.6.51)
98..99	O	B	F	Streaming Performance Granularity (DWord) (see 7.13.6.52)
100..103	O	B	V	Number of User Addressable Logical Sectors (QWord) (see 7.13.6.53)
104	O	B	V	Streaming Transfer Time – PIO (see 7.13.6.54)
105	O	B	V	Maximum number of 512-byte blocks per DATA SET MANAGEMENT command (see 7.5)
106	O			Physical sector size / logical sector size (see 7.13.6.56)
		B	F	15 Shall be cleared to zero
		B	F	14 Shall be set to one
		B	F	13 Device has multiple logical sectors per physical sector.
		B	F	12 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/IEC 7779 standard acoustic testing (see 7.13.6.57)
108..111	M	B	F	World wide name (see 7.13.6.58)
112..115				Reserved
116			X	Obsolete
117..118	O	B	F	Logical sector size (DWord) (see 7.13.6.61)

Key:
F/V – Fixed/variable content
- F – The content of the field does not change except following a download microcode or power-on reset.
- 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 57 — IDENTIFY DEVICE data (Sheet 14 of 17)

Word	O M	S P	F V		Description
119	M				Commands and feature sets supported (Continued from words 82..84) (see 7.13.6.40)
		B	F	15	Shall be cleared to zero
		B	F	14	Shall be set to one
				13:10	Reserved
		B	F	9	DSN feature set is supported.
		S	F	8	Accessible Max Address Configuration feature set is supported.
		S	F	7	EPC feature set is supported.
		B	F	6	Sense Data Reporting feature set is supported.
		B	F	5	The Free-fall Control feature set is supported.
		B	F	4	Download Microcode mode 3 is supported.
		B	F	3	The READ LOG DMA EXT command and WRITE LOG DMA EXT command are supported.
		B	F	2	The WRITE UNCORRECTABLE EXT command is supported.
		B	F	1	The Write-Read-Verify feature set is supported.
			X	0	Obsolete
120	M				Commands and feature sets supported or enabled (Continued from words 85..87) (see 7.13.6.41)
		B	F	15	Shall be cleared to zero
		B	F	14	Shall be set to one
				13:10	Reserved
		B	V	9	DSN feature set is enabled.
				8	Reserved
		B	V	7	EPC feature set is enabled.
		B	V	6	Sense Data Reporting feature set is enabled.
		B	V	5	The Free-fall Control feature set is enabled.
		B	F	4	Download Microcode mode 3 is supported.
		B	F	3	The READ LOG DMA EXT command and WRITE LOG DMA EXT command are supported.
		B	F	2	The WRITE UNCORRECTABLE EXT command is supported.
		B	V	1	The Write-Read-Verify feature set is enabled.
			X	0	Obsolete
121..126					Reserved for expanded supported and enabled settings

Key:
F/V – Fixed/variable content
- F – The content of the field does not change except following a download microcode or power-on reset.
- 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 57 — IDENTIFY DEVICE data (Sheet 15 of 17)

Word	O M	S P	F V	Description
127			X	Obsolete
128	O			Security status (see 7.13.6.66)
				15:9 Reserved
		B	V	8 Master Password Capability: 0 = High, 1 = Maximum
				7:6 Reserved
		B	F	5 Enhanced security erase supported
		B	V	4 Security count expired
		B	V	3 Security frozen
		B	V	2 Security locked
		B	V	1 Security enabled
		B	F	0 Security supported
129..159			X	Vendor specific
160..167				Reserved for CFA
168				See 7.13.6.69
				15:4 Reserved
	O	B	F	3:0 Device Nominal Form Factor
169				DATA SET MANAGEMENT command support (see 7.13.6.70)
				15:1 Reserved
	O	B	F	0 The TRIM bit in the DATA SET MANAGEMENT command is supported.
170..173	O	B	F	Additional Product Identifier (see 7.13.6.71)
174..175				Reserved
176..205	O	B	V	Current media serial number (see 7.13.6.73)

Key:
F/V – Fixed/variable content
- F – The content of the field does not change except following a download microcode or power-on reset.
- 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 57 — IDENTIFY DEVICE data (Sheet 16 of 17)

Word	O M	S P	F V	Description
206	O	B		SCT Command Transport (see 7.13.6.74)
			X	15:12 Vendor Specific
				11:8 Reserved
				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.
			X	1 Obsolete
			F	0 The SCT Command Transport is supported.
207..208				Reserved
209	O	B	F	Alignment of logical sectors within a physical sector (see 7.13.6.75)
				15 Shall be cleared to zero
				14 Shall be set to one
				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 Mode 3 Count (DWord) (see 7.13.6.76)
212..213	O	B	F	Write-Read-Verify Sector Mode 2 Count (DWord) (see 7.13.6.77)
214..216			X	Obsolete
217	M	B	F	Nominal media rotation rate (see 7.13.6.79)
218				Reserved
219			X	Obsolete
220	O			See 7.13.6.82
				15:8 Reserved
		B	V	7:0 Write-Read-Verify feature set current mode
221				Reserved

Key:
F/V – Fixed/variable content
F – The content of the field does not change except following a download microcode or power-on reset.
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 57 — IDENTIFY DEVICE data (Sheet 17 of 17)

Word	O M	S P	F V	Description			
222	M	B		Transport major version number (see 7.13.6.84) 0000h or FFFFh = device does not report version			
			F	15:12	Transport Type 0h = Parallel 1h = Serial Eh = PCIe All others = Reserved		
					Parallel	**Serial**	**PCIe**
				11	Reserved	Reserved	Reserved
				10	Reserved	SATA 3.5	Reserved
				9	Reserved	SATA 3.4	Reserved
				8	Reserved	SATA 3.3	Reserved
			F	7	Reserved	SATA 3.2	Reserved
			F	6	Reserved	SATA 3.1	Reserved
			F	5	Reserved	SATA 3.0	Reserved
			F	4	Reserved	SATA 2.6	Reserved
			F	3	Reserved	SATA 2.5	Reserved
			F	2	Reserved	SATA II: Extensions	Reserved
			X	1	Obsolete	SATA 1.0a	Reserved
			X	0	Obsolete	ATA8-AST	Reserved
223	M	B	F	Transport minor version number (see 7.13.6.85)			
224..229				Reserved			
230..233	O	B	V	Extended Number of User Addressable Sectors (QWord) (see 7.13.6.87)			
234	O	B	F	Minimum number of 512-byte data blocks per Download Microcode operation (see 7.13.6.88)			
235	O	B	F	Maximum number of 512-byte data blocks per Download Microcode operation (see 7.13.6.89)			
236..254				Reserved			
255	M	B	V	Integrity word (see 7.13.6.91)			
				15:8	Checksum		
				7:0	Checksum Validity Indicator		

Key:

F/V – Fixed/variable content
- F – The content of the field does not change except following a download microcode or power-on reset.
- 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

7.13.6.2 Word 0: General configuration

If the device is an ATA device, then bit 15 of word 0 shall be cleared to zero.

Bits 14:8 of word 0 are retired.

Bits 7:6 of word 0 are obsolete.

Bits 5:3 of word 0 are retired.

If bit 2 of word 0 is set to one, then the content of the IDENTIFY DEVICE data is incomplete (e.g., the device supports the Power-up In Standby feature set and required data is contained on the device media (see 4.18)).

Bit 1 of word 0 is retired.

Bit 0 of word 0 is reserved.

The content of IDENTIFY DEVICE data word 0 shall be valid.

7.13.6.3 Word 1

Word 1 is obsolete.

7.13.6.4 Word 2: Specific configuration

Word 2 shall be set as defined in table 58. The content of IDENTIFY DEVICE data word 2 shall be valid.

Table 58 — Specific configuration

Value	Description
37C8h	Device requires SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is incomplete (see 4.18).
738Ch	Device requires SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is complete (see 4.18).
8C73h	Device does not require SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is incomplete (see 4.18).
C837h	Device does not require SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is complete (see 4.18).
All other values	Reserved

7.13.6.5 Word 3

Word 3 is obsolete.

7.13.6.6 Words 4..5

Words 4..5 are retired.

7.13.6.7 Word 6

Word 6 is obsolete.

7.13.6.8 Words 7..8:

Words 7..8 are reserved for CFA.

7.13.6.9 Word 9

Word 9 is retired.

7.13.6.10 Words 10..19: Serial number

Words 10..19 are a copy of the SERIAL NUMBER field (see 9.10.7.2).

7.13.6.11 Words 20..21

Words 20..21 are retired.

7.13.6.12 Word 22

Word 22 is obsolete.

7.13.6.13 Words 23..26: Firmware revision

Words 23..26 are a copy of the FIRMWARE REVISION field (see 9.10.7.3).

7.13.6.14 Words 27..46: Model number

Words 27..46 are a copy of the MODEL NUMBER field (see 9.10.7.4).

7.13.6.15 Word 47

Word 47 is obsolete.

7.13.6.16 Word 48: Trusted Computing feature set options

Bit 0 of word 48 is a copy of the TRUSTED COMPUTING SUPPORTED bit (see 9.10.8.6).

7.13.6.17 Words 49..50: Capabilities

Bits 15:14 of word 49 are obsolete.

If bit 13 of word 49 is set to one, then table 62 shall define the Standby timer values used by the device. If bit 13 of word 49 is cleared to zero, then the Standby timer values used by the device are vendor specific.

Bit 12 of word 49 is obsolete.

For PATA devices:

a) bit 11 of word 49 is a copy of the IORDY SUPPORTED bit (see 9.10.9.2.1); and
b) bit 10 of word 49 is a copy of the IORDY DISABLE SUPPORTED bit (see 9.10.9.2.2).

For SATA devices, bits 11:10 of word 49 shall be set to 11b.

Bit 9 of word 49 shall be set to one (i.e., LBA is supported).

For PATA devices, bit 8 of word 49 is a copy of the DMA SUPPORTED bit (see 9.10.9.2.3).

For SATA devices, bit 8 of word 49 shall be set to one.

Bits 7:2 of word 49 are reserved.

Bits 1:0 of word 49 are a copy of the ALIGNMENT ERROR REPORTING field (see 9.10.4.3.3).

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, the device has a minimum Standby timer value that is vendor specific. If this bit is cleared to zero, there is no minimum Standby timer value.

7.13.6.18 Words 51..52

Words 51..52 are obsolete.

7.13.6.19 Word 53

Bit 0 of word 53 is obsolete.

For PATA devices, if bit 1 of word 53 is:

a) set to one, then the values reported in words 64..70 are valid; and
b) cleared to zero, then the values reported in words 64..70 are not valid.

All PATA devices except CFA-APT devices shall:

a) support PIO mode 3 or above;
b) set bit 1 of word 53 to one; and

c) support the fields contained in words 64..70.

If Minimum PIO transfer cycle time without flow control is supported (see 9.10.9.5.2), bit 1 of word 53 shall be set to one.

For SATA devices, bit 1 of word 53 shall be set to one.

If a PATA device supports Ultra DMA (i.e., the values reported in word 88 are valid), then bit 2 of word 53 shall be set to one. If a PATA device does not support Ultra DMA (i.e., the values reported in word 88 are not valid), then bit 2 of word 53 shall be cleared to zero.

For SATA devices, bit 2 of word 53 shall be set to one.

Bits 15:8 of word 53 are a copy of the FREE-FALL SENSITIVITY field (see 9.10.6.9).

7.13.6.20 Words 54..58

Words 54..58 are obsolete.

7.13.6.21 Word 59

Bit 15 of word 59 is a copy of the BLOCK ERASE SUPPORTED bit (see 9.10.8.7.1).

Bit 14 of word 59 is a copy of the OVERWRITE SUPPORTED bit (see 9.10.8.7.2).

Bit 13 of word 59 is a copy of the CRYPTO SCRAMBLE SUPPORTED bit (see 9.10.8.7.3).

Bit 12 of word 59 is a copy of the SANITIZE SUPPORTED bit (see 9.10.8.7.4).

Bit 11 of word 59 shall be set to one.

Bit 10 of word 59 is a copy of the SANITIZE ANTIFREEZE LOCK SUPPORTED bit (see 9.10.8.7.5).

Bit 9 of word 59 is reserved.

Bits 8:0 of word 59 are obsolete.

7.13.6.22 Words 60..61: Total number of user addressable logical sectors for 28-bit commands

Words 60..61 contain 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 words 60..61 contain 0FFF_FFFFh and the device has user addressable LBAs greater than or equal to 0FFF_FFFFh, then the ACCESSIBLE CAPACITY field (see 9.10.4.2) contains the total number of user addressable LBAs (see 4.1).

7.13.6.23 Word 62

Word 62 is obsolete.

7.13.6.24 Word 63

Bits 15:11 of word 63 are reserved.

Bit 10 of word 63 shall have the content described for the MULTIWORD DMA MODE 2 ENABLED bit (see 9.10.9.2.4.2).

Bit 9 of word 63 shall have the content described for the MULTIWORD DMA MODE 1 ENABLED bit (see 9.10.9.2.4.3).

Bit 8 of word 63 shall have the content described for the MULTIWORD DMA MODE 0 ENABLED bit (see 9.10.9.2.4.4).

Bits 7:3 of word 63 are reserved.

For PATA devices:

a) bit 2 of word 63 is a copy of the MULTIWORD DMA MODE 2 SUPPORTED bit (see 9.10.9.2.4.5);
b) bit 1 of word 63 is a copy of the MULTIWORD DMA MODE 1 SUPPORTED bit (see 9.10.9.2.4.6); and
c) bit 0 of word 63 is a copy of the MULTIWORD DMA MODE 0 SUPPORTED bit (see 9.10.9.2.4.7).

For SATA devices, bits 2:0 of word 63 shall be set to 111b.

7.13.6.25 Word 64

Bits 15:2 of word 64 are reserved.

For PATA devices:

a) bit 1 of word 64 is a copy of the PIO MODE 4 IS SUPPORTED bit (see 9.10.9.3.1); and
b) bit 0 of word 64 is a copy of the PIO MODE 3 IS SUPPORTED bit (see 9.10.9.3.2).

For SATA devices, bits 1:0 of word 64 shall be set to 11b.

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

For PATA devices, word 65 is a copy the MIN MULTIWORD CYCLE TIME field (see 9.10.9.4.2).

For SATA devices, word 65 shall be set to 0078h.

7.13.6.27 Word 66: Manufacturer's recommended Multiword DMA transfer cycle time

For PATA devices, word 66 is a copy the RECOMMENDED MULTIWORD CYCLE TIME field (see 9.10.9.4.1).

For SATA devices, word 66 shall be set to 0078h.

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

For PATA devices, word 67 is a copy of the MIN PIO TRANSFER TIME WITHOUT IORDY field (see 9.10.9.5.2).

For SATA devices, word 67 shall be set to 0078h.

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

For PATA devices, word 68 is a copy of the MIN PIO TRANSFER TIME WITH IORDY field (see 9.10.9.5.1).

For SATA devices, word 68 shall be set to 0078h.

7.13.6.30 Word 69: Additional Supported

Word 69 shall indicate features, feature sets, or commands that are supported. If a defined bit is cleared to zero, the indicated feature, feature set or command is not supported. Feature sets and commands for which bits in word 69 indicate support do not include a mechanism to disable them.

Bit 15 of word 69 is reserved for CFA (e.g., for use in CFast).

Bit 14 of word 69 is a copy of the DRAT SUPPORTED bit (see 9.10.5.2.2).

Bit 13 of word 69 is a copy of the LPS MISALIGNMENT REPORTING SUPPORTED bit (see 9.10.5.2.3).

Bit 12 of word 69 is obsolete.

Bit 11 of word 69 is a copy of the READ BUFFER DMA SUPPORTED bit (see 9.10.5.2.4).

Bit 10 of word 69 is a copy of the WRITE BUFFER DMA SUPPORTED bit (see 9.10.5.2.5).

Bit 9 of word 69 is obsolete.

Bit 8 of word 69 is a copy of the DOWNLOAD MICROCODE DMA SUPPORTED bit (see 9.10.5.2.6).

Bit 7 is reserved for IEEE 1667.

Bit 6 of word 69 is a copy of the 28-BIT SUPPORTED bit (see 9.10.5.2.7).

Bit 5 of word 69 is a copy of the RZAT SUPPORTED bit (see 9.10.5.2.8).

Bit 4 of word 69 is a copy of the ENCRYPT ALL SUPPORTED bit (see 9.10.8.7.6).

If word 69 bit 3 is set to one, then words 230..233 (see 7.13.6.87) are valid. If word 69 bit 3 is cleared to zero, then words 230..233 (see 7.13.6.87) are reserved.

Bit 2 of word 69 is a copy of the NON-VOLATILE WRITE CACHE bit (see 9.10.6.2.13).

Bits 1:0 of word 69 are obsolete.

7.13.6.31 Word 70

Word 70 is reserved.

7.13.6.32 Words 71..74

Words 71..74 are obsolete.

7.13.6.33 Word 75: Queue depth

Bits 4:0 are a copy of the QUEUE DEPTH field (see 9.10.5.15).

7.13.6.34 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..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..79 shall be valid.

Bit 15 of word 76 is a copy of the READ LOG DMA EXT AS EQUIVALENT TO READ LOG EXT SUPPORTED bit (see 9.10.10.2.11).

Bit 14 of word 76 is a copy of the DEVICE AUTOMATIC PARTIAL TO SLUMBER TRANSITIONS SUPPORTED bit (see 9.10.10.2.10).

Bit 13 of word 76 is a copy of the HOST AUTOMATIC PARTIAL TO SLUMBER TRANSITIONS SUPPORTED bit (see 9.10.10.2.9).

Bit 12 of word 76 is a copy of the NCQ PRIORITY INFORMATION SUPPORTED bit (see 9.10.10.2.8).

Bit 11 of word 76 is a copy of the UNLOAD WHILE NCQ COMMANDS ARE OUTSTANDING SUPPORTED bit (see 9.10.10.2.7).

Bit 10 of word 76 is a copy of the SATA PHY EVENT COUNTERS LOG SUPPORTED bit (see 9.10.10.2.6).

Bit 9 of word 76 is a copy of the RECEIPT OF HOST INITIATED POWER MANAGEMENT REQUESTS SUPPORTED bit (see 9.10.10.2.5).

Bit 8 of word 76 is a copy of the NCQ FEATURE SET SUPPORTED bit (see 9.10.10.2.4).

Bits 7:4 of word 76 are reserved for Serial ATA.

Bit 3 of word 76 is a copy of the SATA GEN3 SIGNALING SPEED SUPPORTED bit (see 9.10.10.2.3).

Bit 2 of word 76 is a copy of the SATA GEN2 SIGNALING SPEED SUPPORTED bit (see 9.10.10.2.2).

Bit 1 of word 76 is a copy of the SATA GEN1 SIGNALING SPEED SUPPORTED bit (see 9.10.10.2.1).

Bit 0 of word 76 shall be cleared to zero.

7.13.6.35 Word 77: Serial ATA Additional Capabilities

Word 77 reports additional capabilities supported by the device. Support for this word is optional and if not supported, the word shall be zero indicating the device has no support for additional Serial ATA capabilities.

Bits 15:10 of word 77 are reserved for Serial ATA.

Bit 9 of word 77 is a copy of the OUT OF BAND MANAGEMENT INTERFACE SUPPORTED bit (see 9.10.10.2.30).

Bit 8 of word 77 is a copy of the POWER DISABLE FEATURE ALWAYS ENABLED bit (see 9.10.10.2.29).

Bit 7 of word 77 is a copy of the DEVSLEEP TO REDUCEDPWRSTATE CAPABILITY SUPPORTED bit (see 9.10.10.2.24).

Bit 6 of word 77 is a copy of the SEND AND RECEIVE QUEUED COMMANDS SUPPORTED bit (see 9.10.10.2.14).

Bit 5 of word 77 is a copy of the NCQ QUEUE MANAGEMENT COMMAND SUPPORTED bit (see 9.10.10.2.13).

Bit 4 of word 77 is a copy of the NCQ STREAMING SUPPORTED bit (see 9.10.10.2.12).

Bits 3:1 of word 77 are a copy of the CURRENT SERIAL ATA SIGNAL SPEED field (see 9.10.10.2.21).

Bit 0 of word 77 shall be cleared to zero.

7.13.6.36 Word 78: Serial ATA features supported

If word 76 is not 0000h or FFFFh, word 78 reports the features supported by the device. If this word is not supported, the word shall be cleared to zero.

Bits 15:13 of word 78 are reserved for Serial ATA.

Bit 12 of word 78 is a copy of the POWER DISABLE FEATURE SUPPORTED bit (see 9.10.10.2.28).

Bit 11 of word 78 is a copy of the REBUILD ASSIST SUPPORTED bit (see 9.10.10.2.27).

Bits 10 of word 78 is reserved for Serial ATA.

Bit 9 of word 78 is a copy of the HYBRID INFORMATION SUPPORTED bit (see 9.10.10.2.23).

Bit 8 of word 78 is a copy of the DEVICE SLEEP SUPPORTED bit (see 9.10.10.2.22).

Bit 7 of word 78 is a copy of the NCQ AUTOSENSE SUPPORTED bit (see 9.10.10.2.21).

Bit 6 of word 78 is a copy of the SOFTWARE SETTINGS PRESERVATION SUPPORTED bit (see 9.10.10.2.20).

Bit 5 of word 78 is a copy of the HARDWARE FEATURE CONTROL SUPPORTED bit (see 9.10.10.2.19).

Bit 4 of word 78 is a copy of the IN-ORDER DATA DELIVERY SUPPORTED bit (see 9.10.10.2.18).

Bit 3 of word 78 is a copy of the DEVICE INITIATED POWER MANAGEMENT SUPPORTED bit (see 9.10.10.2.17).

Bit 2 of word 78 is a copy of the DMA SETUP AUTO-ACTIVATION SUPPORTED bit (see 9.10.10.2.16).

Bit 1 of word 78 is a copy of the NONZERO BUFFER OFFSETS SUPPORTED bit (see 9.10.10.2.15).

Bit 0 of word 78 shall be cleared to zero.

7.13.6.37 Word 79: Serial ATA features enabled

If word 76 is not 0000h or FFFFh, word 79 reports which 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 15:12 of word 79 are reserved for Serial ATA.

Bit 11 of word 79 is a copy of the REBUILD ASSIST ENABLED bit (see 9.10.10.3.11).

Bit 10 of word 79 is a copy of the POWER DISABLE FEATURE ENABLED bit (see 9.10.10.3.10).

Bit 9 of word 79 is a copy of the HYBRID INFORMATION ENABLED bit (see 9.10.10.3.12).

Bit 8 of word 79 is a copy of the DEVICE SLEEP ENABLED bit (see 9.10.10.3.9).

Bit 7 of word 79 is a copy of the AUTOMATIC PARTIAL TO SLUMBER TRANSITIONS ENABLED bit (see 9.10.10.3.8).

Bit 6 of word 79 is a copy of the SOFTWARE SETTINGS PRESERVATION ENABLED bit (see 9.10.10.3.7).

Bit 5 of word 79 is a copy of the HARDWARE FEATURE CONTROL IS ENABLED bit (see 9.10.10.3.6).

Bit 4 of word 79 is a copy of the IN-ORDER DATA DELIVERY ENABLED bit (see 9.10.10.3.5).

Bit 3 of word 79 is a copy of the DEVICE INITIATED POWER MANAGEMENT ENABLED bit (see 9.10.10.3.4).

Bit 2 of word 79 is a copy of the DMA SETUP AUTO-ACTIVATION ENABLED bit (see 9.10.10.3.3).

Bit 1 of word 79 is a copy of the NONZERO BUFFER OFFSETS ENABLED bit (see 9.10.10.3.2).

Bit 0 of word 79 shall be cleared to zero.

7.13.6.38 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 any of the bits 15:8 being set to one. Values other than 0000h and FFFFh are bit significant. A device may set more than one bit.

7.13.6.39 Word 81: Minor version number

Table 59 defines the value that shall be reported in word 81 to indicate the version of the standard that guided the implementation.

Table 59 — 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	Obsolete
0014h	Obsolete
0015h	Obsolete
0016h	Obsolete
0017h	Obsolete
0018h	Obsolete
0019h	Obsolete
001Ah	Obsolete
001Bh	Obsolete
001Ch	Obsolete
001Dh	Obsolete
001Eh	Obsolete
001Fh	Obsolete
0020h	Reserved
0021h	Obsolete
0022h	Obsolete
0023h..0026h	Reserved
0027h	ATA8-ACS version 3c

Table 59 — Minor version number (Sheet 2 of 2)

Value	Minor Version
0028h	ATA8-ACS version 6
0029h	ATA8-ACS version 4
0030h	ACS-5 version 10
0031h	ACS-2 version 2
0032h	Reserved
0033h	ATA8-ACS version 3e
0034h..0038h	Reserved
0039h	ATA8-ACS version 4c
003Ah..0041h	Reserved
0042h	ATA8-ACS version 3f
0043h..0051h	Reserved
0052h	ATA8-ACS version 3b
0053h..005Dh	Reserved
005Eh	ACS-4 version 5
005Fh..006Ch	Reserved
006Dh	ACS-3 version 5
006Eh..0081h	Reserved
0082h	ACS-2 published, INCITS 482-2012
0083h..009Bh	Reserved
009Ch	ACS-4 published, INCITS 529-2018
009Dh..0106h	Reserved
0107h	ATA8-ACS version 2d
0108h..0109h	Reserved
010Ah	ACS-3 published, INCITS 522-2014
010Bh..010Fh	Reserved
0110h	ACS-2 version 3
0111h..011Ah	Reserved
011Bh	ACS-3 version 4
011Ch..FFFEh	Reserved
FFFFh	Minor version is not reported

7.13.6.40 Words 82..84, 119: Commands and feature sets supported

Words 82..84 and 119 indicate features, feature sets, or commands supported. If a defined bit is cleared to zero, the indicated feature, feature set, or command 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 words 82..83.

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 word 84.

If bit 15 of word 86 is set to one, 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 contain 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 SUPPORTED bit (see 9.10.5.2.9).

Bit 13 of word 82 is a copy of the READ BUFFER SUPPORTED bit (see 9.10.5.2.10).

Bit 12 of word 82 is a copy of the WRITE BUFFER SUPPORTED bit (see 9.10.5.2.11).

Bits 11:7 of word 82 are obsolete.

Bit 6 of word 82 is a copy of the READ LOOK-AHEAD SUPPORTED bit (see 9.10.5.2.12).

Bit 5 of word 82 is a copy of the VOLATILE WRITE CACHE SUPPORTED bit (see 9.10.5.2.13).

Bit 4 of word 82 obsolete.

Bit 3 of word 82 shall be set to one.

Bit 2 of word 82 is obsolete.

Bit 1 of word 82 is a copy of the SECURITY SUPPORTED bit (see 9.10.8.3.1).

Bit 0 of word 82 is a copy of the SMART bit (see 9.10.5.2.14).

Bit 13 of word 83 is a copy of the FLUSH CACHE EXT SUPPORTED bit (see 9.10.5.2.15).

Bit 12 of word 83 shall be set to one (i.e., the FLUSH CACHE command is supported).

Bit 11 of word 83 is obsolete.

Bit 10 of word 83 is a copy of the 48-BIT SUPPORTED bit (see 9.10.5.2.16).

Bits 9:8 of word 83 are obsolete.

Bit 7 of word 83 is obsolete.

Bit 6 of word 83 is a copy of the SPIN-UP SUPPORTED bit (see 9.10.5.2.17).

Bit 5 of word 83 is a copy of the PUIS SUPPORTED bit (see 9.10.5.2.18).

Bit 4 of word 83 is obsolete.

Bit 3 of word 83 is a copy of the APM SUPPORTED bit (see 9.10.5.2.19).

Bit 2 of word 83 is reserved for CFA.

Bit 1 of word 83 is obsolete.

Bit 0 of word 83 is a copy of the DOWNLOAD MICROCODE SUPPORTED bit (see 9.10.5.2.20).

Bit 13 of word 84 is a copy of the UNLOAD SUPPORTED bit (see 9.10.5.2.21).

Bits 12:11 of word 84 are obsolete.

Bits 10:9 of word 84 are obsolete.

Bit 8 of word 84 shall be set to one (i.e., the World Wide Name (see 7.13.6.58) is supported).

Bit 7 of word 84 is obsolete.

Bit 6 of word 84 is a copy of the WRITE FUA EXT SUPPORTED bit (see 9.10.5.2.22).

Bit 5 of word 84 is a copy of the GPL SUPPORTED bit (see 9.10.5.2.23).

Bit 4 of word 84 is a copy of the STREAMING SUPPORTED bit (see 9.10.5.2.24).

Bit 3 of word 84 is obsolete.

Bit 2 of word 84 is reserved.

Bit 1 of word 84 is a copy of the SMART SELF-TEST SUPPORTED bit (see 9.10.5.2.25).

Bit 0 of word 84 is a copy of the SMART ERROR LOGGING SUPPORTED bit (see 9.10.5.2.26).

Bits 13:10 of word 119 are reserved.

Bit 9 of word 119 is a copy of the DSN SUPPORTED bit (see 9.10.5.2.37).

Bit 8 of word 119 is a copy of the AMAX ADDR SUPPORTED bit (see 9.10.5.2.34).

Bit 7 of word 119 is a copy of the EPC SUPPORTED bit (see 9.10.5.2.27).

Bit 6 of word 119 is a copy of the SENSE DATA SUPPORTED bit (see 9.10.5.2.28).

Bit 5 of word 119 is a copy of the FREE-FALL SUPPORTED bit (see 9.10.5.2.29).

Bit 4 of word 119 is a copy of the DM MODE 3 SUPPORTED bit (see 9.10.5.2.30).

Bit 3 of word 119 is a copy of the GPL DMA SUPPORTED bit (see 9.10.5.2.31).

Bit 2 of word 119 is a copy of the WRITE UNCORRECTABLE SUPPORTED bit (see 9.10.5.2.32).

Bit 1 of word 119 is a copy of the WRV SUPPORTED bit (see 9.10.5.2.33).

Bit 0 of word 119 is obsolete.

7.13.6.41 Words 85..87, 120: Commands and feature sets supported or enabled

Words 85..87 and 120 indicate features, feature sets, or commands enabled. If a defined bit is cleared to zero, the indicated feature, feature set, or command 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 that feature or feature set 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. Otherwise, the information is not valid in words 85..87.

If bit 15 of word 86 is set to one, 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, the information is not valid in word 120.

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.

Bits 9:7 of word 85 are obsolete.

Bit 6 of word 85 is a copy of the READ LOOK-AHEAD ENABLED bit (see 9.10.6.2.14).

Bit 5 of word 85 is a copy of the VOLATILE WRITE CACHE ENABLED bit (see 9.10.6.2.10).

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 bit 1 in word 128.

Bit 0 of word 85 is a copy of the SMART ENABLED bit (see 9.10.6.2.15).

If bit 15 of word 86 is set to one, bit 14 of word 119 is set to one, and bit 15 of word 119 is cleared to zero, then word 119 is valid. If bit 15 of word 86 is set to one, bit 14 of word 120 is set to one, and bit 15 of word 120 is cleared to zero, then word 120 is 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 obsolete.

Bit 6 of word 86 is a copy of bit 6 of word 83.

Bit 5 of word 86 is a copy of the PUIS ENABLED bit (see 9.10.6.2.16).

Bit 3 of word 86 is a copy of the APM ENABLED bit (see 9.10.6.2.17)

Bit 2 of word 86 is reserved for CFA.

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.

Bits 12:11 of word 87 are obsolete.

Bits 10:9 of word 87 are obsolete.

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.

Bit 3 of word 87 is obsolete.

If bit 2 of word 87 is set to one, then the current media serial number 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.

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 13:10 of word 120 are reserved.

Bit 9 of word 120 is a copy of the DSN ENABLED bit (see 9.10.6.2.8).

Bit 8 of word 120 is reserved.

Bit 7 of word 120 is a copy of the EPC ENABLED bit (see 9.10.6.2.9).

Bit 6 of word 120 is a copy of the SENSE DATA ENABLED bit (see 9.10.6.2.12).

Bit 5 of word 120 is a copy of the FREE-FALL ENABLED bit (see 9.10.6.2.18).

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 WRV ENABLED bit (see 9.10.6.2.19).

Bit 0 of word 120 is obsolete.

7.13.6.42 Word 88: Ultra DMA modes

Bit 15 of word 88 is reserved.

Bit 14 of word 88 shall have the content described for the UDMA MODE 6 ENABLED bit (see 9.10.9.2.5.2).

Bit 13 of word 88 shall have the content described for the UDMA MODE 5 ENABLED bit (see 9.10.9.2.5.3).

Bit 12 of word 88 shall have the content described for the UDMA MODE 4 ENABLED bit (see 9.10.9.2.5.4).

Bit 11 of word 88 shall have the content described for the UDMA MODE 3 ENABLED bit (see 9.10.9.2.5.5).

Bit 10 of word 88 shall have the content described for the UDMA MODE 2 ENABLED bit (see 9.10.9.2.5.6).

Bit 9 of word 88 shall have the content described for the UDMA MODE 1 ENABLED bit (see 9.10.9.2.5.7).

Bit 8 of word 88 shall have the content described for the UDMA MODE 0 ENABLED bit (see 9.10.9.2.5.8).

Bit 7 of word 88 is reserved.

For PATA devices, bit 6 of word 88 is a copy of the UDMA MODE 6 SUPPORTED bit (see 9.10.9.2.5.9).

For SATA devices, bit 6 of word 88 may be set to one.

For PATA devices:

a) bit 5 of word 88 is a copy of the UDMA MODE 5 SUPPORTED bit (see 9.10.9.2.5.10);
b) bit 4 of word 88 is a copy of the UDMA MODE 4 SUPPORTED bit (see 9.10.9.2.5.11);
c) bit 3 of word 88 is a copy of the UDMA MODE 3 SUPPORTED bit (see 9.10.9.2.5.12);
d) bit 2 of word 88 is a copy of the UDMA MODE 2 SUPPORTED bit (see 9.10.9.2.5.13);
e) bit 1 of word 88 is a copy of the UDMA MODE 1 SUPPORTED bit (see 9.10.9.2.5.14); and
f) bit 0 of word 88 is a copy of the UDMA MODE 0 SUPPORTED bit (see 9.10.9.2.5.15).

For SATA devices, bits 5:0 of word 88 shall be set to 3Fh.

7.13.6.43 Word 89

Word 89 bit 15 is a copy of the NORMAL SECURITY ERASE TIME FORMAT bit (see 9.10.8.5).

Word 89 bits 14:0 are a copy of the NORMAL SECURITY ERASE TIME field (see 9.10.8.5).

7.13.6.44 Word 90

Word 90 is a copy of the ENHANCED SECURITY ERASE TIME field (see 9.10.8.4).

7.13.6.45 Word 91: Current advanced power management level value

Bits 15:8 of word 91 are reserved.

Bits 7:0 of word 91 are a copy of the APM LEVEL field (see 9.10.6.3.2).

7.13.6.46 Word 92: Master Password Identifier

Word 92 is a copy of the MASTER PASSWORD IDENTIFIER field (see 9.10.8.2).

7.13.6.47 Word 93: Hardware reset results

For PATA devices, if bit 14 of word 93 is set to one and bit 15 of word 93 is cleared to zero, then the content of word 93 contains valid information.

Bit 13 of word 93 is a copy of the CBLID bit (see 9.10.9.2.6.1).

Bit 12 of word 93 is reserved.

Bit 11 of word 93 is a copy of the D1 PDIAG bit (see 9.10.9.2.6.2).

Bits 10:9 of word 93 are a copy of the D1 DEVICE NUMBER DETECT field (see 9.10.9.2.6.3).

Bit 8 of word 93 shall be set to one for a PATA device.

Bit 7 of word 93 is reserved.

Bit 6 of word 93 is a copy of the D0/D1 SELECTION bit (see 9.10.9.2.6.6),

Bit 5 of word 93 is a copy of the D0 DASP bit (see 9.10.9.2.6.5).

Bit 4 of word 93 is a copy of the D0 PDIAG bit (see 9.10.9.2.6.4).

Bit 3 of word 93 is a copy of the D0 DIAGNOSTICS bit (see 9.10.9.2.6.7).

Bits 2:1 of word 93 are a copy of the D0 DEVICE NUMBER DETECT field (see 9.10.9.2.6.8).

Bit 0 of word 93 shall be set to one for a PATA device.

For SATA devices, word 93 shall be set to the value 0000h.

7.13.6.48 Word 94

Word 94 is obsolete.

7.13.6.49 Word 95: Stream Minimum Request Size

Word 95 is a copy of the STREAM MIN REQUEST SIZE field (see 9.10.6.6).

7.13.6.50 Word 96: Streaming Transfer Time – DMA

Word 96 is a copy of the DMA SECTOR TIME field (see 9.10.6.4).

7.13.6.51 Word 97: Streaming Access Latency – DMA and PIO

Word 97 is a copy of the STREAM ACCESS LATENCY field (see 9.10.6.7).

7.13.6.52 Words 98..99: Streaming Performance Granularity

Words 98..99 are a copy of the STREAM GRANULARITY field (see 9.10.6.8).

7.13.6.53 Words 100..103: Number of User Addressable Logical Sectors

Words 100..103 contain a value that is one greater than the maximum LBA in user accessible space. The maximum value placed in the words 100..103:

a) shall be 0000_FFFF_FFFF_FFFFh if bit 3 in word 69 is cleared to zero; and
b) may be 0000_0000_FFFF_FFFFh if bit 3 in word 69 is set to one.

Support of words 100..103 is mandatory if the 48-bit Address feature set is supported.

7.13.6.54 Word 104: Streaming Transfer Time – PIO

Word 104 is a copy of the PIO SECTOR TIME field (see 9.10.6.5).

7.13.6.55 Word 105: Max pages per DSM command

Word 105 is a copy of the MAX PAGES PER DSM COMMAND field (see 9.10.5.9.3).

7.13.6.56 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 the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP SUPPORTED bit (see 9.10.4.3.1).

Bit 12 of word 106 is a copy of the LOGICAL SECTOR SIZE SUPPORTED bit (see 9.10.4.3.2).

Bits 11:4 of word 106 are reserved.

Bits 3:0 of word 106 are a copy of the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP field (see 9.10.4.3.4).

7.13.6.57 Word 107: Inter-seek delay for ISO/IEC 7779 standard acoustic testing

Word 107 is the manufacturer’s recommended time delay between seeks in microseconds during ISO/IEC 7779 standard acoustic testing (i.e., the ISO/IEC 7779 value t_D (see ISO/IEC 7779:1999 (E))).

7.13.6.58 Words 108..111: World wide name

Words 108..111 are a copy of the WORLD WIDE NAME field (see 9.10.5.8)

7.13.6.59 Words 112..115: Reserved for extending the world wide name

Words 112..115 are reserved for extending the world wide name.

7.13.6.60 Word 116

Word 116 is obsolete.

7.13.6.61 Words 117..118: Logical sector size

Words 117..118 are a copy of the LOGICAL SECTOR SIZE field (see 9.10.4.4).

7.13.6.62 Word 119

Word 119 is described in 7.13.6.40.

7.13.6.63 Word 120

Word 120 is described in 7.13.6.41.

7.13.6.64 Words 121..126

Words 121..126 are reserved for expanded supported and enabled settings.

7.13.6.65 Word 127

Word 127 is obsolete.

7.13.6.66 Word 128: Security status

Support of word 128 is mandatory if the Security feature set is supported. If the Security feature set is not supported, word 128 shall be cleared to zero.

Bits 15:9 of word 128 are reserved.

Bit 8 of word 128 is a copy of the MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2).

Bits 7:6 of word 128 are reserved.

Bit 5 of word 128 is a copy of the ENHANCED SECURITY ERASE SUPPORTED bit (see 9.10.8.3.3).

Bit 4 of word 128 is a copy of the SECURITY COUNT EXPIRED bit (see 9.10.8.3.4).

Bit 3 of word 128 is a copy of the SECURITY FROZEN bit (see 9.10.8.3.5).

Bit 2 of word 128 is a copy of the SECURITY LOCKED bit (see 9.10.8.3.6).

Bit 1 of word 128 is a copy of the SECURITY ENABLED bit (see 9.10.8.3.7).

Bit 0 of word 128 is a copy of the SECURITY SUPPORTED bit (see 9.10.8.3.1).

7.13.6.67 Words 129..159

Words 129..159 are vendor specific.

7.13.6.68 Words 160..167

Words 160..167 are reserved for CFA.

7.13.6.69 Word 168: Device Nominal Form Factor

Bits 15:4 of 168 are reserved.

Bits 3:0 of word 168 is a copy of the NOMINAL FORM FACTOR field (see 9.10.5.5).

7.13.6.70 Word 169: DATA SET MANAGEMENT support

Bits 15:1 of 169 are reserved.

Bit 0 of word 169 is a copy of the TRIM SUPPORTED bit (see 9.10.5.9.2).

7.13.6.71 Words 170..173: Additional Product Identifier

Words 170..173 are a copy of the ADDITIONAL PRODUCT IDENTIFIER field (see 9.10.7.5).

7.13.6.72 Words 174..175

Words 174..175 are reserved.

7.13.6.73 Words 176..205: Current media serial number

Words 176..205 are the current media serial number. Media serial numbers shall be an ATA string of 60 bytes in the format defined by 3.4.9. The first 40 bytes shall indicate the media serial number and the remaining 20 bytes shall indicate the media manufacturer.

7.13.6.74 Word 206: SCT Command Transport

Bits 15:12 of word 206 are vendor specific.

Bits 11:6 of word 206 are reserved.

Bit 5 of word 206 is a copy of the SCT DATA TABLES SUPPORTED bit (see 9.10.5.16.5).

Bit 4 of word 206 is a copy of the SCT FEATURE CONTROL SUPPORTED bit (see 9.10.5.16.4).

Bit 3 of word 206 is a copy of the SCT ERROR RECOVERY CONTROL SUPPORTED bit (see 9.10.5.16.3).

Bit 2 of word 206 is a copy of the SCT WRITE SAME SUPPORTED bit (see 9.10.5.16.2).

Bit 1 of word 206 is obsolete.

Bit 0 of word 206 is a copy of the SCT SUPPORTED bit (see 9.10.5.16.1).

7.13.6.75 Word 209: Alignment of logical blocks within a physical block

Word 209 indicates the location of logical sector zero within the first physical sector of the media. See Annex C for more information. Word 209 is valid if the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP SUPPORTED bit (see 9.10.4.3.1) 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 are a copy of the LOGICAL SECTOR OFFSET field (see 9.10.4.3.5).

7.13.6.76 Words 210..211: Write-Read-Verify Sector Mode 3 Count

Words 210..211 are a copy of the WRV MODE 3 COUNT field (see 9.10.5.6).

7.13.6.77 Words 212..213: Write-Read-Verify Sector Mode 2 Count

Words 212..213 are a copy of the WRV MODE 2 COUNT field (see 9.10.5.7).

7.13.6.78 Words 214..216

Words 214..216 are obsolete.

7.13.6.79 Word 217: Nominal media rotation rate

Word 217 is a copy of the NOMINAL MEDIA ROTATION RATE field (see 9.10.5.4).

7.13.6.80 Word 218

Word 218 is reserved.

7.13.6.81 Word 219

Word 219 is obsolete.

7.13.6.82 Word 220

Bits 15:8 of word 220 are reserved.

Bits 7:0 of word 220 are a copy of the WRV MODE field (see 9.10.6.3.3).

7.13.6.83 Word 221

Word 221: reserved

7.13.6.84 Word 222: Transport major version number

If word 222 is not set to FFFFh, 0000h, or E000h, 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.

7.13.6.85 Word 223: Transport minor version number

Table 60 defines the value that shall be reported in word 223 to indicate the version of the standard that guided the implementation.

Table 60 — 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	ATA8-AST T13 Project D1697 Version 1
0052h..FFFEh	Reserved
FFFFh	Minor version not reported

7.13.6.86 Words 224..229

Words 224..229 are reserved.

7.13.6.87 Words 230..233: Extended Number of User Addressable Sectors

If word 69 bit 3 (see 7.13.6.30) 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.

7.13.6.88 Word 234: Minimum number of 512-byte data blocks per Download Microcode operation

Word 234 is a copy of the DM MINIMUM TRANSFER SIZE field (see 9.10.5.3.6).

7.13.6.89 Word 235: Maximum number of 512-byte data blocks per Download Microcode operation

Word 235 is a copy of the DM MAXIMUM TRANSFER SIZE field (see 9.10.5.3.5).

7.13.6.90 Words 236..254

Words 236..254 are reserved.

7.13.6.91 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 if the checksum is correct.

7.14 IDLE – E3h, Non-Data

7.14.1 Feature Set

This 28-bit command is for devices that support the Power Management feature set (see 4.17).

7.14.2 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.

See 4.9.4 for interactions with the EPC feature set.

7.14.3 Inputs

7.14.3.1 Overview

See table 61 for the IDLE command inputs.

Table 61 — IDLE command inputs

Field	Description
FEATURE	Reserved
COUNT	STANDBY TIMER PERIOD field – See 7.14.3.2
LBA	Reserved
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 E3h

7.14.3.2 STANDBY TIMER PERIOD field

If the host sets the STANDBY TIMER PERIOD field to a value greater than 00h, the device shall prepare to enable the Standby timer (see 4.17.3) and set the Standby timer to the period defined by table 62. If the host sets the STANDBY TIMER PERIOD field to 00h, the device shall disable the Standby timer.

Table 62 — STANDBY TIMER PERIOD field

Value	Description
00h	Standby timer disabled
01h-F0h	(value × 5) seconds (i.e., 5 s to 1 200 s (i.e., 20 min))
F1h-FBh	((value – 240) × 30) minutes (i.e., 30 min to 330 min (i.e., 5.5 h))
FCh	21 min
FDh	Between 8 h and 12 h
FEh	Reserved
FFh	21 min 15 s
Note – Times are approximate.	

7.14.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.14.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 361.

7.15 IDLE IMMEDIATE – E1h, Non-Data

7.15.1 Feature Set

This 28-bit command is for devices that support the Power Management feature set (see 4.17).

7.15.2 Description

7.15.2.1 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 4.9.4 for interactions with the EPC feature set.

7.15.2.2 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, the 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) retract the heads onto the ramp if the device implements unloading those heads onto a ramp;
d) park the heads in the landing zone if the device implements parking those heads 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 return command completion after the heads have been unloaded or parked.

7.15.3 Inputs (Default function)

See table 63 for the IDLE IMMEDIATE command inputs.

Table 63 — IDLE IMMEDIATE command inputs

Field	Description
FEATURE	N/A except when the Unload feature is requested, see 7.15.4
COUNT	N/A except when the Unload feature is requested, see 7.15.4
LBA	N/A except when the Unload feature is requested, see 7.15.4
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 E1h

7.15.4 Inputs (Unload feature)

See table 64 for the IDLE IMMEDIATE with the Unload feature command inputs.

Table 64 — IDLE IMMEDIATE with the Unload feature command inputs

Field	Description
FEATURE	44h
COUNT	00h
LBA	055_4E4Ch
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 E1h

7.15.5 Normal Outputs (Default function)

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.15.6 Normal Outputs (Unload feature)

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 350.

7.15.7 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 361.

7.16 MUTATE EXT - 96h, Non-Data

7.16.1 Feature Set

This 48-bit command is for devices that support the User Data Initialization feature set (see 4.29).

7.16.2 Description

As summarized in 4.29.3, the MUTATE EXT command:

a) translates the command inputs (see 7.16.3) into user data initialization operation inputs (see 4.29.2.2) based on the contents of the Mutate Configurations log (see 9.30); and
b) performs a user data initialization operation (see 4.29.2).

7.16.3 Inputs

7.16.3.1 Overview

See table 65 for MUTATE EXT command inputs.

Table 65 — MUTATE EXT command inputs

Field	Description
FEATURE	**Bit Description** 15:1 Reserved 0 REQUEST MAXIMUM ACCESSIBLE CAPACITY bit – See 7.16.3.2
COUNT	Reserved
LBA	**Bit Description** 47:32 Reserved 31:0 REQUESTED CONFIGURATION IDENTIFIER field – See 7.16.3.3
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 96h

7.16.3.2 REQUEST MAXIMUM ACCESSIBLE CAPACITY bit

A REQUEST MAXIMUM ACCESSIBLE CAPACITY bit cleared to zero specifies that the user data initialization operation should result in the accessible capacity being equal to the value in the DESIGNED ACCESSIBLE CAPACITY field (see 9.30.4.6). A REQUEST MAXIMUM ACCESSIBLE CAPACITY bit set to one specifies that the user data initialization operation shall result in the accessible capacity being set to the largest possible value based on the condition of the media being initialized.

7.16.3.3 REQUESTED CONFIGURATION IDENTIFIER field

The REQUESTED CONFIGURATION IDENTIFIER field specifies which Mutate Configuration descriptor (see 9.30.4) is used by the MUTATE EXT command. If the specified configuration identifier is not equal to the contents of any CONFIGURATION IDENTIFIER field (see 9.30.4.2) in the Mutate Configurations log (see 9.30), then the device shall return command aborted with the additional sense code set to INVALID FIELD IN CDB (see 6.8.17).

7.16.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.16.5 Error Outputs

If deferred microcode data (see 7.7) exists, then the MUTATE command shall return command aborted with the additional sense code set to LOGICAL UNIT NOT READY, MICROCODE ACTIVATION REQUIRED (see 6.8.23).

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See 7.16.3.3 and table 361.

7.17 NCQ NON-DATA – 63h, Non-Data

7.17.1 Overview

This 48-bit command is for devices that support the NCQ feature set (see 4.15).

7.17.2 Description

The NCQ NON-DATA command is a non-data NCQ command.

The queueing behavior of the device depends on which subcommand is specified. Some NCQ NON-DATA subcommands are executed as Immediate NCQ commands (see SATA 3.5). Some NCQ NON-DATA subcommands are processed as ordered NCQ commands.

7.17.3 Inputs

7.17.3.1 Overview

See table 66 for the NCQ NON-DATA command inputs.

Table 66 — NCQ NON-DATA command inputs

Field	Description
FEATURE	**Bit Description** 15:4 Subcommand specific 3:0 SUBCOMMAND field – See 7.17.3.2
COUNT	**Bit Description** 15:8 Subcommand specific 7:3 NCQ TAG field – See 7.17.3.3 2:0 Reserved
LBA	Subcommand specific
AUXILIARY	Subcommand specific
DEVICE	**Bit Description** 7 Reserved 6 Shall be set to one 5 Reserved 4 Shall be cleared to zero 3:0 Reserved
COMMAND	7:0 63h

7.17.3.2 Subcommand

Table 67 defines the NCQ NON-DATA subcommands.

Table 67 — NCQ NON-DATA Subcommands

Subcommand	Description	Processing order requirements [b]	Reference	
			Queued command [a]	Non-queued command
0h	ABORT NCQ QUEUE	immediate	7.17.11	none
1h	DEADLINE HANDLING	none	7.17.12	none
2h	HYBRID DEMOTE BY SIZE	none	7.17.8	none
3h	HYBRID CHANGE BY LBA RANGE	none	7.17.9	none
4h	HYBRID CONTROL	none	7.17.10	none
5h	SET FEATURES	none	7.45.1.6	7.45
6h	ZERO EXT	none	7.69.6	7.69
7h	ZAC Management Out	See ZAC-2	ZAC-2	ZAC-2
8h	DURABLE/ORDERED WRITE NOTIFICATION	none	7.17.13	none
9h..Fh	Reserved			

[a] see 4.15.6
[b] see 4.15.5

7.17.3.3 NCQ TAG field

The NCQ TAG field shall contain the NCQ Tag value for this 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 7.13.6.33).

7.17.4 Output from the Host to the Device Data Structure

The output from the host to the device is subcommand-specific.

7.17.5 Command Acceptance Outputs

The command acceptance outputs for this command are subcommand specific.

7.17.6 Normal Outputs

The normal outputs for this command are subcommand specific.

7.17.7 Error Outputs

The error outputs for this command are subcommand specific.

7.17.8 HYBRID DEMOTE BY SIZE – 63h/2h, Non-Data

7.17.8.1 Overview

This 48-bit command is for devices that support the NCQ feature set (see 4.15).

7.17.8.2 Description

The HYBRID DEMOTE BY SIZE command is a subcommand of the NCQ NON-DATA command.

Support for this command is indicated in the NCQ Non-Data log (see 9.17).

The HYBRID DEMOTE BY SIZE command shall affect only those NCQ commands for which the device has indicated command acceptance before accepting this NCQ NON-DATA command.

The HYBRID DEMOTE BY SIZE command is used to change the requested caching priority level associated with logical sectors. Support for this command is indicated in the NCQ NON-DATA log (see 9.17).

The device changes the caching priority level of logical sectors in the non-volatile cache from the value specified in the FROM PRIORITY field (see 7.17.8.3.2) to the value specified in the REQUESTED CACHING PRIORITY LEVEL field (see 7.17.8.4.3).

Table 68 specifies the number of logical sectors that should be demoted by the HYBRID DEMOTE BY SIZE field. The number of logical sectors demoted may be less than what is specified by the host.

Table 68 — HYBRID DEMOTE BY SIZE - Number of logical sectors affected

SECTOR COUNT field is less than actual [a]	Number of logical sectors to change to the To Priority [b]
Y	sector count [a]
N	actual number of logical sectors in the non-volatile cache associated with the from priority

[a] The value of the SECTOR COUNT field in the command parameters.
[b] the value of the REQUESTED CACHING PRIORITY LEVEL field (see 7.17.8.4).

7.17.8.3 Inputs

7.17.8.3.1 Overview

See table 69 for the HYBRID DEMOTE BY SIZE command inputs.

Table 69 — HYBRID DEMOTE BY SIZE command inputs

Field	Description
FEATURE	**Bit Description** 15:8 SECTOR COUNT field (7:0) - See 7.17.8.3.3 7:4 FROM PRIORITY field – See 7.17.8.3.2 3:0 SUBCOMMAND field – Shall be set to 2h
COUNT	**Bit Description** 15:8 SECTOR COUNT field (15:8) – See 7.17.8.3.3 7:3 NCQ TAG field – See 7.17.3.3 2:0 Reserved
LBA	Starting LBA
AUXILIARY	**Bit Description** 31:24 Reserved 23:16 HYBRID INFORMATION field – See 7.17.8.4 15:0 Reserved
DEVICE	**Bit Description** 7 Reserved 6 Shall be set to one 5 Reserved 4 Shall be cleared to zero 3:0 Reserved
COMMAND	7:0 63h

7.17.8.3.2 FROM PRIORITY field

The FROM PRIORITY field specifies the Hybird caching priority level corresponding to the data that is to be changed to the hybrid priority specified in the HYBRID INFORMATION field (see 7.17.8.4).

7.17.8.3.3 SECTOR COUNT field

The SECTOR COUNT field specifies the requested number of logical sectors that the change of requested caching priority level applies.

7.17.8.4 HYBRID INFORMATION field

7.17.8.4.1 HYBRID INFORMATION field overview

Table 70 describes the HYBRID INFORMATION field.

Table 70 — HYBRID INFORMATION field

AUXILIARY field bit	Description	Reference
23:22	Reserved for Serial ATA	
21	HYBRID INFORMATION IS VALID bit	7.17.8.4.2
20	Reserved for Serial ATA	
19:16	REQUESTED CACHING PRIORITY LEVEL field	7.17.8.4.3

7.17.8.4.2 HYBRID INFORMATION IS VALID bit

If:

a) the Hybrid Information feature is supported;
b) the Hybrid Information feature is enabled; and
c) the HYBRID INFORMATION IS VALID bit is set to one,

then the device shall process the REQUESTED CACHING PRIORITY LEVEL field. Otherwise, the device shall ignore the REQUESTED CACHING PRIORITY LEVEL field.

7.17.8.4.3 REQUESTED CACHING PRIORITY LEVEL field

7.17.8.4.3.1 REQUESTED CACHING PRIORITY LEVEL overview

If:

a) the Hybrid Information feature is supported;
b) the Hybrid Information feature is enabled; and
c) the HYBRID INFORMATION IS VALID bit is set to one,

then the REQUESTED CACHING PRIORITY LEVEL field contains the requested caching priority level.

Table 71 describes the interactions between the REQUESTED CACHING PRIORITY LEVEL field, the MAXIMUM CACHING PRIORITY LEVEL field, the MAX PRIORITY BEHAVIOR bit, the AVOID HYBRID SPINUP bit, and whether the rotating medium is accessible or not.

Table 71 — Interactions with the requested caching priority level

Requested caching priority [a]	Max priority behavior [b]	Avoid hybrid spinup	Rotating medium access [c]	Case	Reference
greater than maximum caching priority level [d]	n/a	n/a	n/a	1	7.17.8.4.3.2
equal to maximum caching priority level [d]	1	n/a	n/a	2	7.17.8.4.3.3
	0	0	n/a	3	7.17.8.4.3.4
		1	not accessible	4	7.17.8.4.3.5
			accessible	5	7.17.8.4.3.6
less than maximum caching priority level [d]	n/a	0	n/a	6	7.17.8.4.3.7
		1	not accessible	7	7.17.8.4.3.8
			accessible	8	7.17.8.4.3.9
equal to zero	n/a	n/a	n/a	9	7.17.8.4.3.10

[a] See 7.17.8.4.3
[b] See 9.19.2.11.3
[c] See 7.17.9.3.2
[d] See 9.19.2.8

7.17.8.4.3.2 Case 1

If the value of the REQUESTED CACHING PRIORITY LEVEL field is greater than the value of the MAXIMUM CACHING PRIORITY LEVEL field (see 9.19.2.8), then the device shall return command aborted.

7.17.8.4.3.3 Case 2

If:

a) the Hybrid Information feature is enabled;
b) the device processes a command, with the HYBRID INFORMATION IS VALID bit set to one and the value of the REQUESTED CACHING PRIORITY LEVEL field is equal to the value of the MAXIMUM CACHING PRIORITY LEVEL field (see 9.19.2.8); and
c) the MAX PRIORITY BEHAVIOR bit (see 9.19.2.11.3) is set to one,

then:

a) the device shall not evict logical sectors associated with the maximum caching priority level from the non-volatile cache in order to insert the logical sectors specified by the command into the non-volatile cache;
b) the device may evict logical sectors associated with a lower caching priority from the non-volatile cache in order to insert all of the logical sectors specified by the command into the non-volatile cache;
c) if:
   A) the logical sectors specified by the command are not currently in the non-volatile cache; and
   B) the device does not have capacity available for to add all of the requested logical sectors in the non-volatile cache,

   then the device shall return command aborted with the additional sense code set to INSUFFICIENT RESOURCES (see 6.8.14);

d) copy the requested logical sectors to the non-volatile cache if the logical sectors specified by the command are not currently in the non-volatile cache and the non-volatile cache has capacity available for all of the requested logical sectors; and
e) associate all of the logical sectors specified by the command with the requested caching priority level and return command complete without error.

7.17.8.4.3.4 Case 3

If:

a) the Hybrid Information feature is enabled;
b) the device processes a read command or a write command, with the HYBRID INFORMATION IS VALID bit set to one and the value of the REQUESTED CACHING PRIORITY LEVEL field is set to the value of the MAXIMUM CACHING PRIORITY LEVEL field (see 9.19.2.8);
c) the MAX PRIORITY BEHAVIOR bit (see 9.19.2.11.3) is cleared to zero; and
d) the AVOID HYBRID SPINUP bit (see 7.17.9.3.2), if any, is cleared to zero,

then the device:

a) may evict any logical sectors from the non-volatile cache in order to insert all of the logical sectors specified by the command into the non-volatile cache;
b) should put all of the specified logical sectors in the non-volatile cache; and
c) should associate all of the logical sectors that were put in the non-volatile cache with the requested caching priority level and return command complete without error.

7.17.8.4.3.5 Case 4

If:

a) the Hybrid Information feature is enabled;
b) the device processes a command, with the HYBRID INFORMATION IS VALID bit set to one and the value of the REQUESTED CACHING PRIORITY LEVEL field is set to the value of the MAXIMUM CACHING PRIORITY LEVEL field (see 9.19.2.8);
c) the MAX PRIORITY BEHAVIOR bit (see 9.19.2.11.3) is cleared to zero;
d) the AVOID HYBRID SPINUP bit (see 7.17.9.3.2) is set to one; and
e) the rotating medium is not accessible (e.g., disk is not spinning),

then the device shall:

a) not put the requested logical sectors in the non-volatile cache;
b) not associate any of the logical sectors with the requested caching priority level; and
c) return command complete without error.

7.17.8.4.3.6 Case 5

If:

a) the Hybrid Information feature is enabled;
b) the device processes a command, with the HYBRID INFORMATION IS VALID bit set to one and the value of the REQUESTED CACHING PRIORITY LEVEL field is set to the value of the MAXIMUM CACHING PRIORITY LEVEL field (see 9.19.2.8);
c) the MAX PRIORITY BEHAVIOR bit (see 9.19.2.11.3) is cleared to zero;
d) the AVOID HYBRID SPINUP bit (see 7.17.9.3.2) is set to one; and
e) the rotating medium is accessible (e.g., disk is spinning),

then:

1) the device may evict logical sectors from the non-volatile cache in order to insert all of the logical sectors specified by the command into the non-volatile cache with the requested caching priority level if the logical sectors in the non-volatile cache:
   A) have a lower requested caching priority level; or
   B) have the same requested caching priority level but the logical sectors in the non-volatile cache are older;
2) if the logical sectors specified by the command are not currently in the non-volatile cache, then the device:
   A) should put the requested logical sectors into the non-volatile cache; and
   B) may put the requested logical sectors into the non-volatile cache after returning command completion;
3) the device should associate all of the logical sectors specified by the command with the requested caching priority level; and

4) the device shall return command complete without error.

7.17.8.4.3.7 Case 6

If the Hybrid Information feature is enabled and the device processes a command, with:

a) the HYBRID INFORMATION IS VALID bit set to one;
b) the non-zero REQUESTED CACHING PRIORITY LEVEL field set less than the maximum caching priority level; and
c) the AVOID HYBRID SPINUP bit (see 7.17.9.3.2) is cleared to zero,

then:

1) the device may evict logical sectors from the non-volatile cache in order to insert all of the logical sectors specified by the command into the non-volatile cache with the requested caching priority level if the logical sectors in the non-volatile cache:
   A) have a lower requested caching priority level; or
   B) have the same requested caching priority level but are is older;
2) if the logical sectors specified by the command are not currently in the non-volatile cache, then the device:
   A) should put the requested logical sectors to the non-volatile cache; and
   B) may put the requested logical sectors to the non-volatile cache after returning command completion;
3) the device should associate all of the logical sectors specified by the command with the requested caching priority level; and
4) the device shall return command complete without error.

7.17.8.4.3.8 Case 7

If:

a) the Hybrid Information feature is enabled;
b) the device processes a command, with the HYBRID INFORMATION IS VALID bit set to one and the non-zero requested caching priority level is less than the maximum caching priority level;
c) the AVOID HYBRID SPINUP bit (see 7.17.9.3.2) is set to one; and
d) the rotating medium is not accessible (e.g., disk is not spinning),

then the device shall:

a) not put the requested logical sectors in the non-volatile cache;
b) not associate any of the logical sectors with the requested caching priority level; and
c) return command complete without error.

7.17.8.4.3.9 Case 8

If:

a) the Hybrid Information feature is enabled;
b) the device processes a rcommand, with the HYBRID INFORMATION IS VALID set to one and the requested caching priority level is less than the maximum caching priority level;
c) the AVOID HYBRID SPINUP bit (see 7.17.9.3.2) is set to one; and
d) the rotating medium is accessible (e.g., disk is spinning),

then:

1) the device may evict logical sectors from the non-volatile cache in order to insert all of the logical sectors specified by the command into the non-volatile cache with the requested caching priority level if the logical sectors in the non-volatile cache:
   A) have a lower requested caching priority level; or
   B) have the same requested caching priority level but is older;
2) if the logical sectors specified by the command are not currently in the non-volatile cache, then the device:
   A) should put the requested logical sectors to the non-volatile cache; and
   B) may put the requested logical sectors to the non-volatile cache after returning command completion;
3) the device should associate all of the logical sectors specified by the command with the requested caching priority level; and

4) the device shall return command complete without error.

7.17.8.4.3.10 Case 9

If the Hybrid Information feature is enabled and the device processes a command, with the HYBRID INFORMATION IS VALID bit set to one and the REQUESTED CACHING PRIORITY LEVEL field cleared to zero, then:

a) no requested caching priority level preference is specified; and
b) if the command is a write command, then the device should write to primary medium.

7.17.8.5 Command Acceptance Outputs

See table 353.

7.17.8.6 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 354.

7.17.8.7 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device sets the ERROR bit to one and aborts the command in response to an LBA out of range, a duplicate tag number, an invalid tag number (see table 382).

Errors that occur during the processing of this command are reported by returning a transport dependent indicator (see table 383) with additional information available in the NCQ Command Error log (see 9.14).

7.17.9 HYBRID CHANGE BY LBA RANGE – 63h/3h, Non-Data

7.17.9.1 Overview

This 48-bit command is for devices that support the NCQ feature set (see 4.15).

7.17.9.2 Description

The HYBRID CHANGE BY LBA RANGE command is a subcommand of the NCQ NON-DATA command.

Support for this command is indicated in the NCQ Non-Data Log (see 9.17).

The HYBRID CHANGE BY LBA RANGE command shall affect only those NCQ commands for which the device has indicated command acceptance before accepting this NCQ NON-DATA command.

The HYBRID CHANGE BY LBA RANGE command is used to change the hybrid information associated with a specified range of logical sectors.

The device sets the requested caching priority level associated with a number of logical sectors starting at the LBA specified by the STARTING LBA field, regardless of what requested caching priority level is associated with the selected logical sectors. The requested new requested caching priority level may be any valid caching priority.

The SECTOR COUNT field specifies the number of logical sectors that the device should change to the caching priority value specified in the REQUESTED CACHING PRIORITY LEVEL field (see 7.17.8.4.3).

The values of the MAX PRIORITY BEHAVIOR bit (see 9.19.2.11.3), the REQUESTED CACHING PRIORITY LEVEL field (see 7.17.8.4.3), and the AVOID HYBRID SPINUP bit (see 7.17.9.3.2) shall control the movement of all of the selected logical sectors that are not already in the non-volatile cache into the non-volatile cache as defined in table 72.

Table 72 — Cache Behavior

Requested caching priority level [a]	Max priority behavior [b]	Avoid hybrid spinup [c]	Description
Equal to maximum priority	1	N/A	See 7.17.8.4.3.3
	0	0	See 7.17.8.4.3.4
	0	1	See 7.17.8.4.3.5 and 7.17.8.4.3.6
Less than maximum priority but greater than zero	N/A	0	See 7.17.8.4.3.7
	N/A	1	The device shall not copy any of the selected logical sectors that are not already in the non-volatile cache if such movement causes the device to spin-up (see 7.17.8.4.3.5 and 7.17.8.4.3.6).
Zero	N/A	N/A	See 7.17.8.4.3.10

[a] See 7.17.8.4.3
[b] See 9.19.2.11.3
[c] See 7.17.9.3.2

If:

a) the REQUESTED CACHING PRIORITY LEVEL field (see 7.17.8.4.3) is set to the maximum priority;
b) the MAX PRIORITY BEHAVIOR bit (see 9.19.2.11.3) is set to one; and
c) the non-volatile cache does not have mapping resources,

then:

a) the device shall return command aborted; and
b) in the NCQ Command Error log (see 9.14), the device shall set the additional sense code to INSUFFICIENT RESOURCES (see 6.8.14).

If any of the selected logical sectors are already in the non-volatile cache associated with other HYBRID INFORMATION field (see 7.17.8.4) values, then the new values shall replace the previous values.

The device shall complete the requested changes and move the data, if needed, before returning command completed.

NOTE 7 — The device may take 30 seconds or more to complete the command if a large LBA range is specified. To minimize system response issues, large LBA ranges should be broken up into multiple smaller operations.

If the value of the REQUESTED CACHING PRIORITY LEVEL field (see 7.17.8.4.3) is cleared to zero, then the device may evict the selected logical sectors from the non-volatile cache.

7.17.9.3 Inputs

7.17.9.3.1 Overview

See table 73 for the HYBRID CHANGE BY LBA RANGE command inputs.

Table 73 — HYBRID CHANGE BY LBA RANGE command inputs

Field	Description
FEATURE	**Bit Description** 15:8 SECTOR COUNT field (7:0) – See 7.17.9.3.3 7:5 Reserved 4 AVOID HYBRID SPINUP bit – See 7.17.9.3.2 3:0 SUBCOMMAND field – Shall be set to 3h
COUNT	**Bit Description** 15:8 SECTOR COUNT field (15:8) – See 7.17.9.3.3 7:3 NCQ TAG field – See 7.17.3.3 2:0 Reserved
LBA	Starting LBA
AUXILIARY	**Bit Description** 31:24 Reserved 23:16 HYBRID INFORMATION field – See 7.17.8.4 15:0 Reserved
DEVICE	**Bit Description** 7 Reserved 6 Shall be set to one 5 Reserved 4 Shall be cleared to zero 3:0 Reserved
COMMAND	7:0 63h

7.17.9.3.2 AVOID HYBRID SPINUP bit

The AVOID HYBRID SPINUP bit specifies the movement or non-movement of logical sectors into the non-volatile cache (see table 72).

7.17.9.3.3 SECTOR COUNT field

The SECTOR COUNT field specifies the requested number of logical sectors, starting from starting LBA.

7.17.9.4 Command Acceptance Outputs

See table 353.

7.17.9.5 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 354.

7.17.9.6 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device sets the ERROR bit to one and aborts the command in response to an LBA out of range, a duplicate tag number, an invalid tag number, or an Interface CRC error (see table 382).

Errors that occur during the processing of this command are reported by returning a transport dependent indicator (see table 383) with additional information available in the NCQ Command Error log (see 9.14).

7.17.10 HYBRID CONTROL – 63h/4h, Non-Data

7.17.10.1 Overview

This 48-bit command is for devices that support the NCQ feature set (see 4.15).

7.17.10.2 Description

The HYBRID CONTROL command is a subcommand of the NCQ NON-DATA command.

Support for this command is indicated in the NCQ Non-Data Log (see 9.17).

The HYBRID CONTROL command shall affect only those NCQ commands for which the device has indicated command acceptance before accepting this NCQ NON-DATA command.

The HYBRID CONTROL command provides parameters for the use of the non-volatile cache.

In contrast, the SET FEATURES Enable/Disable Hybrid Information subcommand (see 7.45.16.10) provides a mechanism to enable or disable the Hybrid Information feature.

If the command completes without error, then the device shall preserve the values of the DIRTY LOW THRESHOLD field (see 7.17.10.3.3) and the DIRTY HIGH THRESHOLD field (see 7.17.10.3.4) across all resets and power cycle events. Current values are available (see 9.19).

7.17.10.3 Inputs

7.17.10.3.1 Overview

See table 74 for the HYBRID CONTROL command inputs.

Table 74 — HYBRID CONTROL command inputs

Field	Description
FEATURE	**Bit Description** 15:8 Reserved 7 DISABLE CACHING MEDIA field – See 7.17.10.3.2 6:4 Reserved 3:0 SUBCOMMAND field – Shall be set to 4h
COUNT	**Bit Description** 15:8 Reserved 7:3 NCQ TAG field – See 7.17.3.3 2:0 Reserved
LBA	**Bit Description** 47:16 Reserved 15:8 DIRTY HIGH THRESHOLD field – See 7.17.10.3.3 7:0 DIRTY LOW THRESHOLD field – See 7.17.10.3.4
AUXILIARY	Reserved
DEVICE	**Bit Description** 7 Reserved 6 Shall be set to one 5 Reserved 4 Shall be cleared to zero 3:0 Reserved
COMMAND	7:0 63h

7.17.10.3.2 DISABLE CACHING MEDIA bit

If the DISABLE CACHING MEDIA bit is cleared to zero, then the device shall process the DIRTY LOW THRESHOLD field and the DIRTY HIGH THRESHOLD field.

If the DISABLE CACHING MEDIA bit is set to one and the Hybrid Information feature is enabled, then the device shall:

1) ignore the contents of the DIRTY LOW THRESHOLD field and the DIRTY HIGH THRESHOLD field;
2) change the value of the ENABLED field (see 9.19.2.3) to 80h (i.e., Hybrid Information Disable In Process);

3) sync all dirty data in the non-volatile cache to the primary medium;
4) evict all data from the non-volatile cache;
5) disable the Hybrid Information feature (see 4.12);
6) change the value of the ENABLED field (see 9.19.2.3) to 00h (i.e., Hybrid Information Disabled); and
7) disable the use of the non-volatile cache for storing user data until the device processes a SET FEATURES Enable Hybrid Information subcommand (see 7.45.16.10.1).

If the device processes a reset or a power cycle while the value of the ENABLED field (see 9.19.2.3) is 80h (i.e., Hybrid Information Disable In Process), then the device shall change the value of the ENABLED field to FFh (i.e., Hybrid Information Enabled).

If the DISABLE CACHING MEDIA bit is set to one, then the device may report command completion before making the requested changes. The host should check the Hybrid Information log (see 9.19) to determine if the requested changes have been completed.

7.17.10.3.3 DIRTY LOW THRESHOLD field

The DIRTY LOW THRESHOLD field represents the threshold for the amount of dirty user logical sectors in the non-volatile cache that sync operations should stop. The value of the DIRTY LOW THRESHOLD field divided by 255 specifies a fraction of the total reported NVM Size of the non-volatile cache that contains dirty logical sectors.

The device shall preserve this setting over all power cycles and all resets. See 4.12.2 for additional information on syncing. The current value is reported in the Hybrid Information log (see 9.19).

7.17.10.3.4 DIRTY HIGH THRESHOLD field

The DIRTY HIGH THRESHOLD represents the threshold for the amount of dirty user logical sectors in the non-volatile cache that sync operations should begin. The value of the DIRTY HIGH THRESHOLD field divided by 255 specifies a fraction of the total reported NVM Size of the non-volatile cache that contains dirty data. The device shall preserve this setting over all power cycles and all resets. The current value is reported in the Hybrid Information log (see 9.19). See 4.12.2 for additional information on syncing.

7.17.10.4 Command Acceptance Outputs

See table 353.

7.17.10.5 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 354.

7.17.10.6 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device sets the ERROR bit to one and aborts the command in response to an LBA out of range, a duplicate tag number, an invalid tag number, or an Interface CRC error (see table 382).

Errors that occur during the processing of this command are reported by returning a transport dependent indicator (see table 383) with additional information available in the NCQ Command Error log (see 9.14).

7.17.11 ABORT NCQ QUEUE – 63h/0h, Non-Data

7.17.11.1 Overview

This 48-bit command is for devices that support the NCQ feature set (see 4.15).

7.17.11.2 Description

The ABORT NCQ QUEUE command is a subcommand of the NCQ NON-DATA command.

The ABORT NCQ QUEUE subcommand is an Immediate NCQ command (see SATA 3.5). Support for this subcommand is indicated in the SATA NCQ Non-Data Log (see 9.17).

The ABORT NCQ QUEUE command shall affect only those NCQ commands for which the device has indicated command acceptance before accepting this ABORT NCQ QUEUE command.

7.17.11.3 Inputs

7.17.11.3.1 Overview

See table 75 for the ABORT NCQ QUEUE command inputs.

Table 75 — ABORT NCQ QUEUE command inputs

Field	Description
FEATURE	**Bit Description** 15:8 Reserved 7:4 ABORT TYPE field – See 7.17.11.3.2 3:0 SUBCOMMAND field – Shall be set to 0h
COUNT	**Bit Description** 15:14 PRIO field – See 4.15.2 13:8 Reserved 7:3 NCQ TAG field – See 7.17.3.3 2:0 Reserved
LBA	**Bit Description** 47:8 Reserved 7:3 TTAG field – See 7.17.11.3.3 2:0 Reserved
AUXILIARY	Subcommand specific
DEVICE	**Bit Description** 7 Reserved 6 Shall be set to one 5 Reserved 4 Shall be cleared to zero 3:0 Reserved
COMMAND	7:0 63h

7.17.11.3.2 ABORT TYPE field

The ABORT TYPE field describes the action requested. Table 76 shows the defined abort types. The SATA NCQ Non-Data log (see 9.17) provides a list of abort types supported by the device.

Table 76 — ABORT NCQ QUEUE Abort Types

Abort Type	Name	Description
0h	Abort All	The device shall attempt to abort all outstanding NCQ commands.
1h	Abort Streaming	The device shall attempt to abort all outstanding NCQ Streaming commands. All non-streaming NCQ commands shall be unaffected.
2h	Abort Non-Streaming	The device shall attempt to abort all outstanding NCQ Non-Streaming commands. All NCQ Streaming commands shall be unaffected.
3h	Abort Selected	The device shall attempt to abort the outstanding NCQ command associated with the tag represented in TTAG field.
4h..Fh	Reserved	

7.17.11.3.3 TTAG field

The TTAG field contains the value of the NCQ Tag (see 4.15.1) of the outstanding command that is requested to be aborted.The TTAG value is only valid if the ABORT TYPE field is set to 3h (i.e., Abort Selected). TTAG shall not exceed the value specified in IDENTIFY DEVICE data word 75.

7.17.11.4 Command Acceptance Outputs

See table 353.

7.17.11.5 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 354.

7.17.11.6 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device sets the ERROR bit to one and aborts the command in response to an LBA out of range, a duplicate tag number, an invalid tag number, or an Interface CRC error (see table 382).

Errors that occur during the processing of this command are reported by returning a transport dependent indicator (see table 383) with additional information available in the NCQ Command Error log (see 9.14).

The device shall return command aborted if:

a) the NCQ feature set is disabled;
b) the value of the TTAG field equals the value of the TAG field;
c) the value of the TTAG field is an invalid NCQ Tag number; or
d) the ABORT TYPE field contains an unsupported value.

7.17.12 DEADLINE HANDLING – 63h/1h, Non-Data

7.17.12.1 Overview

This 48-bit command is for devices that support the NCQ feature set (see 4.15).

7.17.12.2 Description

The DEADLINE HANDLING command controls how NCQ Streaming commands are processed by the device.

The DEADLINE HANDLING command is a subcommand of the NCQ NON-DATA command.

Support for this subcommand is indicated in the NCQ Non-Data Log (see 9.17).

The DEADLINE HANDLING command shall affect only those NCQ commands for which the device has indicated command acceptance before accepting this NCQ NON-DATA command.

7.17.12.3 Inputs

7.17.12.3.1 Overview

See table 77 for the DEADLINE HANDLING command inputs.

Table 77 — DEADLINE HANDLING command inputs

Field	Description
FEATURE	**Bit Description** 15:6 Reserved 5 RDNC bit – See 7.17.12.3.3 4 WDNC bit – See 7.17.12.3.2 3:0 SUBCOMMAND field – Shall be set to 1h
COUNT	**Bit Description** 15:8 Reserved 7:3 NCQ TAG field – See 7.17.3.3 2:0 Reserved
LBA	Reserved
AUXILIARY	Subcommand specific
DEVICE	**Bit Description** 7 Reserved 6 Shall be set to one 5 Reserved 4 Shall be cleared to zero 3:0 Reserved
COMMAND	7:0 63h

7.17.12.3.2 WDNC bit

If the Write Data Not Continue (WDNC) bit is cleared to zero, then the device may allow WRITE FPDMA QUEUED command completion times to exceed the time specified by the ICC field (see 7.23.3.3 and 7.23.3.3). If the WDNC bit is set to one, then all WRITE FPDMA QUEUED commands with the PRIO field (see 4.15.2) set to 01b shall be completed by the time specified by the ICC field timer value in that WRITE FPDMA QUEUED command, otherwise the device shall return command aborted for all outstanding commands. The WDNC bit is only applicable to WRITE FPDMA QUEUED commands (see 7.61) with the PRIO field set to 01b (i.e., Isochronous – deadline dependent priority).

The state of the WDNC bit:

a) shall be preserved across:
   A) software resets; and
   B) COMRESETs if the SSP feature set (see 4.25) is enabled (see 7.45.16.6);
   and
b) shall not be preserved across power cycles.

The device shall ignore the WDNC bit for WRITE FPDMA QUEUED commands where the PRIO field is not set to 01b.

7.17.12.3.3 RDNC bit

If the Read Data Not Continue (RDNC) bit is cleared to zero, then the device may allow READ FPDMA QUEUED command completion times to exceed the time specified by the ICC field (see 7.23.3.3). If the RDNC bit is set to one, then all READ FPDMA QUEUED commands with the PRIO field (see 4.15.2) set to 01b shall be completed by the time specified by the ICC field timer value in that READ FPDMA QUEUED command, otherwise the device shall return command aborted for all outstanding commands. The RDNC bit is only applicable to READ FPDMA QUEUED commands (see 7.23) with the PRIO field set to 01b (i.e., Isochronous – deadline dependent priority).

The state of the RDNC bit:

a) shall be preserved across:
   A) software resets; and
   B) COMRESETs if the SSP feature set (see 4.25) is enabled (see 7.45.16.6);
   and
b) shall not be preserved across power cycles.

The device shall ignore the RDNC bit for READ FPDMA QUEUED commands where the PRIO field is not set to 01b.

7.17.12.4 Command Acceptance Outputs

See table 353.

7.17.12.5 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 354.

7.17.12.6 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device sets the ERROR bit to one and aborts the command in response to an LBA out of range, a duplicate tag number, an invalid tag number, or an Interface CRC error (see table 382).

Errors that occur during the processing of this command are reported by returning a transport dependent indicator (see table 383) with additional information available in the NCQ Command Error log (see 9.14).

The device shall return command aborted if:

a) the NCQ feature set is disabled; or
b) the ABORT TYPE field contains an unsupported value.

7.17.13 DURABLE/ORDERED WRITE NOTIFICATION – 63h/8h, Non-Data

7.17.13.1 Overview

This 48-bit command is for devices that support the NCQ feature set (see 4.15).

7.17.13.2 Description

The DURABLE/ORDERED WRITE NOTIFICATION subcommand provides all Group IDs to be used when processing the DURABLE/ORDERED WRITE NOTIFICATION subcommand. Support for this subcommand is indicated in the NCQ NON-DATA log (see 9.17).

If a DURABLE/ORDERED WRITE NOTIFICATION subcommand is marked by the host as high priority (i.e., the PRIO field is set to 10b), the device should attempt to provide better quality of service for the command than for other NCQ commands that are not marked by the host as high priority.

WRITE FPDMA QUEUED commands outstanding at the same time as a DURABLE/ORDERED WRITE NOTIFICATION subcommand may have data associated with any of the Group IDs provided by this command and may add data associated with those Group IDs to the volatile cache and may delay the completion of this command. If the device indicates command acceptance of multiple DURABLE/ORDERED WRITE NOTIFICATION subcommands with the same values in the GROUP ID MASK field, then the device shall complete all DURABLE/ORDERED WRITE NOTIFICATION subcommands with the same values in the GROUP ID MASK field concurrently.

NOTE 8 — This command may take more than 30 seconds to complete.

7.17.13.3 Inputs

7.17.13.3.1 Overview

See table 78 for the DURABLE/ORDERED WRITE NOTIFICATION command inputs.

Table 78 — DURABLE/ORDERED WRITE NOTIFICATION command inputs

Field	Description
FEATURE	**Bit Description** 15:8 GROUP ID MASK field (55:48) – See 7.17.13.3.4 7 D/OW bit – See 7.17.13.3.2 6:5 PRIO field – See 7.17.13.3.3 4 Reserved 3:0 SUBCOMMAND field – Shall be set to 8h
COUNT	**Bit Description** 15:8 GROUP ID MASK field (63:56) – See 7.17.13.3.4 7:3 NCQ TAG field – See 7.17.3.3 2:0 Reserved
LBA	**Bit Description** 47:40 GROUP ID MASK field (47:40) – See 7.17.13.3.4 39:32 GROUP ID MASK field (39:32) – See 7.17.13.3.4 31:24 GROUP ID MASK field (31:24) – See 7.17.13.3.4 23:16 GROUP ID MASK field (23:16) – See 7.17.13.3.4 15:8 GROUP ID MASK field (15:8) – See 7.17.13.3.4 7:0 GROUP ID MASK field (7:0) – See 7.17.13.3.4
AUXILIARY	Reserved
DEVICE	**Bit Description** 7 Reserved 6 Shall be set to one 5 Reserved 4 Shall be cleared to zero 3:0 Reserved
COMMAND	7:0 63h

7.17.13.3.2 D/OW bit

If the SUPPORTS D/OW bit (see 9.17.17) is cleared to zero or the D/OW bit is cleared to zero, the device shall not indicate successful completion until all data received and stored in the device's cache associated with any of the

Group IDs provided by this command has been flushed to the non-volatile media. If the volatile cache is disabled or no volatile cache is present, the device shall indicate command completion without error.

If the SUPPORTS D/OW bit is set one and the D/OW bit is set to one, then successful completion indicates that all data received and stored in the device's write cache associated with any of the Group IDs provided by this command shall be flushed to the non-volatile media before all data not yet received and stored in the device's write cache associated with any of the Group IDs provided by this command. If the volatile write cache is disabled or no volatile write cache is present, the device shall indicate command completion without error.

7.17.13.3.3 PRIO field

The PRIO field (see 4.15.2) value is assigned by the host based on the priority of the command issued. The device should complete high priority requests in a more timely fashion than normal priority and isochronous requests. If the PRIO field value is isochronous, then the device shall complete this command with command aborted (see 4.15.2).

7.17.13.3.4 GROUP ID MASK field

The GROUP ID MASK field of the durable/ordered write notification subcommand communicates the data targeted in the device's write cache. Data associated with a Group ID was specified during the WRITE FPDMA QUEUED command. The GROUP ID MASK field is bit-significant with each bit corresponding to a Group ID, where bit 0 corresponds to Group ID 0 and bit 63 corresponds to Group ID 63. More than one bit may be set to one.

7.17.13.4 Command Acceptance Outputs

See table 353.

7.17.13.5 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 354.

7.17.13.6 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device sets the ERROR bit to one and aborts the command in response to a duplicate tag number, an invalid tag number, or an Interface CRC error (see table 382).

Errors that occur during the processing of this command are reported by returning a transport dependent indicator (see table 383) with additional information available in the NCQ Command Error log (see 9.14).

The device shall return command aborted if:

a) the NCQ feature set is disabled; or
b) the ABORT TYPE field contains an unsupported value.

7.18 NOP – 00h, Non-Data

7.18.1 Feature Set

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

7.18.2 Description

The NOP command shall return command completion with an error.

7.18.3 Inputs

See table 79 for the NOP command inputs.

Table 79 — NOP command inputs

Field	Description
FEATURE	Subcommand Code **Value Description** 00h Return command aborted 01h..FFh Obsolete
COUNT	Value to be returned in the error outputs (see table 376)
LBA	Value to be returned in the error outputs (see table 376)
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 00h

7.18.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

When processed by a device, this command always returns command completion with an error.

7.18.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 376.

7.19 READ BUFFER – E4h, PIO Data-In

7.19.1 Feature Set

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

7.19.2 Description

The READ BUFFER command enables the host to read a 512-byte block of 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.

7.19.3 Inputs

See table 80 for the READ BUFFER command inputs.

Table 80 — READ BUFFER command inputs

Field	Description
FEATURE	N/A
COUNT	N/A
LBA	N/A
DEVICE	**Bit Description** 7:5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 E4h

7.19.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.19.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

A device may return command completion with the ERROR bit set to one if an Interface CRC error has occurred.

See table 362.

7.20 READ BUFFER DMA – E9h, DMA

7.20.1 Feature Set

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

7.20.2 Description

See 7.19.2.

7.20.3 Inputs

See table 81 for the READ BUFFER DMA command inputs.

Table 81 — READ BUFFER DMA command inputs

Field	Description
FEATURE	N/A
COUNT	N/A
LBA	N/A
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 E9h

7.20.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See 7.19.4.

7.20.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See 7.19.5.

7.21 READ DMA – C8h, DMA

7.21.1 Feature Set

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

7.21.2 Description

The READ DMA command allows the host to read data using the DMA data transfer protocol.

7.21.3 Inputs

See table 82 for the READ DMA command inputs.

Table 82 — READ DMA command inputs

Field	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 6.2.11 3:0 Reserved
COMMAND	7:0 C8h

7.21.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.21.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

If an unrecoverable error occurs while the device is processing this command, the device shall return command completion with the ERROR bit set to one and the LBA field set to the LBA of First Unrecoverable Error (see 6.7.2). The validity of the data transferred is indeterminate. See table 369.

7.22 READ DMA EXT – 25h, DMA

7.22.1 Feature Set

This 48-bit command is for devices that support the 48-bit Address feature set (see 4.3).

7.22.2 Description

The READ DMA EXT command allows the host to read data using the DMA data transfer protocol.

7.22.3 Inputs

7.22.3.1 Overview

See table 83 for the READ DMA EXT command inputs.

Table 83 — READ DMA EXT command inputs

Field	Description
FEATURE	**Bit Description** 15:4 Reserved 3 RARC bit – See 7.22.3.2 2:0 COMMAND DURATION LIMITS INDEX field – See 4.7.2
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
AUXILIARY	**Bit Description** 31:24 Reserved 23:16 HYBRID INFORMATION field – See 7.17.8.4 15:0 Reserved
DEVICE	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 25h

7.22.3.2 RARC bit

The RARC (Rebuild Assist Recovery Control) bit specifies how the device shall process read recovery attempts for this command. If the Rebuild Assist feature set:

a) is not supported (see 9.10.10.2.27); or
b) is supported and disabled (see 9.10.10.3.11),

then the RARC bit shall be ignored.

If the Rebuild Assist feature set is supported and enabled, the processing of the RARC bit is defined in see 4.19.

7.22.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 352.

7.22.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

If an unrecoverable error occurs while the device is processing this command, the device shall return command completion with the ERROR bit set to one and the LBA field set to the LBA of First Unrecoverable Error (see 6.7.2). The validity of the data transferred is indeterminate. See table 367.

7.23 READ FPDMA QUEUED – 60h, DMA Queued

7.23.1 Feature Set

This 48-bit command is for devices that support the NCQ feature set (see 4.15).

7.23.2 Description

The READ FPDMA QUEUED command requests that user data be transferred from the device to the host.

7.23.3 Inputs

7.23.3.1 Overview

See table 84 for the READ FPDMA QUEUED command inputs.

Table 84 — READ FPDMA QUEUED command inputs

Field	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** 15:14 PRIO field – See 4.15.2 13:8 Reserved 7:3 NCQ TAG field – See 7.17.3.3 2:1 Reserved 0 RARC bit – See 7.22.3.2
LBA	LBA of first logical sector to be transferred
ICC	See 7.23.3.3
AUXILIARY	**Bit Description** 31:24 Reserved 23:16 HYBRID INFORMATION field – See 7.17.8.4 15:3 Reserved 2:0 COMMAND DURATION LIMITS INDEX field – See 4.7.2
DEVICE	**Bit Description** 7 FUA bit – See 7.23.3.2 6 Shall be set to one 5 Reserved 4 Shall be cleared to zero 3:0 Reserved
COMMAND	7:0 60h

7.23.3.2 FUA bit

If the Forced Unit Access (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 the 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. If the FUA bit is cleared to zero, the data shall be retrieved either from the device's non-volatile media or cache.

7.23.3.3 ICC field

The Isochronous Command Completion (ICC) field is valid if the PRIO field is set to 01b. The ICC field is set by the host based on the intended deadline associated with the command issued. If a deadline has expired, the device shall continue to complete the command as soon as possible. This behavior may be modified by the host if the device supports the NCQ NON-DATA command (see 7.17) and supports the DEADLINE HANDLING subcommand (see 7.17.12). This subcommand allows the host to set whether the device shall abort or continue processing commands that have exceeded the time set by the ICC field.

There are several parameters encoded in the ICC field:

a) Fine or Coarse timing;
b) Interval;
c) Time Limit; and
d) Max Time.

The Interval indicates the time units of the Time Limit parameter.

If the ICC field bit 7 is cleared to zero, then:

a) the time interval is fine-grained;
b) Interval = 10 ms;
c) Time Limit = (ICC field (6:0) + 1) $\times$ 10 ms; and
d) Max Fine Time = 128 $\times$ 10 ms = 1.28 s.

If the ICC field bit 7 is set to one, then:

a) the time interval is coarse-grained;
b) Interval = 0.5 s;
c) Time Limit = (ICC field (6:0) + 1) $\times$ 0.5 s; and
d) Max Coarse Time = 128 $\times$ 0.5 s = 64 s.

7.23.4 Command Acceptance Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 353.

7.23.5 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 354.

7.23.6 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device sets the ERROR bit to one and aborts the command in response to an LBA out of range, a duplicate tag number, an invalid tag number, or an Interface CRC error (see table 382).

Errors that occur during the processing of this command are reported by returning a transport dependent indicator (see table 383) with additional information available in the NCQ Command Error log (see 9.14).

7.24 READ LOG EXT – 2Fh, PIO Data-In

7.24.1 Feature Set

This 48-bit command is for devices that support the GPL feature set (see 4.11).

7.24.2 Description

The READ LOG EXT command returns the specified log to the host. See table 218 for the list of logs.

7.24.3 Inputs

7.24.3.1 Overview

All the logs in this standard reserve the FEATURE field unless otherwise specified. See table 85 for the READ LOG EXT command inputs.

Table 85 — READ LOG EXT command inputs

Field	Description
FEATURE	If not defined by the log (see 9.1) specified by the LOG ADDRESS field, this field is reserved.
COUNT	LOG PAGE COUNT field – See 7.24.3.2
LBA	**Bit Description** 47:40 Reserved 39:32 PAGE NUMBER field (15:8) – See 7.24.3.4 31:16 Reserved 15:8 PAGE NUMBER field (7:0) – See 7.24.3.4 7:0 LOG ADDRESS field – See 7.24.3.3
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 2Fh

7.24.3.2 LOG PAGE COUNT field

The LOG PAGE COUNT field specifies the number of 512-byte log pages (see 9.1) to be read from the specified log. A value of zero is invalid (see 7.24.5).

7.24.3.3 LOG ADDRESS field

The LOG ADDRESS field specifies the log to be read as described in 9.1. 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 logs is mandatory for devices that support the associated feature set.

7.24.3.4 PAGE NUMBER field

The PAGE NUMBER field specifies the first page number to be read from the specified log (see 9.1).

7.24.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 352.

7.24.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

A device shall return command aborted if:

a) the feature set associated with the log (see 9.1) specified in the LOG ADDRESS field is not supported or not enabled; or
b) the values in other fields are invalid (e.g., the LOG PAGE COUNT field is cleared to zero).

Unless otherwise specified, a device shall return command aborted if the value in the PAGE NUMBER field plus the value in the LOG PAGE 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 368.

7.25 READ LOG DMA EXT – 47h, DMA

7.25.1 Feature Set

This 48-bit command is for devices that support the General Purpose Logging feature set (see 4.11).

7.25.2 Description

See 7.24.2.

The device processes the READ LOG DMA EXT command in the NCQ feature set environment (see 4.15.6) if the READ LOG DMA EXT command is encapsulated in a RECEIVE FPDMA QUEUED command (see 7.32) with the inputs encapsulated as shown in 7.25.6.

7.25.3 Inputs

All the logs in this standard reserve the FEATURE field unless otherwise specified. See table 86 for the READ LOG DMA EXT command inputs.

Table 86 — READ LOG DMA EXT command inputs

Field	Description
FEATURE	If this field is not defined by the log (see 9.1) specified by the LOG ADDRESS field, then this field is reserved.
COUNT	LOG PAGE COUNT field – See 7.24.3.2
LBA	**Bit Description** 47:40 Reserved 39:32 PAGE NUMBER field (15:8) – See 7.24.3.4 31:16 Reserved 15:8 PAGE NUMBER field (7:0) – See 7.24.3.4 7:0 LOG ADDRESS field – See 7.24.3.3
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 47h

7.25.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See 7.24.4.

7.25.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See 7.24.5.

If the READ LOG DMA EXT command is NCQ encapsulated (see 7.25.6), then:

a) the device sets the ERROR bit to one and aborts the command in response to an LBA out of range, a duplicate tag number, an invalid tag number, or an Interface CRC error (see table 382); and
b) errors that occur during the processing of this command are reported by returning a transport dependent indicator (see table 383) with additional information available in the NCQ Command Error log (see 9.14).

7.25.6 NCQ encapsulation

If a READ LOG DMA EXT command is processed in an NCQ environment as subcommand 01h of a RECEIVE FPDMA QUEUED command (see 7.32), the ATA command inputs are encapsulated as:

a) defined by the RECEIVE FPDMA QUEUED command for some inputs (e.g., the COUNT field); and
b) shown in table 87 for subcommand specific inputs.

Table 87 — RECEIVE FPDMA QUEUED command encapsulation for the subcommand specific inputs from a READ LOG DMA EXT command

RECEIVE FPDMA QUEUED field (see table 94)	READ LOG DMA EXT field (see table 86), if any
LBA	LBA
AUXILIARY (15:0)	FEATURE
AUXILIARY (31:16)	Reserved

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

7.26.1 Feature Set

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

7.26.2 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.

7.26.3 Inputs

See table 88 for the READ SECTOR(S) command inputs.

Table 88 — READ SECTOR(S) command inputs

Field	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 6.2.11 3:0 Reserved
COMMAND	7:0 20h

7.26.4 Outputs

7.26.5 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.26.6 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

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 369.

7.27 READ SECTOR(S) EXT – 24h, PIO Data-In

7.27.1 Feature Set

This 48-bit command is for devices that support the 48-bit Address feature set (see 4.3).

7.27.2 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.

7.27.3 Inputs

See table 89 for the READ SECTOR(S) EXT command inputs.

Table 89 — READ SECTOR(S) EXT command inputs

Field	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 6.2.11 3:0 Reserved
COMMAND	7:0 24h

7.27.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 352.

7.27.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

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 378.

7.28 READ STREAM DMA EXT – 2Ah, DMA

7.28.1 Feature Set

This 48-bit command is for devices that support the Streaming feature set (see 4.27).

7.28.2 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.

7.28.3 Inputs

7.28.3.1 Inputs Overview

See table 90 for the READ STREAM DMA EXT command inputs.

Table 90 — READ STREAM DMA EXT command inputs

Field	Description
FEATURE	**Bit Description** 15:8 COMMAND CCTL field – See 7.28.3.2 7 Obsolete 6 READ CONTINUOUS bit – See 7.28.3.3 5 NOT SEQUENTIAL bit – See 7.28.3.4 4 Obsolete 3 Reserved 2:0 STREAM ID field – See 7.28.3.5
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 6.2.11 3:0 Reserved
COMMAND	7:0 2Ah

7.28.3.2 COMMAND CCTL field

The COMMAND CCTL field specifies the time allowed for the device to process the command before reporting command completion.

If the COMMAND CCTL field is not cleared to zero, then the device shall return command completion within ((the contents of the COMMAND CCTL field) × (the contents of the STREAM GRANULARITY field (see 9.10.6.8))) μs. The device shall measure the time before reporting command completion from command acceptance.

If the COMMAND CCTL field is cleared to zero, and the DEFAULT CCTL field was not cleared to zero in the most recent CONFIGURE STREAM command (see 7.4) for the stream specified by the STREAM ID field, then the device shall return command completion within the time specified by the DEFAULT CCTL field (see 7.4.3.4).

The result is vendor specific if:

a) the COMMAND CCTL field is cleared to zero, and the DEFAULT CCTL field was cleared to zero in the most recent CONFIGURE STREAM command (see 7.4) for the stream specified by the STREAM ID field; or
b) the COMMAND CCTL field is cleared to zero and no previous CONFIGURE STREAM command was used to specify a default CCTL for the stream specified by the STREAM ID field.

7.28.3.3 READ CONTINUOUS bit

If the READ CONTINUOUS 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 COMMAND CCTL field (see 7.28.3.2), or the DEFAULT CCTL field (see 7.4.3) 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 return command completion after all data for the command has been transferred; and
   4) shall save the error information in the Read Streaming Error log;

   and
c) if the amount of time allowed for command completion based on the setting of the COMMAND CCTL field (see 7.28.3.2) or the DEFAULT CCTL field (see 7.4.3) is reached, then the device:
   1) shall stop processing the command;
   2) shall return command completion; and
   3) shall set the COMMAND COMPLETION TIME OUT bit in the Read Streaming Error log to one.

If the READ CONTINUOUS bit is cleared to zero and an error occurs, then the device:

a) may continue transferring data; and
b) shall return command completion after the data transfer has been completed.

7.28.3.4 NOT SEQUENTIAL bit

If the NOT SEQUENTIAL bit is set to one, the next read stream command that specifies the same stream in the STREAM ID field may not be sequential in the LBA space. If the NOT SEQUENTIAL bit is cleared to zero, the device may perform operations (e.g., read ahead operations) that anticipate the next read stream command with the same stream in the STREAM ID field to 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 NOT SEQUENTIAL bit is vendor specific.

7.28.3.5 STREAM ID field

The STREAM ID field specifies the stream to be read. The device shall operate according to the parameters specified by the most recent CONFIGURE STREAM command specifying this stream in the STREAM ID field that returned command completion without error.

7.28.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 348.

7.28.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

If:

a) the READ CONTINUOUS bit was set to one in the read stream command, and
b) the device is able to return the amount of data requested for the read stream 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 READ CONTINUOUS bit was set to one in the read stream command, and
b) the device is not able to return the amount of data requested for the read stream 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 READ CONTINUOUS bit was cleared to zero;
b) the COMMAND CCTL field (see 7.28.3.2) was not cleared to zero, or the COMMAND CCTL field was cleared to zero and the DEFAULT CCTL field (see 7.4.3) specified in the most recent CONFIGURE STREAM command (see 7.4) for this stream was not cleared to zero; and
c) the time specified for command completion by the COMMAND CCTL field or the DEFAULT CCTL field has been reached,

in the read stream command, then the device shall clear the STREAM ERROR bit to zero, set the ERROR bit to one, and set:

a) the COMMAND COMPLETION TIME OUT bit to one; or
b) the ABORT bit to one.

If:

a) the READ CONTINUOUS bit was cleared to zero;
b) the COMMAND CCTL field was cleared to zero; and
c) the DEFAULT CCTL field was cleared to zero in the most recent CONFIGURE STREAM command (see 7.4) for this stream,

in the read stream 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 370.

7.29 READ STREAM EXT – 2Bh, PIO Data-In

7.29.1 Feature Set

This 48-bit command is for devices that support the Streaming feature set (see 4.27).

7.29.2 Description

See 7.28.2.

7.29.3 Inputs

See table 91 for the READ STREAM EXT command inputs.

Table 91 — READ STREAM EXT command inputs

Field	Description
FEATURE	**Bit Description** 15:8 COMMAND CCTL field – See 7.28.3.2 7 Obsolete 6 READ CONTINUOUS bit – See 7.28.3.3 5 NOT SEQUENTIAL bit – See 7.28.3.4 4 Obsolete 3 Reserved 2:0 STREAM ID field – See 7.28.3.5
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 6.2.11 3:0 Reserved
COMMAND	7:0 2Bh

7.29.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See 7.28.4.

7.29.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See 7.28.5.

7.30 READ VERIFY SECTOR(S) – 40h, Non-Data

7.30.1 Feature Set

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

7.30.2 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 host. 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.

7.30.3 Inputs

See table 92 for the READ VERIFY SECTOR(S) command inputs.

Table 92 — READ VERIFY SECTOR(S) command inputs

Field	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 6.2.11 3:0 Reserved
COMMAND	7:0 40h

7.30.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.30.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 369.

7.31 READ VERIFY SECTOR(S) EXT – 42h, Non-Data

7.31.1 Feature Set

This 48-bit command is for devices that support the 48-bit Address feature set (see 4.3).

7.31.2 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 host. 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.

7.31.3 Inputs

See table 93 for the READ VERIFY SECTOR(S) EXT command inputs.

Table 93 — READ VERIFY SECTOR(S) EXT command inputs

Field	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 6.2.11 3:0 Reserved
COMMAND	7:0 42h

7.31.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 352.

7.31.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 378.

7.32 RECEIVE FPDMA QUEUED – 65h, DMA Queued

7.32.1 Overview

This 48-bit command is for devices that support the NCQ feature set (see 4.15).

7.32.2 Description

The RECEIVE FPDMA QUEUED command requests that data to be transferred from the device to the host in 512-byte data units.

Some RECEIVE FPDMA QUEUED subcommands are processed as sequential NCQ commands (see 4.15.5).

Some RECEIVE FPDMA QUEUED subcommands are processed as ordered NCQ commands (see 4.15.5).

7.32.3 Inputs

7.32.3.1 Overview

See table 94 for the RECEIVE FPDMA QUEUED command inputs.

Table 94 — RECEIVE FPDMA QUEUED command inputs

Field	Description
FEATURE	The number of 512-byte blocks of data to be transferred. A value of 0000h indicates that 65_536 512-byte blocks of data are to be transferred
COUNT	**Bit Description** 15:14 PRIO field – See 4.15.2 13 Reserved 12:8 SUBCOMMAND field – See 7.32.3.2 7:3 NCQ TAG field – See 7.17.3.3 2:0 Reserved
LBA	Subcommand specific
AUXILIARY	Subcommand specific
DEVICE	**Bit Description** 7 Reserved 6 Shall be set to one 5 Reserved 4 Shall be cleared to zero 3:0 Reserved
COMMAND	7:0 65h

7.32.3.2 Subcommand

Table 95 defines the RECEIVE FPDMA QUEUED subcommands.

Table 95 — RECEIVE FPDMA QUEUED Subcommands

Subcommand	Description	Processing order requirements [b]	Reference	
			Queued command [a]	Non-queued command
00h	Reserved			
01h	READ LOG DMA EXT	sequential	7.25.6	7.25
02h	ZAC Management In	See ZAC-2	ZAC-2	ZAC-2
03h..1Fh	Reserved			

[a] see 4.15.6
[b] see 4.15.5

7.32.4 Command Acceptance Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 353.

7.32.5 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 354.

7.32.6 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device sets the ERROR bit to one and aborts the command in response to an invalid value in the SUBCOMMAND field, a duplicate tag number, an invalid tag number, or an Interface CRC error (see table 382).

Errors that occur during the processing of this command are reported by returning a transport dependent indicator (see table 383) with additional information available in the NCQ Command Error log (see 9.14).

7.33 REMOVE ELEMENT AND TRUNCATE – 7Ch, Non-Data

7.33.1 Feature Set

This 48-bit command is for devices that support the Storage Element Depopulation feature set (see 4.26).

7.33.2 Description

The REMOVE ELEMENT AND TRUNCATE command requests that the device depopulate a storage element and truncate the capacity of the device as described in 4.26.

7.33.3 Inputs

7.33.3.1 Inputs Overview

See table 96 for the REMOVE ELEMENT AND TRUNCATE command inputs.

Table 96 — REMOVE ELEMENT AND TRUNCATE command inputs

Field	Description
FEATURE	ELEMENT IDENTIFIER field (31:16) – See 7.33.3.2
COUNT	ELEMENT IDENTIFIER field (15:0) – See 7.33.3.2
LBA	REQUESTED MAX LBA field – See 7.33.3.3
DEVICE	**Bit Description** 7 Obsolete 6 Reserved 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 7Ch

7.33.3.2 ELEMENT IDENTIFIER field

The ELEMENT IDENTIFIER field specifies the identifier associated with the storage element to be depopulated.

If the ELEMENT IDENTIFIER field specifies a physical element that is not a storage element (i.e., the PHYSICAL ELEMENT TYPE field (see 7.12.6.5.4) is not set to 01h in the corresponding physical element status descriptor) or specifies a physical element not supported by the device, then the device shall return command aborted with the additional sense code set to INVALID FIELD IN CDB (see 6.8.17).

If the ELEMENT IDENTIFIER field specifies an element that is depopulated, then the device shall not take any action and the command shall complete without error.

7.33.3.3 REQUESTED MAX LBA field

The REQUESTED MAX LBA field is used to specify the maximum LBA after completion of this command without error.

A value of zero specifies that the device shall choose a single value for the native max address and the accessible max address. A non-zero value specifies that the device shall:

a) set:
   A) the native max address to the specified value; and
   B) the accessible max address to the specified value;

   or

b) return command aborted with the additional sense code set to INVALID FIELD IN CDB (see 6.8.17), and not change the native max address or the accessible max address.

7.33.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.33.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

A REMOVE ELEMENT AND TRUNCATE command shall return command aborted with the additional sense code set to LOGICAL UNIT NOT READY, MICROCODE ACTIVATION REQUIRED (see 6.8.23) if the FW ACTIVATION PENDING bit (see 9.10.6.2.5) is set to one.

See table 361.

7.34 REQUEST SENSE DATA EXT – 0Bh, Non-Data

7.34.1 Feature Set

This 48-bit command is for devices that support the Sense Data Reporting feature set (see 4.24).

7.34.2 Description

The REQUEST SENSE DATA EXT command allows the reporting of the most recent sense data from the device.

7.34.3 Inputs

See table 97 for the REQUEST SENSE DATA EXT command inputs.

Table 97 — REQUEST SENSE DATA EXT command inputs

Field	Description
FEATURE	Reserved
COUNT	Reserved
LBA	Reserved
DEVICE	**Bit Description** 7:5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 0Bh

7.34.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

If sense data is available (see 4.24), then:

a) the DEFERRED ERROR bit shall be set as defined in 4.24.2; and
b) the SENSE KEY field, ADDITIONAL SENSE CODE field, and ADDITIONAL SENSE CODE QUALIFIER field shall be set to values that are defined in SPC-5.

Otherwise, the DEFERRED ERROR bit, SENSE KEY field, ADDITIONAL SENSE CODE field, and ADDITIONAL SENSE CODE QUALIFIER field shall be cleared to zero.

See table 355.

7.34.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 361.

7.35 RESTORE ELEMENTS AND REBUILD – 7Dh, Non-Data

7.35.1 Feature Set

This 48-bit command is for devices that support the Storage Element Depopulation feature set (see 4.26).

7.35.2 Description

The RESTORE ELEMENTS AND REBUILD command requests that the device restore previously depopulated storage elements and rebuild the capacity of the device as described in 4.26.

7.35.3 Inputs

See table 98 for the RESTORE ELEMENTS AND REBUILD command inputs.

Table 98 — RESTORE ELEMENTS AND REBUILD command inputs

Field	Description
FEATURE	Reserved
COUNT	Reserved
LBA	Reserved
DEVICE	**Bit** **Description** 7 Obsolete 6 Reserved 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 7Dh

7.35.4 Normal Outputs

For a RESTORE ELEMENTS AND REBUILD command, the device shall return command completion without error if:

a) the device has no depopulated storage elements; or
b) at least one depopulated storage element has the RESTORATION ALLOWED bit (see 7.12.6.5.3) set to one.

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 358.

7.35.5 Error Outputs

A RESTORE ELEMENTS AND REBUILD command shall be terminated with an error with the additional sense code set to COMMAND SEQUENCE ERROR if:

a) the device has at least one depopulated storage element; and
b) all depopulated storage elements have the RESTORATION ALLOWED bit (see 7.12.6.5.3) cleared to zero.

A RESTORE ELEMENTS AND REBUILD command shall return command aborted with the additional sense code set to LOGICAL UNIT NOT READY, MICROCODE ACTIVATION REQUIRED (see 6.8.23) if the FW ACTIVATION PENDING bit (see 9.10.6.2.5) is set to one.

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 361.

7.36 Sanitize Device

7.36.1 Sanitize Device Overview

Individual Sanitize Device feature set commands are identified by the value specified in the FEATURE field. Table 99 shows these FEATURE field values.

Table 99 — Sanitize Device FEATURE field values

Value	Command
0000h	SANITIZE STATUS EXT (see 7.36.7)
0001h..0010h	Reserved
0011h	CRYPTO SCRAMBLE EXT (see 7.36.3)
0012h	BLOCK ERASE EXT (see 7.36.2)
0013h	Reserved
0014h	OVERWRITE EXT (see 7.36.4)
0015h..001Fh	Reserved
0020h	SANITIZE FREEZE LOCK EXT (see 7.36.6)
0021h..003Fh	Reserved
0040h	SANITIZE ANTIFREEZE LOCK EXT (see 7.36.5)
0041h..FFFFh	Reserved

7.36.2 BLOCK ERASE EXT – B4h/0012h, Non-Data

7.36.2.1 Feature Set

This 48-bit command is for devices that support the Sanitize Device feature set (see 4.20).

7.36.2.2 Description

The BLOCK ERASE EXT command starts a block erase sanitize operation (i.e., a sanitize operation (see 4.20.4) that uses the block erase method on the user data areas, including user data areas that are not currently allocated (e.g., previously allocated areas and physical sectors that have become inaccessible)) to cause the user data to become unretrievable.

The BLOCK ERASE EXT command shall only be reported as supported if the internal media supports block erase (i.e., an internal operation that sets the contents of a block of the internal media to a vendor specific value and may precondition the internal media for subsequent write operations).

After a block erase operation has been successfully completed, the contents of the user data area are indeterminate.

The BLOCK ERASE EXT command shall only start a block erase sanitize operation if:

a) the Sanitize Device feature set is supported;
b) the BLOCK ERASE EXT command is supported;
c) LBA field bits 31:0 are set to 426B_4572h;
d) the device is in the SD0: Sanitize Idle state (see 4.20.10.2), the SD3: Sanitize Operation Failed state (see 4.20.10.5), or the SD4: Sanitize Operation Succeeded state (see 4.20.10.6); and
e) the device is in:
    A) the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5);
    B) the SEC2: Security Disabled/Not Locked/Frozen state (see 4.22.11.6);
    C) the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8) with:
        a) the RESTRICTED SANITIZE OVERRIDES SECURITY bit set to one (see 9.10.8.7.8); and
        b) the FAILURE MODE bit cleared to zero (see 7.36.2.3.3);
    D) the SEC5: Security Enabled/Not Locked/Not Frozen state (see 4.22.11.9); or
    E) the SEC6: Security Enabled/Not Locked/Frozen state (see 4.22.11.10).

See 7.68.2.1 for a description of the interactions between the BLOCK ERASE EXT command and the WRITE UNCORRECTABLE EXT command.

7.36.2.3 Inputs

7.36.2.3.1 Overview

See table 100 for the BLOCK ERASE EXT command inputs.

Table 100 — BLOCK ERASE EXT command inputs

Field	Description
FEATURE	0012h
COUNT	**Bit Description** 15 ZONED NO RESET bit – See 7.36.2.3.2 14:5 Reserved 4 FAILURE MODE bit – See 7.36.2.3.3 3:0 Reserved
LBA	**Bit Description** 47:32 Reserved 31:0 Shall be set to 426B_4572h (DWord)
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 B4h

7.36.2.3.2 ZONED NO RESET bit

For an ATA device that is a zoned device (see ZAC-2), if the ZONED NO RESET bit is:

a) cleared to zero, then as part of completing a sanitize operation (see 4.20.4) the device shall perform the equivalent of a RESET WRITE POINTERS EXT command (see ZAC-2) with the RESET ALL bit set to one; or
b) set to one, then as part of completing a sanitize operation initiated by:
   A) a CRYPTO SCRAMBLE EXT command (see 7.36.3) the device shall not modify the write pointer for any write pointer zone (see ZAC-2) unless otherwise specified (e.g., a write pointer zone that has a Zone Condition of OFFLINE); or
   B) a BLOCK ERASE EXT command (see 7.36.2) or an OVERWRITE EXT command (see 7.36.4) the device shall perform the equivalent of a FINISH ZONE EXT command (see ZAC-2) with the FINISH ALL bit set to one.

The contents of the ZONED NO RESET bit shall not affect the processing performed by an ATA device that is not a zoned device.

7.36.2.3.3 FAILURE MODE bit

The contents of the FAILURE MODE bit in the command that causes the Sanitize Device state machine to take the SD0:SD2 transition (see 4.20.10.2) shall be stored as the Failure Mode Policy value (see 4.20.8).

7.36.2.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 357.

7.36.2.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device shall return command aborted if:

a) the device does not support the Sanitize feature set;
b) the device does not support the BLOCK ERASE EXT command;
c) the value of LBA field bits 31:0 is not set to 426B_4572h;
d) deferred microcode data exists (see 7.7);
e) the device is in:
    A) the SD1: Sanitize Frozen state (see 4.20.10.3); or
    B) the SD2: Sanitize Operation In Progress state (see 4.20.10.4);
f) the following conditions exist:
    A) the device is in the SD3: Sanitize Operation Failed state (see 4.20.10.5) or the SD4: Sanitize Operation Succeeded state (see 4.20.10.6);
    B) the Failure Mode Policy value (see 4.20.8) is zero; and
    C) the FAILURE MODE bit is set to one (see 7.36.2.3.3);

    or
g) the device is in the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8) and:
    A) the RESTRICTED SANITIZE OVERRIDES SECURITY bit is cleared to zero (see 9.10.8.7.8); or
    B) the RESTRICTED SANITIZE OVERRIDES SECURITY bit is set to one and the FAILURE MODE bit set to one (see 7.36.2.3.3).

See table 385.

7.36.3 CRYPTO SCRAMBLE EXT – B4h/0011h, Non-Data

7.36.3.1 Feature Set

This 48-bit command is for devices that support the Sanitize Device feature set (see 4.20).

7.36.3.2 Description

The CRYPTO SCRAMBLE EXT command starts a crypto scramble sanitize operation (i.e., a sanitize operation (see 4.20.4) that changes the internal encryption keys that are used for user data) causing the user data to become unretrievable.

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 crypto scramble sanitize operation, 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;
b) the CRYPTO SCRAMBLE EXT command is supported;
c) LBA field bits 31:0 are set to 4372_7970h;
d) the device is in the SD0: Sanitize Idle state (see 4.20.10.2), the SD3: Sanitize Operation Failed state (see 4.20.10.5), or the SD4: Sanitize Operation Succeeded state (see 4.20.10.6); and
e) the device is in:
   A) the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5);
   B) the SEC2: Security Disabled/Not Locked/Frozen state (see 4.22.11.6);
   C) the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8) with:
      a) the RESTRICTED SANITIZE OVERRIDES SECURITY bit set to one (see 9.10.8.7.8); and
      b) the FAILURE MODE bit cleared to zero (see 7.36.2.3.3);
   D) the SEC5: Security Enabled/Not Locked/Not Frozen state (see 4.22.11.9); or
   E) the SEC6: Security Enabled/Not Locked/Frozen state (see 4.22.11.10).

See 7.68.2.1 for a description of the interactions between the CRYPTO SCRAMBLE EXT command and the WRITE UNCORRECTABLE EXT command.

7.36.3.3 Inputs

See table 101 for the CRYPTO SCRAMBLE EXT command inputs.

Table 101 — CRYPTO SCRAMBLE EXT command inputs

Field	Description
FEATURE	0011h
COUNT	**Bit Description** 15 ZONED NO RESET bit – See 7.36.2.3.2 14:5 Reserved 4 FAILURE MODE bit – See 7.36.2.3.3 3:0 Reserved
LBA	**Bit Description** 47:32 Reserved 31:0 Shall be set to 4372_7970h (DWord)
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 B4h

7.36.3.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 357.

7.36.3.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device shall return command aborted if:

a) the device does not support the Sanitize feature set;
b) the device does not support the CRYPTO SCRAMBLE EXT command;
c) the value of LBA field bits 31:0 is not set to 4372_7970h;
d) deferred microcode data exists (see 7.7);
e) the device is in:
   A) the SD1: Sanitize Frozen state (see 4.20.10.3); or
   B) the SD2: Sanitize Operation In Progress state (see 4.20.10.4);

f) the following conditions exist:
   A) the device is in the SD3: Sanitize Operation Failed state (see 4.20.10.5) or the SD4: Sanitize Operation Succeeded state (see 4.20.10.6);
   B) the Failure Mode Policy value (see 4.20.8) is zero; and
   C) the FAILURE MODE bit is set to one (see 7.36.2.3.3);

   or
g) the device is in the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8) and:
   A) the RESTRICTED SANITIZE OVERRIDES SECURITY bit is cleared to zero (see 9.10.8.7.8); or
   B) the RESTRICTED SANITIZE OVERRIDES SECURITY bit is set to one and the FAILURE MODE bit set to one (see 7.36.2.3.3).

See table 385.

7.36.4 OVERWRITE EXT – B4h/0014h, Non-Data

7.36.4.1 Feature Set

This 48-bit command is for devices that support the Sanitize Device feature set (see 4.20).

7.36.4.2 Description

The OVERWRITE EXT command starts an overwrite sanitize operation (i.e., a sanitize operation (see 4.20.4) to overwrite the internal media with a constant value) that fills physical sectors within the Sanitize operation scope (see 4.20.2) with a four byte pattern specified by the OVERWRITE PATTERN field (see 7.36.4.3.5) of the command.

The host also specifies a count for multiple overwrites (see 7.36.4.3.4) and whether to invert the four byte pattern between consecutive overwrite passes (see 7.36.4.3.2).

After a successful overwrite sanitize operation, affected data blocks shall be readable without error.

The OVERWRITE EXT command shall only start an overwrite sanitize operation if:

a) the Sanitize Device feature set is supported;
b) the OVERWRITE EXT command is supported;
c) the value of the LBA field bits 47:32 is set to 4F57h;
d) the device is in the SD0: Sanitize Idle state (see 4.20.10.2), the SD3: Sanitize Operation Failed state (see 4.20.10.5), or the SD4: Sanitize Operation Succeeded state (see 4.20.10.6); and
e) the device is in:
    A) the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5);
    B) the SEC2: Security Disabled/Not Locked/Frozen state (see 4.22.11.6);
    C) the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8) with:
        a) the RESTRICTED SANITIZE OVERRIDES SECURITY bit set to one (see 9.10.8.7.8); and
        b) the FAILURE MODE bit cleared to zero (see 7.36.2.3.3);
    D) the SEC5: Security Enabled/Not Locked/Not Frozen state (see 4.22.11.9); or
    E) the SEC6: Security Enabled/Not Locked/Frozen state (see 4.22.11.10).

See 7.68.2.1 for a description of the interactions between the OVERWRITE EXT command and the WRITE UNCORRECTABLE EXT command.

7.36.4.3 Inputs

7.36.4.3.1 Overview

See table 102 for the OVERWRITE EXT command inputs.

Table 102 — OVERWRITE EXT command inputs

Field	Description
FEATURE	0014h
COUNT	**Bit** **Description** 15 ZONED NO RESET bit – See 7.36.2.3.2 14:8 Reserved 7 INVERT PATTERN BETWEEN OVERWRITE PASSES bit – See 7.36.4.3.2 6 DEFINITIVE ENDING PATTERN bit – See 7.36.4.3.3 5 Reserved 4 FAILURE MODE bit – See 7.36.2.3.3 3:0 OVERWRITE PASS COUNT field – See 7.36.4.3.4
LBA	**Bit** **Description** 47:32 Shall be set to 4F57h (word) 31:0 OVERWRITE PATTERN field (DWord) – See 7.36.4.3.5
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 B4h

7.36.4.3.2 INVERT PATTERN BETWEEN OVERWRITE PASSES bit

An INVERT PATTERN BETWEEN OVERWRITE PASSES bit set to one specifies that the OVERWRITE PATTERN field shall be inverted on each overwrite pass. An INVERT PATTERN BETWEEN OVERWRITE PASSES bit cleared to zero specifies that the overwrite pattern shall not be inverted.

7.36.4.3.3 DEFINITIVE ENDING PATTERN bit

If the INVERT PATTERN BETWEEN OVERWRITE PASSES bit (see 7.36.4.3.2) is set to one and:

a) the DEFINITIVE ENDING PATTERN SUPPORTED bit (see 9.10.5.2.44) is set to one and the DEFINITIVE ENDING PATTERN bit is set to one, then the pattern used for the first write pass shall consist of the user data set to:
   A) the inversion of the OVERWRITE PATTERN field (see 7.36.4.3.5), if the OVERWRITE PASS COUNT field (see 7.36.4.3.4) is set to an even number; or
   B) the OVERWRITE PATTERN field, if the OVERWRITE PASS COUNT field is set to an odd number;
   or

b) the DEFINITIVE ENDING PATTERN SUPPORTED bit is cleared to zero or the DEFINITIVE ENDING PATTERN bit is cleared to zero, then the pattern used for the first write pass may consist of the user data set to:
   A) the inversion of the OVERWRITE PATTERN field; or
   B) the OVERWRITE PATTERN field.

7.36.4.3.4 OVERWRITE PASS COUNT field

The OVERWRITE PASS COUNT field specifies the number of overwrite passes (i.e., how many times the data in the user area is to be overwritten) using the data from the OVERWRITE PATTERN field of this command. An overwrite pass count of zero specifies 16 overwrite passes.

7.36.4.3.5 OVERWRITE PATTERN field

The OVERWRITE PATTERN field specifies a 32-bit pattern that shall be repeated as necessary to fill each physical sector within the Sanitize operation scope (see 4.20.2).

7.36.4.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 357.

7.36.4.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device shall return command aborted if:

a) the device does not support the Sanitize feature set;
b) the device does not support the OVERWRITE EXT command;
c) the value of LBA field bits 47:32 are not set to 4F57h;
d) deferred microcode data exists (see 7.7);
e) the device is in:
   A) the SD1: Sanitize Frozen state (see 4.20.10.3); or
   B) the SD2: Sanitize Operation In Progress state (see 4.20.10.4);
f) the following conditions exist:
   A) the device is in the SD3: Sanitize Operation Failed state (see 4.20.10.5) or the SD4: Sanitize Operation Succeeded state (see 4.20.10.6);
   B) the Failure Mode Policy value (see 4.20.8) is zero; and
   C) the FAILURE MODE bit is set to one (see 7.36.2.3.3);
   or
g) the device is in the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8) and:
   A) the RESTRICTED SANITIZE OVERRIDES SECURITY bit is cleared to zero (see 9.10.8.7.8); or
   B) the RESTRICTED SANITIZE OVERRIDES SECURITY bit is set to one and the FAILURE MODE bit set to one (see 7.36.2.3.3).

See table 385.

7.36.5 SANITIZE ANTIFREEZE LOCK EXT – B4h/0040h, Non-Data

7.36.5.1 Feature Set

This 48-bit command is for devices that support the Sanitize Device feature set (see 4.20).

7.36.5.2 Description

The SANITIZE ANTIFREEZE LOCK EXT command requests that all subsequent SANITIZE FREEZE LOCK EXT commands (see 7.36.6) return command aborted until the device clears the Sanitize Antifreeze value to zero (see 4.20.9). If a SANITIZE ANTIFREEZE LOCK EXT command returns command completion without error, the device sets the Sanitize Antifreeze value to one.

The SANITIZE ANTIFREEZE LOCK EXT command shall only be processed if:

a) the Sanitize Device feature set is supported;
b) the SANITIZE ANTIFREEZE LOCK EXT command is supported;
c) LBA field bits 31:0 are set to 416E_7469h;
d) the Sanitize Antifreeze value is cleared to zero (see 4.20.9);
e) the device is in any state except SD1: Sanitize Frozen state (see 4.20.10.3); and
f) the device is in:
   A) the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5);
   B) the SEC2: Security Disabled/Not Locked/Frozen state (see 4.22.11.6);
   C) the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8) with the RESTRICTED SANITIZE OVERRIDES SECURITY bit set to one (see 9.10.8.7.8);
   D) the SEC5: Security Enabled/Not Locked/Not Frozen state (see 4.22.11.9); or
   E) the SEC6: Security Enabled/Not Locked/Frozen state (see 4.22.11.10).

7.36.5.3 Inputs

See table 103 for the SANITIZE ANTIFREEZE LOCK EXT command inputs.

Table 103 — SANITIZE ANTIFREEZE LOCK EXT command inputs

Field	Description
FEATURE	0040h
COUNT	Reserved
LBA	**Bit Description** 47:32 Reserved 31:0 Shall be set to 416E_7469h (DWord)
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 B4h

7.36.5.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 357.

7.36.5.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device shall return command aborted if:

a) the device does not support the Sanitize feature set;
b) the device does not support the SANITIZE ANTIFREEZE LOCK EXT command;
c) the value of LBA field bits 31:0 is not set to 416E_7469h;
d) the device is in the SD1: Sanitize Frozen state (see 4.20.10.3);
e) the Sanitize Antifreeze value is set to one (see 4.20.9); or
f) the device is in the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8) and the RESTRICTED SANITIZE OVERRIDES SECURITY bit is cleared to zero (see 9.10.8.7.8).

See table 385.

7.36.6 SANITIZE FREEZE LOCK EXT – B4h/0020h, Non-Data

7.36.6.1 Feature Set

This 48-bit command is for devices that support the Sanitize Device feature set (see 4.20).

7.36.6.2 Description

The SANITIZE FREEZE LOCK EXT command causes any subsequent sanitize command other than the SANITIZE STATUS EXT command (see 7.36.7) to be aborted (see 4.20.10.3) until a power-on reset or hardware reset is processed with SSP disabled (see 4.25).

The SANITIZE FREEZE LOCK EXT command shall only be processed if the device is in:

a) the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5);
b) the SEC2: Security Disabled/Not Locked/Frozen state (see 4.22.11.6);
c) the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8) with the RESTRICTED SANITIZE OVERRIDES SECURITY bit set to one (see 9.10.8.7.8);
d) the SEC5: Security Enabled/Not Locked/Not Frozen state (see 4.22.11.9); or
e) the SEC6: Security Enabled/Not Locked/Frozen state (see 4.22.11.10).

7.36.6.3 Inputs

See table 104 for the SANITIZE FREEZE LOCK EXT command inputs.

Table 104 — SANITIZE FREEZE LOCK EXT command inputs

Field	Description
FEATURE	0020h
COUNT	Reserved
LBA	**Bit** **Description** 47:32 Reserved 31:0 Shall be set to 4672_4C6Bh (DWord)
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 B4h

7.36.6.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 357.

7.36.6.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device shall return command aborted if:

a) the device does not support the Sanitize feature set;
b) the value of LBA field bits 31:0 is not set to 4672_4C6Bh;
c) the device is in the SD1: Sanitize Frozen state (see 4.20.10.3);
d) the Sanitize Antifreeze value is set to one (see 4.20.9); or
e) the device is in the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8) and the RESTRICTED SANITIZE OVERRIDES SECURITY bit is cleared to zero (see 9.10.8.7.8).

See table 385.

7.36.7 SANITIZE STATUS EXT – B4h/0000h, Non-Data

7.36.7.1 Feature Set

This 48-bit command is for devices that support the Sanitize Device feature set (see 4.20).

7.36.7.2 Description

The SANITIZE STATUS EXT command returns the following information about current or previously completed sanitize operations:

a) progress indication on a current sanitize operation; and
b) whether a previous sanitize operation completed successfully or unsuccessfully.

The SANITIZE STATUS EXT command allows the host to request the device to return to normal operations after a sanitize operation has failed (see 4.20.10.5 and 7.36.7.3.2).

7.36.7.3 Inputs

7.36.7.3.1 Overview

See table 105 for the SANITIZE STATUS EXT command inputs.

Table 105 — SANITIZE STATUS EXT command inputs

Field	Description
FEATURE	0000h
COUNT	**Bit Description** 15:1 Reserved 0 CLEAR SANITIZE OPERATION FAILED bit – See 7.36.7.3.2
LBA	Reserved
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 B4h

7.36.7.3.2 CLEAR SANITIZE OPERATION FAILED bit

A CLEAR SANITIZE OPERATION FAILED bit set to one may affect the Sanitize Device state machine (see 4.20.10) if the device is in the SD3: Sanitize Operation Failed state (see 4.20.10.5). A CLEAR SANITIZE OPERATION FAILED bit cleared to zero does not affect the Sanitize Device state machine.

7.36.7.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 357.

7.36.7.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device shall return command aborted if:

a) the device does not support the Sanitize feature set; or
b) the following conditions exist:
   A) the device is in the SD3: Sanitize Operation Failed state (see 4.20.10.5) or the SD4: Sanitize Operation Succeeded state (see 4.20.10.6);
   B) the CLEAR SANITIZE OPERATION FAILED bit (see 7.36.7.3.2) is set to one; and
   C) the Failure Mode Policy value (see 4.20.8) is cleared to zero.

If the device is in the SD3: Sanitize Operation Failed state (see 4.20.10.5) (i.e., after a sanitize operation has completed with physical sectors that are available to be allocated for user data not successfully sanitized) and the CLEAR SANITIZE OPERATION FAILED bit (see 7.36.7.3.2) is cleared to zero, then this command:

a) shall return the ABORT bit set to one; and
b) should set the SANITIZE DEVICE ERROR REASON field (see table 385) to Sanitize Command Unsuccessful (i.e., 01h).

See table 385.

7.37 SECURITY DISABLE PASSWORD – F6h, PIO Data-Out

7.37.1 Feature Set

This 28-bit command is for devices that support the Security feature set (see 4.22).

7.37.2 Description

The SECURITY DISABLE PASSWORD command transfers 512 bytes of data from the host. Table 107 defines the content of this information.

If the password selected by the IDENTIFIER bit (see table 107) matches the password previously saved by the device and the device is not frozen, then the device shall disable the User password, and return the device to the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5).

This command shall not change the Master password or the Master Password Identifier (see 4.22.10).

If the SECURITY ENABLED bit (see 9.10.8.3.7) is cleared to zero, then:

a) if the IDENTIFIER bit is cleared to zero (i.e., compare User password), the device shall return command aborted; or
b) if the IDENTIFIER bit is set to one (i.e., compare Master password), the device may compare the contents of the PASSWORD field (see table 107) with the stored Master password.

If the SECURITY ENABLED bit is set to one and the MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2) is cleared to zero (i.e., High), then:

a) if the IDENTIFIER bit is set to one (i.e., compare Master password), the device shall compare contents of the PASSWORD field with the stored Master password; or
b) if the IDENTIFIER bit is cleared to zero (i.e., compare User password), the device shall compare contents of the PASSWORD field with the stored User password.

If the SECURITY ENABLED bit is set to one and the MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2) is set to one (i.e., Maximum), then:

a) if the IDENTIFIER bit is set to one (i.e., compare Master password), 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), the device shall compare contents of the PASSWORD field with the stored User password.

7.37.3 Inputs

See table 106 for the SECURITY DISABLE PASSWORD command inputs.

Table 106 — SECURITY DISABLE PASSWORD command inputs

Field	Description
FEATURE	N/A
COUNT	N/A
LBA	N/A
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 F6h

7.37.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.37.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

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 the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8));
c) security is Frozen (i.e., the device is in the SEC2: Security Disabled/Not Locked/Frozen state (see 4.22.11.6) or the SEC6: Security Enabled/Not Locked/Frozen state (see 4.22.11.10)); or
d) the contents of the PASSWORD field does not match the stored password.

A device may return command completion with the ERROR bit set to one if an Interface CRC error has occurred. See table 362.

7.37.6 Output from the Host to the Device Data Structure

The output from the host to the device for a SECURITY DISABLE PASSWORD command is shown in table 107.

Table 107 — 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 field (32 bytes)
17..255	Reserved

7.38 SECURITY ERASE PREPARE – F3h, Non-Data

7.38.1 Feature Set

This 28-bit command is for devices that support the Security feature set (see 4.22).

7.38.2 Description

The SECURITY ERASE PREPARE command is issued immediately before the SECURITY ERASE UNIT command (see 7.39).

7.38.3 Inputs

See table 108 for the SECURITY ERASE PREPARE command inputs.

Table 108 — SECURITY ERASE PREPARE command inputs

Field	Description
FEATURE	N/A
COUNT	N/A
LBA	N/A
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 F3h

7.38.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.38.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The ABORT bit shall be set to one if the device is in Frozen mode. See table 361.

7.39 SECURITY ERASE UNIT – F4h, PIO Data-Out

7.39.1 Feature Set

This 28-bit command is for devices that support the Security feature set (see 4.22).

7.39.2 Description

The SECURITY ERASE UNIT command transfers 512 bytes of data from the host. Table 111 defines the content of this information.

A SECURITY ERASE PREPARE command (see 7.38) prior to a SECURITY ERASE UNIT command prepares the device to process a SECURITY ERASE UNIT command. If the device processes 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.

If the SECURITY ENABLED bit (see 9.10.8.3.7) is cleared to zero and the IDENTIFIER bit (see table 111) is cleared to zero (i.e.,compare User password), then the device shall return command aborted.

If the SECURITY ENABLED bit is set to one and the:

a) IDENTIFIER bit (see table 111) is set to one (i.e.,compare Master password), the contents of the PASSWORD field shall be compared with the stored Master password; or
b) IDENTIFIER bit is cleared to zero (i.e.,compare User password), the contents of the PASSWORD field shall be compared with the stored User password.

The ERASE MODE bit (see table 109) specifies the operation of the SECURITY ERASE UNIT command.

Table 109 — Erase Mode characteristics

ERASE MODE bit	Erase Mode	Reallocated user data erased	Data pattern [b]	User data erased [b]
0	Normal	No [d]	binary 0's or binary 1's	0..native max address
1	Enhanced [c]	Yes [a]	vendor specific	

[a] User data sectors that were previously written and are no longer in use due to reallocation are written by the SECURITY ERASE UNIT command.
[b] The SECURITY ERASE UNIT command shall write the specified data pattern to the specified LBA range.
[c] The ENHANCED SECURITY ERASE SUPPORTED bit (see 9.10.8.3.3) indicates whether the Enhanced Erase mode is supported.
[d] User data sectors that were previously written and are no longer in use due to reallocation may be written by the SECURITY ERASE UNIT command.

The NORMAL SECURITY ERASE TIME field (see 9.10.8.5) gives an estimate of the time required to complete the erasure.

The ENHANCED SECURITY ERASE TIME field (see 9.10.8.4) gives an estimate of the time required to complete the erasure.

On successful completion, this command shall disable Security (i.e., return the device to the SEC1: Security Disabled/Not Locked/Not Frozen state (see 4.22.11.5)), and invalidate any existing User password. Any previously valid Master password and the MASTER PASSWORD IDENTIFIER field (see 9.10.8.2) remain valid.

7.39.3 Inputs

See table 110 for the SECURITY ERASE UNIT command inputs.

Table 110 — SECURITY ERASE UNIT command inputs

Field	Description
FEATURE	N/A
COUNT	N/A
LBA	N/A
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 F4h

7.39.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.39.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device shall return command aborted if:

a) this command was not immediately preceded by a SECURITY ERASE PREPARE command;
b) the ERASE MODE bit was set to one and the device does not support Enhanced Erase mode;
c) the contents of the PASSWORD field do not match the stored password;
d) the PASSWORD field contained an invalid value; or
e) 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 362.

7.39.6 Output from the Host to the Device Data Structure

The output from the host to the device for a SECURITY ERASE UNIT command is shown in table 111.

Table 111 — SECURITY ERASE UNIT data content

<table>
<tr><th>Word</th><th colspan="3">Description</th></tr>
<tr><td>0</td><td colspan="3">Control word</td></tr>
<tr><td></td><td>Bit</td><td>Field Name</td><td>Description</td></tr>
<tr><td></td><td>15:3</td><td>Reserved</td><td></td></tr>
<tr><td></td><td>2</td><td>ZAC SECURITY OPTION</td><td>See ZAC-2 [a]</td></tr>
<tr><td></td><td>1</td><td>ERASE MODE</td><td>0=Normal Erase mode
1=Enhanced Erase mode</td></tr>
<tr><td></td><td>0</td><td>IDENTIFIER</td><td>0=Compare User password
1=Compare Master password</td></tr>
<tr><td>1..16</td><td colspan="3">PASSWORD field (32 bytes)</td></tr>
<tr><td>17..255</td><td colspan="3">Reserved</td></tr>
<tr><td colspan="4">[a] If the device is not a zoned device, this bit is reserved.</td></tr>
</table>

7.40 SECURITY FREEZE LOCK – F5h, Non-Data

7.40.1 Feature Set

This 28-bit command is for devices that support the Security feature set (see 4.22).

7.40.2 Description

The SECURITY FREEZE LOCK command sets the device to Frozen mode. Frozen mode is disabled by:

a) a power-off or a hardware reset; or
b) the successful completion of a sanitize operation (see 4.20.4).

If a SECURITY FREEZE LOCK command is issued and the device is in Frozen mode, the command is processed and the device shall remain in Frozen mode.

If a SECURITY FREEZE LOCK command returns command completion without error, the device shall:

a) set the SECURITY FROZEN bit (see 9.10.8.3.5) to one; and
b) respond to commands as specified in the Frozen column of table 12.

7.40.3 Inputs

See table 112 for the SECURITY FREEZE LOCK command inputs.

Table 112 — SECURITY FREEZE LOCK command inputs

Field	Description
FEATURE	N/A
COUNT	N/A
LBA	N/A
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 F5h

7.40.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.40.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5)

The ABORT bit shall be set to one if the device is in the SEC3: Powered down/Security Enabled/Locked/Not Frozen state (see 4.22.11.7) or the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8). See table 361.

7.41 SECURITY SET PASSWORD – F1h, PIO Data-Out

7.41.1 Feature Set

This 28-bit command is for devices that support the Security feature set (see 4.22).

7.41.2 Description

7.41.2.1 Overview

The SECURITY SET PASSWORD command transfers 512 bytes of data from the host. Table 114 defines the content of this information. If the SECURITY SET PASSWORD commands returns command completion without error, the command sets only one of the following:

a) the User password (see 4.22.3.2); or
b) the Master password (see 4.22.3.3).

7.41.2.2 Setting the Master Password

If the IDENTIFIER bit (see table 114) is set to one (i.e., set Master password), the device shall save the contents of the NEW PASSWORD field (see table 114) as the stored Master password in a non-volatile location. The MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2) shall remain unchanged.

If the device supports the Master Password Identifier feature (see 4.22.10) and the NEW MASTER PASSWORD IDENTIFIER field (see table 114) contains a value other than 0000h or FFFFh, then the device shall save the contents of the NEW MASTER PASSWORD IDENTIFIER field in the MASTER PASSWORD IDENTIFIER field (see 9.10.8.2). If the NEW MASTER PASSWORD IDENTIFIER field contains 0000h or FFFFh, the device shall preserve the existing contents of the MASTER PASSWORD IDENTIFIER field and return command completion without error.

If the device does not support the Master Password Identifier feature, then the device shall:

a) ignore the NEW MASTER PASSWORD IDENTIFIER field;
b) not alter the MASTER PASSWORD IDENTIFIER field; and
c) not return command aborted based on the value supplied in the NEW MASTER PASSWORD IDENTIFIER field.

7.41.2.3 Setting the User Password

If the IDENTIFIER bit (see table 114) is cleared to zero (i.e., set User password), the device shall save the contents of the NEW PASSWORD field (see table 114) as the stored User password in a non-volatile location. The MASTER PASSWORD IDENTIFIER field (see 9.10.8.2) shall not be changed.

Bits in the Security page (see 9.10.8) of the IDENTIFY DEVICE data log shall be updated as follows:

a) the SECURITY ENABLED bit (see 9.10.8.3.7) shall be set to one (i.e., security is enabled); and
b) the MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2) shall be set to the value in the NEW MASTER PASSWORD CAPABILITY bit (see table 114).

7.41.3 Inputs

See table 113 for the SECURITY SET PASSWORD command inputs.

Table 113 — SECURITY SET PASSWORD command inputs

Field	Description
FEATURE	N/A
COUNT	N/A
LBA	N/A
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 F1h

7.41.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.41.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device shall not modify the Security page (see 9.10.8) of the IDENTIFY DEVICE data log and shall return command aborted if:

a) the SECURITY LOCKED bit (see 9.10.8.3.6) is set to one; or
b) the SECURITY FROZEN bit (see 9.10.8.3.5) is set to one.

The device may return command completion with the ERROR bit set to one if an Interface CRC error has occurred. See table 362.

7.41.6 Output from the Host to the Device Data Structure

The output from the host to the device for a SECURITY SET PASSWORD command is shown in table 114.

Table 114 — SECURITY SET PASSWORD data content

Word	Description		
0	Control word		
	Bit	**Bit Name**	**Description**
	15:9	Reserved	
	8	NEW MASTER PASSWORD CAPABILITY (see 7.41.2.3)	0=High 1=Maximum
	7:1	Reserved	
	0	IDENTIFIER (see 7.41.2.1)	0=set User password 1=set Master password
1..16	NEW PASSWORD field (32 bytes)		
17	NEW MASTER PASSWORD IDENTIFIER field (see 7.41.2.2)		
18..255	Reserved		

7.42 SECURITY UNLOCK – F2h, PIO Data-Out

7.42.1 Feature Set

This 28-bit command is for devices that support the Security feature set (see 4.22).

7.42.2 Description

The SECURITY UNLOCK command modifies the device's security state in a way that allows read and write access to user data.

The SECURITY UNLOCK command transfers 512 bytes of data from the host. Table 116 defines the content of this information.

If the SECURITY ENABLED bit (see 9.10.8.3.7) is cleared to zero and the IDENTIFIER bit (see table 116) is cleared to zero (i.e., compare User password), then the device shall return command aborted.

If the SECURITY ENABLED bit is set to one and the MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2) is cleared to zero (i.e., High), then:

a) if the IDENTIFIER bit is set to one (i.e., compare Master password), then the contents of the PASSWORD field (see table 116) 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 contents of the PASSWORD field shall be compared with the stored User password.

If the SECURITY ENABLED bit is set to one and the MASTER PASSWORD CAPABILITY bit 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; or
b) if the IDENTIFIER bit is cleared to zero (i.e., compare User password), then the contents of the PASSWORD field shall be compared with the stored User password.

If the contents of the PASSWORD field (see table 116) are not the same as the stored password specified by the IDENTIFIER bit, then the device shall return command aborted and modify the password attempt counter as described in 4.22.9. SECURITY UNLOCK commands issued while the device is unlocked have no effect on the unlock counter.

Upon successful completion of this command, the SECURITY LOCKED bit (see 9.10.8.3.6) shall be cleared to zero (i.e., the device is not in the SEC3: Powered down/Security Enabled/Locked/Not Frozen state (see 4.22.11.7) or the SEC4: Security Enabled/Locked/Not Frozen state (see 4.22.11.8)).

7.42.3 Inputs

See table 115 for the SECURITY UNLOCK command inputs.

Table 115 — SECURITY UNLOCK command inputs

Field	Description
FEATURE	N/A
COUNT	N/A
LBA	N/A
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 F2h

7.42.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.42.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device shall not modify the Security page (see 9.10.8) of the IDENTIFY DEVICE data log and shall return command aborted if:

a) the contents of the PASSWORD field (see table 116) are not the same as the stored password specified by the IDENTIFIER bit (see 7.42.2);
b) the SECURITY FROZEN bit (see 9.10.8.3.5) is set to one; or
c) the SECURITY COUNT EXPIRED bit (see 9.10.8.3.4) is set to one.

The device may return command completion with the ERROR bit set to one if an Interface CRC error has occurred. See table 362.

7.42.6 Output From the Host to the Device Data Structure

The output from the host to the device for a SECURITY UNLOCK command is shown in table 116.

Table 116 — SECURITY UNLOCK data content

Word	Description
0	Control word **Bit** **Bit Name** **Description** 15:1 Reserved 0 IDENTIFIER 0=compare User password 1=compare Master password
1..16	PASSWORD field (32 bytes)
17..255	Reserved

7.43 SEND FPDMA QUEUED – 64h, DMA Queued

7.43.1 Overview

This 48-bit command is for devices that support the NCQ feature set (see 4.15).

7.43.2 Description

The SEND FPDMA QUEUED command requests that data to be transferred from the host to the device in 512-byte data units.

Some SEND FPDMA QUEUED subcommands are processed as sequential NCQ commands (see 4.15.5).

Some SEND FPDMA QUEUED subcommands are processed as ordered NCQ commands (see 4.15.5).

7.43.3 Inputs

7.43.3.1 Overview

See table 117 for the SEND FPDMA QUEUED command inputs.

Table 117 — SEND FPDMA QUEUED command inputs

Field	Description
FEATURE	The number of 512-byte blocks of data to be transferred. A value of 0000h indicates that 65_536 512-byte blocks of data are to be transferred
COUNT	**Bit Description** 15:14 PRIO field – See 4.15.2 13 Reserved 12:8 SUBCOMMAND field – See 7.43.3.2 7:3 NCQ TAG field – See 7.17.3.3 2:0 Reserved
LBA	Subcommand specific
AUXILIARY	Subcommand specific
DEVICE	**Bit Description** 7 Reserved 6 Shall be set to one 5 Reserved 4 Shall be cleared to zero 3:0 Reserved
COMMAND	7:0 64h

7.43.3.2 Subcommand

Table 118 defines the SEND FPDMA QUEUED subcommands.

Table 118 — SEND FPDMA QUEUED Subcommands

Subcommand	Description	Processing order requirements [b]	Reference	
			Queued command [a]	Non-queued command
00h	DATA SET MANAGEMENT	none	7.5.7	7.5
01h	HYBRID EVICT	none	7.43.8	none
02h	WRITE LOG DMA EXT	sequential	7.63.6	7.63
03h	ZAC Management Out	See ZAC-2	ZAC-2	ZAC-2
04h	DATA SET MANAGEMENT XL	none	7.6.7	7.6
05h..1Fh	Reserved			

[a] See 4.15.6
[b] See 4.15.5

7.43.4 Output from the Host to the Device Data Structure

The output from the host to the device is subcommand-specific.

7.43.5 Command Acceptance Outputs

The command acceptance outputs for this command are subcommand specific.

7.43.6 Normal Outputs

The normal outputs for this command are subcommand specific.

7.43.7 Error Outputs

The error outputs for this command are subcommand specific.

7.43.8 HYBRID EVICT – 64h/1h, DMA Queued

7.43.8.1 Overview

This 48-bit command is for devices that support the NCQ feature set (see 4.12).

7.43.8.2 Description

The HYBRID EVICT command is a subcommand of the SEND FPDMA QUEUED command.

Support for this command is indicated in the NCQ Send And Receive Log (see 9.18).

The HYBRID EVICT command shall affect only those NCQ commands for which the device has indicated command acceptance before accepting this SEND FPDMA QUEUED command.

The HYBRID EVICT command evicts data from the non-volatile cache to the primary medium.

If the EVICT ALL bit (see 7.43.8.3.2) is cleared to zero, then for each LBA range specified in the data transferred from the host (see 7.43.8.7), the device:

a) shall sync all dirty data in the non-volatile cache;
b) may evict the specified LBA range in the non-volatile cache; and
c) may free vendor specific resources in the non-volatile cache related to the specified LBA range.

If the EVICT ALL bit is set to one, then:

a) the device shall ignore all data transferred from the host; and
b) for all data in the non-volatile cache, the device shall:
    A) sync all dirty data in the non-volatile cache;
    B) evict all user data in the non-volatile cache; and
    C) free vendor specific resources in the non-volatile cache.

If the value of the FEATURE field (see 7.43.8.3.1) is greater than the value of the MAXIMUM EVICTION DATA BLOCKS field (see 9.19.2.16), then the device shall return command aborted.

The device may limit the number of HYBRID EVICT commands that are in the queue at the same time. The device shall return command aborted if:

a) a new HYBRID EVICT command is accepted; and
b) the number of HYBRID EVICT commands in the queue was previously equal to the value of the MAXIMUM EVICTION COMMANDS field (see 9.19.2.15).

If the device processes any reset while processing a HYBRID EVICT command, then the resulting condition of the non-volatile cache is indeterminate.

The device should return command completion without error after all selected LBA ranges have been successfully evicted.

NOTE 9 — This command may take longer than 30 seconds to complete.

7.43.8.3 Inputs

7.43.8.3.1 Overview

See table 119 for the HYBRID EVICT command inputs.

Table 119 — HYBRID EVICT command inputs

Field	Description
FEATURE	The number of 512-byte blocks of data to be transferred. A value of 0000h indicates that 65_536 512-byte blocks of data are to be transferred
COUNT	**Bit** **Description** 15:14 PRIO field – See 4.15.2 13 Reserved 12:8 SUBCOMMAND field – Shall be set to 2h 7:3 NCQ TAG field – See 7.17.3.3 2:0 Reserved
LBA	Reserved
AUXILIARY	**Bit** **Description** 31:1 Reserved 0 EVICT ALL bit – See 7.43.8.3.2
DEVICE	**Bit** **Description** 7 Reserved 6 Shall be set to one 5 Reserved 4 Shall be cleared to zero 3:0 Reserved
COMMAND	7:0 64h

7.43.8.3.2 EVICT ALL bit

The EVICT ALL bit specifies that all of the data in the non-volatile cache is to be evicted.

7.43.8.4 Command Acceptance Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 353.

7.43.8.5 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 354.

7.43.8.6 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device sets the ERROR bit to one and aborts the command in response to an LBA out of range, a duplicate tag number, an invalid tag number, or an Interface CRC error (see table 382).

Errors that occur during the processing of this command are reported by returning a transport dependent indicator (see table 383) with additional information available in the NCQ Command Error log (see 9.14).

7.43.8.7 Output from the host to the device data structure

Table 120 describes the format for all 512-byte data blocks transferred from the host to the device for the HYBRID EVICT command, containing up to 64 LBA Range entries each. There may be more than one 512-byte data block transferred. The LBA Range entries shall be sorted in order of increasing starting LBA. If the value of the RANGE LENGTH field of an LBA Range entry is cleared to zero, then the device shall ignore the LBA Range entry and all following LBA Range entries.

For any LBA range, if the value of the STARTING LBA field plus the value of the RANGE LENGTH field is greater than the maximum LBA, then the device:

a) shall return command aborted; and
b) may evict LBA ranges that are valid.

Table 120 — Output from the host for the HYBRID EVICT command

Offset	Type	Description
0..7	QWord	Entry 0 **Bit Description** 63:48 RANGE LENGTH field (see 7.43.8.7.1) 47:0 STARTING LBA field (see 7.43.8.7.2)
8..15	QWord	Entry 1 **Bit Description** 63:48 RANGE LENGTH field (see 7.43.8.7.1) 47:0 STARTING LBA field (see 7.43.8.7.2)
		...
496..511	QWord	Entry 31 **Bit Description** 63:48 RANGE LENGTH field (see 7.43.8.7.1) 47:0 STARTING LBA field (see 7.43.8.7.2)

7.43.8.7.1 RANGE LENGTH field

The RANGE LENGTH field specifies the number of logical sectors in the LBA range. If the RANGE LENGTH field is cleared to zero, the STARTING LBA field shall be ignored.

7.43.8.7.2 STARTING LBA field

The STARTING LBA field specifies the starting LBA of the LBA range. If the starting lba plus the range length is greater than the accessible capacity (see 9.10.4.2), the device shall return command aborted.

7.43.8.7.3 Hybrid Evict examples

Examples of how to combine LBA values and range lengths to form a LBA Range Entry follow.

EXAMPLE 1 - If logical blocks 11 through 18 are represented in an LBA Range Entry, then the LBA VALUE field is set to 11 and the RANGE LENGTH field is set to 8 ((i.e., the LBA Range Entry is 0008_0000_0000_000Bh).

EXAMPLE 2 - If only logical block 20 is represented in an LBA Range Entry, then the LBA VALUE field is set to 20 and the RANGE LENGTH field is set to 1 (i.e., the LBA Range Entry is 0001_0000_0000_0014h).

7.44 SET DATE & TIME EXT – 77h, Non-Data

7.44.1 Feature Set

This 48-bit command is for ATA devices (see 4.2).

7.44.2 Description

This command sets the Date and Time TimeStamp device statistic (see 9.5.6.9) to the value in the TIMESTAMP field. The host should set the TIMESTAMP field to the current date and time in milliseconds using January 1, 1970 UT 12:00 am as the baseline. If the device processes a power-on reset, the Date and Time TimeStamp device statistic is reset as described in 9.5.6.4. The TIMESTAMP field has a range from January 1, 1970 to approximately January 1, 10895.

7.44.3 Normal Inputs

See table 121 for the SET DATE & TIME EXT command inputs.

Table 121 — SET DATE & TIME EXT command inputs

Field	Description
FEATURE	Reserved
COUNT	Reserved
LBA	**Bit Description** 47:0 TIMESTAMP field
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 77h

7.44.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 352.

7.44.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 361.

7.45 SET FEATURES – EFh, Non-Data

7.45.1 Introduction

7.45.1.1 Feature Set

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

7.45.1.2 Description

The SET FEATURES command is used by the host to establish parameters that affect the processing of certain device features (see 7.45.2).

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.

The device processes the SET FEATURES command in the NCQ feature set environment (see 4.15.6) if the SET FEATURES command is encapsulated in a NCQ NON-DATA command (see 7.17) with the inputs encapsulated as shown in 7.45.1.6.

7.45.1.3 Inputs

See table 122 for the SET FEATURES command inputs.

Table 122 — SET FEATURES command inputs

Field	Description
FEATURE	SET FEATURES SUBCOMMAND field – See 7.45.2
COUNT	Subcommand specific
LBA	Subcommand specific
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 EFh

7.45.1.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.45.1.5 Error Outputs

Unless otherwise specified, the error outputs for the SET FEATURES command are as follows.

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The ABORT bit shall be set to one if any subcommand input value is not supported or is invalid. See table 361.

If the SET FEATURES command is NCQ encapsulated (see 7.45.1.6), then:

a) the device sets the ERROR bit to one and aborts the command in response to an LBA out of range, a duplicate tag number, an invalid tag number, or an Interface CRC error (see table 382); and

b) errors that occur during the processing of this command are reported by returning a transport dependent indicator (see table 383) with additional information available in the NCQ Command Error log (see 9.14).

7.45.1.6 NCQ encapsulation

If a SET FEATURES command is processed in an NCQ environment as subcommand 05h of an NCQ NON-DATA command (see 7.17), the ATA command inputs are encapsulated as:

a) defined by the NCQ NON-DATA command for some inputs (e.g., the TAG field); and
b) shown in table 123 for subcommand specific inputs.

Table 123 — NCQ NON-DATA command encapsulation for the subcommand specific inputs from a SET FEATURES command

NCQ NON-DATA field (see table 66)	SET FEATURES field (see table 122), if any
FEATURE (7:4)	Reserved
FEATURE (15:8)	FEATURE (7:0)
COUNT (15:8)	COUNT (7:0)
LBA (27:0)	LBA (27:0)
LBA (31:28)	Reserved
AUXILIARY	Reserved

7.45.2 SET FEATURES subcommands

The SET FEATURES SUBCOMMAND field (see table 122) specifies the SET FEATURES subcommand to be processed using the codes shown in table 124.

Table 124 — SET FEATURES command subcommand codes (Sheet 1 of 3)

Code	Description
00h	Reserved
01h	Reserved for CFA
02h	Enable volatile write cache (see 7.45.3)
03h	Set transfer mode (see 7.45.4)
04h	Obsolete
05h	Enable the APM feature set (see 7.45.5)
06h	Enable the PUIS feature set (see 7.45.6)
07h	PUIS feature set device spin-up (see 7.45.7)
08h	Reserved
09h	Obsolete
0Ah	Reserved for CFA
0Bh	Enable Write-Read-Verify feature set (see 7.45.8)
0Ch	Enable device life control (see 7.45.9)
0Dh	Enable/Disable Command Duration Limits feature set (see 7.45.10)
0Eh..0Fh	Reserved
10h	Enable use of SATA feature (see 7.45.16)
11h..1Fh	Reserved
20h..21h	Obsolete
22h..30h	Reserved
31h	Obsolete

Table 124 — SET FEATURES command subcommand codes (Sheet 2 of 3)

Code	Description
32h	Reserved
33h	Obsolete
34h..40h	Reserved
41h	Enable the Free-fall Control feature set (see 7.45.15)
42h	Obsolete
43h	Set Maximum Host Interface Sector Times (see 7.45.11)
44h	Obsolete
45h	Set rate basis (see 7.45.12)
46h..47h	See ZAC-2
48h..49h	Reserved
4Ah	Extended Power conditions (see 7.45.20)
4Bh..4Fh	Reserved
50h	Advanced Background Operation Control (see 7.45.22)
51h..53h	Reserved
54h	Obsolete
55h	Disable read look-ahead feature (see 7.45.13)
56h..5Ch	Vendor Specific
5Dh..5Eh	Obsolete
5Fh	Obsolete
60h..61h	Reserved
62h	Long Physical Sector Alignment Error Reporting Control (see 7.45.19)
63h	Enable/Disable the DSN feature set (see 7.45.21)
64h..65h	Reserved
66h	Disable reverting to power-on defaults (see 7.45.14)
67h..68h	Reserved
69h	Reserved for CFA
6Ah..76h	Reserved
77h	Obsolete
78h..80h	Reserved
81h	Reserved for CFA
82h	Disable volatile write cache (see 7.45.3)
83h	Reserved
84h	Obsolete
85h	Disable the APM feature set (see 7.45.5)
86h	Disable the PUIS feature set (see 7.45.6)
87h	Reserved
88h	Obsolete
89h	Obsolete
8Ah	Reserved for CFA
8Bh	Disable Write-Read-Verify feature set (see 7.45.8)

Table 124 — SET FEATURES command subcommand codes (Sheet 3 of 3)

Code	Description
8Ch	Disable device life control (see 7.45.9)
8Dh..8Fh	Reserved
90h	Disable use of SATA feature (see 7.45.16)
91h..94h	Reserved
95h	Obsolete
96h..98h	Reserved
99h	Obsolete
9Ah	Obsolete
9Bh..A9h	Reserved
AAh	Enable read look-ahead feature (see 7.45.13)
ABh	Obsolete
ACh..BAh	Reserved
BBh	Obsolete
BCh..C0h	Reserved
C1h	Disable the Free-fall Control feature set (see 7.45.15)
C2h	Obsolete
C3h	Enable/Disable the Sense Data Reporting feature set (see 7.45.17)
C4h	Enable/Disable sense data return for successful NCQ commands (see 7.45.18)
C5h..CBh	Reserved
CCh	Enable reverting to power-on defaults (see 7.45.14)
CDh..D5h	Reserved
D6h..DCh	Vendor Specific
DDh..DFh	Obsolete
E0h	Vendor Specific
E1h..EFh	Reserved
F0h..F3h	Reserved for CFA
F4h..FFh	Reserved

7.45.3 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. If the disable volatile write cache subcommand is processed, the device shall initiate the sequence to flush volatile cache to non-volatile media before command completion (see 7.10). These subcommands may affect caching for commands in the Streaming feature set (see 4.27). Support for the enable/disable volatile write cache subcommands is mandatory if a volatile write cache is supported.

Support for the volatile write cache is indicated by the VOLATILE WRITE CACHE SUPPORTED bit (see 9.10.5.2.13). The enabled state of the volatile write cache is indicated by the VOLATILE WRITE CACHE ENABLED bit (see 9.10.6.2.10).

The processing of subcommands 02h and 82h may be affected by the processing of SCT Feature Control commands (see 8.3.4).

7.45.4 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 125 shows the available transfer modes.

Table 125 — 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 7.13.6.24, 7.13.6.25, 7.13.6.42)

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 if 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).

The current transfer mode is indicated in the TRANSFER MODE field (see 9.10.9.6.1).

7.45.5 Enable/disable the APM feature set

Subcommand code 05h enables APM (see 4.6). The APM level is a scale from the lowest power consumption setting of 01h to the maximum performance level of FEh. Table 126 shows these values.

Table 126 — APM levels

COUNT field	Level
00h	Reserved
01h	Minimum power consumption with Standby mode
02h..7Fh	Intermediate power management levels with Standby mode
80h	Minimum power consumption without Standby mode
81h..FDh	Intermediate power management levels without Standby mode
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 support 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, if possible, to save power.

Subcommand code 85h disables APM. Subcommand 85h may not be implemented on all devices that implement subcommand 05h.

Support for the APM feature set is indicated by the APM SUPPORTED bit (see 9.10.5.2.19). The enabled state of the APM feature set is indicated by the APM ENABLED bit (see 9.10.6.2.17). The current APM level is indicated in the APM LEVEL field (see 9.10.6.3.2).

7.45.6 Enable/disable the PUIS feature set

Subcommand code 06h enables the PUIS feature set (see 4.18). If 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 4.18). After this feature set is enabled, this feature set shall only be disabled by a subsequent subcommand code 86h that disables 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. If this feature set is disabled, the device shall power-up into Active mode. The factory default for this feature set shall be disabled.

Support for the PUIS feature set is indicated by the PUIS SUPPORTED bit (see 9.10.5.2.18).The enabled state of the PUIS feature set is indicated in the PUIS ENABLED bit (see 9.10.6.2.16).

7.45.7 PUIS feature set device spin-up

Subcommand code 07h shall cause a device that has powered-up into Standby mode to go to the Active mode (see 4.18 and figure 8).

7.45.8 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 127 defines the Write-Read-Verify modes.

Table 127 — Write-Read-Verify modes

LBA field bits 7:0	Description
00h [a]	**Write-Read-Verify Mode 0** Always enabled (i.e., the device shall perform a Write-Read-Verify for all logical sectors for all write commands).
01h [a]	**Write-Read-Verify Mode 1** 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]	**Write-Read-Verify Mode 2** The number of logical sectors on which a device performs a Write-Read-Verify is vendor specific.
03h	**Write-Read-Verify Mode 3** 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. $n = y \times 1\,024$ where: y=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 the 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 SSP feature set (see 4.25) is enabled and a hardware reset is processed, then the device does not change the settings of the Write-Read-Verify feature set.

If a device is in the reverting to defaults enabled mode (see 7.45.14), then the device shall set the Write-Read-Verify feature set to the factory default setting after processing of a software reset.

If a device is in the reverting to defaults disabled mode (see 7.45.14), then the device shall not change the settings of the Write-Read-Verify feature set after processing of a software reset.

Support for the Write-Read-Verify feature set is indicated by the WRV SUPPORTED bit (see 9.10.5.2.33). The enabled state of the Write-Read-Verify feature set is indicated by the WRV ENABLED bit (see 9.10.6.2.19).

The number of logical sectors to be verified after every spin-up if Write-Read-Verify feature set mode 2 selected is indicated in the WRV MODE 2 COUNT field (see 9.10.5.7). The number of logical sectors to be verified after every spin-up, if Write-Read-Verify feature set mode 3 is selected is indicated in the WRV MODE 3 COUNT field (see 9.10.5.6).

The current Write-Read-Verify mode is indicted in the WRV MODE field (see 9.10.6.3.3)

7.45.9 Enable/disable device life control

Subcommand codes 0Ch and 8Ch allow the host to enable or disable device life control. If device life control is enabled, the device may degrade performance in order to extend device life (e.g., manage endurance). If device life control is disabled, the device shall not degrade performance in order to extend device life.

The device life control state shall not be affected by a power-on reset, a hardware reset, or a software reset.

Support for the SET FEATURES subcommands to enable and disable device life control is indicated by the DLC SUPPORTED bit (see 9.10.5.2.39). The state of the device life control is indicated in the DLC ENABLED bit (see 9.10.6.2.7).

7.45.10 Enable/Disable Command Duration Limits feature set

7.45.10.1 Overview

Subcommand code 0Dh allows the host to enable or disable:

a) the Command Duration Limits feature set (see 4.7); or
b) the High Priority Enhancement feature in the Command Duration Limits feature set (see 4.7.4).

Support for the Command Duration Limits feature set is indicated by the COMMAND DURATION LIMITS SUPPORTED bit (see 9.10.5.19.3).

The enabled state of the Command Duration Limits feature set is indicated by the COMMAND DURATION LIMITS ENABLED bit (see 9.10.6.2.3) and shall persist across all resets.

Support for the High Priority Enhancement feature in the Command Duration Limits feature set is indicated by the HIGH PRIORITY ENHANCEMENT SUPPORTED bit (see 9.10.5.19.1).

The enabled state of the High Priority Enhancement feature in the Command Duration Limits feature set is indicated by the HIGH PRIORITY ENHANCEMENT ENABLED bit (see 9.10.6.2.2) and shall persist across all resets.

The device shall return command aborted, if:

a) the COMMAND DURATION LIMITS SUPPORTED bit is cleared to zero; and
b) the HIGH PRIORITY ENHANCEMENT SUPPORTED bit is cleared to zero.

See table 128 for the COUNT field and LBA field definitions.

Table 128 — Enable/Disable Command Duration Limits parameters

Field	Bits	Description
COUNT	15:2	Reserved
	1:0	CDL ACTION field (see table 129)
LBA	47:0	Reserved

The CDL ACTION field (see table 129) specifies what the device shall enable or disable as a result of processing subcommand code 0Dh.

Table 129 — CDL ACTION field

Code	Description	Reference
00b	Disable the Command Duration Limits feature set and the High Priority Enhancement feature	7.45.10.2
01b	Enable the Command Duration Limits feature set and disable the High Priority Enhancement feature	7.45.10.3
10b	Enable the High Priority Enhancement feature [a]	7.45.10.4
11b	Reserved	
[a] While the Command Duration Limits feature set is enabled, the device returns command aborted if a SET FEATURES command is processed with subcommand code 0Dh and the CDL ACTION field set to 10b.		

7.45.10.2 Disabling the Command Duration Limits feature set and High Priority Enhancement feature

The device shall clear:

a) the COMMAND DURATION LIMITS ENABLED bit (see 9.10.6.2.3) to zero; and
b) the HIGH PRIORITY ENHANCEMENT ENABLED bit (see 9.10.6.2.2) to zero.

The host may use the SCT Error Recovery Control command (see 8.3.3) to establish the settings that were cleared to zero by a previous SET FEATURES command that enabled the Command Duration Limits feature set (see 7.45.10.3).

If the Command Duration Limits feature set is disabled and the High Priority Enhancement feature is disabled, then disabling the Command Duration Limits feature set and the High Priority Enhancement feature shall not be considered an error.

7.45.10.3 Enabling the Command Duration Limits feature set

If the COMMAND DURATION LIMITS SUPPORTED bit (see 9.10.5.19.3) is:

a) cleared to zero, then the device shall return command aborted with the additional sense code set to INVALID FIELD IN CDB (see 6.8.17); and
b) set to one, then the device shall:
   A) set the COMMAND DURATION LIMITS ENABLED bit (see 9.10.6.2.3) to one;
   B) clear the HIGH PRIORITY ENHANCEMENT ENABLED bit (see 9.10.6.2.2) to zero;
   C) initialize the device statistics in Command Duration Limits Statistics log page (see 9.5.4); and
   D) clear the following SCT Error Recovery Control settings (see 8.3.3) to zero:
      a) the Read Command Timer;
      b) the Write Command Timer;
      c) the Power-on Read Command Timer; and
      d) the Power-on Write Command Timer.

If the Command Duration Limits feature set is enabled, then enabling the Command Duration Limits feature set shall:

a) not be considered an error; and
b) result in the device statistics in the Command Duration Limits Statistics log page being reset as described in this subclause (i.e., 7.45.10.3).

7.45.10.4 Enabling the High Priority Enhancement feature

If the HIGH PRIORITY ENHANCEMENT SUPPORTED bit (see 9.10.5.19.1) is:

a) cleared to zero, then the device shall return command aborted with the additional sense code set to INVALID FIELD IN CDB (see 6.8.17); and
b) set to one and the COMMAND DURATION LIMITS ENABLED bit (see 9.10.6.2.3) is:
   A) set to one, then the device shall return command aborted with the additional sense code set to COMMAND SEQUENCE ERROR (see 6.8.3); and

B) cleared to zero, then the device shall set the HIGH PRIORITY ENHANCEMENT ENABLED bit (see 9.10.6.2.2) to one.

If the High Priority Enhancement feature is enabled, the enabling the High Priority Enhancement feature shall not be considered an error.

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 Typical PIO Host Interface Sector Time value (see table 130) to the COUNT field (7:0) and LBA field (7:0) and writes the Typical DMA Host Interface Sector Time value (see table 130) to the LBA field (23:8). The Typical Host Interface Sector Times (see table 130) have the same units as the:

a) DMA SECTOR TIME field (see 9.10.6.4) for DMA; and
b) PIO SECTOR TIME field (see 9.10.6.5) 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.

See table 130 for the COUNT field and LBA field definitions.

Table 130 — 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)

Upon completion of SET FEATURES subcommand 43h, the device may adjust the following fields to allow for the specified host interface sector time:

a) DMA SECTOR TIME (see 9.10.6.4);
b) PIO SECTOR TIME (see 9.10.6.5); and
c) STREAM ACCESS LATENCY (see 9.10.6.7).

7.45.12 Set rate basis

Subcommand 45h sets the value of the Utilization Usage Rate device statistic RATE BASIS field (see 9.5.6.12.3) to the value in the COUNT field.

Support for the Set rate basis subcommand is indicated by the SETTING RATE BASIS SUPPORTED bit (see 9.5.6.12.3). Supported values for the COUNT field are indicated by the Utilization Usage Rate Support QWord (see 9.10.5.11) in the Supported Capabilities page (see 9.10.5).

The value in the RATE BASIS field:

a) may be reset during the processing of a power-on reset; and
b) shall be preserved over all other resets (i.e., hardware reset and software reset).

7.45.13 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.

Support for the read look-ahead feature set is indicated by the READ LOOK-AHEAD SUPPORTED bit (see 9.10.5.2.12). The enabled state of the read look-ahead feature set is indicated by the READ LOOK-AHEAD ENABLED bit (see 9.10.6.2.14).

7.45.14 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.

The enabled state of the reverting to defaults mode is indicated by the REVERTING TO DEFAULTS ENABLED bit (see 9.10.6.2.11).

7.45.15 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 4.10). To enable the Free-fall Control feature set, the host sends subcommand code 41h with the COUNT field set to the requested free-fall control sensitivity value.

The sensitivity is specified using a scale from 00h to FFh. A value of zero specifies the device manufacturer'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).

Support for the Free-fall Control feature set is indicated by the FREE-FALL SUPPORTED bit (see 9.10.5.2.29). The enabled state of the Free-fall Control feature set is indicated by the FREE-FALL ENABLED bit (see 9.10.6.2.18). The current free-fall sensitivity value is indicated in the FREE-FALL SENSITIVITY field (see 9.10.6.9).

7.45.16 Enable/Disable SATA feature

7.45.16.1 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 131.

Table 131 — SATA features

COUNT field	Description	Reference
00h	Reserved for Serial ATA	
01h	Nonzero Buffer Offsets	7.45.16.2
02h	DMA Setup FIS Auto-Activate optimization	7.45.16.3
03h	Device-initiated interface power state transitions	7.45.16.4
04h	Guaranteed In-Order Data Delivery	7.45.16.5
05h	Obsolete	
06h	Software Settings Preservation	7.45.16.6
07h	Device Automatic Partial to Slumber transitions	7.45.16.7
08h	Enable Hardware Feature Control	7.45.16.8
09h	Enable/Disable Device Sleep	7.45.16.9
0Ah	Enable/Disable Hybrid Information	7.45.16.10
0Bh	Enable/Disable Power Disable Feature	7.45.16.11
0Ch..FFh	Reserved for Serial ATA	

7.45.16.2 Enable/Disable Nonzero Buffer Offsets

A COUNT field value of 01h is used to enable or disable nonzero buffer offsets for commands in the NCQ feature set (see 4.15). By default, nonzero buffer offsets are disabled. The enable/disable state for nonzero offsets shall be preserved across software reset. The enable/disable state for nonzero offsets shall be reset to the default state upon COMRESET. See SATA 3.5 for more information.

7.45.16.3 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 3.5 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 the default state upon COMRESET.

7.45.16.4 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 3.5 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 the 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 349).

7.45.16.5 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 4.15). This setting is only valid if nonzero buffer offsets are enabled. By default, guaranteed in-order data delivery is disabled. See SATA 3.5 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 the default state upon COMRESET.

7.45.16.6 Enable/Disable Software Settings Preservation

See table 18 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 the device 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 the 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.

7.45.16.7 Enable/Disable Device Automatic Partial to Slumber Transitions

A COUNT field (7:0) set to 07h is used by the host to enable or disable Device Automatic Partial to Slumber transitions. By default, if the device supports Device Automatic Partial to Slumber transitions the feature is disabled on power-up. The enable/disable state for Device Automatic Partial to Slumber transitions shall persist across software reset. The enable/disable state for Automatic Partial to Slumber transitions shall be reset to the default state upon hardware reset.

Device Automatic Partial to Slumber transitions shall not be enabled if Device-Initiated Interface Power State transitions are disabled. Attempting to enable Automatic Partial to Slumber transitions while Device-Initiated Interface Power State transitions are disabled results in the device aborting the SET FEATURES command. Attempting to disable Device Automatic Partial to Slumber transitions while Device-Initiated Interface Power State transitions are already disabled has no effect and the device shall return completion for the SET FEATURES command without an error.

7.45.16.8 Enable Hardware Feature Control

See 4.21 for additional information about Hardware Feature Control.

This function enables an extended use of Hardware Feature Control (see table 132). The Hardware Feature Control feature shall be disabled by processing a power-on reset.

A COUNT field (7:0) set to 08h is used by the host to enable Hardware Feature Control.

The LBA field (15:0) contains a function identifier (see table 132).

Table 132 — Extended Uses of Hardware Feature Control

Function identifier	Description	Preserved across	
		Software Reset	Hardware Reset
0000h	Reserved		
0001h	See SATA 3.5	Yes	Yes
0002h..EFFFh	Reserved		
F000h..FFFFh	Vendor specific	Vendor specific	Vendor specific

After a SET FEATURES Enable Hardware Feature Control command returns command completion without error:

a) the CURRENT HARDWARE FEATURE CONTROL IDENTIFIER field (see 9.10.10.4) shall be set to the value in the LBA field (15:0);
b) the Hardware Feature Control feature shall be enabled (i.e., IDENTIFY DEVICE data word 79, bit 5 is set to one); and
c) the behavior of Hardware Feature Control is specified by table 132.

The device shall return command aborted if:

a) the Hardware Feature Control feature is not supported (i.e., IDENTIFY DEVICE data word 78 bit 5 is cleared to zero);
b) the value in the LBA field (15:0) is not equal to the value in the SUPPORTED HARDWARE FEATURE CONTROL IDENTIFIER field (see 9.10.10.5); or
c) the CURRENT HARDWARE FEATURE CONTROL IDENTIFIER field (see 9.10.10.4) is not cleared to zero.

7.45.16.9 Enable/Disable Device Sleep

The Device Sleep feature manages an interface power condition for low power consumption. See SATA 3.5 for a complete description.

A COUNT field (7:0) set to 09h is used by the host to enable or disable the Device Sleep feature.

If the DEVICE SLEEP SUPPORTED bit (see 9.10.10.2.22) is cleared to zero (i.e., the Device Sleep feature is not supported), then the device shall return command aborted.

If:

a) the DEVICE SLEEP SUPPORTED bit is set to one (see 9.10.10.2.22);
b) the FEATURES field (7:0) is set to 10h (i.e., enable a SATA feature);
c) the COUNT field (7:0) is set to 09h; and
d) the POWER DISABLE FEATURE SUPPORTED bit is set to one (see 9.10.10.2.28) or the POWER DISABLE FEATURE ALWAYS ENABLED bit is set to one (see 9.10.10.2.29),

then the device shall return command aborted.

If:

a) the DEVICE SLEEP SUPPORTED bit is set to one (see 9.10.10.2.22);
b) the FEATURES field (7:0) is set to 10h (i.e., enable a SATA feature);
c) the COUNT field (7:0) is set to 09h;
d) the POWER DISABLE FEATURE SUPPORTED bit is cleared to zero (see 9.10.10.2.28); and
e) the POWER DISABLE FEATURE ALWAYS ENABLED bit is cleared to zero (see 9.10.10.2.29),

then the device shall:

1) set the DEVICE SLEEP ENABLED bit to one (see 9.10.10.3.9); and
2) return command completion without error.

If:

a) the DEVICE SLEEP SUPPORTED bit is set to one (see 9.10.10.2.22);

b) the FEATURES field (7:0) is set to 90h (i.e., disable a SATA feature); and
c) the COUNT field (7:0) is set to 09h,

then the device shall:

1) clear the DEVICE SLEEP ENABLED bit to zero (see 9.10.10.3.9); and
2) return command completion without error.

As a result of processing a power on reset, the device shall clear the DEVICE SLEEP ENABLED bit to zero (see 9.10.10.3.9).

7.45.16.10 Enable/Disable Hybrid Information

7.45.16.10.1 Enable/Disable Hybrid Information overview

See 4.12 for additional information about the Hybrid Information feature.

The Enable/Disable Hybrid Information subcommand:

a) enables the Hybrid Information feature and the non-volatile cache; or
b) disables the Hybrid Information feature and leaves the non-volatile cache in a vendor specific state.

The device shall return command aborted if the Hybrid Information feature is not supported. If the Hybrid Information feature is enabled, then the feature shall remain enabled across all resets (e.g., power cycles), except as specified in 4.12.4.5.

7.45.16.10.2 Enable Hybrid Information subcommand

The Enable Hybrid Information subcommand enables the Hybrid Information feature.

If the Hybrid Information feature is currently enabled (i.e., the ENABLED field (see 9.19.2.3) is set to FFh), then the device shall return command aborted.

If the Hybrid Information feature is currently disabled(i.e., the ENABLED field is set to 00h), then the device shall:

a) enable the Hybrid Information feature (i.e., set the HYBRID INFORMATION ENABLED bit (see 9.10.10.3.12) to one);
b) set the ENABLED field (see 9.19.2.3) to FFh;
c) increment the ENABLE COUNT field (see 9.19.2.14) by one; and
d) enable the use of the non-volatile cache.

7.45.16.10.3 Disable Hybrid Information subcommand

The Disable Hybrid Information Feature subcommand disables the Hybrid Information feature.

If the Hybrid Information feature is currently enabled (i.e., the ENABLED field (see 9.19.2.3) is set to FFh), then the device shall:

a) disable the Hybrid Information feature (i.e., clear the HYBRID INFORMATION ENABLED bit (see 9.10.10.3.12) to zero);
b) set the ENABLED field (see 9.19.2.3) to 00h; and
c) change the requested caching priority level for all logical sectors in the non-volatile cache to zero.

If the Hybrid Information feature is currently disabled, then the device should return command completed without error.

7.45.16.11 Enable/Disable Power Disable Feature

The Power Disable feature defines a mechanism for the host to disable power to the device circuitry within the device when power is present at the SATA device power connector. See SATA 3.5 for a complete description.

A COUNT field (7:0) set to 0Bh is used by the host to enable or disable the Power Disable feature.

If the POWER DISABLE FEATURE SUPPORTED bit is cleared to zero (see 9.10.10.2.28), then the device shall return command aborted.

If:

a) the POWER DISABLE FEATURE SUPPORTED bit is set to one (see 9.10.10.2.28);

b) the FEATURES field (7:0) is set to 10h (i.e., enable a SATA feature);
c) the COUNT field (7:0) is set to 0Bh; and
d) the DEVICE SLEEP ENABLED bit is set to one (see 9.10.10.3.9),

then the device shall return command aborted.

If:

a) the POWER DISABLE FEATURE SUPPORTED bit is set to one (see 9.10.10.2.28);
b) the FEATURES field (7:0) is set to 10h (i.e., enable a SATA feature);
c) the COUNT field (7:0) is set to 0Bh; and
d) the POWER DISABLE FEATURE ENABLED bit is set to one (see 9.10.10.3.10) or the POWER DISABLE FEATURE ALWAYS ENABLED bit is set to one (see 9.10.10.2.29),

then the device shall return command completion without error.

If:

a) the POWER DISABLE FEATURE SUPPORTED bit is set to one (see 9.10.10.2.28);
b) the FEATURES field (7:0) is set to 10h (i.e., enable a SATA feature); and
c) the COUNT field (7:0) is set to 0Bh,

then the device shall:

1) set the POWER DISABLE FEATURE ENABLED bit to one (see 9.10.10.3.10); and
2) return command completion without error.

If:

a) the POWER DISABLE FEATURE SUPPORTED bit is set to one (see 9.10.10.2.28);
b) the FEATURES field (7:0) is set to 90h (i.e., disable a SATA feature);
c) the COUNT field (7:0) is set to 0Bh; and
d) the POWER DISABLE FEATURE ENABLED bit is cleared to zero (see 9.10.10.3.10),

then the device shall return command completion without error.

If the POWER DISABLE FEATURE SUPPORTED bit is set to one (see 9.10.10.2.28) and the POWER DISABLE FEATURE ALWAYS ENABLED bit (see 9.10.10.2.29) is:

a) set to one, then the POWER DISABLE FEATURE ENABLED bit is always set to one (see 9.10.10.3.10); or
b) cleared to zero, then the POWER DISABLE FEATURE ENABLED bit (see 9.10.10.3.10):
   A) shall be cleared to zero as a result of processing a power on reset; and
   B) shall not be changed as a result of processing a hardware reset or a software reset.

7.45.17 Enable/Disable the Sense Data Reporting feature set

Subcommand code C3h allows the host to enable the Sense Data Reporting feature set (see 4.24) by sending this subcommand with the COUNT field bit 0 set to one.

The Sense Data Reporting feature set is disabled by sending this subcommand with the COUNT field bit 0 cleared to zero.

All other subcommand specific fields are reserved.

If the device reports the signature for a Host Managed Zoned device (see table 349) and this subcommand has the COUNT field bit 0 cleared to zero, then the device shall return command completion with an error.

Support for the Sense Data Reporting feature set is indicated by the SENSE DATA SUPPORTED bit (see 9.10.5.2.28). The enabled state of the Sense Data Reporting feature set is indicated by the SENSE DATA ENABLED bit (see 9.10.6.2.12).

7.45.18 Enable/Disable sense data return for successful NCQ commands

If the SUCCESSFUL NCQ COMMAND SENSE DATA SUPPORTED bit (see 9.10.5.2.40) is set to one, subcommand code C4h allows the host to enable the returning of sense data (see 4.24) for NCQ commands (see 4.15) that the device completes without an error using the Sense Data for Successful NCQ Commands log (see 9.28) as defined in 4.15.7.

The host enables returning sense data for NCQ commands that the device completes without an error by sending this subcommand with the COUNT field bit 0 set to one. The returning sense data for NCQ commands that the device completes without an error is disabled by sending this subcommand with the COUNT field bit 0 cleared to zero.

All other subcommand specific fields are reserved.

Support for the returning sense data for NCQ commands that the device completes without an error is indicated by the SUCCESSFUL NCQ COMMAND SENSE DATA SUPPORTED bit (see 9.10.5.2.40). The enabled state for the returning sense data for NCQ commands that the device completes without an error is indicated by the SUCCESSFUL NCQ COMMAND SENSE DATA ENABLED bit (see 9.10.6.2.6).

If the PERSISTENT SENSE DATA REPORTING bit (see 9.10.5.2.47) is set to one, then the setting persists over all resets (e.g., power-on reset).

7.45.19 Long Physical Sector Alignment Error Reporting Control

Subcommand code 62h allows the host to control the reporting of errors associated with the LPS feature set (see 4.14). The LPS MISALIGNMENT REPORTING SUPPORTED bit (see 9.10.5.2.3) indicates whether Long Physical Sector Alignment Error Reporting is supported. The ALIGNMENT ERROR REPORTING field (see 9.10.4.3.3) indicates the current Long Physical Sector Alignment Error Reporting setting.

If the COUNT field is cleared to zero, the device shall disable Alignment Error reporting;

If the COUNT field is set to one, the device shall process the command and set the ALIGNMENT ERROR bit (see 6.2.2) to one in response to a write command in which:

a) the first byte of data does not begin at the first byte of a physical sector (see 7.13.6.75); or
b) the last byte of data does not end at the last byte of a physical sector (see 7.13.6.75).

If the COUNT field is set to two, the device shall return command aborted and set the ALIGNMENT ERROR bit (see 6.2.2) to one, leaving the condition of the data unknown, in response to a write command in which:

a) the first byte of data does not begin at the first byte of a physical sector (see 7.13.6.75); or
b) the last byte of data does not end at the last byte of a physical sector (see 7.13.6.75).

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 9.13).

This setting shall be preserved across all resets.

7.45.20 Extended Power Conditions subcommand

7.45.20.1 Overview

SET FEATURES subcommand code 4Ah configures the use of the EPC feature set (see 4.9). If the EPC feature set is not supported, the device shall return command aborted.

Table 133 describes the EPC subcommands that are specified in LBA field bits (3:0) for the Extended Power Conditions subcommand of the SET FEATURES command.

Table 133 — EPC subcommands

EPC subcommands	Description
0h	Restore Power Condition Settings (see 7.45.20.2)
1h	Go To Power Condition (see 7.45.20.3)
2h	Set Power Condition Timer (see 7.45.20.4)
3h	Set Power Condition State (see 7.45.20.5)
4h	Enable the EPC feature set (see 7.45.20.6)
5h	Disable the EPC feature set (see 7.45.20.7)
6h	Set EPC Power Source (see 7.45.20.8)
7h..Fh	Reserved

Table 134 describes the contents of the POWER CONDITION ID field that are specified in the COUNT field and select the power condition or power conditions to be processed.

Table 134 — POWER CONDITION ID field

Code	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 power conditions
[a] See 4.17.4 for the description of the power states.		

Support for the EPC feature set is indicated by the EPC SUPPORTED bit (see 9.10.5.2.27). The enabled state of the EPC feature set is indicated by the EPC ENABLED bit (see 9.10.6.2.9).

7.45.20.2 Restore Power Condition Settings subcommand

7.45.20.2.1 Description

If the value in the POWER CONDITION ID field is FFh and the SAVE bit is set to one, then all power conditions that are supported, changeable, and saveable are selected.

If the value in the POWER CONDITION ID field is FFh and the SAVE bit is cleared to zero, then all power conditions that are supported and changeable are selected.

All power conditions that are not selected shall not be changed.

As part of returning command completion for this EPC subcommand without an error, the device shall update the Power Conditions log (see 9.8) for each selected power condition (see table 134) as follows:

1) if the DEFAULT bit is set to one or the SAVED TIMER SETTING field is not initialized, then:
   A) copy the DEFAULT TIMER SETTING field (see 9.8) to the CURRENT TIMER SETTING field (see 9.8); and
   B) copy the DEFAULT TIMER ENABLED bit (see 9.8) to the CURRENT TIMER ENABLED bit (see 9.8);
2) if the DEFAULT bit is cleared to zero and the SAVED TIMER SETTING field is initialized, then:
   A) copy the contents of the SAVED TIMER SETTING field (see 9.8) to the CURRENT TIMER SETTING field; and
   B) copy the SAVED TIMER ENABLED bit (see 9.8) to the CURRENT TIMER ENABLED bit;
   and
3) if the SAVE bit is set to one and the power condition is saveable, then:
   A) copy the CURRENT TIMER SETTING field to the SAVED TIMER SETTING field; and
   B) copy the CURRENT TIMER ENABLED bit to the SAVED TIMER ENABLED bit.

7.45.20.2.2 Inputs

See table 135 for the SET FEATURES command inputs.

Table 135 — Restore Power Condition Settings inputs

Field	Description
COUNT	POWER CONDITION ID field (see table 134)
LBA	**Bit Description** 27:7 Reserved 6 DEFAULT bit 1 = Restore from Default settings 0 = Restore from Saved settings 5 Reserved 4 SAVE bit 1 = Save settings on completion 0 = Do not save settings on completion 3:0 0h (i.e., Restore Power Condition subcommand (see table 133))

7.45.20.2.3 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.45.20.2.4 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

If any selected power condition:

a) is not supported;
b) is not changeable; or
c) the SAVE bit is set to one and the selected power condition is not saveable,

then the device shall return command aborted. See table 361.

7.45.20.3 Go To Power Condition subcommand

7.45.20.3.1 Description

Prior to returning command completion without error the device shall stop all power condition timers (see 4.9.3).

If the LOW POWER STANDBY SUPPORTED bit (see 9.10.5.2.36) is cleared to zero and the selected power condition is supported, then the device:

1) shall ignore:
   A) the DELAYED ENTRY bit; and
   B) the HOLD POWER CONDITION bit;

   and
2) shall:
   A) enter the selected power condition (see 4.9.2); and
   B) return command completion without error.

If the LOW POWER STANDBY SUPPORTED bit (see 9.10.5.2.36) is set to one, then if:

a) the DELAYED ENTRY bit is cleared to zero, then the device shall enter the selected power condition (see 4.9.2) before returning command completion;
b) the DELAYED ENTRY bit is set to one, then the device may enter the selected power condition after returning command completion; and
c) the device is in the selected power condition or the device enters the selected power condition as a result of processing the Go To Power Condition subcommand, and if:
   A) the HOLD POWER CONDITION bit is cleared to zero, then the device shall:
      a) return command completion without error; and
      b) remain in the selected power condition until the device processes a command or any reset;

      or
   B) the HOLD POWER CONDITION bit is set to one, then:
      a) if the HOLD POWER CONDITION NOT SUPPORTED bit (see 9.8.4.8) for the selected power condition is cleared to zero, then the device shall:
         A) return command completion without error; and
         B) abort all commands that cause the device to enter a higher power condition, except the Go To Power Condition subcommand;

         or
      b) if the HOLD POWER CONDITION NOT SUPPORTED bit for the selected power condition is set to one, then the device shall return command aborted.

7.45.20.3.2 Inputs

See table 136 for the SET FEATURES command inputs.

Table 136 — Go To Power Condition inputs

Field	Description
COUNT	POWER CONDITION ID field (see table 134)
LBA	**Bit** **Description** 27:26 Reserved 25 DELAYED ENTRY bit – See 7.45.20.3.1 24 HOLD POWER CONDITION bit – See 7.45.20.3.1 23:4 Reserved 3:0 1h (i.e., Go To Power Condition subcommand (see table 133))

7.45.20.3.3 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.45.20.3.4 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device shall return command aborted if:

a) the POWER CONDITION ID field is set to FFh;
b) the POWER CONDITION ID field is set to a reserved value;
c) the POWER CONDITION ID field is set to an unsupported value; or
d) the HOLD POWER CONDITION bit is set to one and the HOLD POWER CONDITION NOT SUPPORTED bit (see 9.8.4.8) for the selected power condition is valid and set to one.

See table 361.

7.45.20.4 Set Power Condition Timer subcommand

7.45.20.4.1 Description

As part of returning command completion for this subcommand without an error, the device shall update the Power Conditions log (see 9.8) for the selected and supported power condition as follows:

1) set the CURRENT TIMER SETTING field based on the contents of the TIMER field and the TIMER UNITS bit as described in 7.45.20.4.3;
2) if the ENABLE bit is set to one and the TIMER field is nonzero, then enable the Current Timer;
3) if the ENABLE bit is set to one and the TIMER field is zero, then disable the Current Timer;
4) if the ENABLE bit is cleared to zero, then disable the Current Timer; and
5) if the SAVE bit is set to one and the Power Condition settings are saveable, then:
   A) copy the CURRENT TIMER SETTING field to the SAVED TIMER SETTING field; and
   B) copy the CURRENT TIMER ENABLED bit to the SAVED TIMER ENABLED bit.

The host should not set the POWER CONDITION ID field to FFh. If the device processes the Set Power Condition Timer subcommand with the POWER CONDITION ID field set to FFh, then the setting of the timers are vendor specific.

7.45.20.4.2 Inputs

See table 137 for the SET FEATURES command inputs.

Table 137 — Set Power Condition Timer inputs

Field	Description
COUNT	POWER CONDITION ID field (see table 134)
LBA	**Bit** **Description** 27:24 Reserved 23:8 TIMER field – See 7.45.20.4.3 7 TIMER UNITS bit – See 7.45.20.4.3 1 = TIMER field units of measure are 1 min 0 = TIMER field units of measure are 100 ms 6 Reserved 5 ENABLE bit 1 = Enable the selected power condition 0 = Disable the selected power condition 4 SAVE bit 1 = Save settings on completion 0 = Do not save settings on completion 3:0 2h (i.e., Set Power Condition Timer subcommand (see table 133))

7.45.20.4.3 TIMER field and TIMER UNITS bit

The device shall compute a new timer value as described in this subclause and store the result in the CURRENT TIMER SETTING field (see 9.8.4.11).

If the TIMER UNITS bit is cleared to zero, the new timer value shall be equal to the contents of the TIMER field. If the TIMER UNITS bit is set to one, the new timer value shall be equal to the contents of the TIMER field multiplied by 600.

If the new timer value is greater than the value in the MAXIMUM TIMER SETTING field (see 9.8.4.14) for the selected power condition, then the device may set the new timer value to the maximum timer setting for the selected power condition. If the new timer value is less than the value in the MINIMUM TIMER SETTING field (see 9.8.4.13) for the selected power condition, then the device may set the new timer value to the minimum timer setting for the selected power condition.

7.45.20.4.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.45.20.4.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device shall return command aborted If:

a) the new timer value is:
   A) less than the maximum setting for the selected power condition;
   B) greater than the minimum setting for the selected power condition; and
   C) not supported by the device;
b) the POWER CONDITION ID field is invalid;
c) the selected power condition is not changeable;
d) the selected power condition is not supported;
e) the SAVE bit is set to one and the selected power condition is not saveable;
f) the new timer value is greater than the maximum setting (see 9.8) for the selected power condition and the device did not set the timer to the maximum setting; or
g) the new timer value is less than the minimum setting (see 9.8) for the selected power condition 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 361.

7.45.20.5 Set Power Condition State subcommand

7.45.20.5.1 Description

If the value of the POWER CONDITION ID field is FFh and the SAVE bit is set to one, then all power conditions that are supported, changeable, and saveable are selected.

If the value of the POWER CONDITION ID field is FFh and the SAVE bit is cleared to zero, then all power conditions that are supported and changeable are selected.

All power conditions that are not selected shall be unchanged.

As part of returning command completion for this EPC subcommand without an error, the device shall update the Power Conditions log (see 9.8) for each selected and supported Power Condition as follows:

1) If the ENABLE bit is set to one, then enable the Current Timer, otherwise disable the Current Timer; and
2) If the SAVE bit is set to one, then copy the CURRENT TIMER ENABLED bit (see 9.8.4.7) to the SAVED TIMER ENABLED bit (see 9.8.4.6).

7.45.20.5.2 Inputs

See table 138 for the SET FEATURES command inputs.

Table 138 — Set Power Condition State inputs

Field	Description
COUNT	POWER CONDITION ID field (see table 134)
LBA	**Bit Description** 27:6 Reserved 5 ENABLE bit 1 = Enable the selected power condition 0 = Disable the selected power condition 4 SAVE bit 1 = Save settings on completion 0 = Do not save settings on completion 3:0 3h (i.e., Set Power Condition State subcommand (see table 133))

7.45.20.5.3 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.45.20.5.4 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device shall return command aborted if:

a) the selected power condition is invalid;
b) the selected power condition is not supported;
c) the selected power condition is not changeable; or
d) the SAVE bit is set to one and the selected power condition is not saveable.

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 361.

7.45.20.6 Enable the EPC feature set subcommand

7.45.20.6.1 Description

As part of returning command completion for this EPC subcommand without an error, the device shall:

1) enable the EPC feature set;
2) set the EPC ENABLED bit (see 9.10.6.2.9) to one;
3) disable the APM feature set; and
4) for each supported power condition:
    1) if the SAVED TIMER SETTING field (see 9.8.4.10) is cleared to zero, then:
        a) copy the value in the DEFAULT TIMER SETTING field (see 9.8.4.9) to the CURRENT TIMER SETTING field (see 9.8.4.11); and
        b) copy the DEFAULT TIMER ENABLED bit (see 9.8.4.5) to the CURRENT TIMER ENABLED bit (see 9.8.4.7);

        or
    2) if the SAVED TIMER SETTING field is nonzero, then:
        a) copy the value of the SAVED TIMER SETTING field to the CURRENT TIMER SETTING field; and
        b) copy the SAVED TIMER ENABLED bit (see 9.8.4.6) to the CURRENT TIMER ENABLED bit;

    and
5) if the CURRENT TIMER SETTING field is nonzero and the CURRENT TIMER ENABLED bit 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).

7.45.20.6.2 Inputs

See table 139 for the SET FEATURES command inputs.

Table 139 — Enable the EPC feature set inputs

Field	Description
COUNT	Reserved
LBA	**Bit** **Description** 27:4 Reserved 3:0 4h (i.e., Enable the EPC feature set (see table 133))

7.45.20.6.3 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.45.20.6.4 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 361.

7.45.20.7 Disable the EPC feature set subcommand

7.45.20.7.1 Description

As part of returning command completion for this subcommand without an error, the device shall:

a) stop all power condition timers (see 4.9.3);
b) disable the EPC feature set; and
c) clear the EPC ENABLED bit (see 9.10.6.2.9) to zero.

The EPC feature set shall remain disabled across all resets (i.e., power-on reset, hardware reset, and software reset).

7.45.20.7.2 Inputs

See table 140 for the SET FEATURES command inputs.

Table 140 — Disable the EPC feature set inputs

Field	Description
COUNT	Reserved
LBA	**Bit** **Description** 27:4 Reserved 3:0 5h (i.e., Disable the EPC feature set (see table 133))

7.45.20.7.3 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.45.20.7.4 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 361.

7.45.20.8 Set EPC Power Source

7.45.20.8.1 Description

Set EPC Power Source indicates to the device the power source.

7.45.20.8.2 Inputs

7.45.20.8.2.1 Overview

See table 141 for the SET FEATURES command inputs.

Table 141 — Set EPC Power Source inputs

Field	Description
COUNT	**Bit** **Description** 7:2 Reserved 1:0 POWER SOURCE field – See 7.45.20.8.2.2
LBA	**Bit** **Description** 27:4 Reserved 3:0 6h (i.e., Set EPC Power Source)

7.45.20.8.2.2 POWER SOURCE field

The POWER SOURCE field indicates the current power source as described in 9.10.6.3.1.

7.45.20.8.3 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.45.20.8.4 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 361.

7.45.21 Enable/Disable the DSN feature set

7.45.21.1 Overview

Subcommand code 63h allows the host to enable or disable the DSN feature set (see 4.8). If the device receives subcommand code 63h and the DSN feature set is not supported, then the device returns command aborted.

The DSN feature set is disabled by processing a power-on reset and does not change state by processing any other reset event.

Table 142 describes the Enable/Disable the DSN feature set functions. The Enable/Disable the DSN function is provided in the COUNT field.

Table 142 — DSN feature set subcommands

DSN Function	Description
00h	Reserved
01h	Enable DSN feature set (see 7.45.21.2)
02h	Disable DSN feature set (see 7.45.21.2)
03h..FFh	Reserved

7.45.21.2 Enable/Disable DSN feature set

DSN function 01h enables the DSN feature set. If the device processes the DSN function 01h, then the device shall:

a) enable the DSN feature set; and
b) set DSN ENABLED bit (see 9.10.6.2.8) to one.

DSN function 02h disables the DSN feature set. If the device processes the DSN function 02h, the device shall:

a) disable the DSN feature set; and
b) clear DSN ENABLED bit (see 9.10.6.2.8) to zero.

7.45.22 Advanced Background Operation Control

7.45.22.1 Overview

Subcommand code 50h allows the host to control advanced background operations. Table 143 describes the command inputs.

If the ADVANCED BACKGROUND OPERATION SUPPORTED bit (see 9.10.5.2.48) is cleared to zero, the device shall return command aborted.

If the ADVANCED BACKGROUND OPERATION SUPPORTED bit (see 9.10.5.2.48) is set to one, then the device shall process the IR bit (see 7.45.22.4), the ABO TIMELIMIT field (see 7.45.22.3) and the ABO CONTROL field (see 7.45.22.2).

Table 143 — SET FEATURES fields for Advanced Background Operation Control

Field	Description	
COUNT	Reserved	
LBA	**Bits**	**Description**
	27:25	ABO CONTROL field (see 7.45.22.2)
	24	IR bit (see 7.45.22.4)
	23:16	Reserved
	15:0	ABO TIMELIMIT field (see 7.45.22.3)

7.45.22.2 ABO CONTROL field

Table 144 describes the meaning of the values of the ABO CONTROL field.

Table 144 — ABO CONTROL field

Code	Description
0h	Do not change host initiated advanced background operations.
1h	Start host initiated advanced background operations.
2h	Stop host initiated advanced background operations.
3h..7h	Reserved

7.45.22.3 ABO TIMELIMIT field

The ABO TIMELIMIT field specifies the amount of time in milliseconds that the device may perform host initiated advanced background operations.

If the value of the ABO TIMELIMIT field is zero, then there is no time limit.

If the value of the ABO TIMELIMIT field is non-zero, then

a) if the value of the ABO MIN TIMELIMIT field (see 9.10.5.13.4):
   A) is non-zero; and
   B) is greater than the value of the ABO TIMELIMIT field,

   then the device shall use the value of the ABO MIN TIMELIMIT field as the effective value of the ABO TIMELIMIT field;

   and

b) if the value of the ABO MAX TIMELIMIT field (see 9.10.5.13.5):
   A) is non-zero; and
   B) is less than the value of the ABO TIMELIMIT field,

   then the device shall use the value of the ABO MAX TIMELIMIT field as the effective value of the ABO TIMELIMIT field;

7.45.22.4 Immediate response (IR) bit

The immediate response (IR) bit specifies whether host initiated background operations shall complete before returning command completion as described in 7.45.22.5.

7.45.22.5 Operation of host initiated background operations

Host initiated background operations shall be performed as described in this subclause.

If the ABO CONTROL field is set to 0h, then the device shall:

a) not change any host initiated advanced background operations;
b) ignore the IR bit, and the ABO TIMELIMIT field; and
c) return command completion without error.

If the ABO CONTROL field is set to 1h (i.e., start host initiated advanced background operations), then:

a) if the IR bit is cleared to zero, then:
   A) if the ABO FOREGROUND MODE SUPPORTED bit (see 9.10.5.13.1) is cleared to zero, the device shall return command aborted; and
   B) if the ABO FOREGROUND MODE SUPPORTED bit is set to one, then the device shall:
      1) reset the abo_timer (see 4.5) to zero, if the ABO TIMELIMIT field is non-zero;
      2) initialize and start the abo_timer (see 4.5), if the ABO TIMELIMIT field is non-zero;
      3) perform host initiated advanced background operations until:
         A) the abo_timer is greater than or equal to a non-zero ABO TIMELIMIT field; or
         B) the device determines that all necessary advanced background operations are completed;

and

4) return command completion without error;

and

b) if the IR bit is set to one, then:
   A) if the ABO IR MODE SUPPORTED bit (see 9.10.5.13.2) is cleared to zero, the device shall return command aborted; and
   B) if the ABO IR MODE SUPPORTED bit is set to one, the device shall:
      1) return command completion without error;
      2) reset the abo_timer to zero, if the ABO TIMELIMIT field is non-zero;
      3) initialize and start the abo_timer, if the ABO TIMELIMIT field is non-zero; and
      4) perform host initiated advanced background operations until;
         A) the abo_timer is greater than or equal to a non-zero ABO TIMELIMIT field;
         B) the device determines that all necessary advanced background operations are completed; or
         C) the device processes a SET FEATURES subcommand Advanced Background Operation Control with the ABO CONTROL field set to 2h (i.e., stop host initiated background control operations).

If the ABO CONTROL field is set to 2h and the device is:

a) not performing host initiated advanced background operations, then the device shall return command completion without error; or
b) performing host initiated advanced background operations, then the device shall:
   1) ignore the IR bit, and the ABO TIMELIMIT field;
   2) stop performing host initiated advanced background operations; and
   3) return command completion without error.

7.46 SET SECTOR CONFIGURATON EXT – B2h, Non-Data

7.46.1 Feature Set

This 48-bit command is for ATA devices (see 4.2).

7.46.2 Description

This command sets the device logical block length and number of logical sectors per physical sector. The setting is selected from a list of descriptors in the Sector Configuration Log (see 9.29).

If a SET SECTOR CONFIGURATION EXT command is processed and returns command completion without error, the following shall be set as specified in the selected Sector Configuration descriptor (see 9.29.2):

a) value of the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP field (see 9.10.4.3.4), and
b) logical sector size (see 9.10.4.4).

The successful processing of a SET SECTOR CONFIGURATION command results in the device setting the ACCESSIBLE CAPACITY field (see 9.10.4.2) to the new native max address.

During the successful processing of a SET SECTOR CONFIGURATION command, the device may change:

a) user data;
b) trimmed logical sectors (see 7.5.3.3);
c) markup LBA ranges (see 7.5.3.4);
d) IDENTIFY DEVICE data (see 7.13.6);
e) IDENTIFY DEVICE data log (see 9.10); and
f) settings managed by the SET FEATURES command (see 7.45).

During the successful processing of a SET SECTOR CONFIGURATION command, the device recalculates the following device statistics due to a change in logical sector size to reflect the sector size of the new configuration:

a) Logical Sectors Written (see 9.5.6.5);
b) Logical Sectors Read (see 9.5.6.7);
c) Number of Reallocated Logical Sectors (see 9.5.8.6);
d) Number of Reallocation Candidate Logical Sectors (see 9.5.8.9); and
e) Read Recovery Attempts (see 9.5.8.7).

During the successful processing of a SET SECTOR CONFIGURATION command, the device may change the following logs:

a) the Summary SMART Error log (see 9.22);
b) the Comprehensive SMART Error log (see 9.4);
c) the Extended Comprehensive SMART Error log (see 9.7);
d) the Selective Self-Test log (see 9.21);
e) the Pending Defects log (see 9.27);
f) the LPS Mis-alignment log (see 9.13);
g) the LBA Status log (see 9.12);
h) the Write Stream Error log (see 9.23); and
i) the Read Stream Error log (see 9.15).

7.46.3 Inputs

7.46.3.1 Overview

See table 145 for the SET SECTOR CONFIGURATION EXT command inputs.

Table 145 — SET SECTOR CONFIGURATION EXT command inputs

Field	Description
FEATURE	COMMAND CHECK field – See 7.46.3.2
COUNT	**Bit Description** 15:3 Reserved 2:0 SECTOR CONFIGURATION DESCRIPTOR INDEX field – See 7.46.3.3
LBA	Reserved
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 B2h

7.46.3.2 COMMAND CHECK field

The value in the COMMAND CHECK field is taken from the DESCRIPTOR CHECK field (see 9.29.2.2.4) in the descriptor specified by the SECTOR CONFIGURATION DESCRIPTOR INDEX field.

7.46.3.3 SECTOR CONFIGURATION DESCRIPTOR INDEX field

The SECTOR CONFIGURATION DESCRIPTOR INDEX field specifies the Sector Configuration descriptor in the Set Sector Configuration log page (see 9.29.2.1).

EXAMPLE - A SECTOR CONFIGURATION DESCRIPTOR INDEX field set to 1 specifies Sector Configuration descriptor 1 (see table 326).

If the value in the COMMAND CHECK field (see 7.46.3.2) matches the value in the DESCRIPTOR CHECK field (see 9.29.2.2.4) in the descriptor specified by the SECTOR CONFIGURATION DESCRIPTOR INDEX field, then the device shall use the specified Sector Configuration descriptor to:

a) set the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP field (see 9.10.4.3.4) to the value in the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP SETTING field (see 9.29.2.2.3); and
b) if the LOGICAL SECTOR SIZE SETTING field (see 9.29.2.2.5) is set to:
   A) 256, then clear the LOGICAL SECTOR SIZE SUPPORTED bit (see 9.10.4.3.2) to zero; or
   B) a value greater than 256, then set:
      a) the LOGICAL SECTOR SIZE SUPPORTED bit to one; and
      b) the LOGICAL SECTOR SIZE field (see 9.10.4.4) to the value in the LOGICAL SECTOR SIZE SETTING field.

7.46.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.46.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device shall return command aborted if:

a) the SECTOR CONFIGURATION DESCRIPTOR INDEX field (see 7.46.3.3) does not specify a Sector Configuration descriptor with the DESCRIPTOR VALID bit set to one (see 9.29.2.2.2);
b) the COMMAND CHECK field (see 7.46.3.2) does not match the DESCRIPTOR CHECK field (see 9.29.2.2.4) in the specified Sector Configuration descriptor; or
c) the device is unable to complete processing of the command.

See table 361.

7.47 SLEEP – E6h, Non-Data

7.47.1 Feature Set

This 28-bit command is for devices that support the Power Management feature set (see 4.17).

7.47.2 Description

The SLEEP command causes the device to enter Sleep mode. The device shall exit Sleep mode (i.e., PM3: Sleep state (see 4.17.4)) only after processing a hardware reset or a software reset.

A device shall not power-on in Sleep mode.

7.47.3 Inputs

See table 146 for the SLEEP command inputs.

Table 146 — SLEEP command inputs

Field	Description
FEATURE	N/A
COUNT	N/A
LBA	N/A
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 E6h

7.47.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.47.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 361.

7.48 SMART

7.48.1 Overview

Individual SMART commands are identified by the value placed in the FEATURE field. Table 147 shows these values.

Table 147 — FEATURE field values

Value	Command
00h..CFh	Reserved
D0h..D4h	Obsolete
D5h	SMART READ LOG (see 7.48.2)
D6h	SMART WRITE LOG (see 7.48.4)
D7h..D9h	Obsolete
DAh	SMART RETURN STATUS (see 7.48.3)
DBh	Obsolete
DCh..DFh	Reserved
E0h..FFh	vendor specific

7.48.2 SMART READ LOG – B0h/D5h, PIO Data-In

7.48.2.1 Feature Set

This 28-bit command is for devices that support the SMART feature set (see 4.23).

7.48.2.2 Description

The SMART READ LOG command returns the specified log to the host. See table 218 for the list of logs.

7.48.2.3 Inputs

See table 148 for the SMART READ LOG command inputs.

Table 148 — SMART READ LOG command inputs

Field	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 field, specifies the log to be read – See 7.24.3.3
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 B0h

7.48.2.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.48.2.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

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 9.3). A device may return command completion with the ERROR bit set to one if an Interface CRC error has occurred. See table 377.

7.48.3 SMART RETURN STATUS – B0h/DAh, Non-Data

7.48.3.1 Feature Set

This 28-bit command is for devices that support the SMART feature set (see 4.23).

7.48.3.2 Description

The SMART RETURN STATUS command causes the device to communicate the reliability status of the device to the host.

7.48.3.3 Inputs

See table 149 for the SMART RETURN STATUS command inputs.

Table 149 — SMART RETURN STATUS command inputs

Field	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 6.2.11 3:0 Reserved
COMMAND	7:0 B0h

7.48.3.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 351.

7.48.3.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The ABORT bit shall be set to one if SMART is not enabled. See table 361.

7.48.4 SMART WRITE LOG – B0h/D6h, PIO Data-Out

7.48.4.1 Feature Set

This 28-bit command is for devices that support the SMART feature set (see 4.23).

7.48.4.2 Description

The SMART WRITE LOG command specifies the log to be written as described in table 150. This command causes the device to write the specified number of log pages to the specified log. See table 218 for the list of logs.

7.48.4.3 Inputs

7.48.4.3.1 Overview

See table 150 for the SMART WRITE LOG command inputs.

Table 150 — SMART WRITE LOG command inputs

Field	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 field – See 7.48.4.3.2
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 B0h

7.48.4.3.2 LOG ADDRESS field

The LOG ADDRESS field specifies the log to be written as described in 9.1. 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 logs is mandatory for devices that support the associated feature set. If the host attempts to write to a read only log (see table 218), the device shall return command aborted.

7.48.4.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.48.4.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

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 371.

7.49 STANDBY – E2h, Non-Data

7.49.1 Feature Set

This 28-bit command is for devices that support the Power Management feature set (see 4.17).

7.49.2 Description

The STANDBY command causes the device to enter the Standby mode (see 4.17.4).

If the host sets the COUNT field to a value greater than 00h, the device shall prepare to enable the Standby timer (see 4.17.3) and set the Standby timer to the period defined by table 62. If the host sets the COUNT field to 00h, the device shall disable the Standby timer.

See 4.9.4 for interactions with the EPC feature set.

7.49.3 Inputs

See table 151 for the STANDBY command inputs.

Table 151 — STANDBY command inputs

Field	Description
FEATURE	N/A
COUNT	Standby timer period (see table 62)
LBA	N/A
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 E2h

7.49.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.49.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 361.

7.50 STANDBY IMMEDIATE – E0h, Non-Data

7.50.1 Feature Set

This 28-bit command is for devices that support the Power Management feature set (see 4.17).

7.50.2 Description

The STANDBY IMMEDIATE command causes the device to enter the Standby mode (see 4.17.4).

Processing a STANDBY IMMEDIATE command shall cause the device to prepare for a power cycle (e.g., flush volatile write cache) prior to returning command completion.

See 4.9.4 for interactions with the EPC feature set.

7.50.3 Inputs

See table 152 for the STANDBY IMMEDIATE command inputs.

Table 152 — STANDBY IMMEDIATE command inputs

Field	Description
FEATURE	N/A
COUNT	N/A
LBA	N/A
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 E0h

7.50.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.50.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 361.

7.51 TRUSTED NON-DATA – 5Bh, Non-Data

7.51.1 Feature Set

This 28-bit command is for devices that support the Trusted Computing feature set (see 4.28).

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 153 for the TRUSTED NON-DATA command inputs.

Table 153 — TRUSTED NON-DATA command inputs

Field	Description
FEATURE	SECURITY PROTOCOL field – See 7.51.3.2
COUNT	Reserved
LBA	**Bit Description** 27:25 Reserved 24 TRUSTED NON-DATA SEND/RECEIVE bit 0 = Non-Data TRUSTED SEND 1 = Non-Data TRUSTED RECEIVE 23:8 SP SPECIFIC field, Security Protocol specific (word) – See 7.51.3.3 7:0 Reserved
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 5Bh

7.51.3.2 SECURITY PROTOCOL field

If the TRUSTED NON-DATA SEND/RECEIVE bit is cleared to zero, see 7.54.3.2. If the TRUSTED NON-DATA SEND/RECEIVE bit is set to one, see 7.52.3.2.

7.51.3.3 SP SPECIFIC field

If the TRUSTED NON-DATA SEND/RECEIVE bit is cleared to zero, see 7.54.3.3. If the TRUSTED NON-DATA SEND/RECEIVE bit is set to one, see 7.52.3.3.

7.51.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

If the TRUSTED NON-DATA SEND/RECEIVE bit is cleared to zero, then see 7.54.4. If the TRUSTED NON-DATA SEND/RECEIVE bit is set to one, see 7.52.4.

7.51.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

If the TRUSTED NON-DATA SEND/RECEIVE bit is cleared to zero, then see 7.54.5. If the TRUSTED NON-DATA SEND/RECEIVE bit is set to one, see 7.52.5.

7.52 TRUSTED RECEIVE – 5Ch, PIO Data-In

7.52.1 Feature Set

This 28-bit command is for devices that support the Trusted Computing feature set (see 4.28).

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 155). 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 that there is 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 155).

If the SECURITY PROTOCOL field is 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 RECEIVE command shall be nonzero 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 155) 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 154 for the TRUSTED RECEIVE command inputs.

Table 154 — TRUSTED RECEIVE command inputs

Field	Description
FEATURE	SECURITY PROTOCOL field – See 7.52.3.2
COUNT	TRANSFER LENGTH field (7:0) – See 7.52.3.4
LBA	**Bit** **Description** 27:24 Reserved 23:8 SP SPECIFIC field, Security Protocol specific (word) – See 7.52.3.3 7:0 TRANSFER LENGTH field (15:8) – See 7.52.3.4
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 5Ch

7.52.3.2 SECURITY PROTOCOL field

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 155). If the SECURITY PROTOCOL field is set to a reserved value, the device shall return command aborted.

Table 155 — TRUSTED RECEIVE SECURITY PROTOCOL field

Value	Description
00h	Return security protocol information (see 7.52.6)
01h..06h	Reserved for TCG
07h	Reserved for T10
08h..1Fh	Reserved
20h..21h	Reserved for T10
22h..3Fh	Reserved
40h..41h	Reserved for T10
42h..E9h	Reserved
EAh	Reserved for NVM Express
EBh	Defined by SCSA (see 3.1.77)
ECh	Reserved for JEDEC®
EDh	Reserved for SDCard
EEh	Reserved for IEEE 1667
EFh	Reserved for T10
F0h..FFh	Vendor Specific

7.52.3.3 SP SPECIFIC field

The SP SPECIFIC field provides information defined by the contents of the SECURITY PROTOCOL field. The meaning of this field is defined by each security protocol.

7.52.3.4 TRANSFER LENGTH field

The TRANSFER LENGTH field is security protocol specific

7.52.4 Normal outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 352.

7.52.5 Error outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device shall return command aborted if an 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 363.

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 the 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. Pad bytes that are cleared to zero shall be added at the end of a 512-byte block, if specified data is less than a multiple of 512 bytes.

If the length of the TRUSTED RECEIVE parameter data is greater than the value in the transfer length, the device shall return the TRUSTED RECEIVE parameter data truncated to the requested transfer length without indicating an error.

If the SECURITY PROTOCOL field is set to 00h, the SP SPECIFIC field is shown in table 156.

Table 156 — Security Protocol 00h SP SPECIFIC field

Code	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 the 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

If the SECURITY PROTOCOL field is set to 00h and the SP SPECIFIC field is set to 0000h in a TRUSTED RECEIVE command, then the parameter data shall have the format shown in table 157.

Table 157 — 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 (word) (M–7)							
7								
8	Supported Security Protocol List							
…								
M								
M+1	Pad bytes, if any (see 7.52.6.1)							
…								
511								

The LIST LENGTH field indicates the total length, in bytes, of the supported security protocol list.

The Supported Security Protocol List 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 RFC 3281) or an X.509 Public Key Certificate (see RFC 3280) depending on the capabilities of the device.

If the SECURITY PROTOCOL field of the TRUSTED RECEIVE command is set to 00h, and the SP SPECIFIC field is 0001h, then the parameter data shall have the format shown in table 158.

Table 158 — TRUSTED RECEIVE parameter data for SP Specific=0001h

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	CERTIFICATES LENGTH (word) (M–3)							
3								
4	Certificates (zero or more)							
…								
M								
M+1	Pad bytes, if any (see 7.52.6.1)							
…								
(512×t)–1								

Key:
t - Total data length. The total data length shall conform to the TRANSFER LENGTH field (see 7.52.3.4) requirements described in 7.52.6.2.

The CERTIFICATES LENGTH field indicates the total length, in bytes, of the certificates. This length includes one or more certificates. If the device has no certificate to return, the certificate length is set to 0000h, the 4 byte header, and 508 pad bytes are returned.

The contents of the Certificates are defined in 7.52.6.3.2 and 7.52.6.3.3.

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.

If the SECURITY PROTOCOL field is set to 00h and the SP SPECIFIC field is set to 0002h in a TRUSTED RECEIVE command, then the parameter data shall have the format shown in table 159.

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 159 — TRUSTED RECEIVE parameter data for SP Specific=0002h

Byte \ Bit	7	6	5	4	3	2	1	0
0	LENGTH OF COMPLIANCE DESCRIPTORS (DWord) (M–3)							
…								
3								
4	Compliance Descriptors (see 7.52.6.4.3)							
…								
M								
M+1	Pad bytes, if any (see 7.52.6.1)							
…								
(512×t)-1								

7.52.6.4.2 LENGTH OF COMPLIANCE DESCRIPTORS field

The LENGTH OF COMPLIANCE DESCRIPTORS field indicates the number of bytes in the Compliance Descriptors.

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 160 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 160 — Compliance Descriptor Type

Compliance Descriptor Type	Description	Reference	Compliance Descriptor
0000h	Reserved		
0001h	Security requirements for cryptographic modules	FIPS 140-2 FIPS 140-3	7.52.6.4.3.2
0002h..FFFFh	Reserved		

Table 161 defines the Compliance Descriptor Header format.

Table 161 — Compliance Descriptor Header

Offset	Type	Length	Description
0..1	Word	2	Compliance Descriptor Type (see table 160)
2..3	Word	2	Reserved
4..7	DWord	4	DESCRIPTOR LENGTH field (see 7.52.6.4.3.2.2)

7.52.6.4.3.2 Security Requirements for Cryptographic Modules descriptor

7.52.6.4.3.2.1 Overview

The Security Requirements for Cryptographic Modules descriptor (see table 162) 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.

The compliance descriptor type shall be set to 0001h.

Table 162 — Security Requirements for Cryptographic Modules descriptor

Offset	Type	Description
0..7	Word	Compliance Descriptor Header (see table 161)
8	ATA String	REVISION field (e.g., ‘2’)
9	ATA String	OVERALL SECURITY LEVEL field (e.g., ‘1’)
10..15	Bytes	Reserved
16..143	ATA String	HARDWARE VERSION field
144..271	ATA String	VERSION field
272..527	ATA String	MODULE NAME field

7.52.6.4.3.2.2 DESCRIPTOR LENGTH field

The DESCRIPTOR LENGTH field (see table 161) indicates how many bytes of Compliance Descriptor data follow the DESCRIPTOR LENGTH field.

The DESCRIPTOR LENGTH field shall be set to 520.

7.52.6.4.3.2.3 REVISION field

For FIPS 140-2, the REVISION field shall be set to ‘2’.

For FIPS 140-3, the REVISION field shall be set to ‘3’.

7.52.6.4.3.2.4 OVERALL SECURITY LEVEL field

For FIPS 140-2, the OVERALL SECURITY LEVEL field shall be set to ‘1’, ‘2’, ‘3’, or ‘4’.

For FIPS 140-3, the OVERALL SECURITY LEVEL field shall be set to ‘1’, ‘2’, ‘3’, or ‘4’.

7.52.6.4.3.2.5 HARDWARE VERSION field

The HARDWARE VERSION field shall contain the version number of the hardware in the module, as reported by NIST.

7.52.6.4.3.2.6 VERSION field

The VERSION field shall contain the version number of the software or firmware in the module, as reported by NIST.

7.52.6.4.3.2.7 MODULE NAME field

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 that support the Trusted Computing feature set (see 4.28).

7.53.2 Description

See 7.52.2.

7.53.3 Inputs

See table 163 for the TRUSTED RECEIVE DMA command inputs.

Table 163 — TRUSTED RECEIVE DMA command inputs

Field	Description
FEATURE	SECURITY PROTOCOL field – See 7.52.3.2
COUNT	TRANSFER LENGTH field (7:0) – See 7.52.3.4
LBA	**Bit** **Description** 27:24 Reserved 23:8 SP SPECIFIC field, Security Protocol specific (word) – See 7.52.3.3 7:0 TRANSFER LENGTH field (15:8) – See 7.52.3.4
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 5Dh

See 7.52.3.

7.53.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See 7.52.4.

7.53.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See 7.52.5.

7.54 TRUSTED SEND – 5Eh, PIO Data-Out

7.54.1 Feature Set

This 28-bit command is for devices that support the Trusted Computing feature set (see 4.28).

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 165). 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 165).

Data transfer lengths for the TRUSTED SEND command shall be nonzero 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 164 for the TRUSTED SEND command inputs.

Table 164 — TRUSTED SEND command inputs

<table>
<tr><th>Field</th><th colspan="2">Description</th></tr>
<tr><td>FEATURE</td><td colspan="2">SECURITY PROTOCOL field – See 7.54.3.2</td></tr>
<tr><td>COUNT</td><td colspan="2">TRANSFER LENGTH field (7:0) – See 7.54.3.4</td></tr>
<tr><td rowspan="4">LBA</td><td>Bit</td><td>Description</td></tr>
<tr><td>27:24</td><td>Reserved</td></tr>
<tr><td>23:8</td><td>SP SPECIFIC field, Security Protocol specific (word) – See 7.54.3.3</td></tr>
<tr><td>7:0</td><td>TRANSFER LENGTH field (15:8) – See 7.54.3.4</td></tr>
<tr><td rowspan="6">DEVICE</td><td>Bit</td><td>Description</td></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 6.2.11</td></tr>
<tr><td>3:0</td><td>Reserved</td></tr>
<tr><td>COMMAND</td><td>7:0</td><td>5Eh</td></tr>
</table>

7.54.3.2 SECURITY PROTOCOL field

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 165). If the SECURITY PROTOCOL field is set to a reserved value, the device shall return command aborted.

Table 165 — TRUSTED SEND – SECURITY PROTOCOL field

Value	Description
00h	Reserved
01h..06h	Reserved for TCG
07h	Reserved for T10
08h..1Fh	Reserved
20h..21h	Reserved for T10
22h..40h	Reserved
41h	Reserved for T10
42h..E9h	Reserved
EAh	Reserved for NVM Express
EBh	Defined by SCSA (see 3.1.77)
ECh	Reserved for JEDEC
EDh	Reserved for SDCard
EEh	Reserved for IEEE 1667
EFh	Reserved for T10
F0h..FFh	Vendor Specific

7.54.3.3 SP SPECIFIC field

The meaning of the SP SPECIFIC field is defined by each security protocol.

7.54.3.4 TRANSFER LENGTH field

The TRANSFER LENGTH field is defined by each security protocol.

7.54.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 352

7.54.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device shall return command aborted if an 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 363.

7.55 TRUSTED SEND DMA – 5Fh, DMA

7.55.1 Feature Set

This 28-bit command is for devices that support the Trusted Computing feature set (see 4.28).

7.55.2 Description

See 7.54.2.

7.55.3 Inputs

See table 166 for the TRUSTED SEND DMA command inputs.

Table 166 — TRUSTED SEND DMA command inputs

Field	Description
FEATURE	SECURITY PROTOCOL field – 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 field, Security Protocol specific (word) – 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 6.2.11 3:0 Reserved
COMMAND	7:0 5Fh

7.55.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See 7.54.4.

7.55.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

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 167 for the WRITE BUFFER command inputs.

Table 167 — WRITE BUFFER command inputs

Field	Description
FEATURE	N/A
COUNT	N/A
LBA	N/A
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 E8h

7.56.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.56.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

A device may return command completion with the ERROR bit set to one if an Interface CRC error has occurred. See table 362.

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 168 for the WRITE BUFFER DMA command inputs.

Table 168 — WRITE BUFFER DMA command inputs

Field	Description
FEATURE	N/A
COUNT	N/A
LBA	N/A
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 EBh

7.57.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See 7.56.4.

7.57.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

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 169 for the WRITE DMA command inputs.

Table 169 — WRITE DMA command inputs

Field	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 6.2.11 3:0 Reserved
COMMAND	7:0 CAh

7.58.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.58.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 381.

7.59 WRITE DMA EXT – 35h, DMA

7.59.1 Feature Set

This 48-bit command is for devices that support the 48-bit Address feature set (see 4.3).

7.59.2 Description

The WRITE DMA EXT command writes data using the DMA data transfer protocol.

7.59.3 Inputs

See table 170 for the WRITE DMA EXT command inputs.

Table 170 — WRITE DMA EXT command inputs

Field	Description
FEATURE	**Bit** **Description** 15:3 Reserved 2:0 COMMAND DURATION LIMITS INDEX field – See 4.7.2
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
AUXILIARY	**Bit** **Description** 31:24 Reserved 23:16 HYBRID INFORMATION field – See 7.17.8.4 15:0 Reserved
DEVICE	**Bit** **Description** 7:5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 35h

7.59.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 352.

7.59.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 373.

7.60 WRITE DMA FUA EXT – 3Dh, DMA

7.60.1 Feature Set

This 48-bit command is for devices that support the 48-bit Address feature set (see 4.3).

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 171 for the WRITE DMA FUA EXT command inputs.

Table 171 — WRITE DMA FUA EXT command inputs

Field	Description
FEATURE	**Bit Description** 15:3 Reserved 2:0 COMMAND DURATION LIMITS INDEX field – See 4.7.2
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
AUXILIARY	**Bit Description** 31:24 Reserved 23:16 HYBRID INFORMATION field – See 7.17.8.4 15:0 Reserved
DEVICE	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 3Dh

7.60.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 352.

7.60.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 373.

7.61 WRITE FPDMA QUEUED – 61h, DMA Queued

7.61.1 Feature Set

This 48-bit command is for devices that support the NCQ feature set (see 4.15).

7.61.2 Description

The WRITE FPDMA QUEUED command requests that user data be transferred from the host to the device.

7.61.3 Inputs

7.61.3.1 Overview

See table 172 for the WRITE FPDMA QUEUED command inputs.

Table 172 — WRITE FPDMA QUEUED command inputs

Field	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** 15:14 PRIO field – See 4.15.2 13:8 GROUP ID field – See 7.61.3.2 7:3 NCQ TAG field – See 7.17.3.3 2:0 Reserved
LBA	LBA of first logical sector to be transferred
ICC	See 7.23.3.3
AUXILIARY	**Bit Description** 31:24 Reserved 23:16 HYBRID INFORMATION field – See 7.17.8.4 15:3 Reserved 2:0 COMMAND DURATION LIMITS INDEX field – See 4.7.2
DEVICE	**Bit Description** 7 FUA bit – See 7.61.3.3 6 Shall be set to one 5 Reserved 4 Shall be cleared to zero 3:0 Reserved
COMMAND	7:0 61h

7.61.3.2 GROUP ID field

If the SUPPORTS DURABLE/ORDERED WRITE NOTIFICATION bit (see 9.17.16) is set to one, then the data transferred by this WRITE FPDMA QUEUED command is associated with the Group ID, while the data is in the device's write cache.

7.61.3.3 FUA bit

If the Forced Unit Access (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. If 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

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 353.

7.61.5 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 354.

7.61.6 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

The device sets the ERROR bit to one and aborts the command in response to an LBA out of range, a duplicate tag number, an invalid tag number, or an Interface CRC error (see table 382).

Errors that occur during the processing of this command are reported by returning a transport dependent indicator (see table 383) with additional information available in the NCQ Command Error log (see 9.14).

7.62 WRITE LOG EXT – 3Fh, PIO Data-Out

7.62.1 Feature Set

This 48-bit command is for devices that support the General Purpose Logging feature set (see 4.11).

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 218 for the list of logs.

7.62.3 Inputs

7.62.3.1 Overview

See table 173 for the WRITE LOG EXT command inputs.

Table 173 — WRITE LOG EXT command inputs

Field	Description
FEATURE	Reserved
COUNT	LOG PAGE COUNT field – See 7.62.3.2
LBA	**Bit Description** 47:40 Reserved 39:32 PAGE NUMBER field (15:8) – See 7.62.3.3 31:16 Reserved 15:8 PAGE NUMBER field (7:0) – See 7.62.3.3 7:0 LOG ADDRESS field, specifies the log to be written – See 7.48.4.3.2
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 3Fh

7.62.3.2 LOG PAGE COUNT field

The LOG PAGE COUNT field 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 219), the device shall return command aborted.

7.62.3.3 PAGE NUMBER field

The PAGE NUMBER field specifies the first page number to be written to the specified log (see 9.1).

7.62.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 352.

7.62.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

A device shall return command aborted for the command if:

a) the LOG PAGE COUNT field is cleared to zero;
b) the feature set associated with the log (see 9.1) specified in the LOG ADDRESS field is not supported or not enabled;
c) the values in the FEATURE field, LOG PAGE COUNT field, or LBA field (47:8) are invalid;
d) the host attempts to write to a read only log (see table 218); or
e) the value in the PAGE NUMBER field plus the value in the LOG PAGE COUNT field is larger than the log size reported in the GPL Directory (see 9.2).

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 372.

7.63 WRITE LOG DMA EXT – 57h, DMA

7.63.1 Feature Set

This 48-bit command is for devices that support the General Purpose Logging feature set (see 4.11).

7.63.2 Description

See 7.62.2.

The device processes the WRITE LOG DMA EXT command in the NCQ feature set environment (see 4.15.6) if the WRITE LOG DMA EXT command is encapsulated in a SEND FPDMA QUEUED command (see 7.43) with the inputs encapsulated as shown in 7.63.6.

7.63.3 Inputs

See table 174 for the WRITE LOG DMA EXT command inputs.

Table 174 — WRITE LOG DMA EXT command inputs

Field	Description
FEATURE	Reserved
COUNT	LOG PAGE COUNT field – See 7.62.3.2
LBA	**Bit** **Description** 47:40 Reserved 39:32 PAGE NUMBER field (15:8) – See 7.62.3.3 31:16 Reserved 15:8 PAGE NUMBER field (7:0) – See 7.62.3.3 7:0 LOG ADDRESS field, specifies the log to be written – See 7.48.4.3.2
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 57h

7.63.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See 7.62.4.

7.63.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See 7.62.5.

If the WRITE LOG DMA EXT command is NCQ encapsulated (see 7.63.6), then:

a) the device sets the ERROR bit to one and aborts the command in response to an LBA out of range, a duplicate tag number, an invalid tag number, or an Interface CRC error (see table 382); and
b) errors that occur during the processing of this command are reported by returning a transport dependent indicator (see table 383) with additional information available in the NCQ Command Error log (see 9.14).

7.63.6 NCQ encapsulation

If a WRITE LOG DMA EXT command is processed in an NCQ environment as subcommand 02h of a SEND FPDMA QUEUED command (see 7.43), the ATA command inputs are encapsulated as:

a) defined by the SEND FPDMA QUEUED command for some inputs (e.g., the COUNT field); and
b) shown in table 175 for subcommand specific inputs.

Table 175 — SEND FPDMA QUEUED command encapsulation for the subcommand specific inputs from a WRITE LOG DMA EXT command

SEND FPDMA QUEUED field (see table 116)	WRITE LOG DMA EXT field (see table 174), if any
LBA	LBA
AUXILIARY	Reserved

7.64 WRITE SECTOR(S) – 30h, 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 SECTOR(S) command writes from 1 to 256 logical sectors as specified in the COUNT field.

7.64.3 Inputs

See table 176 for the WRITE SECTOR(S) command inputs.

Table 176 — WRITE SECTOR(S) command inputs

Field	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 6.2.11 3:0 Reserved
COMMAND	7:0 30h

7.64.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.64.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

If an unrecoverable error occurs while the device is processing this command, the device shall return command completion with the ERROR bit set to one and the LBA field set to the LBA of First Unrecoverable Error (see 6.7.2). 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 380.

7.65 WRITE SECTOR(S) EXT – 34h, PIO Data-Out

7.65.1 Feature Set

This 48-bit command is for devices that support the 48-bit Address feature set (see 4.3).

7.65.2 Description

The WRITE SECTOR(S) EXT command writes from 1 to 65 536 logical sectors as specified in the COUNT field.

7.65.3 Inputs

See table 177 for the WRITE SECTOR(S) EXT command inputs.

Table 177 — WRITE SECTOR(S) EXT command inputs

Field	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 6.2.11 3:0 Reserved
COMMAND	7:0 34h

7.65.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 352.

7.65.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

If an unrecoverable error occurs while the device is processing this command, the device shall return command completion with the ERROR bit set to one and the LBA field set to the LBA of First Unrecoverable Error (see 6.7.2). 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 373.

7.66 WRITE STREAM DMA EXT – 3Ah, DMA

7.66.1 Feature Set

This 48-bit command is for devices that support the Streaming feature set (see 4.27).

7.66.2 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.

7.66.3 Inputs

7.66.3.1 Inputs overview

See table 178 for the WRITE STREAM DMA EXT command inputs.

Table 178 — WRITE STREAM DMA EXT command inputs

Field	Description
FEATURE	**Bit Description** 15:8 COMMAND CCTL field – See 7.28.3.2. 7 Obsolete 6 WRITE CONTINUOUS bit – See 7.66.3.2 5 FLUSH bit – See 7.66.3.3 4 Obsolete 3 Reserved 2:0 STREAM ID field – See 7.66.3.4
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 6.2.11 3:0 Reserved
COMMAND	7:0 3Ah

7.66.3.2 WRITE CONTINUOUS bit

The WRITE CONTINUOUS bit specifies whether the Write Continuous mode is enabled or disabled.

If the WRITE CONTINUOUS 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 the COMMAND CCTL field (see 7.28.3.2) or the DEFAULT CCTL field (see 7.4.3) 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 return 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 9.23);

or

c) if the amount of time allowed for command completion based on the setting of the COMMAND CCTL field or the DEFAULT CCTL field (see 7.4.3) is reached, then the device:
   1) shall stop processing the command;
   2) shall return 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 WRITE CONTINUOUS bit is cleared to zero and an error occurs, then the device:

a) shall stop processing the command and return command completion; and
b) may continue writing data to the media.

7.66.3.3 FLUSH bit

If the FLUSH bit is set to one, the DEFAULT CCTL field (see 7.4.3.4) is cleared to zero in the most recent CONFIGURE STREAM command (see 7.4) for the Stream ID, and the COMMAND CCTL field (see 7.28.3.2) 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 cleared to zero in the most recent CONFIGURE STREAM command for the Stream ID, then the device shall return command completion within the time specified by the DEFAULT CCTL field.

If the FLUSH bit is set to one and the COMMAND CCTL field is not cleared to zero, then the device shall return command completion within ((the contents of the COMMAND CCTL field) × (the contents of the STREAM GRANULARITY field (see 9.10.6.8))) µs.

If the FLUSH bit is set to one and either the DEFAULT CCTL field was not cleared to zero in the most recent CONFIGURE STREAM command (see 7.4) for the Stream ID, or the COMMAND CCTL field is not cleared 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 bit (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 the media; and
c) should continue writing data to the media after reporting command completion.

7.66.3.4 STREAM ID field

The STREAM ID field specifies the stream to be written. The device shall operate according to the parameters specified by the most recent CONFIGURE STREAM command specifying this Stream ID that returned command completion without error. Any write to the device media or internal device buffer management as a result of the Stream ID is vendor specific.

7.66.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 348.

7.66.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

If:

a) The WRITE CONTINUOUS 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 WRITE CONTINUOUS 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 WRITE CONTINUOUS bit was cleared to zero in the command;
b) the COMMAND CCTL field (see 7.28.3.2) was not cleared to zero in the command, or the COMMAND CCTL field was cleared to zero in the command and the DEFAULT CCTL field (see 7.4.3) specified in the most recent CONFIGURE STREAM command (see 7.4) for the STREAM ID field was not cleared to zero; and
c) the time specified for command completion by the COMMAND CCTL field or the DEFAULT CCTL field 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 WRITE CONTINUOUS bit was cleared to zero in the command;
b) the COMMAND CCTL field was cleared to zero in the command; and
c) the DEFAULT CCTL field was cleared to zero in the most recent CONFIGURE STREAM command (see 7.4) 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 374.

7.67 WRITE STREAM EXT – 3Bh, PIO Data-Out

7.67.1 Feature Set

This 48-bit command is for devices that support the Streaming feature set (see 4.27).

7.67.2 Description

See 7.66.2.

7.67.3 Inputs

See table 179 for the WRITE STREAM EXT command inputs.

Table 179 — WRITE STREAM EXT command inputs

Field	Description
FEATURE	**Bit Description** 15:8 COMMAND CCTL field – See 7.28.3.2. 7 Obsolete 6 WRITE CONTINUOUS bit – See 7.66.3.2 5 FLUSH bit – See 7.66.3.3 4 Obsolete 3 Reserved 2:0 STREAM ID field – See 7.66.3.4
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 6.2.11 3:0 Reserved
COMMAND	7:0 3Bh

7.67.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See 7.66.4.

7.67.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See 7.66.5.

7.68 WRITE UNCORRECTABLE EXT – 45h, Non-Data

7.68.1 Feature Set

This 48-bit command is for ATA devices (see 4.2).

7.68.2 Description

7.68.2.1 Overview

The WRITE UNCORRECTABLE EXT command causes the device to report an uncorrectable error when the specified logical sectors are subsequently read.

If the device processes a read command that accesses a pseudo uncorrectable logical sector or a flagged uncorrectable logical sector, then the device shall set the UNCORRECTABLE ERROR bit to one and the ERROR bit to one. Reading a flagged uncorrectable logical sector or a pseudo uncorrectable logical sector may affect the Number of Reallocated Logical Sectors device statistic (see 9.5.8.6).

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 error or flagged uncorrectable error of the logical sector; and
e) should verify that the logical sector may now be read without error.

The device shall clear the pseudo uncorrectable error and the flagged uncorrectable error of all logical sectors, if:

a) an OVERWRITE EXT command (see 7.36.4) returns command complete without an error; or
b) a BLOCK ERASE EXT command (see 7.36.2) returns command complete without an error.

If a CRYPTO SCRAMBLE EXT command (see 7.36.3) completes without error, the device may clear the pseudo uncorrectable error and the flagged uncorrectable error of all logical sectors.

If a DATA SET MANAGEMENT command (see 7.5) with the TRIM bit set to one completes without error, the device may clear the pseudo uncorrectable error and the flagged uncorrectable error of all specified logical sectors.

If a SET ACCESSIBLE MAX ADDRESS EXT command (see 7.2.3) that reduces the accessible capacity of the device completes without error, then the device may clear the pseudo uncorrectable error and the flagged uncorrectable error of all logical sectors that have become inaccessible.

The pseudo uncorrectable error or flagged uncorrectable error 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.

7.68.2.2 Pseudo Uncorrectable Logical Sectors

If 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).

As part of 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 6.3.6).

7.68.2.3 Flagged Uncorrectable Logical Sectors

If 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.

As part of 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 6.3.6).

7.68.3 Inputs

See table 180 for the WRITE UNCORRECTABLE EXT command inputs.

Table 180 — WRITE UNCORRECTABLE EXT command inputs

Field	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 6.2.11 3:0 Reserved
COMMAND	7:0 45h

7.68.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.68.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 361.

7.69 ZERO EXT – 44h, Non-Data

7.69.1 Feature Set

This 48-bit command is for ATA devices (see 4.2).

7.69.2 Description

The ZERO EXT command writes zeros and may perform a Trim function (see 7.69.3.2).

The device processes the ZERO EXT command in the NCQ feature set environment (see 4.15.6) if the ZERO EXT command is encapsulated in a NCQ NON-DATA command (see 7.17) with the inputs encapsulated as shown in 7.69.6.

7.69.3 Inputs

7.69.3.1 Inputs overview

See table 181 for the ZERO EXT command inputs.

Table 181 — ZERO EXT command inputs

Field	Description
FEATURE	**Bit Description** 15:1 Reserved 0 TRIM bit – See 7.69.3.2
COUNT	The number of logical sectors to be written with zeros. A value of 0000h is reserved
LBA	LBA of first logical sector to be written with zeros
DEVICE	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 44h

7.69.3.2 TRIM bit

Regardless of the value of the TRIM bit, the ZERO EXT command functions as described in 7.69.2.

If the TRIM SUPPORTED bit (see 9.10.5.9.2) is cleared to zero or the TRIM bit is cleared to zero, the device shall write zeros to all bytes in the specified logical sectors.

If the TRIM SUPPORTED bit is set to one and the TRIM bit is set to one, then for each logical sector the device shall:

a) perform a Trim function (see table 35) for that logical sector, if the DRAT SUPPORTED bit (see 9.10.5.2.2) is set to one and the RZAT SUPPORTED bit (see 9.10.5.2.8) bit is set to one; or
b) write zeros in all bytes of that logical sector.

7.69.4 Normal Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

See table 345.

7.69.5 Error Outputs

If the SENSE DATA AVAILABLE bit is set to one (see 6.2.9), then an additional sense code is available to be returned (see SPC-5).

If an unrecoverable error occurs while the device is processing this command, the device shall return command completion with the ERROR bit set to one and the LBA field set to the LBA of First Unrecoverable Error (see 6.7.2). The number of logical sectors zeroed is indeterminate. See table 375.

If the ZERO EXT command is NCQ encapsulated (see 7.69.6), then:

a) the device sets the ERROR bit to one and aborts the command in response to an LBA out of range, a duplicate tag number, an invalid tag number, or an Interface CRC error (see table 382); and
b) errors that occur during the processing of this command are reported by returning a transport dependent indicator (see table 383) with additional information available in the NCQ Command Error log (see 9.14).

7.69.6 NCQ encapsulation

If a ZERO EXT command is processed in an NCQ environment as subcommand 06h of an NCQ NON-DATA command (see 7.17), the ATA command inputs are encapsulated as:

a) defined by the NCQ NON-DATA command for some inputs (e.g., the TAG field); and
b) shown in table 182 for subcommand specific inputs.

Table 182 — NCQ-NON-DATA command encapsulation for the subcommand specific inputs from a ZERO EXT command

NCQ NON-DATA field (see table 66)	ZERO EXT field (see table 181), if any
FEATURE (7:4)	Reserved
FEATURE (15:8)	COUNT (7:0)
COUNT (15:8)	COUNT (15:8)
LBA	LBA
AUXILIARY (31:1)	Reserved
AUXILIARY (0)	TRIM

8 SCT Command Transport

8.1 Introduction

8.1.1 Overview

The SCT Command Transport uses logs (see table 183) to provide transport methods for:

a) a host to send an SCT Command and data to a device; and
b) a device to send data and SCT Status to a host.

Table 183 — Summary of SCT Command Transport logs

Log		Data transfer direction	Description	Reference
Name	Address			
SCT Command/Status	E0h [a]	host to device	SCT Command	8.2.3
		device to host	SCT Status	table 200
SCT Data Transfer	E1h	host to device	write data	8.2.4
		device to host	read data	
[a] All transfers to and from this log address access page 0.				

See Annex B for SCT Command Transport examples.

ATA Commands (see table 184) are used to access the logs defined for the SCT Command Transport. All reads from an SCT log (see table 184) access the same information and have the same capabilities. All writes to an SCT log (see table 184) access the same information and have the same capabilities.

Table 184 — Summary of ATA commands used by the SCT Command Transport

Action	Defining feature set	Command	Reference
Read from SCT log	GPL feature set	READ LOG EXT	7.24
		READ LOG DMA EXT	7.25
	SMART feature set [a]	SMART READ LOG	7.48.2
Write to SCT log	GPL feature set	WRITE LOG EXT	7.62
		WRITE LOG DMA EXT	7.63
	SMART feature set [a]	SMART WRITE LOG	7.48.4
Note – The number of bytes transported during SCT data transfers (see 8.2.4) is limited to: a)130 560 (i.e., 255 × 512) for the SMART feature set (see 4.23); and b)33 553 920 (i.e., 65 535 × 512) for the GPL feature set (see 4.11).			
[a] If the SMART feature set is supported, the device shall support the processing of SMART READ LOG commands and SMART WRITE LOG commands that access the SCT Command Transport logs (see table 183) without regard for whether the SMART feature set is enabled or disabled.			

Sending a 512-byte block of data (i.e., key page) to the SCT Command/Status log starts the SCT command process. The key page contains the SCT command's ACTION CODE field, FUNCTION CODE field, and parameters, if any, that are required to process the SCT command. If the combination of action code and function code requires data transfer, then the data is transferred by reading or writing the SCT Data Transfer log. The SCT Status (i.e., error or command) is read from the SCT Command/Status log.

SCT commands (see 8.2.3) are processed like other ATA commands, therefore they take precedence over any background activity the device may be performing when the SCT command is processed (e.g., a function initiated by a SMART EXECUTE OFFLINE IMMEDIATE command). Some SCT commands indicate ATA command completion and return status while the SCT command is still processing. Information about the SCT command that is still processing may be retrieved by reading the SCT Command/Status log (see 8.2.5).

A device supporting the SCT Command Transport should report a length of one in the General Purpose Log Directory (see 9.2) and the SMART Log Directory (see 9.3) for the SCT Command/Status log and the SCT Data Transfer log, respectively. 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 9.2) and the SMART Log Directory (see 9.3) report the actual length of the specified log pages.

8.1.2 SCT command interactions with ATA commands

If the value in the EXTENDED STATUS CODE field is FFFFh (i.e., the SCT command is processing in background (see table 189)) and the device processes:

a) an ATA command that reads from the SCT Data Transfer log (see 8.1.1), then the device shall process the command to read the SCT Data Transfer log as described in 8.2.4;
b) an ATA command that writes to the SCT Data Transfer log, then the device shall process the command to write the SCT Data Transfer log as described in 8.2.4;
c) an ATA command that reads from the SCT Command/Status log, then the device shall process the command to read the SCT Command/Status log; or
d) any other ATA command, then:
    1) if the SCT command being processed in the background is SCT Write Same command, the device shall terminate the SCT Write Same command with the EXTENDED STATUS CODE field set to 0008h (i.e., Background SCT command was aborted because of an interrupting host command);
    2) if the SCT command being processed in the background is not the SCT Write Same command, the device shall terminate the SCT command with the EXTENDED STATUS CODE field set to 0000h (i.e., Command complete without error); and
    3) the device shall begin processing the new ATA command.

8.1.3 NCQ accesses to the SCT logs

If:

a) the LOG ADDRESS field is set to E0h (i.e., the SCT Command/Status log) or the LOG ADDRESS field is set to E1h (i.e., the SCT Data Transfer log) in one of the following commands:
    A) a RECEIVE FPDMA QUEUED command with the SUBCOMMAND field (see 7.32.3.2) set to 01h (i.e., READ LOG DMA EXT (see 7.25)); or
    B) a SEND FPDMA QUEUED command with the SUBCOMMAND field (see 7.43.3.2) set to 02h (i.e., WRITE LOG DMA EXT (see 7.63));

    and
b) the SATA NCQ Send and Receive log page 0h (see 9.18) contains:
    A) a SEQUENTIAL QUEUED READ LOG DMA EXT SUPPORTED bit (see 9.18.7) cleared to zero; or
    B) a SEQUENTIAL QUEUED WRITE LOG DMA EXT SUPPORTED bit (see 9.18.9) cleared to zero,

then the device shall return command aborted.

8.1.4 Resets

A device shall terminate processing an SCT command during the processing of a software reset, hardware reset, or power-on reset. Premature termination of SCT command processing may cause data loss or other indeterminate results. There is no indication after the device becomes ready that the previous command was terminated.

If the device processes a power-on reset or a hardware reset, then the device shall clear the following fields in the SCT Status Response (see table 200) to zero:

a) EXTENDED STATUS CODE;
b) ACTION CODE; and
c) FUNCTION CODE.

The device shall clear the EXTENDED STATUS CODE field to zero during processing of a software reset. The other content of the SCT Status Response fields shall not be affected by the device processing a software reset.

8.2 Processing SCT commands

8.2.1 Processing SCT commands overview

The following phases are required to process and SCT command:

1) capability identification (see 8.2.2);
2) SCT Command transfer (see 8.2.3);
3) SCT data transfer (see 8.2.4), if any; and
4) optional SCT 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 7.13.6.74).

8.2.3 SCT Command transfer

Transfer of an SCT Command occurs when a 512-byte block of data (i.e., key page) is written to the SCT Command/Status log (see 8.1.1). The key page contains a single command as defined in the SCT Command Transport.

Table 185 defines the SCT command format, contained in the input data of the SMART WRITE LOG command (see 7.48.4).

Table 185 — Fields to send an SCT Command using SMART WRITE LOG

Field	Description
FEATURE	D6h (i.e., SMART WRITE LOG (see 7.48.4))
COUNT	01h (i.e., one page is transferred)
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 6.2.11 3:0 Reserved
COMMAND	7:0 B0h

Table 186 defines the SCT command format contained in the input data of the WRITE LOG EXT command (see 7.62) and WRITE LOG DMA EXT command (see 7.63).

Table 186 — Fields to send an SCT Command using GPL write logs

Field	Description
FEATURE	Reserved
COUNT	0001h
LBA	**Bit** **Description** 47:40 Reserved 39:32 00h [a] 31:16 Reserved 15:8 00h [a] 7:0 E0h (i.e., SCT Command/Status log address)
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 3Fh (i.e., WRITE LOG EXT (see 7.62)) 57h (i.e., WRITE LOG DMA EXT (see 7.63))
[a] The PAGE NUMBER field is set to 0000h (i.e., the one page transferred is page zero.).	

Table 187 defines how a device shall set the fields for a write to the SCT Command/Status log that returns command completion without error.

Table 187 — Successful SCT Command response

Field	Description
ERROR	00h
COUNT	SCT command dependent
LBA	SCT command dependent
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit** **Description** 7:6 Transport Dependent – See 6.2.11. 5:2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 188 defines how a device shall set the fields after an error occurred during processing of an SCT Command/Status in response to writing the SCT command log.

Table 188 — SCT Command error response

Field	Description
ERROR	**Bit** **Description** 7:5 N/A 4 ID NOT FOUND bit – See 6.3.4 3 N/A 2 ABORT bit – See 6.3.2 1 N/A 0 Obsolete
COUNT	EXTENDED STATUS CODE field (7:0) (see table 189)
LBA	**Bit** **Description** 27:24 Reserved 23:8 SCT command dependent. 7:0 EXTENDED STATUS CODE field (15:8) (see table 189)
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit** **Description** 7:6 Transport Dependent – See 6.2.11. 5:2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 189 defines the extended status codes.

Table 189 — EXTENDED STATUS CODE field

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 (i.e., the COUNT field) by the log command is larger than defined for the SCT command
0004h	Invalid function code in SCT Error Recovery command
0005h	Invalid selection code in SCT 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 operation was terminated because of an interrupting host command
0009h	Background SCT operation 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 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	Operation was terminated 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 returned command completion 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 processing in background

8.2.4 SCT data transfer

8.2.4.1 SCT data transfer requests

Table 190 defines an SCT data transfer using commands for the SMART feature set.

Table 190 — SCT data transfer using the SMART feature set

Field	Description
FEATURE	D6h (i.e., SMART WRITE LOG (see 7.48.4)) D5h (i.e., SMART READ LOG (see 7.48.2))
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 6.2.11 3:0 Reserved
COMMAND	7:0 B0h

Table 191 defines an SCT data transfer using GPL feature set commands.

Table 191 — SCT data transfer using the GPL feature set

Field	Description
FEATURE	Reserved
COUNT	Number of 512-byte data blocks to transfer
LBA	**Bit** **Description** 47:40 Reserved 39:32 00h [a] 31:16 Reserved 15:8 00h [a] 7:0 E1h (i.e., SCT Data Transfer)
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 2Fh (i.e., READ LOG EXT (see 7.24)) 47h (i.e., READ LOG DMA EXT (see 7.25)) 3Fh (i.e., WRITE LOG EXT (see 7.62)) 57h (i.e., WRITE LOG DMA EXT (see 7.63))

[a] The PAGE NUMBER field is set to 0000h (i.e., the one page transferred is page zero.).

8.2.4.2 SCT data transfer normal responses

8.2.4.2.1 Overview

Table 192 defines the SCT data transfer response if a command from the SMART feature set (see table 184) reads from or writes to the SCT Data Transfer log and returns command completion without error.

Table 192 — Successful SMART SCT data transfer response

Field	Description
ERROR	00h
COUNT	Reserved
LBA	**Bit** **Description** 27:24 Reserved 23:8 NUMBER OF PAGES REMAINING field – See 8.2.4.2.2 7:0 Reserved
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit** **Description** 7:6 Transport Dependent – See 6.2.11 5:2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 193 defines the SCT data transfer response for GPL feature set commands (see table 184) that return command completion without error.

Table 193 — Successful GPL SCT data transfer response

Field	Description
ERROR	00h
COUNT	Reserved
LBA	**Bit Description** 47:24 Reserved 23:8 NUMBER OF PAGES REMAINING field – See 8.2.4.2.2 7:0 Reserved
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5:2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

8.2.4.2.2 NUMBER OF PAGES REMAINING field

The NUMBER OF PAGES REMAINING field indicates the number of log pages the device is expecting to receive before processing the SCT command. If NUMBER OF PAGES REMAINING field remaining is cleared to zero, the device has:

a) processed the command and is returning completion status; or
b) accepted the data and started processing the SCT command in the background.

If there are more than FFFFh log pages expected by the device, the NUMBER OF PAGES REMAINING field remaining shall be set to FFFFh by the device until less that FFFFh pages are expected by the device.

8.2.4.3 SCT data transfer error responses

Table 194 defines an SCT data transfer error response for commands from the SMART feature set (see table 184) that read from or write to the SCT Data Transfer log.

Table 194 — SMART SCT data transfer error response

Field	Description
ERROR	**Bit Description** 7:5 N/A 4 ID NOT FOUND bit – See 6.3.4 3 N/A 2 ABORT bit – See 6.3.2 1 N/A 0 Obsolete
COUNT	EXTENDED STATUS CODE field (7:0) (see table 189)
LBA	**Bit Description** 27:8 Reserved 7:0 EXTENDED STATUS CODE field (15:8) (see table 189)
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5:2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 195 defines an SCT data transfer error response for GPL feature set commands (see table 184) that read from or write to the SCT Data Transfer log.

Table 195 — GPL SCT data transfer error response

Field	Description
ERROR	**Bit** **Description** 7:5 N/A 4 ID NOT FOUND bit – See 6.3.4 3 N/A 2 ABORT bit – See 6.3.2 1 N/A 0 Obsolete
COUNT	**Bit** **Description** 15:8 Reserved 7:0 EXTENDED STATUS CODE field (7:0) (see table 189)
LBA	**Bit** **Description** 47:8 Reserved 7:0 EXTENDED STATUS CODE field (15:8) (see table 189)
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit** **Description** 7:6 Transport Dependent – See 6.2.11 5:2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

8.2.5 SCT status

Status for an SCT command may be read at any time by reading the SCT Command/Status log (see 8.1.1). If the SCT command involves data transfer, then:

a) the host should check status before data is transferred to ensure that the device is ready (i.e., the DEVICE STATE field is set to 00h (see table 200)); and
b) the host should check status after data has been transferred to confirm that the data was transferred without error.

The host may check status additional times to determine if the SCT command succeeded, failed, or is still processing in the background.

After an SCT command has been received, the status reported in the ATA fields indicates that the command was accepted or that an error occurred. This ATA status return does not indicate the completion of the SCT actions without an error, 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 SCT Write Same with function code 0102h). Some commands may take several minutes or even hours to process. The host may determine processing progress by reading the SCT Command/Status log. Some commands may require setup time before a device is ready to receive data. The SCT Command/Status log indicates when the device is ready to receive data.

The SCT Command/Status log may be read any time that the host is allowed to send a command to the device. The processing of an SCT Command (see table 184) that reads the SCT Command/Status log shall:

a) not change the power state of the device; and
b) not terminate any background activity, including any SCT command in progress (e.g., if the device is in the PM2: Standby state or PM1: Idle state (see 4.17.4), the log request shall be processed without changing the power state).

Table 196 defines a command from the SMART feature set (see table 184) that reads the SCT Command/Status log for status.

Table 196 — SCT status request using the SMART feature set

Field	Description
FEATURE	D5h (i.e., SMART READ LOG (see 7.48.2))
COUNT	01h (i.e., one page is transferred)
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 6.2.11 3:0 Reserved
COMMAND	7:0 B0h

Table 197 defines the GPL feature set commands (see table 184) that read the SCT Command/Status log for status.

Table 197 — SCT status request using the GPL feature set

Field	Description
FEATURE	Reserved
COUNT	0001h (i.e., one page is transferred)
LBA	**Bit** **Description** 47:40 Reserved 39:32 00h [a] 31:16 Reserved 15:8 00h [a] 7:0 E0h (i.e., SCT Command/Status log address)
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
COMMAND	7:0 2Fh (i.e., READ LOG EXT (see 7.24)) 47h (i.e., READ LOG DMA EXT (see 7.25))

[a] The PAGE NUMBER field is set to 0000h (i.e., the page transferred is page zero).

Table 198 defines the SCT Status response for commands from the SMART feature set (see table 184) that return command completion without error.

Table 198 — Successful SMART SCT status response

Field	Description
ERROR	00h
COUNT	EXTENDED STATUS CODE field (7:0) (see table 189)
LBA	**Bit** **Description** 27:8 Reserved 7:0 EXTENDED STATUS CODE field (15:8) (see table 189)
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit** **Description** 7:6 Transport Dependent – See 6.2.11. 5:2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 199 defines the SCT Status response for GPL feature set commands (see table 184) that return command completion without error.

Table 199 — Successful GPL SCT status response

Field	Description
ERROR	00h
COUNT	**Bit** **Description** 15:8 Reserved 7:0 EXTENDED STATUS CODE field (7:0) (see table 189)
LBA	**Bit** **Description** 47:8 Reserved 7:0 EXTENDED STATUS CODE field (15:8) (see table 189)
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit** **Description** 7:6 Transport Dependent – See 6.2.11 5:2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 200 defines the format of the status response information that shall be set by the device in response to a read of the SCT Command/Status log.

Table 200 — Format of SCT status response (Sheet 1 of 2)

Offset	Type	Field	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		Obsolete
6..9	DWord	STATUS FLAGS	Bits 31:1 – Reserved Bit 0 – SEGMENT INITIALIZED bit (see 8.3.2.5). If this bit is set to one, an SCT Write Same command (see 8.3.2) to all logical blocks has completed without error. This bit shall be cleared to zero at the time that any user LBA is written, even if write cache is enabled. This bit is preserved during the processing of all power and reset event
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
11..13	Byte [3]	Reserved	
14..15	Word	EXTENDED STATUS CODE	Status of most recent SCT command processed since power-on, or FFFFh if SCT command processing in background (see table 189)
16..17	Word	ACTION CODE	Action code of most recent SCT command processed since power-on. If the EXTENDED STATUS CODE field is FFFFh, this field is set to the action code of the SCT command that is currently processing
18..19	Word	FUNCTION CODE	Function code of most recent SCT command processed since power-on. If the EXTENDED STATUS CODE field is FFFFh, this field is set to the function code of the SCT command that is currently processing
20..39	Byte [20]	Reserved	
40..47	QWord	LBA	Current LBA for the SCT command processing in background. If there is no SCT command currently processing in the background, then this field is N/A
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 field does not contain a valid temperature
201	Byte	MIN TEMP	Minimum device temperature in degrees Celsius since the most recent power-on event. This is a two's complement integer. 80h indicates that this field does not contain a valid temperature
202	Byte	MAX TEMP	Maximum device temperature in degrees Celsius since the most recent power-on event. This is a two's complement integer. 80h indicates that this field does not contain a valid temperature
203	Byte	LIFE MIN TEMP	Minimum device temperature in degrees Celsius seen during the life of the device. This is a two's complement integer. 80h indicates that this field does not contain a valid temperature

Table 200 — Format of SCT status response (Sheet 2 of 2)

Offset	Type	Field	Description
204	Byte	LIFE MAX TEMP	Maximum device temperature in degrees Celsius seen during the life of the device. This is a two's complement integer. 80h indicates that this field does not contain a valid temperature
205	Byte	SPECIFIED MAXIMUM OPERATING TEMPERATURE	This is a copy of bits 7:0 of the Specified Maximum Operating Temperature device statistic (see table 238)
206..209	DWord	OVER LIMIT COUNT	Number of temperature recording intervals since the most recent power-on reset where the recorded temperature was greater than max op limit (see table 216)
210..213	DWord	UNDER LIMIT COUNT	Number of temperature recording intervals since the most recent power-on reset where the recorded temperature was less than min op limit (see table 216)
214..215	Word	SMART STATUS	Copy of the LBA field (32:8) for a SMART return status normal or error output, if any, (see table 201)
216..217	Word	MIN RECOVERY TIME LIMIT	Minimum supported value for the RECOVERY TIME LIMIT field (see table 207). A value of zero indicates that there is no minimum supported value reported
218..479	Byte [264]	Reserved	
480..511	Byte [32]	Vendor Specific	

Table 201 defines the contents of the SMART STATUS field in the SCT status response.

Table 201 — SMART STATUS field

Value	Description
0000h	SMART status not reported.
2CF4h	The device has detected a threshold exceeded condition.
C24Fh	The device has not detected a threshold exceeded condition.
all others	Reserved

Table 202 defines the error response for a read of the SCT Command/Status log.

Table 202 — SMART and GPL SCT status error response

Field	Description
ERROR	**Bit Description** 7:5 N/A 4 ID NOT FOUND bit – See 6.3.4 3 N/A 2 ABORT bit – 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 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5:2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

8.3 SCT Command Set

8.3.1 Overview

An SCT command key page shall be 512 bytes long.

While an SCT command is being processed the host may use an SCT status request (see 8.2.5) to retrieve status information (e.g., to determine if a command is active or complete, the current LBA, or error information).

Table 203 defines the basic structure of the key page for an SCT command.

Table 203 — SCT command basic key page structure

Word	Field	Type	Description
0	ACTION CODE	Word	This field specifies the command type and the type of data being accessed, or the action being performed (see table 204).
1	FUNCTION CODE	Word	This command dependent field specifies the type of access.
2..255			This field is SCT command dependent.

Table 204 defines the contents of the ACTION CODE field in an SCT key page.

Table 204 — ACTION CODE field

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

8.3.2.1 Overview

The SCT Write Same command specifies that the device shall write a specific pattern to the media.

The SCT Write Same command shall cause the device to write logical sectors from the first logical sector specified by the key page START field (see table 205) in incrementing order until the number of logical sectors specified by the key page FILL COUNT field (see table 205) have been written.

If the FILL COUNT field is equal to zero, the device shall write all logical sectors beginning with the logical sector specified by the START field through one less than the accessible capacity (see 9.10.4.2).

If the sum of the contents of the START field plus the contents of the FILL COUNT field is greater than or equal to the accessible capacity (see 9.10.4.2), then the device shall return command aborted.

Automatic sector reassignment is permitted during the operation of this function.

If the ATA command that writes the key page returns command completion without error, the EXTENDED STATUS CODE field (see 8.2.3) shall be set to 0000h. If any SCT Write Same error occurs, the EXTENDED STATUS CODE field shall be set to a value other than FFFFh or 0000h.

8.3.2.2 Pattern Data

The logical sector sized pattern data may be specified by the key page PATTERN field (see table 205), a logical sector sized pattern data in the SCT Data Transfer log, or a multiple logical sector sized pattern.

If the key page FUNCTION CODE field (see table 205) is set to 0001h or the FUNCTION CODE field is set to 0101h, then the PATTERN field (see table 205) contains a DWord of data and the device shall create a logical sector sized pattern by repeating the contents of the PATTERN field.

If the FUNCTION CODE field is set to 0002h or the FUNCTION CODE field is set to 0102h, the host writes a logical sector sized pattern data to the SCT Data Transfer log.

The device indicates the number of log pages the device expects to receive for a logical sector pattern in the NUMBER OF PAGES REMAINING field (see 8.2.4.2) of the status response.

If the FUNCTION CODE field is set to 0003h or the FUNCTION CODE field is set to 0103h, the host writes a multiple logical sector sized pattern to the SCT Data Transfer log. The device indicates the number of log pages the device expects to receive for the multiple logical sector pattern in the NUMBER OF PAGES REMAINING field (see 8.2.4.2) of the status response.

8.3.2.3 Foreground vs. Background Processing

8.3.2.3.1 Background Processing

8.3.2.3.1.1 Get the background pattern from the key page

If the key page FUNCTION CODE field (see table 205) is set to 0001h, the device shall:

1) return command completion for the command that wrote to the SCT Command/Status log (see 8.1.1); and
2) write the logical sector sized pattern data defined in 8.3.2.3.1.3.

8.3.2.3.1.2 Get the background pattern from the SCT Data Transfer log

To perform a background SCT Write Same command with a data pattern that is not in the key page PATTERN field:

1) if the device processes a key page write log command without error, and the key page FUNCTION CODE field (see table 205) is set to 0002h or 0003h, then the device shall return command completion for the command that wrote the key page to the SCT Command/Status log (see 8.1.1) with the:
   A) NUMBER OF PAGES REMAINING field (see 8.2.4.2) set to the number of log pages to be written to the SCT Data Transfer log; and
   B) EXTENDED STATUS CODE field (see 8.2.3) set to:
      a) FFFFh (see table 189), if the device is ready to receive data; or
      b) a value other than FFFFh or 0000h, if the device becomes unable to receive the data;
2) while the EXTENDED STATUS CODE field is set to FFFFh, if the device processes a command that writes to the SCT Data Transfer log, then:

A) if the number of pattern blocks written (i.e., the 512-byte data blocks written to the SCT Data Transfer log by previous commands plus the data blocks being written by the current command) is equal to what is required (see 8.3.2.2), then the device shall:
   1) return command completion for the command that wrote to the SCT Data Transfer log (see 8.1.1); and
   2) write the pattern data (see 8.3.2.3.1.3) in the specified logical sectors;
B) if the number of pattern blocks written is more than what is required, the device shall:
   1) terminate the SCT Write Same command;
   2) set the EXTENDED STATUS CODE field to 0009h (see table 189); and
   3) return command aborted for the command that wrote to the SCT Data Transfer log;
   and
C) if the number of pattern blocks written is less than what is required (see 8.3.2.2), the device shall:
   1) set the EXTENDED STATUS CODE field to FFFFh;
   2) set the NUMBER OF PAGES REMAINING field (see 8.2.4.2) to the number of log pages remaining; and
   3) return command completion without error for the command that wrote to the SCT Data Transfer log.

8.3.2.3.1.3 Write the pattern to the specified logical sectors

While the device is writing the logical sector sized pattern data to the specified logical sectors if the key page FUNCTION CODE field (see table 205) is set to 0001h, 0002h, or 0003h, then:

a) if the device indicates command acceptance for a command to read from the SCT Command/Status log (i.e., an SCT Status request (see 8.1.1)), then the device shall process the SCT Status request and shall set:
   A) the EXTENDED STATUS CODE field to FFFFh (see table 189); and
   B) the LBA field (see 8.2.5) to the LBA of the last logical sector that was written;
b) if the device indicates command acceptance for any command other than a read from the SCT Command/Status log, then the device shall:
   1) abort background processing for the SCT Write Same command;
   2) set the EXTENDED STATUS CODE field to 0008h (see table 189); and
   3) process the new command;
   and
c) if writing to any of the specified logical sector fails, the device shall:
   1) abort background processing for the SCT Write Same command; and
   2) set the EXTENDED STATUS CODE field to 0009h (see table 189).

If all specified logical sectors have been written without error, the EXTENDED STATUS CODE field shall be set to 0000h.

8.3.2.3.2 Foreground Processing

8.3.2.3.2.1 Get the foreground pattern from the key page

If the key page FUNCTION CODE field (see table 205) is set to 0101h, then the device shall write the logical sector sized pattern data as defined in 8.3.2.2 (see 8.3.2.3.2.3).

8.3.2.3.2.2 Get the foreground pattern from the SCT Data Transfer log

To perform a foreground SCT Write Same command with a data pattern:

1) if the device processes a write log command to the SCT command log without error and the key page FUNCTION CODE field (see table 205) is set to 0102h or 0103h, then the device shall return command completion for the command that wrote to the SCT Command/Status log (see 8.1.1) with the:
   A) NUMBER OF PAGES REMAINING field (see 8.2.4.2) set to the number of log pages to be written to the SCT Data Transfer log; and
   B) EXTENDED STATUS CODE field set to:
      a) FFFFh (see table 189), if the device is ready to receive data; or
      b) a value other than FFFFh or 0000h, if the device becomes unable to receive the data;
2) while the EXTENDED STATUS CODE field is set to FFFFh, if the device processes a command that writes to the SCT Data Transfer log, then:

A) if the number of pattern blocks written (i.e., the 512-byte data blocks written to the SCT Data Transfer log by previous commands plus the data blocks being written by the current command) is equal to what is required (see 8.3.2.2), then the device shall write that logical sector sized pattern data (see 8.3.2.3.2.3);
B) if the number of pattern blocks written is more than what is required (see 8.3.2.2), then the device shall:
   1) terminate the SCT Write Same command;
   2) set the EXTENDED STATUS CODE field to 0014h (see table 189); and
   3) return command aborted for the command that wrote to the SCT Data Transfer log;
   and
C) if the number of number of pattern blocks written is less than what is required (see 8.3.2.2), then the device shall:
   1) set the EXTENDED STATUS CODE field to FFFFh (see table 189);
   2) set the NUMBER OF PAGES REMAINING field (see 8.2.4.2) to the number of log pages remaining; and
   3) return command completion without error for the command that wrote to the SCT Data Transfer log.

8.3.2.3.2.3 Write the pattern to the specified logical sectors

While the device is writing the pattern data to the specified logical sectors, if the key page FUNCTION CODE field is set to 0101h, 0102h, or 0103h, then:

1) if writing to any of the specified logical sectors fails, the device shall:
   1) abort processing for the SCT Write Same command;
   2) set the EXTENDED STATUS CODE field to 0014h (see table 189); and
   3) return command completion for the command that wrote to the SCT Command/Status log or the SCT Data Transfer log, indicating the failure (see 8.1.1) of the SCT Write Same command;
   and
2) if all specified logical blocks are written without error, the device shall:
   1) set the EXTENDED STATUS CODE field to 0000h (see table 189); and
   2) return command completion without error for the command that wrote to the SCT Command/Status log or the SCT Data Transfer log, indicating the success (see 8.1.1) of the SCT Write Same command.

8.3.2.4 Status Reporting

If the SCT Command returns an error in response to writing the SCT Command/Status log, then table 188 describes the error return.

If the SCT Command returns an error in response to writing the SCT Data log, then:

a) if the error is in response to a SMART read log or write log command, then table 194 describes the error; or
b) if the error is in response to a GPL read log or write log command, then table 195 describes the error;

8.3.2.5 SEGMENT INITIALIZED bit

The SCT Write Same command may change the SEGMENT INITIALIZED bit in the SCT Status response (see table 200). If the SCT Write Same command writes all of the user data without error, the SEGMENT INITIALIZED bit shall be set to one. A write to any user addressable logical sector on the device, except a write caused by another SCT Write Same command with the START field and the FILL COUNT field cleared to zero (i.e., an SCT Write Same command causing the device to write to all logical sectors), shall cause the SEGMENT INITIALIZED bit to be cleared to zero. Reallocations as a result of reading data, either in the foreground or background, shall not clear the SEGMENT INITIALIZED bit.

8.3.2.6 SCT Write Same key page

Table 205 defines the format of the key page that is written to the SCT Command/Status log (see 8.1.1) for the SCT Write Same command.

Table 205 — SCT Write Same command key page

Word	Field	Value	Description
0	ACTION CODE	0002h	SCT Write Same command
1	FUNCTION CODE	0000h	Reserved
		0001h	Repeat write pattern in the background (see 8.3.2.3.1.1) using the PATTERN field
		0002h	Repeat write data sector in the background (see 8.3.2.3.1.2) using one logical sector sized pattern data sent by the host
		0003h	Repeat write data sector in the background (see 8.3.2.3.1.2) using one or more logical sector sized pattern data sent by the host
		0004h..0100h	Reserved
		0101h	Repeat write pattern in the foreground (see 8.3.2.3.2.1) using the PATTERN field
		0102h	Repeat write data sector in the foreground (see 8.3.2.3.2.2) using one logical sector sized pattern data sent by the host
		0103h	Repeat write data sector in the foreground (see 8.3.2.3.2.2) using one or more logical sector sized pattern data sent by the host
		0104h..FFFFh	Reserved
2..5	START	QWord	First logical sector to write (see 8.3.2.1) 63:48 Reserved 47:0 First LBA
6..9	FILL COUNT	QWord	Number of logical sectors to write (see 8.3.2.1)
10..11	PATTERN	DWord	If the function code is 0001h or 0101h, this field contains a 32 bit value used to create a logical sector sized data pattern (see 8.3.2.2)
12..15	PATTERN LENGTH	QWord	If the function code is 0003h or 0103h, this field contains the number of logical sectors in the pattern sent by the host (see 8.3.2.2)
16	ZAC OPTIONS	Word	Reserved for ZAC-2
17..255		Words	Reserved

8.3.2.7 SCT Write Same command status response

Table 206 defines the format of the status response for writing the key page for the SCT Write Same command to the SCT Command/Status log (see 8.1.1).

Table 206 — SCT Write Same command status response

Field	Description
ERROR	**Bit Description** 7:5 N/A 4 ID NOT FOUND bit – See 6.3.4 3 N/A 2 ABORT bit – See 6.3.2 1 N/A 0 Obsolete
COUNT	Reserved
LBA	**Bit Description** 27:24 Reserved 23:8 NUMBER OF PAGES REMAINING field: If the key page FUNCTION CODE field (see table 205) was set to 0001h or 0101h, this field shall be set to 0000h. If the key page FUNCTION CODE field was set to 0002h 0003h, 0102h, or 0103h, this field shall be set to the number of log pages the device expects for the pattern data. 7:0 Reserved
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5:2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

8.3.3 SCT Error Recovery Control command

8.3.3.1 Introduction

The SCT Error Recovery Control command manages the time limits for read error recovery and write error recovery. The time limits specified by this command are:

a) the Read Command Timer that limits the time allowed for processing of read commands; and
b) the Write Command Timer that:
    A) limits the time allowed for processing of write commands; and
    B) may limit the time allowed for processing of flush commands.

The Read Command Timer and the Write Command Timer shall not apply to streaming commands (see 4.27).

For a command that is not an NCQ command (see 4.15) and not a streaming command, the Read Command Timer and the Write Command Timer shall limit the time allowed for processing of that command to reach command completion.

For a command that is an NCQ command, if the IN-ORDER DATA DELIVERY ENABLED bit (see 9.10.10.3.5) is:

a) set to one, then the Read Command Timer or the Write Command Timer shall begin counting at the time the device begins to process that command (e.g., not at the time that command is sent to the device); and
b) cleared to zero, then the Read Command Timer and the Write Command Timer shall not apply.

If a Read Command Timer expires or a Write Command Timer expires before command completion, the device:

a) shall stop processing that command and return an error;
b) shall return an Uncorrectable Error (see 6.3.6), if that command was a read command;
c) should return command aborted, if that command was a write command; and
d) should set the EXTENDED STATUS CODE field to 0015h (see table 189) in the SCT Status data.

The EXTENDED STATUS CODE field shall be cleared during the processing of the next non-SCT command by the device, except if the command being processed is a read of the NCQ Command Error log (see 9.14).

If the Write Command Timer is about to expire, the device should attempt to reallocate the data before the Write Command Timer expires. If volatile write cache is enabled the behavior of the Write Command Timer is vendor specific.

A host implementor should use the Write Command Timer with caution. A very small timer value may cause a device to permanently reallocate good logical sectors as the result of temporary external conditions (e.g., an environmental vibration).

If the Read Command Timer is cleared to zero or the Write Command Timer is cleared to zero, that timer is disabled (i.e., the error recovery time associated with the command type is not limited).

The Read Command Timer value and the Write Command Timer value persist across a hardware reset and a software reset. The Power-on Read Command Timer value and the Power-on Write Command Timer value persist across all resets (e.g. power-on reset).

The Read Command Timer shall be set to the value of the Power-on Read Command Timer as a result of processing a power-on reset.

The Write Command Timer shall be set to the value of the Power-on Write Command Timer as a result of processing a power-on reset.

Table 207 defines the format of an SCT Error Recovery Control command key page written to the SCT Command/Status log (see 8.1.1).

Table 207 — SCT Error Recovery Control command key page

Word	Field	Value	Description
0	ACTION CODE	0003h	SCT Error Recovery Control command
1	FUNCTION CODE	0000h	Reserved
		0001h	Set Current Timer Value (see 8.3.3.2)
		0002h	Return Current Timer Value (see 8.3.3.3)
		0003h	Set Power-on Timer Value (see 8.3.3.4)
		0004h	Return Power-on Timer Value (see 8.3.3.5)
		0005h	Restore Manufacturer's Default Timer Value (see 8.3.3.6)
		0006h..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 or 0003h, this field contains the recovery time limit in 100 ms units (e.g., a value of 1 equals 100 ms, 2 equals 200 ms). The tolerance is vendor specific. If the function code is not 0001h or 0003h, this field is ignored.
4..255			Reserved

8.3.3.2 Set Current Timer Value

If the FUNCTION CODE field is set to 0001h, the SELECTION CODE field is set to 0001h, and:

a) the value in the RECOVERY TIME LIMIT field is greater than or equal to the value in the MIN RECOVERY TIME LIMIT field (see table 200), then the device shall set the Current Read Command Timer the value in the RECOVERY TIME LIMIT field; or
b) the value in the RECOVERY TIME LIMIT field is less than the value in the MIN RECOVERY TIME LIMIT field, then the device shall:
   A) set the extended status code (see table 189) to 0006h; and
   B) return command aborted for the command that wrote to the SCT Command and Status log.

If the FUNCTION CODE field is set to 0001h, and the SELECTION CODE field is set to 0002h, and:

a) the value in the RECOVERY TIME LIMIT field is greater than or equal to the value in the MIN RECOVERY TIME LIMIT field (see table 200), then the device shall set the Current Write Command Timer to the value in the RECOVERY TIME LIMIT field; or
b) the value in the RECOVERY TIME LIMIT field is less than the value in the MIN RECOVERY TIME LIMIT field, then the device shall:
   A) set the extended status code (see table 189) to 0007h; and
   B) return command aborted for the command that wrote to the SCT Command and Status log.

8.3.3.3 Return Current Timer Value

If the FUNCTION CODE field is set to 0002h and the SELECTION CODE field is set to 0001h, the Current Read Command Timer shall be returned (see 8.3.3.7).

If the FUNCTION CODE field is set to 0002h and the SELECTION CODE field is set to 0002h, the Current Write Command Timer shall be returned (see 8.3.3.7).

8.3.3.4 Set Power-on Timer Value

If the FUNCTION CODE field is set to 0003h, the SELECTION CODE field is set to 0001h, and:

a) the value in the RECOVERY TIME LIMIT field is greater than or equal to the value in the MIN RECOVERY TIME LIMIT field (see table 200), then the device shall set:
   A) the Current Read Command Timer to the value in the RECOVERY TIME LIMIT field; and
   B) the Power-on Read Command Timer to the value in the RECOVERY TIME LIMIT field;
   or
b) the value in the RECOVERY TIME LIMIT field is less than the value in the MIN RECOVERY TIME LIMIT field, then the device shall:
   A) set the extended status code (see table 189) to 0006h; and
   B) return command aborted for the command that wrote to the SCT Command and Status log.

If the FUNCTION CODE field is set to 0003h, the SELECTION CODE field is set to 0002h, and:

a) the value in the RECOVERY TIME LIMIT field is greater than or equal to the value in the MIN RECOVERY TIME LIMIT field (see table 200), then the device shall set:
   A) the Current Write Command Timer to the value in the RECOVERY TIME LIMIT field; and
   B) the Power-on Write Command Timer to the value in the RECOVERY TIME LIMIT field;
   or
b) the value in the RECOVERY TIME LIMIT field is less than the value in the MIN RECOVERY TIME LIMIT field, then the device shall:
   A) set the extended status code (see table 189) to 0007h; and
   B) return command aborted for the command that wrote to the SCT Command and Status log.

8.3.3.5 Return Power-on Timer Value

If the FUNCTION CODE field is set to 0004h and the SELECTION CODE field is set to 0001h, the Power-on Read Command Timer shall be returned (see 8.3.3.7).

If the FUNCTION CODE field is set to 0004h and the SELECTION CODE field is set to 0002h, the Power-on Write Command Timer shall be returned (see 8.3.3.7).

8.3.3.6 Restore Manufacturer's Default Timer Value

If the FUNCTION CODE field is set to 0005h and the SELECTION CODE field is set to 0001h, the Power-on Read Command Timer and the Current Read Command Timer shall be set to the manufacturer's default value.

If the FUNCTION CODE field is set to 0005h and the SELECTION CODE field is set to 0002h, the Power-on Write Command Timer and the Current Write Command Timer shall be set to the manufacturer's default value.

8.3.3.7 SCT Error Recovery Control command status response

Table 208 defines the format of the status response for a SCT Error Recovery Control command.

Table 208 — SCT Error Recovery Control command status response

Field	Description
ERROR	**Bit** **Description** 7:5 N/A 4 ID NOT FOUND bit – See 6.3.4 3 N/A 2 ABORT bit – See 6.3.2 1 N/A 0 Obsolete
COUNT	SCT ERROR RECOVERY CONTROL RETURNED VALUE field (7:0) (see table 209)
LBA	**Bit** **Description** 27:8 Reserved 7:0 SCT ERROR RECOVERY CONTROL RETURNED VALUE field (15:8) (see table 209)
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit** **Description** 7:6 Transport Dependent – See 6.2.11. 5:2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

The contents of the SCT ERROR RECOVERY CONTROL RETURNED VALUE field are defined by the contents of the FUNCTION CODE field in the key page as shown in table 209.

Table 209 — SCT ERROR RECOVERY CONTROL RETURNED VALUE field

FUNCTION CODE field (see table 207)	SCT ERROR RECOVERY CONTROL RETURNED VALUE field contents
0000h..0001h	Reserved
0002h	Current Timer Value
0003h	Reserved
0004h	Power-on Timer Value
0005h..FFFFh	Reserved

8.3.4 SCT Feature Control command

8.3.4.1 SCT Feature Control command key page

The SCT Feature Control command reports and sets the state (i.e., enabled or disabled) of the features specified by the command.

Table 210 defines the format of a SCT Feature Control command key page that is written to the SCT Command/Status log (see 8.1.1)

Table 210 — SCT Feature Control command key page

Word	Field	Value	Description
0	ACTION CODE	0004h	SCT Feature Control command
1	FUNCTION CODE	0000h	Reserved
		0001h	Set state and options flags for a feature
		0002h	Return the current state of a feature
		0003h	Return feature option flags
		0004h..FFFFh	Reserved
2	FEATURE CODE		See table 211
3	STATE		Feature Code dependent value
4	OPTION FLAGS		See 8.3.4.2

If the FUNCTION CODE field is set to 0001h, the processing performed by the SCT Feature Control command is defined in table 211 based on the contents of the FEATURE CODE field and the STATE field.

Table 211 — Feature Code list

FEATURE CODE field	STATE field	State definition
0000h		Reserved
0001h	0001h	The SET FEATURES command (see 7.45) shall determine the state of the volatile write cache (see 7.45.3). This is the default value (see 8.3.4.2) for feature code 0001h
	0002h [a]	Volatile write cache shall be enabled
	0003h [a]	Volatile write cache shall be disabled
0002h	0001h [b]	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. This is the default value (see 8.3.4.2) for feature code 0002h
	0002h [b]	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
0003h	0000h	Reserved
	0001h..FFFFh	Set the INTERVAL FIELD in the HDA Temperature History table (see 8.3.5.2) to the larger of: a) the value in the STATE field; or b) the contents of the SAMPLE PERIOD field in the HDA Temperature History table Clear the HDA Temperature History table as described in 8.3.5.2.2.For feature code 0003h, the default value (see 8.3.4.2) is the value in the SAMPLE PERIOD field in the HDA Temperature History table (see 8.3.5.2)
0004h..0005h		Reserved for Serial ATA
0006h..CFFFh		Reserved
D000h..FFFFh		Vendor Specific

[a] Volatile write cache shall be set to the specified state, and any attempt to change the volatile write cache settings using a SET FEATURES command shall not result in an error and shall not change the operational state of the volatile write cache. The VOLATILE WRITE CACHE ENABLED bit (see 9.10.6.2.10) shall reflect the current operational state of the volatile write cache (i.e., if set to one, the volatile write cache is enabled, and if cleared to zero, the volatile write cache is disabled).

[b] 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 4.15).

8.3.4.2 Options Flags

The Options Flags shown in table 212 are associated with each Feature Code (see 8.3.4.1). Options Flags are:

a) set to the value in the OPTIONS FLAGS field in the SCT Feature Control key page (see 8.3.4.1) if the key page FUNCTION CODE field is set to 0001h; and
b) returned in the SCT Feature Control status response (see 8.3.4.3) if the key page FUNCTION CONTROL field is set to 0003h.

Table 212 — Options Flags for each Feature Code

Bit	Name	Description
15:1		Reserved
0	FEATURE STATE VOLATILITY bit	0 = specifies that the associated feature state reverts to the default value (see table 211) or to the most recent non-volatile setting if the device processes a hardware reset 1 = specifies that the associated feature state is preserved across all resets (e.g., power-on resets)

8.3.4.3 SCT Feature Control command status response

Table 213 defines the format of the status response for a SCT Feature Control command.

Table 213 — SCT Feature Control command status response

Field	Description
ERROR	**Bit Description** 7:5 N/A 4 ID NOT FOUND bit – See 6.3.4 3 N/A 2 ABORT bit – See 6.3.2 1 N/A 0 Obsolete
COUNT	If the key page FUNCTION CODE field (see table 210) was set to 0002h, this field contains the Feature State (7:0) associated with the Feature Code specified in the key page. If the key page FUNCTION CODE field was set to 0003h, this field contains the Option Flags (7:0) associated with the Feature Code specified in the key page. Otherwise, this field is reserved.
LBA	**Bit Description** 27:8 Reserved 7:0 If the key page FUNCTION CODE field (see table 205) was set to 0002h, this field contains the Feature State (15:8) associated with the Feature Code specified in the key page. If the key page FUNCTION CODE field was set to 0003h, this field contains the Option Flags (15:8) associated with the Feature Code specified in the key page. Otherwise, this field is reserved.
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11. 5:2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

8.3.5 SCT Data Table command

8.3.5.1 Overview

The SCT Data Table command reads the specified data table.

Table 214 defines the format of an SCT Data Table command key page that is written to the SCT Command/Status log (see 8.1.1).

Table 214 — SCT Data Table command

Word	Field	Value	Description
0	ACTION CODE	0005h	SCT Data Table command
1	FUNCTION CODE	0000h	Reserved
		0001h	Read Table
		0002h..FFFFh	Reserved
2	TABLE ID	Word	See table 215

Table 215 defines the contents of the TABLE ID field.

Table 215 — TABLE ID field

Code	Description
0000h	Invalid - Shall not be used
0001h	Reserved
0002h	HDA Temperature History table (in degrees Celsius) – See 8.3.5.2
0003h-0004h	Reserved for Serial ATA
0005h-CFFFh	Reserved
D000h-FFFFh	Vendor Specific

8.3.5.2 HDA Temperature History table

8.3.5.2.1 Table content

Table 216 defines the contents of the HDA Temperature History table. The HDA Temperature History table shall be preserved during the processing of all power events and reset events.

Table 216 — HDA Temperature History table (Sheet 1 of 2)

Offset	Type [size]	Field	Description
0..1	Word	FORMAT VERSION	0002h – Data table format version
2..3	Word	SAMPLING PERIOD	The device shall sample the HDA temperature sensor once per sampling period, in minutes. This is how often the device samples the 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 minutes, 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	The maximum recommended continuous operating temperature [a]. This is a fixed value and is a two's complement number that allows a range from -127°C to +127°C to be indicated. 80h is an invalid value.
7	Byte	OVER LIMIT	The maximum temperature limit. Operating the device above this temperature may cause physical damage to the device [a]. This is a fixed value and is a two's complement number that allows a range from -127°C to +127°C to be indicated. 80h is an invalid value.
8	Byte	MIN OP LIMIT	The minimum recommended continuous operating limit [a]. This is a fixed value and is a two's complement number that allows a range from -127°C to +127°C to be indicated. 80h is an invalid value.

[a] These values should take into account the accuracy of the temperature sensor. The placement, accuracy, and granularity of temperature sensors to support table 216 are vendor specific.

[b] When the device powers up, a new entry is made in the history queue with a value of 80h (i.e., an invalid 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 mode (e.g., Sleep or Standby) (see 4.17.4), then a value of 80h is entered into the history queue to indicate that temperature sensing has resumed.

[c] The process of clearing the HDA Temperature History table is defined in 8.3.5.2.2.

Table 216 — HDA Temperature History table (Sheet 2 of 2)

Offset	Type [size]	Field	Description
9	Byte	UNDER LIMIT	The minimum temperature limit. Operating the device below this temperature may cause physical damage to the device [a]. This is a fixed value and is a two's complement number that allows a range from -127°C to +127°C to be indicated. 80h is an invalid value.
10..29	Byte [20]	Reserved	
30..31	Word	CB_SIZE	The number of entries in the CB field. This number shall be in the range of 128..478.
32..33	Word	CB_INDEX	The most recent updated entry in the CB field. CB_index is zero-based (e.g., CB_index 0000h is the first entry in the CB field). The most recent temperature entry is at offset CB_index + 34 [b c].
34..(CB_size + 33)	Byte [CB_size]	CB	This is a circular buffer of 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 to take a sample. The sampling period is the minimum time between samples [b]. If the host changes the logging interval with the FEATURE STATE VOLATILITY bit cleared to zero (see 8.3.4.2), then the interval between entries in the queue may not be consistent between power cycles with no indication to the host.
(CB_size + 34)..511	Byte [512 – CB_size – 34]	Reserved	Shall be zero.

[a] These values should take into account the accuracy of the temperature sensor. The placement, accuracy, and granularity of temperature sensors to support table 216 are vendor specific.
[b] When the device powers up, a new entry is made in the history queue with a value of 80h (i.e., an invalid 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 mode (e.g., Sleep or Standby) (see 4.17.4), then a value of 80h is entered into the history queue to indicate that temperature sensing has resumed.
[c] The process of clearing the HDA Temperature History table is defined in 8.3.5.2.2.

8.3.5.2.2 Clearing the HDA Temperature History table

When the HDA Temperature History table is cleared (e.g., at the time of manufacture or after changing the contents of the INTERVAL field):

a) the CB_INDEX field shall be cleared to zero;
b) the first queue location shall be set to the current temperature value;
c) all remaining queue locations shall be set to 80h (i.e., an invalid temperature value).

Clearing the HDA Temperature History table shall not change the contents of the:

a) SAMPLE PERIOD field;
b) MAX OP LIMIT field;

c) OVER LIMIT field;
d) MIN OP LIMIT field; and
e) UNDER LIMIT field.

8.3.5.3 SCT Data Table command status response

Table 217 defines the format of the status response for an SCT Data Table command.

Table 217 — SCT Data Table command status response

Field	Description
ERROR	**Bit** **Description** 7:5 N/A 4 ID NOT FOUND bit – See 6.3.4 3 N/A 2 ABORT bit – See 6.3.2 1 N/A 0 Obsolete
COUNT	Reserved
LBA	**Bit** **Description** 27:24 Reserved 23:8 If the key page TABLE ID field (see table 214) was set to 0002h, this field shall be set to 0001h (i.e., number of pages requested). Otherwise this field is reserved. 7:0 Reserved
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit** **Description** 7:6 Transport Dependent – See 6.2.11. 5:2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

9 Log Definitions

9.1 Overview

This clause provides a description of all logs. All logs are optional unless otherwise specified. These logs are accessible via commands (see 7.24, 7.25, 7.48.2, 7.48.4, 7.62, 7.63). Table 218 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 and each page has a page number.

The LOG ADDRESS field is used by read log commands and write log commands to access a specific log. Data transfer associated with the SMART READ LOG command and the SMART WRITE LOG command starts from the first log page (i.e., log page number zero). GPL feature set (see 4.11) commands allow the host to specify the starting log page number using the PAGE NUMBER field.

Table 218 — Log address definition (Sheet 1 of 3)

Log Address	Log Name	Feature Set	Support	R/W	Access
00h	Log directory, see 9.2 and 9.3	none	M	RO	GPL,SL
01h	Summary SMART Error log, see 9.22	SMART	O	RO	SL [a]
02h	Comprehensive SMART Error log, see 9.4	SMART	O	RO	SL [a]
03h	Extended Comprehensive SMART Error log, see 9.7	SMART	O	RO	GPL [b]
04h	Device Statistics, see 9.5	none	O	RO	GPL,SL
05h	Reserved for CFA				
06h	Obsolete				
07h	Obsolete				
08h	Power Conditions, see 9.8	EPC	F	RO	GPL [b]
09h	Selective Self-Test log, see 9.21	SMART	O	R/W	SL [a]
0Ah	Device Statistics Notification, see 9.26	DSN	F	R/W	GPL [b]
0Bh	Reserved for CFA				
0Ch	Pending Defects log, see 9.27	none	O	RO	GPL [b]
0Dh	LPS Mis-alignment log, see 9.13	LPS	F	RO	GPL,SL
0Eh	Reserved for ZAC-2				
0Fh	Sense Data for Successful NCQ Commands log, see 9.28	NCQ	See [f]	RO	GPL [b]
10h	NCQ Command Error log, see 9.14	NCQ	F	RO	GPL [b]
11h	SATA Phy Event Counters log, see 9.16	NCQ	See [c]	RO	GPL [b]
12h	SATA NCQ Non-Data log, see 9.17	NCQ	See [d]	RO	GPL [b]
13h	SATA NCQ Send and Receive log, see 9.18	NCQ	See [e]	RO	GPL [b]
14h	Hybrid Information log, see 9.19	Hybrid Information	F	RO	GPL [b]
15h	Rebuild Assist log, see 9.20	Rebuild Assist	F	R/W	GPL [b]
16h	Out Of Band Management Control log, see 9.33.	Out Of Band Management Interface	F	R/W	GPL [b]
17h	Reserved for Serial ATA				

Table 218 — Log address definition (Sheet 2 of 3)

Log Address	Log Name	Feature Set	Support	R/W	Access
18h	Command Duration Limits log, see 9.11	Command Duration Limits	F	R/W	GPL
19h	LBA Status, see 9.12	none	O	RO	GPL [b]
1Ah..1Fh	Reserved				
20h	Obsolete				
21h	Write Stream Error log, see 9.23	Streaming	F	RO	GPL [b]
22h	Read Stream Error log, see 9.15	Streaming	F	RO	GPL [b]
23h	Obsolete				
24h	Current Device Internal Status Data log, see 9.24	none	O	RO	GPL [b]
25h	Saved Device Internal Status Data log, see 9.25	none	O	RO	GPL [b]
26h..2Eh	Reserved				
2Fh	Set Sector Configuration, see 9.29	none	See [g]	RO	GPL [b]
30h	IDENTIFY DEVICE data, see 9.10	none	M	RO	GPL, SL
31h..41h	Reserved				
42h	Mutate Configurations log, see 9.30	User Data Initialization	O	RO	GPL [b]
43h..46h	Reserved				
47h	Concurrent Positioning Ranges log, see 9.31	none	O	RO	GPL [b]
48h..52h	Reserved				
53h	Sense Data log, see 9.32	Sense Data Reporting	See [h]	RO	GPL [b]
54h..7Fh	Reserved				
80h..9Fh	Host Specific, see 9.9	SMART	M	R/W	GPL,SL

Table 218 — Log address definition (Sheet 3 of 3)

Log Address	Log Name	Feature Set	Support	R/W	Access
A0h..DFh	Device Vendor Specific, see 9.6	SMART	O	VS	GPL,SL
E0h	SCT Command/Status, see 8.1	SCT	F	R/W	GPL,SL
E1h	SCT Data Transfer, see 8.1	SCT	F	R/W	GPL,SL
E2h..FFh	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
M – Log support is mandatory.
O – Log support is optional.
F – Log support is mandatory if feature set is supported.
SL – SMART Logging

[a] The device shall return command aborted if a GPL feature set (see 4.11) command accesses a log that is marked only with SL.
[b] The device shall return command aborted if a SMART feature set (see 4.23) command accesses a log that is marked only with GPL.
[c] Mandatory if the SATA PHY EVENT COUNTERS LOG SUPPORTED bit (see 9.10.10.2.6) is set to one.
[d] Mandatory if the NCQ QUEUE MANAGEMENT COMMAND SUPPORTED bit (see 9.10.10.2.13) is set to one.
[e] Mandatory if the SEND AND RECEIVE QUEUED COMMANDS SUPPORTED bit (see 9.10.10.2.14) is set to one.
[f] Mandatory if the SUCCESSFUL NCQ COMMAND SENSE DATA SUPPORTED bit (see 9.10.5.2.40) is set to one.
[g] Mandatory if the SET SECTOR CONFIGURATON EXT command (see 7.46) is supported.
[h] Mandatory if the NON-NCQ REBUILD ASSIST SUPPORTED bit (see 9.10.5.2.50) is set to one.

9.2 General Purpose Log Directory (GPL Log Address 00h)

The contents of the General Purpose Log Directory shall only change after the device processes a:

a) power-on reset;
b) hardware reset;
c) DOWNLOAD MICROCODE command (see 7.7); or
d) DOWNLOAD MICROCODE DMA command (see 7.8).

Table 219 defines the 255 words contained in the General Purpose Log Directory.

Table 219 — General Purpose Log Directory

Word	Description
0	General Purpose Logging Version [a]
1	Number of log pages at log address 01h
2	Number of log pages at log address 02h
3	Number of log pages at log address 03h
4	Number of log pages at log address 04h
…	
128	Number of log pages at log address 80h
129	Number of log pages at log address 81h
…	
255	Number of log pages at log address FFh

[a] This word shall be set to 0001h.

9.3 SMART Log Directory (SMART Logging Log Address 00h)

The contents of the SMART Log Directory shall only change after the device processes a:

a) power-on reset;
b) hardware reset;
c) DOWNLOAD MICROCODE command (see 7.7); or
d) DOWNLOAD MICROCODE DMA command (see 7.8).

Table 220 defines the 512-bytes that make up the SMART Log Directory. The SMART Log Directory is defined as one log page.

Table 220 — 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.

9.4 Comprehensive SMART Error log (Log Address 02h)

9.4.1 Overview

Table 221 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 9.7. 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).

Table 221 — 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 n^{th} log page within the log.
[b] The first log page is numbered zero.

9.4.2 SMART error log version

The value of the SMART error log version byte shall be set to 01h.

9.4.3 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 cleared to zero. Valid values for the error log index are zero to 255.

9.4.4 Error log data structure

The error log is a circular buffer (i.e., when the most recent 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 9.22.4.

9.4.5 Device error count

The Device Error Count field is defined in 9.22.5.

9.4.6 Data structure checksum

The data structure checksum is defined in 9.7.6.

9.5 Device Statistics log (Log Address 04h)

9.5.1 Overview

The Device Statistics log contains statistics about the device.

The number of log pages may be greater than one.

For the definition of the FEATURE field, if this log is read by a GPL command, see 9.5.2.

The Device Statistics log may be affected by the processing of a device configuration changing command.

See table 222 for a list of defined log pages. Each supported log page shall consist of a log page header that may be followed by device statistics (see table 223). If the REVISION NUMBER field in the log page header is 0000h, then that log page is not supported.

If an unsupported log page is requested, then 512 bytes of all zeros shall be returned for that log page.

Table 222 — Defined Device Statistics log pages

Log page	Description
00h	List of supported log pages (see 9.5.3)
01h	General Statistics (see 9.5.6)
02h	Free Fall Statistics (see 9.5.5)
03h	Rotating Media Statistics (see 9.5.8)
04h	General Errors Statistics (see 9.5.7)
05h	Temperature Statistics (see 9.5.10)
06h	Transport Statistics (see 9.5.11)
07h	Solid State Device Statistics (see 9.5.9)
08h	Reserved for zoned devices (see ZAC-2)
09h	Command Duration Limits Statistics (see 9.5.4)
0Ah..FEh	Reserved
FFh	Vendor Specific Statistics (see 9.5.12)

Each device statistic shall be one QWord in length and have the format shown in table 223.

Table 223 — Device Statistic format

Bits	Description
63:56	DEVICE STATISTICS FLAGS field (see table 224)
55:0	The device statistic's value that is comprised of one to 56 bits with the least significant bit in bit zero

Table 224 — DEVICE STATISTIC FLAGS field

Bit	Name	F/V	Description
63	DEVICE STATISTIC SUPPORTED	F	1 = This device statistic is supported (i.e., the other bits in the DEVICE STATISTICS FLAGS field contain valid information). 0 = This device statistic is not supported (i.e., the other bits in the DEVICE STATISTICS FLAGS field and the device statistic's value (see table 223) are N/A).
62	VALID VALUE	V	1 = The device statistic's value (see table 223) is valid for this device statistic. 0 = The device statistic's value is not valid for this device statistic (e.g., the value is numerically not accurate or the value is not able to be retrieved by normal means). The VALID VALUE bit may be set to one or cleared to zero independent of the initialization of the device statistic's value unless stated otherwise.
61	NORMALIZED STATISTIC	F	This device statistic may use a normalization algorithm. 1 = The device statistic's value (see table 223) contains a normalized value. 0 = The device statistic's value is not normalized. [a]
60	STATISTIC SUPPORTS DSN	F	1 = This device statistic supports device statistics notification (see 9.26). 0 = This device statistic does not support device statistics notification.
59	MONITORED CONDITION MET	V	1 = The monitored condition set for this device statistic is met (see 9.26). 0 = The monitored condition set for this device statistic is not met.
58	READ THEN INITIALIZE SUPPORTED	F	1 = This device statistic is initialized if the Device Statistics log is read with the READ THEN INITIALIZE bit (see 9.5.2) set to one. 0 = The device statistic is not initialized if the Device Statistics log is read with the READ THEN INITIALIZE bit set to one.
57..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.

[a] If this standard does not define a normalized value for a device statistic, the NORMALIZED STATISTIC bit shall be cleared to zero.

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;
h) initialization information;
i) if the statistic supports Device Statistic Notifications (see 9.26); and
j) if a monitored condition for this statistic has been met (see 9.26).

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 device statistic's value (see table 223) that increments reaches the maximum value, then the device statistic's value 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 4.17.4) or any power management state (see 4.17.4) 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 (i.e., update interval);
g) while the device is in the PM3:Sleep state (see 4.17.4):
   A) the current statistics shall not be updated to the non-volatile locations;
   B) the associated statistic update timers shall not continue operation; and
   C) the device shall not exit PM3:Sleep state to update the non-volatile statistics;
h) while the device is in the PM2:Standby state (see 4.17.4):
   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 associated statistic update timers shall be re-initialized and shall continue operation while in the PM2:Standby state;
   C) if the statistics are not saved to the non-volatile locations, then the associated statistic update timers shall not continue operation while in the PM2:Standby state; and
   D) the device shall not exit PM2:Standby state to update the non-volatile statistics;
   and
i) while the device is in the PM0:Active state (see 4.17.4) or PM1:Idle state (see 4.17.4), if the statistics update timer expires and:
   A) a statistic value has not changed, then the device shall:
      a) save the statistic to a non-volatile location; and
      b) re-initialize the associated statistic update timer;
      or
   B) a statistic's value has changed and:
      a) a command is not being processed, then the device shall save the updated statistic to a non-volatile location and re-initialize the associated statistic update timer; or
      b) a command is being processed, then the device:
         A) should save the updated statistic to a non-volatile location during command processing, and if the statistic is saved, then the device shall re-initialize the associated statistic update timer; and
         B) shall, before processing the next command, save the updated statistic to a non-volatile location and re-initialize the associated statistic update timer.

9.5.2 FEATURE field for GPL commands

If this log is read using a GPL command, then the FEATURE field of that command is defined by table 225.

Table 225 — FEATURE field for READ LOG EXT and READ LOG DMA EXT

Bits	Description
15:1	Reserved
0	READ THEN INITIALIZE bit

If the READ THEN INITIALIZE bit is set to one, then the device shall:

1) transfer the selected pages of this log;
2) initialize each device statistic in the pages transferred for which the READ THEN INITIALIZE SUPPORTED bit (see table 224) is set to one; and
3) return command completion.

If the READ THEN INITIALIZE bit is cleared to zero, then the device shall:

1) transfer the selected pages of this log; and
2) return command completion.

9.5.3 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 226. If the Device Statistics log is supported and any Device Statistics log page other than the General Statics log page (see 9.5.6) is supported, then the list of supported Device Statistics log pages 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 226 — List of supported Device Statistics log pages

Offset	Type	Description
0..7	QWord	Device Statistics Information Header **Bit Description** 63:24 Reserved 23:16 LOG PAGE NUMBER field - shall be set to 00h 15:0 REVISION NUMBER field (Word) - 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

9.5.4 Command Duration Limits Statistics (log page 09h)

9.5.4.1 Overview

The Command Duration Limits Statistics log page contains information related to the Command Duration Limits feature set (see 4.7) as described in table 227.

The Command Duration Limits Descriptors statistics are as follows:

a) Device Statistics Information Header;
b) Lowest Achievable Command Duration;
c) Command Duration Limits Statistics A for Command Duration Limits Descriptors r1..r7;
d) Command Duration Limits Statistics A for Command Duration Limits Descriptors w1..w7;
e) Command Duration Limits Statistics B for Command Duration Limits Descriptors r1..r7; and
f) Command Duration Limits Statistics B for Command Duration Limits Descriptors w1..w7.

Table 227 — Command Duration Limits Statistics (Sheet 1 of 5)

Offset	Type	Description
0..7	QWord	Command Duration Limits Statistics **Bit Description** 63:24 Reserved 23:16 LOG PAGE NUMBER field - shall be set to 09h 15:0 REVISION NUMBER field (Word) - shall be set to 0001h
8..15	QWord	Lowest Achievable Command Duration (see 9.5.4.3) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 LOWEST ACHIEVABLE COMMAND DURATION field (DWord)
16..23	QWord	Command Duration Limits Statistic A (see 9.5.4.4) for Command Duration Limits Descriptor r1 **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
24..31	QWord	Command Duration Limits Statistic A (see 9.5.4.4) for Command Duration Limits Descriptor r2 **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
32..39	QWord	Command Duration Limits Statistic A (see 9.5.4.4) for Command Duration Limits Descriptor r3 **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
40..47	QWord	Command Duration Limits Statistic A (see 9.5.4.4) for Command Duration Limits Descriptor r4 **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)

Table 227 — Command Duration Limits Statistics (Sheet 2 of 5)

Offset	Type	Description
48..55	QWord	Command Duration Limits Statistic A (see 9.5.4.4) for Command Duration Limits Descriptor r5
		Bit Description 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
56..63	QWord	Command Duration Limits Statistic A (see 9.5.4.4) for Command Duration Limits Descriptor r6
		Bit Description 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
64..71	QWord	Command Duration Limits Statistic A (see 9.5.4.4) for Command Duration Limits Descriptor r7
		Bit Description 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
72..79	QWord	Command Duration Limits Statistic A (see 9.5.4.4) for Command Duration Limits Descriptor w1
		Bit Description 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
80..87	QWord	Command Duration Limits Statistic A (see 9.5.4.4) for Command Duration Limits Descriptor w2
		Bit Description 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
88..95	QWord	Command Duration Limits Statistic A (see 9.5.4.4) for Command Duration Limits Descriptor w3
		Bit Description 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)

Table 227 — Command Duration Limits Statistics (Sheet 3 of 5)

Offset	Type	Description
96..103	QWord	Command Duration Limits Statistic A (see 9.5.4.4) for Command Duration Limits Descriptor w4
		Bit Description 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
104..111	QWord	Command Duration Limits Statistic A (see 9.5.4.4) for Command Duration Limits Descriptor w5
		Bit Description 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
112..119	QWord	Command Duration Limits Statistic A (see 9.5.4.4) for Command Duration Limits Descriptor w6
		Bit Description 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
120..127	QWord	Command Duration Limits Statistic A (see 9.5.4.4) for Command Duration Limits Descriptor w7
		Bit Description 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
128..135	QWord	Command Duration Limits Statistic B (see 9.5.4.5) for Command Duration Limits Descriptor r1
		Bit Description 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
136..143	QWord	Command Duration Limits Statistic B (see 9.5.4.5) for Command Duration Limits Descriptor r2
		Bit Description 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)

Table 227 — Command Duration Limits Statistics (Sheet 4 of 5)

Offset	Type	Description
144.151	QWord	Command Duration Limits Statistic B (see 9.5.4.5) for Command Duration Limits Descriptor r3 **Bit** **Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
152..159	QWord	Command Duration Limits Statistic B (see 9.5.4.5) for Command Duration Limits Descriptor r4 **Bit** **Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
160..167	QWord	Command Duration Limits Statistic B (see 9.5.4.5) for Command Duration Limits Descriptor r5 **Bit** **Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
168..175	QWord	Command Duration Limits Statistic B (see 9.5.4.5) for Command Duration Limits Descriptor r6 **Bit** **Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
176..183	QWord	Command Duration Limits Statistic B (see 9.5.4.5) for Command Duration Limits Descriptor r7 **Bit** **Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
184..191	QWord	Command Duration Limits Statistic B (see 9.5.4.5) for Command Duration Limits Descriptor w1 **Bit** **Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)

Table 227 — Command Duration Limits Statistics (Sheet 5 of 5)

Offset	Type	Description
192..199	QWord	Command Duration Limits Statistic B (see 9.5.4.5) for Command Duration Limits Descriptor w2
		Bit **Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
200..207	QWord	Command Duration Limits Statistic B (see 9.5.4.5) for Command Duration Limits Descriptor w3
		Bit **Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
208..215	QWord	Command Duration Limits Statistic B (see 9.5.4.5) for Command Duration Limits Descriptor w4
		Bit **Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
216..223	QWord	Command Duration Limits Statistic B (see 9.5.4.5) for Command Duration Limits Descriptor w5
		Bit **Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
224..231	QWord	Command Duration Limits Statistic B (see 9.5.4.5) for Command Duration Limits Descriptor w6
		Bit **Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
232..239	QWord	Command Duration Limits Statistic B (see 9.5.4.5) for Command Duration Limits Descriptor w7
		Bit **Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 NUMBER OF SPECIFIED POLICY INVOCATIONS field (DWord)
240..511		Reserved

9.5.4.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table 227) for this log page.

9.5.4.3 Lowest Achievable Command Duration

9.5.4.3.1 Description

Lowest Achievable Command Duration is a statistic that indicates the lowest value that the device is able to achieve for the COMMAND DURATION GUIDELINE field (see 9.11.2.9) in any Command Duration Limits Descriptor (see 9.11.2).

Factors that affect the Lowest Achievable Command Duration statistic may include:

a) the commands being processed by the device;
b) data transfer errors, if any, being processed by the device;
c) the background activities, if any, being performed by the device; and
d) the contents of the following fields the Command Duration Limits log (see 9.11):
    A) the PERFORMANCE VERSUS COMMAND DURATION GUIDELINES field (see 9.11.1.2);
    B) the non-zero COMMAND DURATION GUIDELINE fields in each Command Duration Limits Descriptor.

The device shall maintain sufficient information to compute the Lowest Achievable Command Duration statistic based on at least the 10,000 most recently processed duration affected commands (i.e., read commands and write commands). If less than 10,000 duration affected commands has been processed since the initialization of data collection (e.g., a power on reset), then the VALUE VALID bit (see table 224) shall be cleared to zero. Whether the VALUE VALID bit is cleared to zero or set to one after the device as collected information for 10,000 duration affected commands is outside the scope of this standard.

The device shall update the Lowest Achievable Command Duration statistic as part of processing log command that reads the Command Duration Limits Statistics log page.

For this statistic, the READ THEN INITIALIZED SUPPORTED bit (see table 224) shall be set to one.

9.5.4.3.2 Update Interval

This statistic is not saved to non-volatile storage.

9.5.4.3.3 Measurement Units

Microseconds

9.5.4.3.4 Initialization

This statistic and the information that the device maintains to compute it (see 9.5.4.3.1) shall be cleared to zero if:

a) the COMMAND DURATION LIMITS ENABLED bit (see 9.10.6.2.3) is set to one (e.g., at the time, if any, when the Command Duration Limits feature set becomes enabled or re-enabled) as described in 7.45.10.3;
b) the device processes a power on reset; and
c) this statistic is read using a GPL command with the READ THEN INITIALIZE bit (see 9.5.2) set to one.

9.5.4.4 Command Duration Limits Statistic A

9.5.4.4.1 Description

For each Command Duration Limits Statistic A device statistic (see table 227 offsets 16..127), the COMMAND DURATION LIMITS STATISTIC A SELECTOR field in the associated Command Duration Limits Descriptor (see 9.11.2) defines the conditions that result in that statistic being incremented as described in 9.11.2.7.

For each Command Duration Limits Statistic A device statistic, the READ THEN INITIALIZE SUPPORTED bit (see table 224) shall be set to one.

9.5.4.4.2 Update Interval

This statistic is not saved to non-volatile storage.

9.5.4.4.3 Measurement Units

Events

9.5.4.4.4 Initialization

This statistic shall be cleared to zero if:

a) the COMMAND DURATION LIMITS ENABLED bit (see 9.10.6.2.3) is set to one (e.g., at the time, if any, when the Command Duration Limits feature set becomes enabled or re-enabled) as described in 7.45.10;
b) the device processes a power on reset; and
c) this statistic is read using a GPL command with the READ THEN INITIALIZE bit (see 9.5.2) set to one.

9.5.4.5 Command Duration Limits Statistic B

9.5.4.5.1 Description

For each Command Duration Limits Statistic B device statistic (see table 227 offsets 128..239), the COMMAND DURATION LIMITS STATISTIC B SELECTOR field in the associated Command Duration Limits Descriptor (see 9.11.2) defines the conditions that result in that statistic being incremented as described in 9.11.2.8.

For each Command Duration Limits Statistic B device statistic, the READ THEN INITIALIZE SUPPORTED bit (see table 224) shall be set to one.

9.5.4.5.2 Update Interval

This statistic is not saved to non-volatile storage.

9.5.4.5.3 Measurement Units

Events

9.5.4.5.4 Initialization

This statistic shall be cleared to zero if:

a) the COMMAND DURATION LIMITS ENABLED bit (see 9.10.6.2.3) is set to one (e.g., at the time, if any, when the Command Duration Limits feature set becomes enabled or re-enabled) as described in7.45.10;
b) the device processes a power on reset; and
c) this statistic is read using a GPL command with the READ THEN INITIALIZE bit (see 9.5.2) set to one.

9.5.5 Free Fall Statistics (log page 02h)

9.5.5.1 Overview

The Free Fall Statistics log page contains free-fall information as described in table 228.

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 228 — Free Fall Statistics

Offset	Type	Description
0..7	QWord	Device Statistics Information Header **Bit Description** 63:24 Reserved 23:16 LOG PAGE NUMBER field - shall be set to 02h 15:0 REVISION NUMBER field (Word) - shall be set to 0001h
8..15	QWord	Number of Free-Fall Events Detected **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 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 field (see table 224) 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

9.5.5.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table 228) for this log page.

9.5.5.3 Number of Free-Fall Events Detected

9.5.5.3.1 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.

9.5.5.3.2 Update Interval

One hour

9.5.5.3.3 Measurement Units

Events

9.5.5.3.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.5.4 Overlimit Shock Events

9.5.5.4.1 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.

9.5.5.4.2 Update Interval

One hour

9.5.5.4.3 Measurement Units

Events

9.5.5.4.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.6 General Statistics (log page 01h)

9.5.6.1 Overview

The General Statistics log page contains general information about the device as described in table 229.

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;
g) Number of Read Commands;
h) Pending Error Count;
i) Workload Utilization;
j) Utilization Usage Rate;
k) Resource Availability; and
l) Random Write Resources Used.

Table 229 — General 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 field - shall be set to 01h
		15:0	REVISION NUMBER field (Word) - shall be set to 0003h
8..15	QWord	Lifetime Power-On Resets (see 9.5.6.3)	
		Bit	**Description**
		63:56	DEVICE STATISTICS FLAGS field (see table 224)
		55:32	Reserved
		31:0	Number of times that the device has processed a Power-On Reset event (DWord)
16..23	QWord	Power-on Hours (see 9.5.6.4)	
		Bit	**Description**
		63:56	DEVICE STATISTICS FLAGS field (see table 224)
		55:32	Reserved
		31:0	Power-on Hours (DWord)
24..31	QWord	Logical Sectors Written (see 9.5.6.5)	
		Bit	**Description**
		63:56	DEVICE STATISTICS FLAGS field (see table 224)
		55:48	Reserved
		47:0	Logical Sectors Written

Table 229 — General Statistics (Sheet 2 of 3)

Offset	Type	Description
32..39	QWord	Number of Write Commands (see 9.5.6.6) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:48 Reserved 47:0 Number of Write Commands
40..47	QWord	Logical Sectors Read (see 9.5.6.7) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:48 Reserved 47:0 Logical Sectors Read
48..55	QWord	Number of Read Commands (see 9.5.6.8) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:48 Reserved 47:0 Number of Read Commands
56..63	QWord	Date and Time TimeStamp (see 9.5.6.9) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:48 Reserved 47:0 Date and Time TimeStamp
64..71	QWord	Pending Error Count (see 9.5.6.10) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 Pending Error Count
72..79	QWord	Workload Utilization (see 9.5.6.11) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:16 Reserved 15:0 Workload Utilization
80..87	QWord	Utilization Usage Rate (see 9.5.6.12) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:48 Reserved 47:40 RATE VALIDITY field (see 9.5.6.12.2) 39:36 RATE BASIS field (see 9.5.6.12.3) 35:8 Reserved 7:0 UTILIZATION USAGE RATE field (see 9.5.6.12.4)

Table 229 — General Statistics (Sheet 3 of 3)

Offset	Type	Description
88..95	QWord	Resource Availability (see 9.5.6.13)
		Bit **Description**
		63:56 DEVICE STATISTICS FLAGS field (see table 224)
		55:16 Resources
		15:0 FRACTION OF DEVICE RESOURCES AVAILABLE field
96..103	QWord	Random Write Resources Used (see 9.5.6.14)
		Bit **Description**
		63:56 DEVICE STATISTICS FLAGS field (see table 224)
		55:8 Reserved
		7:0 RANDOM WRITE RESOURCES USED field
104..511	Byte	Reserved

9.5.6.2 Device Statistics Information Header

The Device Statistics Information Header indicates the format of the structure (see table 229) for this log page.

9.5.6.3 Lifetime Power-On Resets

9.5.6.3.1 Description

Lifetime Power-On Resets is a counter that records the number of times that the device has processed a power-on reset.

9.5.6.3.2 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.

9.5.6.3.3 Measurement Units

Events

9.5.6.3.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.6.4 Power-on Hours

9.5.6.4.1 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 while the device is in PM0:Active state (see 4.17.4);
b) shall increment this statistic while the device is in PM1:Idle state (see 4.17.4);
c) should increment this statistic while the device is in the PM2:Standby state (see 4.17.4);
d) should increment this statistic while the device is in the PM5: PUIS and spin-up subcommand not supported state (see 4.17.4);
e) should increment this statistic while the device is in the PM6: PUIS and spin-up subcommand supported state (see 4.17.4); and
f) shall not increment this statistic while the device is in PM3:Sleep state (see 4.17.4).

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.

9.5.6.4.2 Update Interval

One hour

9.5.6.4.3 Measurement Units

Hours

9.5.6.4.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.6.5 Logical Sectors Written

9.5.6.5.1 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 received from the host without an error.

9.5.6.5.2 Update Interval

One hour

9.5.6.5.3 Measurement Units

Logical sectors

9.5.6.5.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.6.6 Number of Write Commands

9.5.6.6.1 Description

The Number of Write Commands statistic is the number of write commands that returned command completion without error. This statistic is incremented by one for each write command that returns command completion without error.

9.5.6.6.2 Update Interval

One hour

9.5.6.6.3 Measurement Units

Events

9.5.6.6.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.6.7 Logical Sectors Read

9.5.6.7.1 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 sent to the host without an error.

9.5.6.7.2 Update Interval

One hour

9.5.6.7.3 Measurement Units

Logical sectors

9.5.6.7.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.6.8 Number of Read Commands

9.5.6.8.1 Description

The Number of Read Commands statistic is the number of read commands that returned command completion without error. This statistic is incremented by one for each read command that returns command completion without error.

9.5.6.8.2 Update Interval

One hour

9.5.6.8.3 Measurement Units

Events

9.5.6.8.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.6.9 Date and Time TimeStamp

9.5.6.9.1 Description

The Date and Time TimeStamp statistic is:

a) the TimeStamp set by the most recent SET DATE & TIME EXT command (see 7.44) plus the number of milliseconds that have elapsed since that SET DATE & TIME EXT command was processed; or
b) a copy of the Power-on Hours statistic (see 9.5.6.4) with the hours unit of measure changed to milliseconds as described in 9.5.6.9.4.

9.5.6.9.2 Update Interval

This statistic is not saved to non-volatile storage.

9.5.6.9.3 Measurement Units

Milliseconds

9.5.6.9.4 Initialization

After each power-on reset, this statistic shall be set to the value in the Power-on Hours statistic (see 9.5.6.4) with the hours unit of measure changed to milliseconds.

9.5.6.10 Pending Error Count

9.5.6.10.1 Description

The Pending Error Count statistic is a value that indicates the number of logical sectors listed in the Pending Errors log (see 9.27).

9.5.6.10.2 Update Interval

The information in this statistic is not saved in non-volatile storage on any time interval defined in this standard.

9.5.6.10.3 Measurement Units

The information in this statistic is measured as the number of logical sectors.

9.5.6.10.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.6.11 Workload Utilization

9.5.6.11.1 Description

The Workload Utilization statistic contains an estimate of device utilization as a percentage of the manufacturer's designs for various wear factors (e.g., wear of the medium, head load events), if any. The reported values range from 0.00% to 655.35% (see 9.5.6.11.3).

Table 230 summarizes the values of the Workload Utilization device statistic.

Table 230 — Workload Utilization device statistic

Value	Description
0..9 999	Less than (i.e., 0.00% to 99.99% of) the designed workload has been utilized.
10 000	Exactly the designed workload for the device has been utilized.
10 001..65 534	Greater than (i.e., 100.01% to 655.34% of) the designed workload has been utilized.
65 535	Greater than 655.34% of the designed workload has been utilized.

9.5.6.11.2 Update Interval

The non-volatile value is updated once per power-on hour.

9.5.6.11.3 Measurement Units

The measurement units are percentage and the reported value is percent times 100.

9.5.6.11.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.6.12 Utilization Usage Rate

9.5.6.12.1 Description

The Utilization Usage Rate statistic is an estimate of the rate at which device wear factors (e.g., damage to the recording medium) are being used during a specified interval of time. This statistic is expressed as a percentage of the manufacturer's designs.

The Utilization Usage Rate device statistic contains the following fields:

a) the UTILIZATION USAGE RATE field (see 9.5.6.12.4) that indicates the percentage utilization during the specified time interval;
b) the RATE VALIDITY field (see 9.5.6.12.2) that indicates:
   A) whether the contents of the UTILIZATION USAGE RATE field are valid; or
   B) possible reasons for the UTILIZATION USAGE RATE field being invalid;
   and
c) the RATE BASIS field (see 9.5.6.12.3) that indicates the time interval for which the Utilization Usage Rate device statistic is being calculated.

If the DEVICE STATISTIC SUPPORTED bit is set to one for the Utilization Usage Rate device statistic, the VALID VALUE bit shall be set to one.

9.5.6.12.2 RATE VALIDITY field

The RATE VALIDITY field (see table 231) whether contents of the UTILIZATION USAGE RATE field are valid.

Table 231 — RATE VALIDITY field

Value	Description
00h	The contents of the UTILIZATION USAGE RATE field are valid.
10h	The contents of the UTILIZATION USAGE RATE field are not valid because insufficient information has been collected about the workload utilization (e.g., not enough accesses of the recording media have been detected to allow computation of the UTILIZATION USAGE RATE field).
81h	The contents of the UTILIZATION USAGE RATE field are not valid because the most recently processed SET DATE & TIME command specified a timestamp resulted in usage rate that is unreasonable (e.g., the device has been in service for 25 years).
FFh	The contents of UTILIZATION USAGE RATE field are not valid for an undetermined reason.
all other values	Reserved

9.5.6.12.3 RATE BASIS field

The RATE BASIS field (see table 232) describes the method used to compute the UTILIZATION USAGE RATE field.

Table 232 — RATE BASIS field

Value	Description
0h	The contents of the UTILIZATION USAGE RATE field are based on the time of manufacture until the time indicated by the Date and Time TimeStamp (see 9.5.6.9) device statistic, including times during which the device was powered off.
4h	The contents of the UTILIZATION USAGE RATE field are based on the time elapsed since the most recent processing of a power-on reset.
8h	The contents of the UTILIZATION USAGE RATE field are based on the Power-on Hours device statistic (see 9.5.6.4).
Fh	The basis for the UTILIZATION USAGE RATE field is undetermined.
all other values	Reserved

The Set Rate Basis subcommand of the SET FEATURES command (see 7.45.12) instructs the device set the RATE BASIS field to a specific value.

9.5.6.12.4 UTILIZATION USAGE RATE field

Table 233 summarizes the values of the UTILIZATION USAGE RATE field.

Table 233 — Utilization Usage Rate values

Value	Description
0..99	During the specified time interval (see 9.5.6.12.3), the Workload Utilization usage rate has been less than (i.e., 0% to 99% of) the designed usage rate
100	During the specified time interval, the Workload Utilization usage rate has been the exact usage rate designed for the device
101..254	During the specified time interval, the Workload Utilization usage rate has been greater than (i.e., 101% to 254% of) the designed usage rate
255	During the specified time interval, the Workload Utilization usage rate has been greater than 254% of the designed usage rate

9.5.6.12.5 Update Interval

This device statistic is copied to a non-volatile location once per hour.

9.5.6.12.6 Measurement Units

The measurement units are described in 9.5.6.12.2, 9.5.6.12.3, and 9.5.6.12.4.

9.5.6.12.7 Initialization

At the time of manufacture, the DEVICE STATISTICS FLAGS field shall be set as described in 9.5.1. If the DEVICE STATISTICS FLAGS bit is set to one at the time of manufacture, the VALUE VALID bit (see 9.5.1) shall be set to one.

9.5.6.13 Resource Availability

9.5.6.13.1 Description

The device shall set the FRACTION OF DEVICE RESOURCES AVAILABLE field (see table 229) to the fraction of the total device resources that are available. The fraction of device resources available value is the numerator of a fraction that has 65 535 (i.e., FFFFh) as the denominator.

9.5.6.13.2 Update Interval

One hour

9.5.6.13.3 Measurement Units

See 9.5.6.13.1.

9.5.6.13.4 Initialization

This statistic shall be set to FFFFh at the time of manufacture.

9.5.6.14 Random Write Resources Used

9.5.6.14.1 Description

The RANDOM WRITE RESOURCES USED field represents the relative amount of random write resources that are in use at the time this log page is read The value of the RANDOM WRITE RESOURCES USED field increases as the number of random write resources in use increases, and decreases as the number of random write resources in use decreases. If the value of this field exceeds 7Fh, then performance may be degraded and the host should reduce the frequency of commands sent to the device.

Table 234 summarizes the values of the RANDOM WRITE RESOURCES USED field.

Table 234 — Random write resources values

Value	Description
00h..7Fh	Random write resources used is within nominal bounds.
80h..FFh	Random write resources used have exceeded nominal bounds.

9.5.6.14.2 Update Interval

This statistic is not saved to non-volatile storage.

9.5.6.14.3 Measurement Units

None

9.5.6.14.4 Initialization

None

9.5.7 General Errors Statistics (log page 04h)

9.5.7.1 Overview

The General Errors Statistics log page contains general error information about the device as described in table 235.

The General Errors Statistics are as follows:

a) Device Statistics Information Header;
b) Number of Reported Uncorrectable Errors;
c) Number of Resets Between Command Acceptance and Command Completion; and
d) Physical Element Status Changed.

Table 235 — General Error Statistics

Offset	Type	Description
0..7	QWord	Device Statistics Information Header
		Bit **Description**
		63:24 Reserved
		23:16 LOG PAGE NUMBER field, shall be set to 04h
		15:0 REVISION NUMBER field (Word), shall be set to 0001h
8..15	QWord	Number of Reported Uncorrectable Errors (see 9.5.7.3)
		Bit **Description**
		63:56 DEVICE STATISTICS FLAGS field (see table 224)
		55:32 Reserved
		31:0 NUMBER OF REPORTED UNCORRECTABLE ERRORS field (DWord)
16..23	QWord	Number of Resets Between Command Acceptance and Command Completion (see 9.5.7.4)
		Bit **Description**
		63:56 DEVICE STATISTICS FLAGS field (see table 224)
		55:32 Reserved
		31:0 NUMBER OF RESETS BETWEEN COMMAND ACCEPTANCE AND COMMAND COMPLETION field (DWord)
24..31	QWord	Physical Element Status Changed (see 9.5.7.5)
		Bit **Description**
		63:56 DEVICE STATISTICS FLAGS field (see table 224)
		55:32 Reserved
		31:0 PHYSICAL ELEMENT STATUS CHANGED field (DWord)
32..511	Byte	Reserved

9.5.7.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table 235) for this log page.

9.5.7.3 Number of Reported Uncorrectable Errors

9.5.7.3.1 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 6.3.6). 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 7.68.2) logical blocks should not be counted.

9.5.7.3.2 Update Interval

One hour

9.5.7.3.3 Measurement Units

Events

9.5.7.3.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.7.4 Number of Resets Between Command Acceptance and Command Completion

9.5.7.4.1 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 while 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.

9.5.7.4.2 Update Interval

One hour

9.5.7.4.3 Measurement Units

Events

9.5.7.4.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.7.5 Physical Element Status Changed

9.5.7.5.1 Description

The PHYSICAL ELEMENT STATUS CHANGED field is a counter that is incremented by one each time the physical element status of one or more physical elements changes from less than or equal to 64h (i.e., either not specified or at or within manufacturer's specification limit) to greater than 64h and less than or equal to CFh (i.e., outside manufacturer's specification limit).

9.5.7.5.2 Update Interval

When the value is changed.

9.5.7.5.3 Measurement Units

Events

9.5.7.5.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.8 Rotating Media Statistics (log page 03h)

9.5.8.1 Overview

The Rotating Media Statics log page contains device rotating media information as described in table 236.

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;
h) Number of Reallocation Candidate Logical Sectors; and
i) Number of High Priority Unload Events.

Table 236 — 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 field - shall be set to 03h
		15:0	REVISION NUMBER field (Word) - shall be set to 0001h
8..15	QWord	Spindle Motor Power-on Hours (see 9.5.8.3)	
		Bit	**Description**
		63:56	DEVICE STATISTICS FLAGS field (see table 224)
		55:32	Reserved
		31:0	Spindle Motor Power-on Hours (DWord)
16..23	QWord	Head Flying Hours (see 9.5.8.4)	
		Bit	**Description**
		63:56	DEVICE STATISTICS FLAGS field (see table 224)
		55:32	Reserved
		31:0	Head Flying Hours (DWord)
24..31	QWord	Head Load Events (see 9.5.8.5)	
		Bit	**Description**
		63:56	DEVICE STATISTICS FLAGS field (see table 224)
		55:32	Reserved
		31:0	Head Load Events (DWord)
32..39	QWord	Number of Reallocated Logical Sectors (see 9.5.8.6)	
		Bit	**Description**
		63:56	DEVICE STATISTICS FLAGS field (see table 224)
		55:32	Reserved
		31:0	Number of Reallocated Logical Sectors (DWord)

Table 236 — Rotating Media Statistics (Sheet 2 of 2)

Offset	Type	Description
40..47	QWord	Read Recovery Attempts (see 9.5.8.7) **Bit** **Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 Read Recovery Attempts (DWord)
48..55	QWord	Number of Mechanical Start Failures (see 9.5.8.8) **Bit** **Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 Number of Mechanical Start Failures (DWord)
56..63	QWord	Number of Reallocation Candidate Logical Sectors (see 9.5.8.9) **Bit** **Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 Number of Reallocation Candidate Logical Sectors (DWord)
64..71	QWord	Number of High Priority Unload Events (see 9.5.8.10) **Bit** **Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 Number of High Priority Unload Events (DWord)
72..511	Byte	Reserved

9.5.8.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table 236) for this log page.

9.5.8.3 Spindle Motor Power-on Hours

9.5.8.3.1 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.

9.5.8.3.2 Update Interval

One hour

9.5.8.3.3 Measurement Units

Hours

9.5.8.3.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.8.4 Head Flying Hours

9.5.8.4.1 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.

9.5.8.4.2 Update Interval

One hour

9.5.8.4.3 Measurement Units

Hours

9.5.8.4.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.8.5 Head Load Events

9.5.8.5.1 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.

9.5.8.5.2 Update Interval

One hour

9.5.8.5.3 Measurement Units

Events

9.5.8.5.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.8.6 Number of Reallocated Logical Sectors

9.5.8.6.1 Description

The Number of Reallocated Logical Sectors statistic indicates the number of logical sectors that have been reallocated after device manufacture.

If the NORMALIZED STATISTIC bit (see table 224) is:

a) cleared to zero, then this statistic:
    A) is a counter that records the number of logical sectors that have been reallocated after device manufacture; and
    B) shall be incremented by one for each reallocated logical sector;

    or
b) set to one, then this statistic is the whole number percentage of the available logical sector reallocation resources that have been used (i.e., 0..100).

9.5.8.6.2 Update Interval

One hour

9.5.8.6.3 Measurement Units

if the NORMALIZED STATISTIC bit (see table 224) is:

a) cleared to zero, this statistic is measured in logical sectors; and

b) set to one, this statistic is a percentage (see 9.5.8.6.1).

9.5.8.6.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.8.7 Read Recovery Attempts

9.5.8.7.1 Description

Read Recovery Attempts is a counter that records the number of logical sectors that have required 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.

If that logical sector is in the same physical sector as one or more other logical sectors, then:

a) the counter shall be incremented by one for every logical sector in that physical sector; and
b) the counter shall not be incremented for any other logical sector in that physical sector that are read by the same read command.

These events may be caused by external environmental conditions (e.g., operating in a moving vehicle).

EXAMPLE 1 - If there are eight logical sectors in a physical sector and a read command encounters a read recovery attempt for two logical sectors in the same physical sector, then this statistic is incremented by eight.

EXAMPLE 2 - If there are eight logical sectors in a physical sector and a read command encounters a read recovery attempt for two logical sectors each in a different physical sector, then this statistic is incremented by sixteen.

9.5.8.7.2 Update Interval

One hour

9.5.8.7.3 Measurement Units

Events

9.5.8.7.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.8.8 Number of Mechanical Start Failures

9.5.8.8.1 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.

9.5.8.8.2 Update Interval

One hour

9.5.8.8.3 Measurement Units

Events

9.5.8.8.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.8.9 Number of Reallocation Candidate Logical Sectors

9.5.8.9.1 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 7.68) shall be considered reallocation candidates. Logical sectors marked as flagged uncorrectable (see 7.68) should not be considered reallocation candidates.

9.5.8.9.2 Update Interval

One hour

9.5.8.9.3 Measurement Units

Logical sectors

9.5.8.9.4 Initialization

This statistic shall be initialized to zero at the time of manufacture.

9.5.8.10 Number of High Priority Unload Events

9.5.8.10.1 Description

The Number of High Priority Load Events statistic is a value that records the number of emergency head unload events. An emergency head unload 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,

in response to one of the following events:

a) processing an IDLE IMMEDIATE command with the unload feature (see 7.15.4);
b) unexpected power loss;
c) device initiated self-protection (e.g., Free-fall Control feature set (see 4.10)); or
d) other notification from the host (e.g. SATA pin P11, SATA Direct Head Unload (see SATA 3.5)).

This statistic is incremented by one each time an high priority head unload event occurs.

9.5.8.10.2 Update Interval

One hour

9.5.8.10.3 Measurement Units

Events

9.5.8.10.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.9 Solid State Device Statistics (log page 07h)

9.5.9.1 Overview

The Solid State Device Statistics log page contains solid state device information about the device as described in table 237.

The Solid State Device Statistics are as follows:

a) Device Statistics Information Header; and
b) Percentage Used Endurance Indicator.

Table 237 — Solid State Device Statistics

Offset	Type	Description
0..7	QWord	Device Statistics Information Header
		Bit **Description**
		63:24 Reserved
		23:16 LOG PAGE NUMBER field - shall be set to 07h
		15:0 REVISION NUMBER field (Word) - shall be set to 0001h
8..15	QWord	Percentage Used Endurance Indicator (see 9.5.9.3)
		Bit **Description**
		63:56 DEVICE STATISTICS FLAGS field (see table 224)
		55:8 Reserved
		7:0 Percentage Used Endurance Indicator (Byte)
16..511	Byte	Reserved

9.5.9.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table 237) for this log page.

9.5.9.3 Percentage Used Endurance Indicator

9.5.9.3.1 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 does 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.

9.5.9.3.2 Update Interval

One hour

9.5.9.3.3 Measurement Units

See 9.5.9.3.1

9.5.9.3.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.10 Temperature Statistics (log page 05h)

9.5.10.1 Overview

The Temperature Statistics log page contains general information about the device as described in table 238. The value in each temperature statistic is a two's complement integer in degrees Celsius.

The Temperature Statistics are as follows:

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 238 — 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 field - shall be set to 05h
		15:0	REVISION NUMBER field (Word) - shall be set to 0001h
8..15	QWord	Current Temperature (see 9.5.10.3)	
		Bit	**Description**
		63:56	DEVICE STATISTICS FLAGS field (see table 224)
		55:8	Reserved
		7:0	Current Temperature (signed byte)
16..23	QWord	Average Short Term Temperature (see 9.5.10.4)	
		Bit	**Description**
		63:56	DEVICE STATISTICS FLAGS field (see table 224)
		55:8	Reserved
		7:0	Average Short Term Temperature (signed byte)
24..31	QWord	Average Long Term Temperature (see 9.5.10.5)	
		Bit	**Description**
		63:56	DEVICE STATISTICS FLAGS field (see table 224)
		55:8	Reserved
		7:0	Average Long Term Temperature (signed byte)
32..39	QWord	Highest Temperature (see 9.5.10.6)	
		Bit	**Description**
		63:56	DEVICE STATISTICS FLAGS field (see table 224)
		55:8	Reserved
		7:0	Highest Temperature (signed byte)

Table 238 — Temperature Statistics (Sheet 2 of 3)

Offset	Type	Description
40..47	QWord	Lowest Temperature (see 9.5.10.7) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:8 Reserved 7:0 Lowest Temperature (signed byte)
48..55	QWord	Highest Average Short Term Temperature (see 9.5.10.8) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:8 Reserved 7:0 Highest Average Short Term Temperature (signed byte)
56..63	QWord	Lowest Average Short Term Temperature (see 9.5.10.9) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:8 Reserved 7:0 Lowest Average Short Term Temperature (signed byte)
64..71	QWord	Highest Average Long Term Temperature (see 9.5.10.10) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:8 Reserved 7:0 Highest Average Long Term Temperature (signed byte)
72..79	QWord	Lowest Average Long Term Temperature (see 9.5.10.11) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:8 Reserved 7:0 Lowest Average Long Term Temperature (signed byte)
80..87	QWord	Time in Over-Temperature (see 9.5.10.12) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 Time in Over-Temperature (DWord)
88..95	QWord	Specified Maximum Operating Temperature (see 9.5.10.13) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:8 Reserved 7:0 Specified Maximum Operating Temperature (signed byte)

Table 238 — Temperature Statistics (Sheet 3 of 3)

Offset	Type	Description
96..103	QWord	Time in Under-Temperature (see 9.5.10.14) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 Time in Under-Temperature (DWord)
104..111	QWord	Specified Minimum Operating Temperature (see 9.5.10.15) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:8 Reserved 7:0 Specified Minimum Operating Temperature (signed byte)
112..511	Byte	Reserved

9.5.10.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table 238) for this log page.

9.5.10.3 Current Temperature

9.5.10.3.1 Description

The Current Temperature statistic is the temperature measured by the device at the time this log page is read.

9.5.10.3.2 Update Interval

This statistic is not saved to non-volatile storage.

9.5.10.3.3 Measurement Units

Degrees Celsius

9.5.10.3.4 Initialization

None

9.5.10.4 Average Short Term Temperature

9.5.10.4.1 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 most recent 144 Average Short Term Temperature FIFO entries.

9.5.10.4.2 Update Interval

One hour

9.5.10.4.3 Measurement Units

Degrees Celsius

9.5.10.4.4 Initialization

This statistic is not initialized at the time of manufacture. The VALID VALUE bit (see table 224) shall not be set to one and the data in bits 7:0 are not valid until after the device collects 144 temperature samples.

9.5.10.5 Average Long Term Temperature

9.5.10.5.1 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 most recent 42 Average Long Term Temperature FIFO entries.

9.5.10.5.2 Update Interval

One hour

9.5.10.5.3 Measurement Units

Degrees Celsius

9.5.10.5.4 Initialization

This statistic is not initialized at the time of manufacture. The VALID VALUE bit (see table 224) 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.

9.5.10.6 Highest Temperature

9.5.10.6.1 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.

9.5.10.6.2 Update Interval

One hour

9.5.10.6.3 Measurement Units

Degrees Celsius

9.5.10.6.4 Initialization

This statistic is not initialized at the time of manufacture. The VALID VALUE bit (see table 224) 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.

9.5.10.7 Lowest Temperature

9.5.10.7.1 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.

9.5.10.7.2 Update Interval

One hour

9.5.10.7.3 Measurement Units

Degrees Celsius

9.5.10.7.4 Initialization

This statistic is not initialized at the time of manufacture. The VALID VALUE bit (see table 224) 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.

9.5.10.8 Highest Average Short Term Temperature

9.5.10.8.1 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.

9.5.10.8.2 Update Interval

One hour

9.5.10.8.3 Measurement Units

Degrees Celsius

9.5.10.8.4 Initialization

This statistic is not initialized at the time of manufacture. The VALID VALUE bit (see table 224) shall not be set to one and the data in bits 7:0 are not valid until after the device collects 144 temperature samples.

9.5.10.9 Lowest Average Short Term Temperature

9.5.10.9.1 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.

9.5.10.9.2 Update Interval

One hour

9.5.10.9.3 Measurement Units

Degrees Celsius

9.5.10.9.4 Initialization

This statistic is not initialized at the time of manufacture. The VALID VALUE bit (see table 224) shall not be set to one and the data in bits 7:0 are not valid until after the device collects 144 temperature samples.

9.5.10.10 Highest Average Long Term Temperature

9.5.10.10.1 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.

9.5.10.10.2 Update Interval

One hour

9.5.10.10.3 Measurement Units

Degrees Celsius

9.5.10.10.4 Initialization

This statistic is not initialized at the time of manufacture. The VALID VALUE bit (see table 224) 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.

9.5.10.11 Lowest Average Long Term Temperature

9.5.10.11.1 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.

9.5.10.11.2 Update Interval

One hour

9.5.10.11.3 Measurement Units

Degrees Celsius

9.5.10.11.4 Initialization

This statistic is not initialized at the time of manufacture. The VALID VALUE bit (see table 224) 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.

9.5.10.12 Time in Over-Temperature

9.5.10.12.1 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 9.5.10.13) 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.

9.5.10.12.2 Update Interval

One hour

9.5.10.12.3 Measurement Units

Minutes

9.5.10.12.4 Initialization

This statistic shall be initialized to zero at the time of manufacture.

9.5.10.13 Specified Maximum Operating Temperature

9.5.10.13.1 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.

9.5.10.13.2 Update Interval

This statistic is not saved to non-volatile storage.

9.5.10.13.3 Measurement Units

Degrees Celsius

9.5.10.13.4 Initialization

This value shall be set at the time of manufacture.

9.5.10.14 Time in Under-Temperature

9.5.10.14.1 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 9.5.10.15) 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.

9.5.10.14.2 Update Interval

One hour

9.5.10.14.3 Measurement Units

Minutes

9.5.10.14.4 Initialization

This statistic shall be initialized to zero at the time of manufacture.

9.5.10.15 Specified Minimum Operating Temperature

9.5.10.15.1 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.

9.5.10.15.2 Update Interval

This statistic is not saved to non-volatile storage.

9.5.10.15.3 Measurement Units

Degrees Celsius

9.5.10.15.4 Initialization

This value shall be set at the time of manufacture.

9.5.11 Transport Statistics (log page 06h)

9.5.11.1 Overview

The Transport Statistics log page contains interface transport information about the device as described in table 239.

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 239 — Transport Statistics

Offset	Type	Description
0..7	QWord	Device Statistics Information Header **Bit Description** 63:24 Reserved 23:16 LOG PAGE NUMBER field - shall be set to 06h 15:0 REVISION NUMBER field (Word) - shall be set to 0001h
8..15	QWord	Number of hardware resets (see 9.5.11.3) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 Number of hardware resets (DWord)
16..23	QWord	Number of ASR Events (see 9.5.11.4) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 Number of ASR Events (DWord)
24..31	QWord	Number of Interface CRC Errors (see 9.5.11.5) **Bit Description** 63:56 DEVICE STATISTICS FLAGS field (see table 224) 55:32 Reserved 31:0 Number of Interface CRC Errors (DWord)
32..511	Byte	Reserved

9.5.11.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table 239) for this log page.

9.5.11.3 Number of hardware resets

9.5.11.3.1 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 4.25) is enabled or not.

9.5.11.3.2 Update Interval

Ten minutes

9.5.11.3.3 Measurement Units

Events

9.5.11.3.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.11.4 Number of ASR Events

9.5.11.4.1 Description

The Number of ASR Events statistic is a counter that records the number of ASR events (see SATA 3.5). This statistic is incremented by one for each ASR event detected.

9.5.11.4.2 Update Interval

Ten minutes

9.5.11.4.3 Measurement Units

Events

9.5.11.4.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.11.5 Number of Interface CRC Errors

9.5.11.5.1 Description

The Number of Interface CRC Errors statistic is a counter that records the number of Interface CRC errors (see 6.3.5) 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.

9.5.11.5.2 Update Interval

Ten minutes

9.5.11.5.3 Measurement Units

Events

9.5.11.5.4 Initialization

This statistic shall be cleared to zero at the time of manufacture.

9.5.12 Vendor Specific Statistics (log page FFh)

9.5.12.1 Overview

The Vendor Specific Statistics log page (see table 240) contains up to 63 vendor specific device statistic values for which the DEVICE STATISTIC SUPPORTED bit is set to one (see table 224) and the VALUE VALID bit is set to one (see table 224).

Table 240 — Vendor Specific 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 field - shall be set to FFh
		15:0 REVISION NUMBER field (Word) - shall be set to 0001h

Table 240 — Vendor Specific Statistics (Sheet 2 of 2)

Offset	Type	Description
8..15	QWord	Vendor Specific device statistic 1
		Bit Description
		63:56 DEVICE STATISTICS FLAGS field (see table 224)
		55:48 Reserved
		47:0 VENDOR SPECIFIC VALUE field 1 (see 9.5.12.3)
16..23	QWord	Vendor Specific device statistic 2
		Bit Description
		63:56 DEVICE STATISTICS FLAGS field (see table 224)
		55:48 Reserved
		47:0 VENDOR SPECIFIC VALUE field 2 (see 9.5.12.3)
24..31	QWord	Vendor Specific device statistic 3
		Bit Description
		63:56 DEVICE STATISTICS FLAGS field (see table 224)
		55:48 Reserved
		47:0 VENDOR SPECIFIC VALUE field 3 (see 9.5.12.3)
…	…	…
504..511	QWord	Vendor Specific device statistic 63
		Bit Description
		63:56 DEVICE STATISTICS FLAGS field (see table 224)
		55:48 Reserved
		47:0 VENDOR SPECIFIC VALUE field 63 (see 9.5.12.3)

9.5.12.2 Device Statistics Information Header

Device Statistics Information Header indicates the format of the structure (see table 239) for this log page.

9.5.12.3 Vendor Specific device statistic

9.5.12.3.1 Description

Each supported Vendor Specific device statistic for which the VALUE VALID bit is set to one (see table 224) contains a 48-bit vendor specific value in the VENDOR SPECIFIC VALUE field.

9.5.12.3.2 Update Interval

The information in this statistic is not saved in non-volatile storage on any time interval defined in this standard.

9.5.12.3.3 Measurement Units

This statistic is measured in vendor specific units.

9.5.12.3.4 Initialization

At the time of manufacturer, the value of this statistic is vendor specific.

9.6 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.

9.7 Extended Comprehensive SMART Error log (Log Address 03h)

9.7.1 Overview

Table 241 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 6.3.6), ID Not Found errors (see 6.3.4) 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).

All 28-bit entries contained in the Comprehensive SMART log (see 9.4), shall also be included in the Extended Comprehensive SMART Error log with the 48-bit entries.

Table 241 — 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.

9.7.2 SMART error log version

The value of the SMART error log version byte shall be 01h.

9.7.3 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.

9.7.4 Extended Error log data structure

9.7.4.1 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 242.

Table 242 — 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

9.7.4.2 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 243. 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 243 — 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.

9.7.4.3 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 244. 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 244.

Table 244 — 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 245.

Table 245 — 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.

9.7.5 Device error count

The Device error count word 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 6.3.6), ID Not Found errors (see 6.3.4) 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). If the maximum value for this field is reached, then the count shall remain at the maximum value if additional errors are encountered and logged.

9.7.6 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.

9.8 Power Conditions log (Log Address 08h)

9.8.1 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 4.9) is not supported, then the Power Conditions log shall not be supported.

The Power Conditions log is non-volatile.

9.8.2 Idle power conditions (log page 00h)

Table 246 defines log page 00h of the Power Conditions log. The format of each Idle power condition descriptor is shown in table 248.

Table 246 — Idle Power Conditions log page

Offset	Type	Description
0..63	Byte	Idle_a power conditions descriptor (see table 248). 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 248).
128..191	Byte	Idle_c power conditions descriptor (see table 248).
192..511		Reserved

9.8.3 Standby power conditions (log page 01h)

Table 247 defines log page 01h of the Power Conditions log. The format of each Standby power condition descriptor is shown in table 248.

Table 247 — Standby Power Conditions log page

Offset	Type	Description
0..383		Reserved
384..447	Byte	Standby_y power condition descriptor (see table 248).
448..511	Byte	Standby_z power condition descriptor (see table 248).

9.8.4 Power Conditions log descriptor

9.8.4.1 Power Conditions log descriptor overview

Table 248 defines the Power Conditions log descriptor. Each power condition has a separate descriptor.

Table 248 — Power Conditions log descriptor

Offset	Type	Description
0	Byte	Reserved
1	Byte	Power Condition Flags **Bit Description** 7 POWER CONDITION SUPPORTED bit (see 9.8.4.2) 6 POWER CONDITION SAVEABLE bit (see 9.8.4.3) 5 POWER CONDITION CHANGEABLE bit (see 9.8.4.4) 4 DEFAULT TIMER ENABLED bit (see 9.8.4.5) 3 SAVED TIMER ENABLED bit (see 9.8.4.6) 2 CURRENT TIMER ENABLED bit (see 9.8.4.7) 1 HOLD POWER CONDITION NOT SUPPORTED bit (see 9.8.4.8) 0 Reserved
2..3	Bytes	Reserved
4..7	DWord	DEFAULT TIMER SETTING field (see 9.8.4.9)
8..11	DWord	SAVED TIMER SETTING field (see 9.8.4.10)
12..15	DWord	CURRENT TIMER SETTING field (see 9.8.4.11)
16..19	DWord	NOMINAL RECOVERY TIME TO PM0:ACTIVE field (see 9.8.4.12)
20..23	DWord	MINIMUM TIMER SETTING field (see 9.8.4.13)
24..27	DWord	MAXIMUM TIMER SETTING field (see 9.8.4.14)
28..31	DWord	NUMBER OF TRANSITIONS TO POWER CONDITION field (see 9.8.4.15)
32..35	DWord	POWER ON HOURS IN POWER CONDITION field (see 9.8.4.16)
36..63	Bytes	Reserved

9.8.4.2 POWER CONDITION SUPPORTED bit

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.

9.8.4.3 POWER CONDITION SAVEABLE bit

The POWER CONDITION SAVEABLE bit is valid if the POWER CONDITION SUPPORTED bit (see 9.8.4.2) is set to one, regardless of whether EPC is enabled or disabled.

If the POWER CONDITION SAVEABLE bit is set to one, then the power condition is saveable if EPC is enabled. If the POWER CONDITION SAVEABLE bit is cleared to zero, then the power condition is not saveable.

9.8.4.4 POWER CONDITION CHANGEABLE bit

The POWER CONDITION CHANGEABLE bit is valid if the POWER CONDITION SUPPORTED bit (see 9.8.4.2) is set to one, regardless of whether EPC is enabled or disabled.

If the POWER CONDITION CHANGEABLE bit is set to one, then the power condition is changeable if EPC is enabled. If the POWER CONDITION CHANGEABLE bit is cleared to zero, then the power condition is not changeable

9.8.4.5 DEFAULT TIMER ENABLED bit

The DEFAULT TIMER ENABLED bit is set at the time of manufacture. The DEFAULT TIMER ENABLED bit may be copied to the CURRENT TIMER ENABLED bit (see 9.8.4.7) during the processing of a SET FEATURES command with:

a) the Set Power Condition Timer subcommand (see 7.45.20.4); or
b) the Restore Power Condition Settings subcommand (see 7.45.20.2).

The DEFAULT TIMER ENABLED bit is valid if the POWER CONDITION SUPPORTED bit (see 9.8.4.2) is set to one, regardless of whether EPC is enabled or disabled.

9.8.4.6 SAVED TIMER ENABLED bit

The SAVED TIMER ENABLED bit may be set to the value in the CURRENT TIMER ENABLED bit (see 9.8.4.7) during the processing of a SET FEATURES command with:

a) the Set Power Condition Timer subcommand (see 7.45.20.4); or
b) the Restore Power Condition Settings subcommand (see 7.45.20.2).

The SAVED TIMER ENABLED bit:

a) is copied to the CURRENT TIMER ENABLED bit during the processing of a power-on reset (see 4.9.4); and
b) may be copied to the CURRENT TIMER ENABLED bit during the processing of a SET FEATURES command with:
   A) the Set Power Condition Timer subcommand (see 7.45.20.4); or
   B) the Restore Power Condition Settings subcommand (see 7.45.20.2).

The SAVED TIMER ENABLED bit is valid if the POWER CONDITION SUPPORTED bit (see 9.8.4.2) is set to one, regardless of whether EPC is enabled or disabled.

9.8.4.7 CURRENT TIMER ENABLED bit

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 (see 9.8.4.11) is nonzero 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.

9.8.4.8 HOLD POWER CONDITION NOT SUPPORTED bit

The HOLD POWER CONDITION NOT SUPPORTED bit is valid if the POWER CONDITION SUPPORTED bit (see 9.8.4.2) is set to one and the LOW POWER STANDBY SUPPORTED bit (see 9.10.5.2.36) is set to one, whether EPC is enabled or disabled.

If the HOLD POWER CONDITION NOT SUPPORTED bit is valid and cleared to zero, then the device supports the Hold Power Condition parameter of the EPC Go To Power Condition subcommand (see 7.45.20.3) for this power condition.

If the HOLD POWER CONDITION NOT SUPPORTED bit is valid and set to one, then the device does not support the Hold Power Condition parameter of the EPC Go To Power Condition subcommand for this power condition.

9.8.4.9 DEFAULT TIMER SETTING field

The DEFAULT TIMER SETTING field is set at the time of manufacture. The DEFAULT TIMER SETTING field may be copied to the CURRENT TIMER SETTING field during the processing of a SET FEATURES command with:

a) the Set Power Condition Timer subcommand (see 7.45.20.4); or
b) the Restore Power Condition Settings subcommand (see 7.45.20.2).

The DEFAULT TIMER SETTING field is valid if the POWER CONDITION SUPPORTED bit (see 9.8.4.2) 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 ms.

Measurement Units: 100 ms.

9.8.4.10 SAVED TIMER SETTING field

The SAVED TIMER SETTING field has may be set to the value in the CURRENT TIMER SETTING field (see 9.8.4.11) during the processing of a SET FEATURES command with:

a) the Set Power Condition Timer subcommand (see 7.45.20.4); or
b) the Restore Power Condition Settings subcommand (see 7.45.20.2).

The SAVED TIMER SETTING field:

a) is copied to the CURRENT TIMER SETTING field during the processing of a power-on reset (see 4.9.4); and
b) may be copied to the CURRENT TIMER SETTING field during the processing of a SET FEATURES command with:
   A) the Set Power Condition Timer subcommand (see 7.45.20.4); or
   B) the Restore Power Condition Settings subcommand (see 7.45.20.2).

The SAVED TIMER SETTING field is valid if the POWER CONDITION SUPPORTED bit (see 9.8.4.2) 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 ms.

Measurement Units: 100 ms.

9.8.4.11 CURRENT TIMER SETTING field

The CURRENT TIMER SETTING field contains 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 (see 9.8.4.2) is cleared to zero; or
c) the CURRENT TIMER ENABLED bit (see 9.8.4.7) is cleared to zero.

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 ms.

Measurement Units: 100 ms.

9.8.4.12 NOMINAL RECOVERY TIME TO PM0:ACTIVE field

The NOMINAL RECOVERY TIME TO PM0:ACTIVE field contains the nominal time required to transition from this power condition to PM0:Active state (see 4.17.4) 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 (see 9.8.4.2) 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 ms.

This value shall be preserved over all resets.

Measurement Units: 100 ms.

9.8.4.13 MINIMUM TIMER SETTING field

The MINIMUM TIMER SETTING field contains the minimum timer value allowed by the Set Power Condition Timer subcommand (see 7.45.20.4) for this power condition if the EPC feature set is enabled.

The MINIMUM TIMER SETTING field is valid if the POWER CONDITION SUPPORTED bit (see 9.8.4.2) is set to one, regardless of whether EPC is enabled or disabled.

A value of zero indicates that the minimum timer setting is not specified. A value of FFFF_FFFFh indicates that the minimum time is greater than or equal to 429 496 729 500 ms.

This value shall be preserved over all resets.

Measurement Units: 100 ms.

9.8.4.14 MAXIMUM TIMER SETTING field

The MAXIMUM TIMER SETTING field contains the maximum timer value allowed by the Set Power Condition Timer subcommand (see 7.45.20.4) for this power condition if the EPC feature set is enabled.

The MAXIMUM TIMER SETTING field is valid if the POWER CONDITION SUPPORTED bit (see 9.8.4.2) is set to one, regardless of whether EPC is enabled or disabled.

A value of zero indicates that the maximum timer setting is not specified. A value of FFFF_FFFFh indicates that the maximum time is greater than or equal to 429 496 729 500 ms.

This value shall be preserved over all resets.

Measurement Units: 100 ms.

9.8.4.15 NUMBER OF TRANSITIONS TO POWER CONDITION field

The NUMBER OF TRANSITIONS TO POWER CONDITION field contains the number of times that the device has transitioned to this power condition since the time of manufacture.

A value of zero in the NUMBER OF TRANSITIONS TO POWER CONDITION field may indicate that the device does not support counting the number of times the device has transitioned to this power condition.

If the number of times the device has transitioned to this power condition is greater than FFFF_FFFEh, the NUMBER OF TRANSITIONS TO POWER CONDITION field shall be set to FFFF_FFFFh.

9.8.4.16 POWER ON HOURS IN POWER CONDITION field

The POWER ON HOURS IN POWER CONDITION field contains the amount of time in hours that the device has been operational in this power condition since the device was manufactured.

This value is incremented in a volatile location with a resolution of one minute or less. While the device is in the PM0: Active state, the volatile value is accumulated into a non-volatile location at least once per hour.

A value of zero in the POWER ON HOURS IN POWER CONDITION field may indicate that the device does not record the amount of time that the device has been operational in this power condition.

9.9 Host Specific logs (Log Addresses 80h-9Fh)

The Host Specific logs are mandatory for ATA devices and 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.

9.10 IDENTIFY DEVICE data log (Log Address 30h)

9.10.1 Overview

The IDENTIFY DEVICE data log is mandatory for ATA devices and reports device configuration information. This log shall be read-only. See table 249 for a list of defined IDENTIFY DEVICE data log pages. Each page shall consist of a header field that may be followed by defined data fields. If the Revision Number field in the page header is 0000h, then that page is not supported.

If an unsupported page is requested, then 512 bytes of all zeros shall be returned for that page.

Table 249 — Defined IDENTIFY DEVICE data log pages

Page	Description	Required
00h	List of supported pages (see 9.10.2)	M
01h	Copy of IDENTIFY DEVICE data (see 7.13.6)	M
02h	Capacity (see 9.10.4)	M
03h	Supported Capabilities (see 9.10.5)	M
04h	Current Settings (see 9.10.6)	M
05h	ATA Strings (see 9.10.7)	M
06h	Security (see 9.10.8)	M
07h	Parallel ATA (see 9.10.9)	P
08h	Serial ATA (see 9.10.10)	S
09h	Reserved for ZAC-2	see ZAC-2
0Ah..FFh	Reserved	
Key: M – Mandatory for all devices O – Optional for all devices S – Mandatory for SATA P – Mandatory for PATA		

9.10.2 List of Supported IDENTIFY DEVICE data log pages (Page 00h)

IDENTIFY DEVICE data log page 00h (see table 250) contains a list of which IDENTIFY DEVICE data log pages (see table 249) are supported by the device. Entries shall be in order of ascending page number (e.g., the following entries are returned by a Serial ATA device: 00h, 01h, 02h, 03h, 04h, 05h, 06h, and 08h).

Table 250 — List of supported IDENTIFY DEVICE data log 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 **Description**
		63:24 Reserved
		23:16 PAGE NUMBER field – shall be set to 00h
		15:0 REVISION NUMBER field (Word) - shall be set to 0001h
8	Byte	Number of entries (n) in the following list
9	Byte	Log page number of the first supported IDENTIFY DEVICE data log page
10	Byte	Log page number of the second supported IDENTIFY DEVICE data log page
11	Byte	Log page number of the third supported IDENTIFY DEVICE data log page
		…
n+8	Byte	Log page number of the nth supported IDENTIFY DEVICE data log page
n+9..511		Reserved

9.10.3 Copy of IDENTIFY DEVICE data (page 01h)

This page is a copy of IDENTIFY DEVICE data words 0..255.

This page does not have the header QWord which is present on all the other pages in this log.

9.10.4 Capacity (page 02)

9.10.4.1 Overview

The Capacity log page (see table 251) provides information about the capacity of the device.

Table 251 — Capacity

Offset	Type	Content
0..7	QWord	Capacity page information header
		Bit **Description**
		63 Shall be set to one
		62:24 Reserved
		23:16 PAGE NUMBER field – shall be set to 02h
		15:0 REVISION NUMBER field (Word) – shall be set to 0001h
8..15	QWord	Device Capacity
		Bit **Description**
		63 Shall be set to one
		62:48 Reserved
		47:0 ACCESSIBLE CAPACITY field (see 9.10.4.2)
16..23	QWord	Physical/Logical Sector Size (see 9.10.4.3)
		Bit **Description**
		63 Contents of the QWord are valid
		62 LOGICAL TO PHYSICAL SECTOR RELATIONSHIP SUPPORTED bit (see 9.10.4.3.1)
		61 LOGICAL SECTOR SIZE SUPPORTED bit (see 9.10.4.3.2)
		60:22 Reserved
		21:20 ALIGNMENT ERROR REPORTING field (see 9.10.4.3.3)
		19:16 LOGICAL TO PHYSICAL SECTOR RELATIONSHIP field (see 9.10.4.3.4)
		15:0 LOGICAL SECTOR OFFSET field (see 9.10.4.3.5)
24..31	QWord	Logical Sector Size
		Bit **Description**
		63 Contents of the QWord are valid
		62..32 Reserved
		31..0 LOGICAL SECTOR SIZE field (see 9.10.4.4)
32..39	QWord	Nominal Buffer Size
		63 Contents of the QWord are valid
		62:0 BUFFER SIZE field (see 9.10.4.5)
40..511		Reserved

9.10.4.2 ACCESSIBLE CAPACITY field

The ACCESSIBLE CAPACITY field (see table 251) 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 the ACCESSIBLE CAPACITY field is FFFF_FFFF_FFFFh. The contents of the ACCESSIBLE CAPACITY field may be affected by commands in the Accessible Max Address Configuration feature set (see 4.4) and the Storage Element Depopulation feature set (see 4.26).

9.10.4.3 Physical/Logical Sector Size

9.10.4.3.1 Device has multiple logical sectors per physical sector (LOGICAL TO PHYSICAL SECTOR RELATIONSHIP SUPPORTED bit)

If the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP SUPPORTED bit (see table 251) is set to one, then:

a) the device has more than one logical sector per physical sector; and
b) the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP field (see 9.10.4.3.4) is valid.

See 9.10.4.3.5 for information on the alignment of logical sectors within a physical sector.

If the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP SUPPORTED bit is cleared to zero, then

a) the device has only one logical sector per physical sector; and
b) the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP field is invalid.

The IDENTIFY DEVICE data contains a copy of the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP SUPPORTED bit (see IDENTIFY DEVICE data word 106 in table 57).

9.10.4.3.2 Device has a logical sector size greater than 256 words (LOGICAL SECTOR SIZE SUPPORTED bit)

If the LOGICAL SECTOR SIZE SUPPORTED bit (see table 251) is set to one, then

a) the device has been formatted with a logical sector size larger than 256 words; and
b) the LOGICAL SECTOR SIZE field (see 9.10.4.4) is valid.

If the LOGICAL SECTOR SIZE SUPPORTED bit is cleared to zero, then

a) the logical sector size is 256 words; and
b) the LOGICAL SECTOR SIZE field is invalid.

The IDENTIFY DEVICE data contains a copy of the LOGICAL SECTOR SIZE SUPPORTED bit (see IDENTIFY DEVICE data word 106 in table 57).

9.10.4.3.3 Alignment Error reporting (ALIGNMENT ERROR REPORTING field)

If the LPS MISALIGNMENT REPORTING SUPPORTED bit (see 9.10.5.2.3) is set to one (i.e., if Long Physical Sector Alignment Error Reporting Control is supported), then the ALIGNMENT ERROR REPORTING field (see table 251) indicates the current Long Physical Sector Alignment Error Reporting setting as follows:

a) 00b indicates that Long Physical Sector Alignment Error reporting is disabled;
b) 01b indicates that Long Physical Sector Alignment Error reporting is enabled;
c) 10b indicates that the device shall report command aborted if an Alignment Error occurs; and
d) 11b is reserved.

The Long Physical Sector Alignment Error Reporting Control subcommand of the SET FEATURES command (see 7.45.19) is the method for changing the ALIGNMENT ERROR REPORTING field.

The IDENTIFY DEVICE data contains a copy of the ALIGNMENT ERROR REPORTING field (see IDENTIFY DEVICE data word 49 in table 57).

9.10.4.3.4 2^x logical sectors per physical sectors (LOGICAL TO PHYSICAL SECTOR RELATIONSHIP field)

The LOGICAL TO PHYSICAL SECTOR RELATIONSHIP field (see table 251) indicates the size of the device physical sectors in power of two logical sectors.

EXAMPLE 1 - Bits 3:0: 0 means 2^0 means 1 logical sector per physical sector

EXAMPLE 2 - Bits 3:0: 1 means 2^1 means 2 logical sectors per physical sector

EXAMPLE 3 - Bits 3:0: 2 means 2^2 means 4 logical sectors per physical sector

EXAMPLE 4 - Bits 3:0: 3 means 2^3 means 8 logical sectors per physical sector

The IDENTIFY DEVICE data contains a copy of the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP field (see IDENTIFY DEVICE data word 106 in table 57).

9.10.4.3.5 Logical sector offset within the first physical sector where the first logical sector is placed (LOGICAL SECTOR OFFSET field)

The LOGICAL SECTOR OFFSET field (see table 251) indicates the number of unused logical sectors that precede logical sector zero in the first physical sector of the media. An example of how to use the LOGICAL SECTOR OFFSET field is shown in C.3.2.

The IDENTIFY DEVICE data contains a copy of the LOGICAL SECTOR OFFSET field (see IDENTIFY DEVICE data word 209 in table 57).

9.10.4.4 Logical Sector Size (LOGICAL SECTOR SIZE field)

The LOGICAL SECTOR SIZE field (see table 251) indicates the size of device's logical sectors in words. If the LOGICAL SECTOR SIZE SUPPORTED bit (see 9.10.4.3.2) is set to one, then:

a) the value in the LOGICAL SECTOR SIZE field shall be greater than or equal to 256; and
b) all logical sectors on a device shall be the length indicated by the LOGICAL SECTOR SIZE field.

If the LOGICAL SECTOR SIZE SUPPORTED bit is cleared to zero, the LOGICAL SECTOR SIZE field shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the LOGICAL SECTOR OFFSET field (see IDENTIFY DEVICE data words 117..118 in table 57).

9.10.4.5 Nominal Buffer Size (BUFFER SIZE field)

The BUFFER SIZE field (see table 251) reports the size, in bytes, of the buffer supported by the device. The partitioning of the buffer is vendor specific.

9.10.5 Supported Capabilities (page 03h)

9.10.5.1 Overview

The Supported Capabilities log page (see table 252) provides a mechanism for the device to report support for feature sets, features, commands and other device capabilities.

Table 252 — Supported Capabilities (Sheet 1 of 7)

Offset	Type	Content	
0..7	QWord	Supported Capabilities page information header	
		Bit	**Description**
		63	Shall be set to one
		62:24	Reserved
		23:16	PAGE NUMBER field – shall be set to 03h
		15:0	REVISION NUMBER field (Word) – shall be set to 0001h
8..15	QWord	Supported Capabilities	
		Bit	**Description**
		63	Shall be set to one
		62:57	Reserved
		56	NON-NCQ REBUILD ASSIST SUPPORTED bit (see 9.10.5.2.50)
		55	MUTATE EXT SUPPORTED bit (see 9.10.5.2.49)
		54	ADVANCED BACKGROUND OPERATION SUPPORTED bit (see 9.10.5.2.48)
		53	PERSISTENT SENSE DATA REPORTING bit (see 9.10.5.2.47)
		52	SFF-8447 REPORTING bit (see 9.10.5.2.46)
		51	DEFINITIVE ENDING PATTERN SUPPORTED bit (see 9.10.5.2.44)
		50	DATA SET MANAGEMENT XL SUPPORTED bit (see 9.10.5.2.43)
		49	SET SECTOR CONFIGURATION SUPPORTED bit (see 9.10.5.2.42)
		48	ZERO EXT SUPPORTED bit (see 9.10.5.2.41)
		47	SUCCESSFUL NCQ COMMAND SENSE DATA SUPPORTED bit (see 9.10.5.2.40)
		46	DLC SUPPORTED bit (see 9.10.5.2.39)
		45	REQUEST SENSE DEVICE FAULT SUPPORTED bit (see 9.10.5.2.38)
		44	DSN SUPPORTED bit (see 9.10.5.2.37)
		43	LOW POWER STANDBY SUPPORTED bit (see 9.10.5.2.36)
		42	SET EPC POWER SOURCE SUPPORTED bit (see 9.10.5.2.35)
		41	AMAX ADDR SUPPORTED bit (see 9.10.5.2.34)
		40	Reserved for CFA (see 9.10.5.2.45)
		39	DRAT SUPPORTED bit (see 9.10.5.2.2)
		38	LPS MISALIGNMENT REPORTING SUPPORTED bit (see 9.10.5.2.3)
		37	Reserved
		36	READ BUFFER DMA SUPPORTED bit (see 9.10.5.2.4)
		35	WRITE BUFFER DMA SUPPORTED bit (see 9.10.5.2.5)
		34	Reserved
		33	DOWNLOAD MICROCODE DMA SUPPORTED bit (see 9.10.5.2.6)
		32	28-BIT SUPPORTED bit (see 9.10.5.2.7)

Table 252 — Supported Capabilities (Sheet 2 of 7)

Offset	Type	Content
8..15 *(continued)*		31 RZAT SUPPORTED bit (see 9.10.5.2.8)
		30 Reserved
		29 NOP SUPPORTED bit (see 9.10.5.2.9)
		28 READ BUFFER SUPPORTED bit (see 9.10.5.2.10)
		27 WRITE BUFFER SUPPORTED bit (see 9.10.5.2.11)
		26 Reserved
		25 READ LOOK-AHEAD SUPPORTED bit (see 9.10.5.2.12)
		24 VOLATILE WRITE CACHE SUPPORTED bit (see 9.10.5.2.13)
		23 SMART bit (see 9.10.5.2.14)
		22 FLUSH CACHE EXT SUPPORTED bit (see 9.10.5.2.15)
		21 Reserved
		20 48-BIT SUPPORTED bit (see 9.10.5.2.16)
		19 Reserved
		18 SPIN-UP SUPPORTED bit (see 9.10.5.2.17)
		17 PUIS SUPPORTED bit (see 9.10.5.2.18)
		16 APM SUPPORTED bit (see 9.10.5.2.19)
		15 Reserved for CFA (see 9.10.5.2.45)
		14 DOWNLOAD MICROCODE SUPPORTED bit (see 9.10.5.2.20)
		13 UNLOAD SUPPORTED bit (see 9.10.5.2.21)
		12 WRITE FUA EXT SUPPORTED bit (see 9.10.5.2.22)
		11 GPL SUPPORTED bit (see 9.10.5.2.23)
		10 STREAMING SUPPORTED bit (see 9.10.5.2.24)
		9 Reserved
		8 SMART SELF-TEST SUPPORTED bit (see 9.10.5.2.25)
		7 SMART ERROR LOGGING SUPPORTED bit (see 9.10.5.2.26)
		6 EPC SUPPORTED bit (see 9.10.5.2.27)
		5 SENSE DATA SUPPORTED bit (see 9.10.5.2.28)
		4 FREE-FALL SUPPORTED bit (see 9.10.5.2.29)
		3 DM MODE 3 SUPPORTED bit (see 9.10.5.2.30)
		2 GPL DMA SUPPORTED bit (see 9.10.5.2.31)
		1 WRITE UNCORRECTABLE SUPPORTED bit (see 9.10.5.2.32)
		0 WRV SUPPORTED bit (see 9.10.5.2.33)

Table 252 — Supported Capabilities (Sheet 3 of 7)

Offset	Type	Content
16..23	QWord	DOWNLOAD MICROCODE Capabilities **Bit** **Description** 63 Contents of the QWord are valid 62:36 Reserved 35 DM CLEARS NONACTIVATED DEFERRED DATA bit (see 9.10.5.3.1) 34 DM OFFSETS DEFERRED SUPPORTED bit (see 9.10.5.3.2) 33 DM IMMEDIATE SUPPORTED bit (see 9.10.5.3.3) 32 DM OFFSETS IMMEDIATE SUPPORTED bit (see 9.10.5.3.4) 31:16 DM MAXIMUM TRANSFER SIZE field (see 9.10.5.3.5) 15:0 DM MINIMUM TRANSFER SIZE field (see 9.10.5.3.6)
24..31	QWord	Nominal Media Rotation Rate **Bit** **Description** 63 Shall be set to one 62:16 Reserved 15:0 NOMINAL MEDIA ROTATION RATE field (see 9.10.5.4)
32..39	QWord	Form Factor **Bit** **Description** 63 Contents of the QWord are valid 62:4 Reserved 3:0 NOMINAL FORM FACTOR field (see 9.10.5.5)
40..47	QWord	Write-Read-Verify Sector Count Mode 3 **Bit** **Description** 63 Contents of the QWord are valid 62:32 Reserved 31:0 WRV MODE 3 COUNT field (see 9.10.5.6)
48..55	QWord	Write-Read-Verify Sector Count Mode 2 **Bit** **Description** 63 Contents of the QWord are valid 62:32 Reserved 31:0 WRV MODE 2 COUNT field (see 9.10.5.7)
56..71	DQWord	World Wide Name **Bit** **Description** 127 Shall be set to one 126:64 Reserved 63:0 WORLD WIDE NAME field (see 9.10.5.8)

Table 252 — Supported Capabilities (Sheet 4 of 7)

Offset	Type	Content	
72..79	QWord	DATA SET MANAGEMENT	
		Bit	**Description**
		63	Shall be set to one
		62:32	Reserved
		31:16	MAX PAGES PER DSM COMMAND field (see 9.10.5.9.3)
		15:8	LOGICAL BLOCK MARKUPS SUPPORTED field (see 9.10.5.9.1)
		7:1	Reserved
		0	TRIM SUPPORTED bit (see 9.10.5.9.2)
80..95	DQWord	Utilization Per Unit Time (see 9.10.5.10)	
		Bit	**Description**
		127	Contents of the DQWord are valid
		126:120	Reserved
		119:112	UTILIZATION TYPE field (see 9.10.5.10.2)
		111:104	UTILIZATION UNITS field (see 9.10.5.10.3)
		103:96	UTILIZATION INTERVAL field (see 9.10.5.10.4)
		95:64	Reserved
		63:32	UTILIZATION B field (see 9.10.5.10.5)
		31:0	UTILIZATION A field (see 9.10.5.10.5)
96..103	QWord	Utilization Usage Rate Support	
		Bit	**Description**
		63	Contents of the QWord are valid
		62:24	Reserved
		23	SETTING RATE BASIS SUPPORTED bit (see 9.10.5.11.1)
		22:9	Reserved
		8	SINCE POWER ON RATE BASIS SUPPORTED bit (see 9.10.5.11.2)
		7:5	Reserved
		4	POWER ON HOURS RATE BASIS SUPPORTED bit (see 9.10.5.11.3)
		3:1	Reserved
		0	DATE/TIME RATE BASIS SUPPORTED bit (see 9.10.5.11.4)
104..111	QWord	Obsolete	

Table 252 — Supported Capabilities (Sheet 5 of 7)

Offset	Type	Content	
112..119	QWord	Supported ZAC Capabilities	
		Bit	**Description**
		63	Contents of the QWord are valid
		62:10	Reserved
		9	ZONE COUNT FOR CLOSE SUPPORTED bit (see 9.10.5.12.10)
		8	ZONE COUNT FOR OPEN SUPPORTED bit (see 9.10.5.12.9)
		7	ZONE COUNT FOR FINISH SUPPORTED bit (see 9.10.5.12.8)
		6	ZONE COUNT FOR RWP SUPPORTED bit (see 9.10.5.12.7)
		5	SEQUENTIALIZE ZONE EXT SUPPORTED bit (see 9.10.5.12.6)
		4	NON-DATA RESET WRITE POINTERS EXT SUPPORTED bit (see 9.10.5.12.5)
		3	NON-DATA FINISH ZONE EXT SUPPORTED bit (see 9.10.5.12.4)
		2	NON-DATA CLOSE ZONE EXT SUPPORTED bit (see 9.10.5.12.3)
		1	NON-DATA OPEN ZONE EXT SUPPORTED bit (see 9.10.5.12.2)
		0	REPORT ZONES EXT SUPPORTED bit (see 9.10.5.12.1)
120..127	QWord	Advanced Background Operations Capabilities	
		Bit	**Description**
		63	Contents of the QWord are valid
		62	ABO FOREGROUND MODE SUPPORTED bit (see 9.10.5.13.1)
		61	ABO IR MODE SUPPORTED bit (see 9.10.5.13.2)
		60:48	Reserved
		47:16	ABO MINIMUM FRACTION field (see 9.10.5.13.3)
		15:0	ABO MINIMUM SUPPORTED TIMELIMIT field (see 9.10.5.13.4)
128..135	QWord	Advanced Background Operations Recommendations	
		Bit	**Description**
		63	Contents of the QWord are valid
		62:32	Reserved
		31:16	DEVICE MAINTENANCE POLLING TIME field (see 9.10.5.14.1)
		15:0	ABO RECOMMENDED ABO START INTERVAL field (see 9.10.5.14.2)
136..143	QWord	Queue Depth	
		Bit	**Description**
		63	Contents of the QWord are valid
		62:5	Reserved
		4:0	QUEUE DEPTH field (see 9.10.5.15)

Table 252 — Supported Capabilities (Sheet 6 of 7)

Offset	Type	Content	
144..151	QWord	Supported SCT Capabilities	
		Bit	**Description**
		63	Contents of the QWord are valid
		62:27	Reserved
		26	SCT WRITE SAME FUNCTION 103 SUPPORTED bit (see 9.10.5.16.11)
		25	SCT WRITE SAME FUNCTION 102 SUPPORTED bit (see 9.10.5.16.10)
		24	SCT WRITE SAME FUNCTION 101 SUPPORTED bit (see 9.10.5.16.9)
		23:19	Reserved
		18	SCT WRITE SAME FUNCTION 3 SUPPORTED bit (see 9.10.5.16.8)
		17	SCT WRITE SAME FUNCTION 2 SUPPORTED bit (see 9.10.5.16.7)
		16	SCT WRITE SAME FUNCTION 1 SUPPORTED bit (see 9.10.5.16.6)
		15:6	Reserved
		5	SCT DATA TABLES SUPPORTED bit (see 9.10.5.16.5)
		4	SCT FEATURE CONTROL SUPPORTED bit (see 9.10.5.16.4)
		3	SCT ERROR RECOVERY CONTROL SUPPORTED bit (see 9.10.5.16.3)
		2	SCT WRITE SAME SUPPORTED bit (see 9.10.5.16.2)
		1	Reserved
		0	SCT SUPPORTED bit (see 9.10.5.16.1)
152..159	QWord	Depopulation Capabilities	
		Bit	**Description**
		63	Contents of the QWord are valid
		62:3	Reserved
		2	RESTORE ELEMENTS AND REBUILD SUPPORTED bit (see 9.10.5.17.1)
		1	GET PHYSICAL ELEMENT STATUS SUPPORTED bit (see 9.10.5.17.2)
		0	REMOVE ELEMENT AND TRUNCATE SUPPORTED bit (see 9.10.5.17.3)
160..167	QWord	Depopulation Execution Time	
		Bit	**Description**
		63	Contents of the QWord are valid
		62:0	DEPOPULATION TIME field (see 9.10.5.18)
168..175	QWord	Command Duration Limit Supported bits	
		Bit	**Description**
		63	Contents of the QWord are valid
		62:3	Reserved
		2	HIGH PRIORITY ENHANCEMENT SUPPORTED bit (see 9.10.5.19.1)
		1	COMMAND DURATION GUIDELINES SUPPORTED bit (see 9.10.5.19.2)
		0	COMMAND DURATION LIMITS SUPPORTED bit (see 9.10.5.19.3)

Table 252 — Supported Capabilities (Sheet 7 of 7)

Offset	Type	Content
176..183	QWord	Command Duration Limit Minimum Time Limit
		Bit **Description**
		63 Contents of the QWord are valid
		62:32 Reserved
		31:0 CDL MINIMUM TIME LIMIT field (see 9.10.5.19.4)
184..191	QWord	Command Duration Limit Maximum Time Limit
		Bit **Description**
		63 Contents of the QWord are valid
		62:32 Reserved
		31:0 CDL MAXIMUM TIME LIMIT field (see 9.10.5.19.5)
192..503		Reserved
504..511	QWord	Vendor Specific Supported Capabilities (see 9.10.5.20)
		Bit **Description**
		63 Contents of the QWord are valid
		62:0 Vendor specific

9.10.5.2 Supported Capabilities

9.10.5.2.1 Overview

Supported Capabilities shall indicate features and command sets supported.

9.10.5.2.2 Deterministic read after trim is supported (DRAT SUPPORTED bit)

The DRAT SUPPORTED bit (see table 252) indicates the device behavior when returning data from trimmed logical sectors as described in table 35.

If the TRIM SUPPORTED bit (see 9.10.5.9.2) is cleared to zero, the DRAT SUPPORTED bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the DRAT SUPPORTED bit (see IDENTIFY DEVICE data word 69 in table 57).

9.10.5.2.3 Long Physical Sector Alignment Error Reporting Control is supported (LPS MISALIGNMENT REPORTING SUPPORTED bit)

If the LPS MISALIGNMENT REPORTING SUPPORTED bit (see table 252) is set to one, the device supports the SET FEATURES command with the Long Physical Sector Alignment Error Reporting Control subcommand (see 7.45.19). If the LPS MISALIGNMENT REPORTING SUPPORTED bit is cleared to zero, the device does not support the SET FEATURES command with the Long Physical Sector Alignment Error Reporting Control subcommand.

The IDENTIFY DEVICE data contains a copy of the LPS MISALIGNMENT REPORTING SUPPORTED bit (see IDENTIFY DEVICE data word 69 in table 57).

9.10.5.2.4 READ BUFFER DMA is supported (READ BUFFER DMA SUPPORTED bit)

If the READ BUFFER DMA SUPPORTED bit (see table 252) is set to one, the READ BUFFER DMA command is supported. If the READ BUFFER DMA SUPPORTED bit is cleared to zero, the READ BUFFER DMA command is not supported.

The IDENTIFY DEVICE data contains a copy of the READ BUFFER DMA SUPPORTED bit (see IDENTIFY DEVICE data word 69 in table 57).

9.10.5.2.5 WRITE BUFFER DMA is supported (WRITE BUFFER DMA SUPPORTED bit)

If the WRITE BUFFER DMA SUPPORTED bit (see table 252) is set to one, the WRITE BUFFER DMA command is supported. If the WRITE BUFFER DMA SUPPORTED bit is cleared to zero, the WRITE BUFFER DMA command is not supported.

The IDENTIFY DEVICE data contains a copy of the WRITE BUFFER DMA SUPPORTED bit (see IDENTIFY DEVICE data word 69 in table 57).

9.10.5.2.6 DOWNLOAD MICROCODE DMA is supported (DOWNLOAD MICROCODE DMA SUPPORTED bit)

If the DOWNLOAD MICROCODE DMA SUPPORTED bit (see table 252) is set to one, the DOWNLOAD MICROCODE DMA command is supported. If the DOWNLOAD MICROCODE DMA SUPPORTED bit is cleared to zero, the DOWNLOAD MICROCODE DMA command is not supported.

The IDENTIFY DEVICE data contains a copy of the DOWNLOAD MICROCODE DMA SUPPORTED bit (see IDENTIFY DEVICE data word 69 in table 57).

9.10.5.2.7 Optional ATA device 28-bit commands supported (28-BIT SUPPORTED bit)

The 28-BIT SUPPORTED bit (see table 252) shall be cleared to zero if all of the following commands are supported:

a) FLUSH CACHE;
b) READ DMA;
c) READ SECTOR(S);
d) READ VERIFY SECTOR(S);
e) WRITE DMA; and
f) WRITE SECTOR(S).

The 28-BIT SUPPORTED bit shall be set to one if any of the following commands are not supported:

a) FLUSH CACHE;
b) READ DMA;
c) READ SECTOR(S);
d) READ VERIFY SECTOR(S);
e) WRITE DMA; or
f) WRITE SECTOR(S).

The IDENTIFY DEVICE data contains a copy of the 28-BIT SUPPORTED bit (see IDENTIFY DEVICE data word 69 in table 57).

9.10.5.2.8 Return zeroes data after trim is supported (RZAT SUPPORTED bit)

The RZAT SUPPORTED bit (see table 252) indicates the device behavior when returning data from trimmed logical sectors as described in table 35.

If the DRAT SUPPORTED bit (see 9.10.5.2.2) is cleared to zero, the RZAT SUPPORTED bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the RZAT SUPPORTED bit (see IDENTIFY DEVICE data word 69 in table 57).

9.10.5.2.9 The NOP command is supported (NOP SUPPORTED bit)

If the NOP SUPPORTED bit (see table 252) is set to one, the NOP command (see 7.18) is supported. If the NOP SUPPORTED bit is cleared to zero, the NOP command is not supported.

The IDENTIFY DEVICE data contains a copy of the NOP SUPPORTED bit (see IDENTIFY DEVICE data word 82 in table 57).

9.10.5.2.10 The READ BUFFER command is supported (READ BUFFER SUPPORTED bit)

If the READ BUFFER SUPPORTED bit (see table 252) is set to one, the READ BUFFER command is supported. If the READ BUFFER SUPPORTED bit is cleared to zero, the READ BUFFER command is not supported.

The IDENTIFY DEVICE data contains a copy of the READ BUFFER SUPPORTED bit (see IDENTIFY DEVICE data word 82 in table 57).

9.10.5.2.11 The WRITE BUFFER command is supported (WRITE BUFFER SUPPORTED bit)

If the WRITE BUFFER SUPPORTED bit (see table 252) is supported is set to one, the WRITE BUFFER command is supported. If the WRITE BUFFER SUPPORTED bit is supported is cleared to zero, the WRITE BUFFER command is not supported.

The IDENTIFY DEVICE data contains a copy of the WRITE BUFFER SUPPORTED bit (see IDENTIFY DEVICE data word 82 in table 57).

9.10.5.2.12 Read look-ahead is supported (READ LOOK-AHEAD SUPPORTED bit)

If the READ LOOK-AHEAD SUPPORTED bit (see table 252) is set to one, read look-ahead is supported. If the READ LOOK-AHEAD SUPPORTED bit is cleared to zero, read look-ahead is not supported.

The IDENTIFY DEVICE data contains a copy of the READ LOOK-AHEAD SUPPORTED bit (see IDENTIFY DEVICE data word 82 in table 57).

9.10.5.2.13 The volatile write cache is supported (VOLATILE WRITE CACHE SUPPORTED bit)

If the VOLATILE WRITE CACHE SUPPORTED bit (see table 252) is set to one, volatile write cache is supported. If the VOLATILE WRITE CACHE SUPPORTED bit is cleared to zero, volatile write cache is not supported.

The IDENTIFY DEVICE data contains a copy of the VOLATILE WRITE CACHE SUPPORTED bit (see IDENTIFY DEVICE data word 82 in table 57).

9.10.5.2.14 The SMART feature set is supported (SMART bit)

If the SMART bit (see table 252) is set to one, the SMART feature set is supported. If the SMART bit is cleared to zero, the SMART feature set is not supported.

The IDENTIFY DEVICE data contains a copy of the SMART bit (see IDENTIFY DEVICE data word 82 in table 57).

9.10.5.2.15 The FLUSH CACHE EXT command is supported (FLUSH CACHE EXT SUPPORTED bit)

If the FLUSH CACHE EXT SUPPORTED bit (see table 252) is set to one, the FLUSH CACHE EXT command (see 7.11) is supported. If the FLUSH CACHE EXT SUPPORTED bit is cleared to zero, the FLUSH CACHE EXT command is not supported.

The IDENTIFY DEVICE data contains a copy of the FLUSH CACHE EXT SUPPORTED bit (see IDENTIFY DEVICE data word 83 in table 57).

9.10.5.2.16 The 48-bit Address feature set is supported (48-BIT SUPPORTED bit)

If the 48-BIT SUPPORTED bit (see table 252) is set to one, the 48-bit Address feature set (see 4.3) is supported. If the 48-BIT SUPPORTED bit is cleared to zero, the 48-bit Address feature set (see 4.3) is not supported.

The IDENTIFY DEVICE data contains a copy of the 48-BIT SUPPORTED bit (see IDENTIFY DEVICE data word 83 in table 57).

9.10.5.2.17 SET FEATURES subcommand is required to spin-up after power-up (SPIN-UP SUPPORTED bit)

If the SPIN-UP SUPPORTED bit (see table 252) is set to one, the device requires the SET FEATURES subcommand to spin-up after power-up if the PUIS feature set is enabled (see 7.45.7). If the SPIN-UP SUPPORTED bit is cleared to zero, the device does not require the SET FEATURES subcommand to spin-up after power-up.

The IDENTIFY DEVICE data contains a copy of the SPIN-UP SUPPORTED bit (see IDENTIFY DEVICE data word 83 in table 57).

9.10.5.2.18 The PUIS feature set is supported (PUIS SUPPORTED bit)

If the PUIS SUPPORTED bit (see table 252) is set to one, the PUIS feature set (see 4.18) is supported. If the PUIS SUPPORTED bit is cleared to zero, the PUIS feature set (see 4.18) is not supported.

The IDENTIFY DEVICE data contains a copy of the PUIS SUPPORTED bit (see IDENTIFY DEVICE data word 83 in table 57).

9.10.5.2.19 The APM feature set is supported (APM SUPPORTED bit)

If the APM SUPPORTED bit (see table 252) is set to one, the APM feature set (see 4.6) is supported. If the APM SUPPORTED bit is cleared to zero, the APM feature set is not supported.

The IDENTIFY DEVICE data contains a copy of the APM SUPPORTED bit (see IDENTIFY DEVICE data word 83 in table 57).

9.10.5.2.20 The DOWNLOAD MICROCODE command is supported (DOWNLOAD MICROCODE SUPPORTED bit)

If the DOWNLOAD MICROCODE SUPPORTED bit (see table 252) is set to one, the DOWNLOAD MICROCODE command is supported. If the DOWNLOAD MICROCODE SUPPORTED bit is cleared to zero, the DOWNLOAD MICROCODE command is not supported.

The IDENTIFY DEVICE data contains a copy of the DOWNLOAD MICROCODE SUPPORTED bit (see IDENTIFY DEVICE data word 83 in table 57).

9.10.5.2.21 The IDLE IMMEDIATE command with UNLOAD feature is supported (UNLOAD SUPPORTED bit)

If the UNLOAD SUPPORTED bit (see table 252) is set to one, the IDLE IMMEDIATE command with unload feature (see 7.15.2.2) is supported. If the UNLOAD SUPPORTED bit is cleared to zero, the IDLE IMMEDIATE command with unload feature (see 7.15.2.2) is not supported.

The IDENTIFY DEVICE data contains a copy of the UNLOAD SUPPORTED bit (see IDENTIFY DEVICE data word 84 in table 57).

9.10.5.2.22 The WRITE DMA FUA EXT command is supported (WRITE FUA EXT SUPPORTED bit)

The WRITE FUA EXT SUPPORTED bit (see table 252) shall be set to one if:

a) the 48-BIT SUPPORTED bit (see 9.10.5.2.16) is set to one; and
b) the WRITE DMA FUA EXT command (see 7.60) is supported.

Otherwise, the WRITE FUA EXT SUPPORTED bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the WRITE FUA EXT SUPPORTED bit (see IDENTIFY DEVICE data word 84 in table 57).

9.10.5.2.23 The GPL feature set is supported (GPL SUPPORTED bit)

If the GPL SUPPORTED bit (see table 252) is set to one, the GPL feature set (see 4.11) is supported. If the GPL SUPPORTED bit is cleared to zero, the GPL feature set is not supported.

The IDENTIFY DEVICE data contains a copy of the GPL SUPPORTED bit (see IDENTIFY DEVICE data word 84 in table 57).

9.10.5.2.24 The Streaming feature set is supported (STREAMING SUPPORTED bit)

If the STREAMING SUPPORTED bit (see table 252) is set to one, the Streaming feature set (see 4.27) is supported. If the STREAMING SUPPORTED bit is cleared to zero, the Streaming feature set is not supported.

The IDENTIFY DEVICE data contains a copy of the STREAMING SUPPORTED bit (see IDENTIFY DEVICE data word 84 in table 57).

9.10.5.2.25 The SMART self-test is supported (SMART SELF-TEST SUPPORTED bit)

If the SMART SELF-TEST SUPPORTED bit (see table 252) is set to one, SMART self-test is supported. If the SMART SELF-TEST SUPPORTED bit is cleared to zero, SMART self-test is not supported.

This bit is valid if the SMART bit (see 9.10.5.2.14) is set to one indicating that the SMART feature set is supported. The IDENTIFY DEVICE data contains a copy of the SMART SELF-TEST SUPPORTED bit (see IDENTIFY DEVICE data word 84 in table 57).

9.10.5.2.26 SMART error logging is supported (SMART ERROR LOGGING SUPPORTED bit)

If the SMART ERROR LOGGING SUPPORTED bit (see table 252) is set to one, SMART error logging is supported. If the SMART ERROR LOGGING SUPPORTED bit (see table 252) is cleared to zero, SMART error logging is not supported.

This bit is valid if the SMART bit (see 9.10.5.2.14) is set to one indicating that the SMART feature set is supported. The IDENTIFY DEVICE data contains a copy of the SMART ERROR LOGGING SUPPORTED bit (see IDENTIFY DEVICE data word 84 in table 57).

9.10.5.2.27 Extended Power Conditions feature set is supported (EPC SUPPORTED bit)

If the EPC SUPPORTED bit (see table 252) is set to one, the Extended Power Conditions feature set (see 4.9) is supported. If the EPC SUPPORTED bit is cleared to zero, the Extended Power Conditions feature set is not supported.

If the EPC SUPPORTED bit is cleared to zero, then:

a) the LOW POWER STANDBY SUPPORTED bit (see 9.10.5.2.36) shall be cleared to zero; and
b) the SET EPC POWER SOURCE SUPPORTED bit (see 9.10.5.2.35) shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the EPC SUPPORTED bit (see IDENTIFY DEVICE data word 119 in table 57).

9.10.5.2.28 Sense Data Reporting feature set is supported (SENSE DATA SUPPORTED bit)

If the SENSE DATA SUPPORTED bit (see table 252) is set to one, the Sense Data Reporting feature set (see 4.24) is supported. If the SENSE DATA SUPPORTED bit is cleared to zero, the Sense Data Reporting feature set is not supported.

The IDENTIFY DEVICE data contains a copy of the SENSE DATA SUPPORTED bit (see IDENTIFY DEVICE data word 119 in table 57).

9.10.5.2.29 The Free-fall Control feature set is supported (FREE-FALL SUPPORTED bit)

If the FREE-FALL SUPPORTED bit (see table 252) is set to one, the Free-fall Control feature set (see 4.10) is supported. If the FREE-FALL SUPPORTED bit is cleared to zero, the Free-fall Control feature set (see 4.10) is not supported.

The IDENTIFY DEVICE data contains a copy of the FREE-FALL SUPPORTED bit (see IDENTIFY DEVICE data word 119 in table 57).

9.10.5.2.30 The DOWNLOAD MICROCODE command with mode 3 is supported (DM MODE 3 SUPPORTED bit)

If the DM MODE 3 SUPPORTED bit (see table 252) is set to one, the DOWNLOAD MICROCODE command (see 7.7) and the DOWNLOAD MICROCODE DMA command (see 7.8) requesting the offset transfer method are supported. Otherwise, the DM MODE 3 SUPPORTED bit is cleared to zero.

The IDENTIFY DEVICE data contains a copy of the DM MODE 3 SUPPORTED bit (see IDENTIFY DEVICE data word 119 in table 57).

9.10.5.2.31 The READ LOG DMA EXT and WRITE LOG DMA EXT commands are supported (GPL DMA SUPPORTED bit)

If the GPL DMA SUPPORTED bit (see table 252) is set to one, the READ LOG DMA EXT command (see 7.25) and WRITE LOG DMA EXT command (see 7.63) are supported. Otherwise, the GPL DMA SUPPORTED bit is cleared to zero.

If the GPL SUPPORTED bit (see 9.10.5.2.23) is cleared to zero, the GPL DMA SUPPORTED bit shall be cleared to zero. The IDENTIFY DEVICE data contains a copy of the GPL DMA SUPPORTED bit (see IDENTIFY DEVICE data word 119 in table 57).

9.10.5.2.32 The WRITE UNCORRECTABLE EXT command is supported (WRITE UNCORRECTABLE SUPPORTED bit)

If the WRITE UNCORRECTABLE SUPPORTED bit (see table 252) is set to one, the WRITE UNCORRECTABLE EXT command (see 7.68) is supported. If the WRITE UNCORRECTABLE SUPPORTED bit is cleared to zero, the WRITE UNCORRECTABLE EXT command is not supported.

The IDENTIFY DEVICE data contains a copy of the WRITE UNCORRECTABLE SUPPORTED bit (see IDENTIFY DEVICE data word 119 in table 57).

9.10.5.2.33 The Write-Read-Verify feature set is supported (WRV SUPPORTED bit)

If the WRV SUPPORTED bit (see table 252) is set to one, the Write-Read-Verify feature set (see 4.30) is supported. If the WRV SUPPORTED bit is cleared to zero, the Write-Read-Verify feature set is not supported.

The IDENTIFY DEVICE data contains a copy of the WRV SUPPORTED bit (see IDENTIFY DEVICE data word 119 in table 57).

9.10.5.2.34 Accessible Max Address Configuration feature set is supported (AMAX ADDR SUPPORTED bit)

If the AMAX ADDR SUPPORTED bit (see table 252) is set to one, the Accessible Max Address Configuration feature set (see 4.4) is supported. If the AMAX ADDR SUPPORTED bit is cleared to zero, the Accessible Max Address Configuration feature set is not supported.

The IDENTIFY DEVICE data contains a copy of the AMAX ADDR SUPPORTED bit (see IDENTIFY DEVICE data word 119 in table 57).

9.10.5.2.35 Set EPC Power Source is supported (SET EPC POWER SOURCE SUPPORTED bit)

If the SET EPC POWER SOURCE SUPPORTED bit (see table 252) is set to one, the Set EPC Power Source function (see 7.45.20.8) is supported. If the SET EPC POWER SOURCE SUPPORTED bit is cleared to zero, the Set EPC Power Source function is not supported.

9.10.5.2.36 Low Power Standby is supported (LOW POWER STANDBY SUPPORTED bit)

If the LOW POWER STANDBY SUPPORTED bit is set to one, the device supports the HOLD POWER CONDITION bit and the DELAYED ENTRY bit in the EPC Go To Power Condition subcommand (see 7.45.20.3). If the LOW POWER STANDBY SUPPORTED bit is cleared to zero, the device does not support the HOLD POWER CONDITION bit and the DELAYED ENTRY bit in the EPC Go To Power Condition subcommand.

9.10.5.2.37 DSN feature set is supported (DSN SUPPORTED bit)

If the DSN SUPPORTED bit (see table 252) is set to one, the DSN feature set (see 4.8) is supported. If the DSN SUPPORTED bit (see table 252) is cleared to zero, the DSN feature set is not supported.

The IDENTIFY DEVICE data contains a copy of the DSN SUPPORTED bit (see IDENTIFY DEVICE data word 119 in table 57).

9.10.5.2.38 Request Sense Device Fault Support (REQUEST SENSE DEVICE FAULT SUPPORTED bit)

If the REQUEST SENSE DEVICE FAULT SUPPORTED bit (see table 252) is set to one, the device supports returning normal outputs for the REQUEST SENSE DATA EXT command (see 7.34) while the device is in a device fault condition (see 6.2.6).

If the REQUEST SENSE DEVICE FAULT SUPPORTED bit is cleared to zero, the device does not support returning normal outputs for the REQUEST SENSE DATA EXT command while the device is in a device fault condition.

9.10.5.2.39 DLC SUPPORTED bit

If the DLC SUPPORTED bit set to one, the device supports the SET FEATURES subcommand to Enable device life control (see 7.45.9) and SET FEATURES subcommand to Disable device life control. If the DLC SUPPORTED bit is cleared to zero, the device does not support the SET FEATURES subcommand to Enable device life control and SET FEATURES subcommand to Disable device life control.

9.10.5.2.40 SUCCESSFUL NCQ COMMAND SENSE DATA SUPPORTED bit

A SUCCESSFUL NCQ COMMAND SENSE DATA SUPPORTED bit set to one indicates that the device supports returning sense data (see 4.24) for NCQ commands (see 4.15) that the device completes without an error using the Sense

Data for Successful NCQ Commands log (see 9.28) as defined in 4.15.7. A SUCCESSFUL NCQ COMMAND SENSE DATA SUPPORTED bit cleared to zero indicates that the device does not support returning sense data for NCQ commands that complete without errors.

The SUCCESSFUL NCQ COMMAND SENSE DATA SUPPORTED bit shall be cleared to zero if:

a) the SENSE DATA SUPPORTED bit (see 9.10.5.2.28) is cleared to zero;
b) the NCQ FEATURE SET SUPPORTED bit (see 9.10.10.2.4) is cleared to zero;
c) the NCQ AUTOSENSE SUPPORTED bit (see 9.10.10.2.21) is cleared to zero; or
d) the QUEUED READ LOG DMA EXT SUPPORTED bit (see 9.18.8) is cleared to zero.

9.10.5.2.41 ZERO EXT command is supported (ZERO EXT SUPPORTED bit)

If the ZERO EXT SUPPORTED bit (see table 252) is set to one, the device supports the ZERO EXT command (see 7.69). If the ZERO EXT SUPPORTED bit is cleared to zero, the device does not support the ZERO EXT command.

9.10.5.2.42 Set Sector Configuration command is supported (SET SECTOR CONFIGURATION SUPPORTED bit)

If the SET SECTOR CONFIGURATION SUPPORTED bit (see table 252) is set to one, the device supports the SET SECTOR CONFIGURATION command (see 7.46). If the SET SECTOR CONFIGURATION SUPPORTED bit is cleared to zero, the device does not support the SET SECTOR CONFIGURATION command.

9.10.5.2.43 DATA SET MANAGEMENT XL SUPPORTED bit

If the DATA SET MANAGEMENT XL SUPPORTED bit (see table 252) is set to one, the DATA SET MANAGEMENT XL command (see 7.6) is supported. If the DATA SET MANAGEMENT XL SUPPORTED bit is cleared to zero, the DATA SET MANAGEMENT XL command is not supported.

9.10.5.2.44 DEFINITIVE ENDING PATTERN SUPPORTED bit

If the DEFINITIVE ENDING PATTERN SUPPORTED bit (see table 252) is set to one, the device shall process the DEFINITIVE ENDING PATTERN bit input to the OVERWRITE EXT command as described in 7.36.4.3.3. If the DEFINITIVE ENDING PATTERN SUPPORTED bit is cleared to zero, the device shall ignore the DEFINITIVE ENDING PATTERN bit input to the OVERWRITE EXT command.

9.10.5.2.45 Reserved for CFA

CFA features affect the Supported Capabilities log page as follows:

a) bit 40 of the Supported Capabilities QWord (see table 252) is reserved for CFA. The IDENTIFY DEVICE data contains a copy of bit 40 (see IDENTIFY DEVICE data word 69 in table 57); and
b) bit 15 of the Supported Capabilities QWord is reserved for CFA. The IDENTIFY DEVICE data contains a copy of bit 40 (see IDENTIFY DEVICE data word 83 in table 57).

9.10.5.2.46 SFF-8447 REPORTING bit

If the SFF-8447 REPORTING bit is cleared to zero, then the device may or may not report an SFF-8447 value as the native max address based on the formulas in SFF-8447 for the LBA count that corresponds to the advertised capacity. If the SFF-8447 REPORTING bit is set to one, then the device shall report an SFF-8447 value as the native max address based on the formulas in SFF-8447 for the LBA count that corresponds to the advertised capacity.

9.10.5.2.47 PERSISTENT SENSE DATA REPORTING bit

If the device processes a power-on reset and the PERSISTENT SENSE DATA REPORTING bit is:

a) cleared to zero, then the device should disable the sense data reporting feature set (see 4.24.1); and
b) set to one, then the device shall not change the enable or disabled setting of the sense data reporting feature set.

9.10.5.2.48 ADVANCED BACKGROUND OPERATION SUPPORTED bit

If the ADVANCED BACKGROUND OPERATION SUPPORTED bit (see table 252) is set to one, the Advanced Background Operation feature set is supported. If the ADVANCED BACKGROUND OPERATION SUPPORTED bit is cleared to zero, the Advanced Background Operation feature set is not supported.

9.10.5.2.49 MUTATE EXT SUPPORTED bit

If the MUTATE EXT SUPPORTED bit (see table 252) is set to one, the device supports the MUTATE EXT command (see 7.16). If the MUTATE EXT SUPPORTED bit is cleared to zero, the device does not support the MUTATE EXT command.

9.10.5.2.50 NON-NCQ REBUILD ASSIST SUPPORTED bit

If the NON-NCQ REBUILD ASSIST SUPPORTED bit (see table 252) is set to one, then enabling the Rebuild Assist feature set (see 4.19) allows READ DMA EXT commands (see 7.22), WRITE DMA EXT commands (see 7.59), and WRITE DMA FUA EXT commands (see 7.60) to indicate the location of multiple failing LBAs using the Sense Data log (see 9.32). If the NON-NCQ REBUILD ASSIST SUPPORTED bit is cleared to zero, then enabling the Rebuild Assist feature set has no effect on READ DMA EXT commands, WRITE DMA EXT commands, and WRITE DMA FUA EXT commands.

9.10.5.3 DOWNLOAD MICROCODE Capabilities

9.10.5.3.1 Download microcode clears nonactivated deferred data (DM CLEARS NONACTIVATED DEFERRED DATA bit)

If the device processes a DOWNLOAD MICROCODE command (see 7.7) or a DOWNLOAD MICROCODE DMA command (see 7.8) that specifies a subcommand of:

a) Download with offsets and save microcode for immediate and future use (i.e., 03h); or
b) Download with offsets and save microcode for future use (i.e., 0Eh),

then:

a) if the DM CLEARS NONACTIVATED DEFERRED DATA bit (see table 252) is set to one, any deferred microcode data that has not been activated shall be discarded; or
b) if the DM CLEARS NONACTIVATED DEFERRED DATA bit is cleared to zero, any deferred microcode data that has not been activated shall be retained.

9.10.5.3.2 Subcommands 0Eh and 0Fh are supported (DM OFFSETS DEFERRED SUPPORTED bit)

If the DM OFFSETS DEFERRED SUPPORTED bit (see table 252) is set to one, then:

a) if the DOWNLOAD MICROCODE command is supported (i.e., the DOWNLOAD MICROCODE SUPPORTED bit (see 9.10.5.2.20) is set to one), then the device supports subcommands 0Eh and 0Fh (see 7.7.2.4 and 7.7.2.5) of the DOWNLOAD MICROCODE command; and
b) if the DOWNLOAD MICROCODE DMA command is supported (i.e., the DOWNLOAD MICROCODE DMA SUPPORTED bit (see 9.10.5.2.6) is set to one), then the device supports subcommands 0Eh and 0Fh (see 7.7.2.4 and 7.7.2.5) of the DOWNLOAD MICROCODE DMA command.

Otherwise, the DM OFFSETS DEFERRED SUPPORTED bit is cleared to zero.

9.10.5.3.3 Subcommand 07h is supported (DM IMMEDIATE SUPPORTED bit)

If the DM IMMEDIATE SUPPORTED bit (see table 252) is set to one, then:

a) if the DOWNLOAD MICROCODE command is supported (i.e., the DOWNLOAD MICROCODE SUPPORTED bit (see 9.10.5.2.20) is set to one), then the device supports subcommand 07h (see 7.7.2.3) of the DOWNLOAD MICROCODE command; and
b) if the DOWNLOAD MICROCODE DMA command is supported (i.e., the DOWNLOAD MICROCODE DMA SUPPORTED bit (see 9.10.5.2.6) is set to one), then the device supports subcommand 07h (see 7.7.2.3) of the DOWNLOAD MICROCODE DMA command.

Otherwise, the DM IMMEDIATE SUPPORTED bit is cleared to zero.

9.10.5.3.4 Subcommand 03h is supported (DM OFFSETS IMMEDIATE SUPPORTED bit)

If the DM OFFSETS IMMEDIATE SUPPORTED bit (see table 252) is set to one, then:

a) if the DOWNLOAD MICROCODE command is supported (i.e., the DOWNLOAD MICROCODE SUPPORTED bit (see 9.10.5.2.20) is set to one), then the device supports subcommand 03h (see 7.7.2.2) of the DOWNLOAD MICROCODE command; and

b) if the DOWNLOAD MICROCODE DMA command is supported (i.e., the DOWNLOAD MICROCODE DMA SUPPORTED bit (see 9.10.5.2.6) is set to one), then the device supports subcommand 03h (see 7.7.2.2) of the DOWNLOAD MICROCODE DMA command.

Otherwise, the DM OFFSETS IMMEDIATE SUPPORTED bit is cleared to zero.

9.10.5.3.5 DM MAXIMUM TRANSFER SIZE field

If:

a) the value of the DM MAXIMUM TRANSFER SIZE field (see table 252) is greater than zero;
b) the value of the DM MAXIMUM TRANSFER SIZE field is less than FFFFh;
c) the DOWNLOAD MICROCODE SUPPORTED bit (see 9.10.5.2.20) is set to one or the DOWNLOAD MICROCODE DMA SUPPORTED bit (see 9.10.5.2.6) is set to one; and
d) the DM OFFSETS DEFERRED SUPPORTED bit (see 9.10.5.3.2) is set to one, or the DM OFFSETS IMMEDIATE SUPPORTED bit (see 9.10.5.3.4) is set to one,

then the DM MAXIMUM TRANSFER SIZE field indicates the maximum number of 512-byte data blocks permitted by a DOWNLOAD MICROCODE command (see 7.7) or a DOWNLOAD MICROCODE DMA command (see 7.8) that specifies a subcommand of:

a) Download with offsets and save microcode for immediate and future use (i.e., 03h); or
b) Download with offsets and save microcode for future use (i.e., 0Eh).

Otherwise, no maximum is indicated (i.e., there is no maximum number of 512-byte data blocks).

The IDENTIFY DEVICE data contains a copy of the DM MAXIMUM TRANSFER SIZE field (see IDENTIFY DEVICE data word 235 in table 57).

9.10.5.3.6 DM MINIMUM TRANSFER SIZE field

If:

a) the value of the DM MINIMUM TRANSFER SIZE field (see table 252) is greater than zero;
b) the value of the DM MINIMUM TRANSFER SIZE field is less than FFFFh;
c) the DOWNLOAD MICROCODE SUPPORTED bit (see 9.10.5.2.20) is set to one or the DOWNLOAD MICROCODE DMA SUPPORTED bit (see 9.10.5.2.6) is set to one; and
d) the DM OFFSETS DEFERRED SUPPORTED bit (see 9.10.5.3.2) is set to one, or the DM OFFSETS IMMEDIATE SUPPORTED bit (see 9.10.5.3.4) is set to one,

then the DM MINIMUM TRANSFER SIZE field indicates the minimum number of 512-byte data blocks permitted by a DOWNLOAD MICROCODE command (see 7.7) or a DOWNLOAD MICROCODE DMA command (see 7.8) that specifies a subcommand of:

a) Download with offsets and save microcode for immediate and future use (i.e., 03h); or
b) Download with offsets and save microcode for future use (i.e., 0Eh).

Otherwise, no minimum is indicated (i.e., there is no minimum number of 512-byte data blocks).

The IDENTIFY DEVICE data contains a copy of the DM MINIMUM TRANSFER SIZE field (see IDENTIFY DEVICE data word 234 in table 57).

9.10.5.4 NOMINAL MEDIA ROTATION RATE field

The NOMINAL MEDIA ROTATION RATE field (see table 252) indicates the nominal media rotation rate of the device and is defined in table 253.

Table 253 — 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

The IDENTIFY DEVICE data contains a copy of the NOMINAL MEDIA ROTATION RATE field (see IDENTIFY DEVICE data word 217 in table 57).

9.10.5.5 Form Factor (NOMINAL FORM FACTOR field)

The NOMINAL FORM FACTOR field (see table 252) indicates the dimensional form factor of the device or the connector form factor of the device as defined in table 254.

Table 254 — NOMINAL FORM FACTOR field

Value	Description [a]
0h	Form factor not reported
Dimensional Form Factor	
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
Connector Form Factor	
6h	mSATA (see SATA 3.5)
7h	M.2 (see SATA 3.5)
8h	MicroSSD (see SATA 3.5)
9h	CFast
Reserved	
Ah..Fh	Reserved

[a] If the connector form factor of the device is shown in this table, then the device should report the connector form factor.

The IDENTIFY DEVICE data contains a copy of the NOMINAL FORM FACTOR field (see IDENTIFY DEVICE data word 168 in table 57).

9.10.5.6 Write-Read-Verify Sector Mode 3 Count (WRV MODE 3 COUNT field)

The WRV MODE 3 COUNT field (see table 252) 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 9.10.6.3.3) is 03h). This field is valid if the WRV ENABLED bit (see 9.10.6.2.19) is set to one and Current mode of the Write-Read-Verify feature set (see 9.10.6.3.3) is 03h.

The IDENTIFY DEVICE data contains a copy of the WRV MODE 3 COUNT field (see IDENTIFY DEVICE data words 210..211 in table 57).

9.10.5.7 Write-Read-Verify Sector Count Mode 2 (WRV MODE 2 COUNT field)

The WRV MODE 2 COUNT field (see table 252) is valid if the WRV ENABLED bit (see 9.10.6.2.19) is set to one. The WRV MODE 2 COUNT field shall indicate the number of logical sectors to be verified after every spin-up, with Write-Read-Verify feature set mode 2 selected (i.e., Current mode of the Write-Read-Verify feature set (see 9.10.6.3.3) is 02h).

The IDENTIFY DEVICE data contains a copy of the WRV MODE 2 COUNT field (see IDENTIFY DEVICE data words 212..213 in table 57).

9.10.5.8 World Wide Name

9.10.5.8.1 Bit based world wide name format

When shown as a series of four contiguous words, the world wide name has the format shown in table 255.

Table 255 — World wide name format (word-based view)

Word offset	Bit number within each word															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	NAA (5h)				bit 23 (MSB)			IEEE AOI								bit 12
1	bit 11											(LSB) bit 0	bit 35 (MSB)			bit 32
2	bit 31 (MSB)							UNIQUE ID								bit 16
3	bit 15															(LSB) bit 0
Note – Specified bit numbers (e.g., "(LSB) bit 0") are in relationship to the field in which they appear.																

The NAA field indicates the format of the world wide name and shall be set as shown in table 255.

The IEEE AOI field shall contain the AOI that the IEEE-SA Registration Authority has assigned to the device manufacturer.

The UNIQUE ID field shall contain a value assigned by the device manufacturer that is unique for the device within the AOI domain.

9.10.5.8.2 Supported Capabilities WORLD WIDE NAME field

In the Supported Capabilities log page (see table 252), the WORLD WIDE NAME field shall have the format defined in 9.10.5.8.1.

9.10.5.8.3 IDENTIFY DEVICE data WWN

In the IDENTIFY DEVICE data (see 7.13.6):

a) Word 108 bits 15:12 shall contain the NAA field (see 9.10.5.8.1);
b) Word 108 bits 11:0 and word 109 bits 15:4 shall contain the IEEE AOI field (see 9.10.5.8.1); and
c) Word 109 bits 3:0, word 110, and word 111 shall contain the UNIQUE ID field (see 9.10.5.8.1).

The IDENTIFY DEVICE data WWN is shown by word number in table 256.

Table 256 — IDENTIFY DEVICE data WWN format (word-based view)

Word offset	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 AOI								bit 12
109	bit 11											(LSB) bit 0	bit 35 (MSB)			bit 32
110	bit 31 (MSB)							UNIQUE ID								bit 16
111	bit 15															(LSB) bit 0
Note – Specified bit numbers (e.g., "(LSB) bit 0") are in relationship to the field in which they appear.																

The IDENTIFY DEVICE data WWN is shown by byte number in table 257.

Table 257 — IDENTIFY DEVICE data WWN format (byte-based view)

Word	Offset	Bit number within each byte							
		7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
108	216	bit 19			IEEE AOI				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 AOI				bit 4
110	220	bit 23							bit 16
	221	bit 31							bit 24
111	222	bit 7			UNIQUE ID				(LSB) bit 0
	223	bit 15							bit 8
Note – Specified bit numbers (e.g., "(LSB) bit 0") are in relationship to the field in which they appear.									

9.10.5.9 DATA SET MANAGEMENT

9.10.5.9.1 LOGICAL BLOCK MARKUPS SUPPORTED field

9.10.5.9.1.1 Overview

The LOGICAL BLOCK MARKUPS SUPPORTED field (see table 258) indicates the logical block markup descriptor values supported by the device in the LBA field of a command (e.g., a DATA SET MANAGEMENT command (see 7.5)). If the device receives a command that specifies a logical block markup descriptor value that the contents of the LOGICAL BLOCK MARKUPS SUPPORTED field indicate is not supported, then the device:

a) should ignore that logical block markup descriptor value; and

b) shall not terminate that command with an error as a result of the unsupported logical block markup descriptor value.

Table 258 — LOGICAL BLOCK MARKUPS SUPPORTED field

Code	Description
00h	No logical block markup descriptor values are supported.
01h	The SCSI Block Commands logical block markup descriptor format (see 9.10.5.9.1.2) is supported.
02h..BFh	Reserved
C0h	Only the operating system file logical block markup descriptor values (see 9.10.5.9.1.3) are supported.
C1h..FFh	Reserved

9.10.5.9.1.2 SCSI Block Commands logical block markup descriptors

If the LOGICAL BLOCK MARKUPS SUPPORTED field (see 9.10.5.9.1.1) is set to 01h, table 259 defines the Logical Block Markup Descriptor values (see 7.5.3.4) that the device supports.

Table 259 — SCSI Block Commands logical block markup descriptor format

Field	Type	Content
LBA (7:0)	Byte	**Bit Description** 7 ACDLU bit (see SBC-4) 6 Reserved 5:4 RLBSR field (see SBC-4) 3:0 LBM DESCRIPTOR TYPE field (see SBC-4)
LBA (15:8)	Byte	**Bit Description** 7:6 OVERALL FREQUENCY field (see SBC-4) 5:4 READ/WRITE FREQUENCY field (see SBC-4) 3:2 WRITE SEQUENTIALITY field (see SBC-4) 1:0 READ SEQUENTIALITY field (see SBC-4)
LBA (23:16)	Byte	**Bit Description** 7:4 IO CLASS field (see SBC-4) 3:2 SUBSEQUENT I/O field (see SBC-4) 1:0 OSI PROXIMITY field (see SBC-4)
LBA (31:24)	Byte	Reserved

9.10.5.9.1.3 Operating system file logical block markup descriptors

If the LOGICAL BLOCK MARKUPS SUPPORTED field (see 9.10.5.9.1.1) is set to C0h, table 260 defines the Logical Block Markup Descriptor values (see 7.5.3.4) that the device supports.

Table 260 — Operating system file logical block markup descriptor values

Logical Block Markup Descriptor				
LBA (7:0)	LBA (15:8)	LBA (23:16)	LBA (31:24)	Description
00h	00h	00h	00h	**Remove All Markups:** All logical block markups, if any, associated with the specified logical blocks are removed.
00h	00h	02h	00h	**Post Power On:** Any logical block associated with this logical block markup should be available for low latency access following a power on.
80h	00h	00h	00h	**Accessed During Low Utilization:** Any logical blocks associated with this logical block markup have a high probability of being accessed at times when the number of read commands processed and number of write commands processed per unit time is small.
80h	00h	02h	00h	**Post Power On, Low Utilization:** Any logical block associated with this logical block markup should be available for low latency access (e.g., write access) following a power on with a high probability of being accessed at times when the number of read commands processed and number of write commands processed per unit time is small.
30h	AAh	1Ah	00h	**Circular Log That Contains Metadata:** All logical blocks associated with the command that references this logical block markup have a high probability of being written repeatedly in a sequential manner and a read to any logical block in the group of related logical blocks increases the probability of subsequent reads to other logical blocks in that group of related logical blocks (e.g., a device managed zoned device (see ACS-4) may benefit from storing these blocks in the same zone).
30h	A5h	1Ah	00h	**Critical File System Metadata:** All logical blocks associated with the command that references this logical block markup is metadata that have a high probability of being randomly accessed and a read to any logical block in the group of related logical blocks increases the probability of subsequent reads to other logical blocks in that group of related logical blocks (e.g., a device managed zoned device (see ACS-4) may benefit from storing these blocks in the same zone).
All other combinations of values				Reserved

9.10.5.9.2 TRIM SUPPORTED bit

If the TRIM SUPPORTED bit (see table 252) is set to one, the device supports the TRIM bit of the DATA SET MANAGEMENT command (see 7.5.3.3 and 7.13.6.30).

If the TRIM SUPPORTED bit is cleared to zero, then the TRIM bit in the DATA SET MANAGEMENT command is not supported and:

a) the RZAT SUPPORTED bit (see 9.10.5.2.8) shall be cleared to zero; and
b) the DRAT SUPPORTED bit (see 9.10.5.2.2) shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the TRIM SUPPORTED bit (see 7.13.6.70).

9.10.5.9.3 MAX PAGES PER DSM COMMAND field

The MAX PAGES PER DSM COMMAND field contains the maximum number of 512-byte blocks of LBA Range Entries per DATA SET MANAGEMENT command or DATA SET MANAGEMENT XL 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 the TRIM SUPPORTED bit is cleared to zero, then the MAX PAGES PER DSM COMMAND field is reserved.

The IDENTIFY DEVICE data contains a copy of the MAX PAGES PER DSM COMMAND field (see 7.13.6.55).

9.10.5.10 Utilization Per Unit Time

9.10.5.10.1 Overview

The Utilization Per Unit Time DQWord indicates the designed utilization characteristics (e.g., characterization information that may be found on the product specification sheet associated with the device) for the device using:

a) the UTILIZATION TYPE field (see 9.10.5.10.2) to indicate the meanings of the UTILIZATION A field and the UTILIZATION B field (see 9.10.5.10.5);
b) the UTILIZATION UNITS field (see 9.10.5.10.3) to indicate the measurement units for the UTILIZATION A field and the UTILIZATION B field; and
c) the UTILIZATION INTERVAL field (see 9.10.5.10.4) to indicate the nominal reference time interval over which the values in the UTILIZATION A field and the UTILIZATION B field apply.

9.10.5.10.2 UTILIZATION TYPE field

The UTILIZATION TYPE field (see table 261) indicates the designed utilization characteristics for the device based on the contents of the UTILIZATION A field and the UTILIZATION B field (see 9.10.5.10.5) evaluated using the units indicated by the UTILIZATION UNITS field (see 9.10.5.10.3) over the time interval indicated by the UTILIZATION INTERVAL field (see 9.10.5.10.4).

Table 261 — UTILIZATION TYPE field

Value	Description
01h	**Combined writes and reads:** the UTILIZATION A field contains designed number of host requested write operations and host requested read operations. The UTILIZATION B field is reserved.
02h	**Writes only:** the UTILIZATION A field contains designed number of host requested write operations. The UTILIZATION B field is reserved.
03h	**Separate writes and reads:** the UTILIZATION A field contains designed number of host requested write operations. The UTILIZATION B field contains designed number of host requested read operations.
all other values	Reserved

9.10.5.10.3 UTILIZATION UNITS field

The UTILIZATION UNITS field (see table 262) indicates the units of measure for the values, if any, in the UTILIZATION A field and the UTILIZATION B field (see 9.10.5.10.5).

Table 262 — UTILIZATION UNITS field

Value	Description
02h	megabytes
03h	gigabytes
04h	terabytes
05h	petabytes
06h	exabytes
all other values	Reserved

9.10.5.10.4 UTILIZATION INTERVAL field

The UTILIZATION INTERVAL field (see table 263) indicates a nominal calendar time reference interval over which the values, if any, in the UTILIZATION A field and the UTILIZATION B field (see 9.10.5.10.5) may be applied.

Table 263 — UTILIZATION INTERVAL field

Value	Description
0Ah	per day
0Eh	per year
all other values	Reserved

9.10.5.10.5 UTILIZATION A field and UTILIZATION B field

The UTILIZATION A field and the UTILIZATION B field indicate the designed utilization characteristics for the device as:

a) defined by the UTILIZATION TYPE field (see 9.10.5.10.2);
b) expressed in the units defined by the UTILIZATION UNITS field (see 9.10.5.10.3); and
c) over the time interval defined by the UTILIZATION INTERVAL field (see 9.10.5.10.4).

9.10.5.11 Utilization Usage Rate Support

9.10.5.11.1 SETTING RATE BASIS SUPPORTED bit

If the SETTING RATE BASIS SUPPORTED bit (see table 252) is set to one, the device supports the Set Rate Basis subcommand (see 7.45.12) of the SET FEATURES command (see 7.45). If the SETTING RATE BASIS SUPPORTED bit is cleared to zero, the device does not support the Set Rate Basis subcommand.

9.10.5.11.2 SINCE POWER ON RATE BASIS SUPPORTED bit

If the SINCE POWER ON RATE BASIS SUPPORTED bit (see table 252) is set to one, the device supports a RATE BASIS field set to 8h in the Utilization Usage Rate device statistic (see 9.5.6.12). If the SINCE POWER ON RATE BASIS SUPPORTED bit is cleared to zero, the device does not support a RATE BASIS field set to 8h in the Utilization Usage Rate device statistic.

9.10.5.11.3 POWER ON HOURS RATE BASIS SUPPORTED bit

If the POWER ON HOURS RATE BASIS SUPPORTED bit (see table 252) is set to one, the device supports a RATE BASIS field set to 4h in the Utilization Usage Rate device statistic (see 9.5.6.12). If the POWER ON HOURS RATE BASIS SUPPORTED bit is cleared to zero, the device does not support a RATE BASIS field set to 4h in the Utilization Usage Rate device statistic.

9.10.5.11.4 DATE/TIME RATE BASIS SUPPORTED bit

If the DATE/TIME RATE BASIS SUPPORTED bit (see table 252) is set to one, the device supports a RATE BASIS field set to 0h in the Utilization Usage Rate device statistic (see 9.5.6.12). If the DATE/TIME RATE BASIS SUPPORTED bit is cleared to zero, the device does not support a RATE BASIS field set to 0h in the Utilization Usage Rate device statistic.

9.10.5.12 Supported ZAC-2 Capabilities

9.10.5.12.1 REPORT ZONES EXT SUPPORTED bit

A REPORT ZONES EXT SUPPORTED bit set to one indicates that the device supports the REPORT ZONES EXT command (see ZAC-2). A REPORT ZONES EXT SUPPORTED bit cleared to zero indicates that the device does not support the REPORT ZONES EXT command.

9.10.5.12.2 NON-DATA OPEN ZONE EXT SUPPORTED bit

A NON-DATA OPEN ZONE EXT SUPPORTED bit set to one indicates that the device supports the OPEN ZONE EXT command (see ZAC-2). A NON-DATA OPEN ZONE EXT SUPPORTED bit cleared to zero indicates that the device does not support the OPEN ZONE EXT command.

9.10.5.12.3 NON-DATA CLOSE ZONE EXT SUPPORTED bit

A NON-DATA CLOSE ZONE EXT SUPPORTED bit set to one indicates that the device supports the CLOSE ZONE EXT command (see ZAC-2). A NON-DATA CLOSE ZONE EXT SUPPORTED bit cleared to zero indicates that the device does not support the CLOSE ZONE EXT command.

9.10.5.12.4 NON-DATA FINISH ZONE EXT SUPPORTED bit

A NON-DATA FINISH ZONE EXT SUPPORTED bit set to one indicates that the device supports the FINISH ZONE EXT command (see ZAC-2). A NON-DATA FINISH ZONE EXT SUPPORTED bit cleared to zero indicates that the device does not support the FINISH ZONE EXT command.

9.10.5.12.5 NON-DATA RESET WRITE POINTERS EXT SUPPORTED bit

A NON-DATA RESET WRITE POINTERS EXT SUPPORTED bit set to one indicates that the device supports the RESET WRITE POINTERS EXT command (see ZAC-2). A NON-DATA RESET WRITE POINTERS EXT SUPPORTED bit cleared to zero indicates that the device does not support the RESET WRITE POINTERS EXT command.

9.10.5.12.6 SEQUENTIALIZE ZONE EXT SUPPORTED bit

A SEQUENTIALIZE ZONE EXT SUPPORTED bit set to one indicates that the device supports the SEQUENTIALIZE ZONE EXT command (see ZAC-2). A SEQUENTIALIZE ZONE EXT SUPPORTED bit cleared to zero indicates that the device does not support the SEQUENTIALIZE ZONE EXT command.

9.10.5.12.7 ZONE COUNT FOR RWP SUPPORTED bit

A ZONE COUNT FOR RWP SUPPORTED bit set to one indicates that the device supports a non-zero value in the ZONE COUNT field for the RESET WRITE POINTER EXT command (see ZAC-2). A ZONE COUNT FOR RWP SUPPORTED bit cleared to zero indicates that the ZONE COUNT field for the RESET WRITE POINTER command is reserved.

9.10.5.12.8 ZONE COUNT FOR FINISH SUPPORTED bit

A ZONE COUNT FOR FINISH SUPPORTED bit set to one indicates that the device supports a non-zero value in the ZONE COUNT field for the FINISH ZONE EXT command (see ZAC-2). A ZONE COUNT FOR FINISH SUPPORTED bit cleared to zero indicates that the ZONE COUNT field for the FINISH ZONE EXT command is reserved.

9.10.5.12.9 ZONE COUNT FOR OPEN ZONE SUPPORTED bit

A ZONE COUNT FOR OPEN SUPPORTED bit set to one indicates that the device supports a non-zero value in the ZONE COUNT field for the OPEN ZONE EXT command (see ZAC-2). A ZONE COUNT FOR OPEN SUPPORTED bit cleared to zero indicates that the ZONE COUNT field for the OPEN ZONE EXT command is reserved.

9.10.5.12.10 ZONE COUNT FOR CLOSE SUPPORTED bit

A ZONE COUNT FOR CLOSE SUPPORTED bit set to one indicates that the device supports a non-zero value in the ZONE COUNT field for the CLOSE ZONE EXT command (see ZAC-2). A ZONE COUNT FOR CLOSE SUPPORTED bit cleared to zero indicates that the ZONE COUNT field for the CLOSE ZONE EXT command is reserved.

9.10.5.13 Advanced background operations capabilities

9.10.5.13.1 ABO FOREGROUND MODE SUPPORTED bit

If the ABO FOREGROUND MODE SUPPORTED bit (see table 252) is set to one, then the device supports clearing the IR bit (see table 143) to zero in the SET FEATURES subcommand Advanced Background Operation Control (see 7.45.22). If the ABO FOREGROUND MODE SUPPORTED bit is cleared to zero, then the device does not support clearing the IR bit to zero.

9.10.5.13.2 ABO IR MODE SUPPORTED bit

If the ABO IR MODE SUPPORTED bit (see table 252) is set to one, then the device supports setting the IR bit to one in the SET FEATURES subcommand Advanced Background Operation Control (see 7.45.22). If the ABO IR MODE SUPPORTED bit is cleared to zero, then the device does not support setting the IR bit to one.

9.10.5.13.3 ABO MINIMUM FRACTION field

The ABO MINIMUM FRACTION field (see table 252) indicates the minimum fraction of the total device resources required to avoid device initiated advanced background operations. The abo minimum fraction value is the numerator of a fraction that has 65 535 (i.e., FFFFh) as the denominator.

9.10.5.13.4 ABO MIN TIMELIMIT field

The ABO MIN TIMELIMIT field (see table 252) indicates the minimum number of milliseconds that the device requires for advanced background operations and the minimum value that the ABO TIMELIMIT field should be set to for the SET FEATURES subcommand Advanced Background Operation Control (see 7.45.22). A value of zero indicates that there is no minimum value.

9.10.5.13.5 ABO MAX TIMELIMIT field

The ABO MAX TIMELIMIT field (see table 252) indicates the maximum number of milliseconds that that the device requires for advanced background operations and the maximum value that the ABO TIMELIMIT field should be set to for the SET FEATURES subcommand Advanced Background Operation Control. A value of zero indicates that there is no maximum value.

9.10.5.14 Advanced Background Operations settings

9.10.5.14.1 DEVICE MAINTENANCE POLLING TIME field

The DEVICE MAINTENANCE POLLING TIME field (see table 252) indicates how often the host should read the Device Maintenance schedule (see 9.10.6.10). The time is expressed in seconds. If the DEVICE MAINTENANCE POLLING TIME field is cleared to zero, then no recommended polling time is specified.

9.10.5.14.2 ABO RECOMMENDED ABO START INTERVAL field

If the ABO RECOMMENDED ABO START INTERVAL field (see table 252) is non-zero, then the device recommends that the host send the SET FEATURES subcommand Advanced Background Operation Control (see 7.45.22) to start host-initiated advanced background operations to the device on a regular basis. The time is expressed in seconds, and is the maximum regular time interval recommended between sending a SET FEATURES subcommand Advanced Background Operation Control to the device. If the ABO RECOMMENDED ABO START INTERVAL field is cleared to zero, then no recommended interval is specified.

9.10.5.15 QUEUE DEPTH field

The QUEUE DEPTH field indicates 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 the QUEUE DEPTH field shall be set to one less than the maximum queue depth (e.g., a value of zero indicates a queue depth of one, and a value of 31 indicates a queue depth of 32). If the NCQ FEATURE SET SUPPORTED bit (see 9.10.10.2.4) is cleared to zero indicating that the device does not support NCQ feature set commands, then the value in the QUEUE DEPTH field shall be cleared to zero. Support of this word is mandatory if the NCQ feature set is supported.

9.10.5.16 Supported SCT Capabilities

9.10.5.16.1 SCT SUPPORTED bit

If the SCT SUPPORTED bit is set to one, then the device supports the SCT Command Transport including SCT Read Status (see clause 8).

The IDENTIFY DEVICE data contains a copy of the SCT SUPPORTED bit (see IDENTIFY DEVICE data word 206 in table 57).

9.10.5.16.2 SCT WRITE SAME SUPPORTED bit

If the SCT WRITE SAME SUPPORTED bit is set to one, then the device supports SCT Write Same (see 8.3.2).

The IDENTIFY DEVICE data contains a copy of the SCT WRITE SAME SUPPORTED bit (see IDENTIFY DEVICE data word 206 in table 57).

9.10.5.16.3 SCT ERROR RECOVERY CONTROL SUPPORTED bit

If the SCT ERROR RECOVERY CONTROL SUPPORTED bit is set to one, then the device supports SCT Error Recovery Control (see 8.3.3).

The IDENTIFY DEVICE data contains a copy of the SCT ERROR RECOVERY CONTROL SUPPORTED bit (see IDENTIFY DEVICE data word 206 in table 57).

9.10.5.16.4 SCT FEATURE CONTROL SUPPORTED bit

If the SCT FEATURE CONTROL SUPPORTED bit is set to one, then the device supports SCT Feature Control (see 8.3.4).

The IDENTIFY DEVICE data contains a copy of the SCT FEATURE CONTROL SUPPORTED bit (see IDENTIFY DEVICE data word 206 in table 57).

9.10.5.16.5 SCT DATA TABLES SUPPORTED bit

If the SCT DATA TABLES SUPPORTED bit is set to one, then the device supports SCT Data Tables (see 8.3.5).

The IDENTIFY DEVICE data contains a copy of the SCT DATA TABLES SUPPORTED bit (see IDENTIFY DEVICE data word 206 in table 57).

9.10.5.16.6 SCT WRITE SAME FUNCTION 1 SUPPORTED bit

If the SCT WRITE SAME FUNCTION 1 SUPPORTED bit is set to one, then the device supports the SCT Write Same FUNCTION CODE field (see 8.3.2.3.1.1) set to 0001h.

9.10.5.16.7 SCT WRITE SAME FUNCTION 2 SUPPORTED bit

If the SCT WRITE SAME FUNCTION 2 SUPPORTED bit is set to one, then the device supports the SCT Write Same FUNCTION CODE field (see 8.3.2.3.1.2) set to 0002h.

9.10.5.16.8 SCT WRITE SAME FUNCTION 3 SUPPORTED bit

If the SCT WRITE SAME FUNCTION 3 SUPPORTED bit is set to one, then the device supports the SCT Write Same FUNCTION CODE field (see 8.3.2.3.1.3) set to 0003h.

9.10.5.16.9 SCT WRITE SAME FUNCTION 101 SUPPORTED bit

If the SCT WRITE SAME FUNCTION 101 SUPPORTED bit is set to one, then the device supports the SCT Write Same FUNCTION CODE field (see 8.3.2.3.2.1) set to 0101h.

9.10.5.16.10 SCT WRITE SAME FUNCTION 102 SUPPORTED bit

If the SCT WRITE SAME FUNCTION 102 SUPPORTED bit is set to one, then the device supports the SCT Write Same FUNCTION CODE field (see 8.3.2.3.2.2) set to 0102h.

9.10.5.16.11 SCT WRITE SAME FUNCTION 103 SUPPORTED bit

If the sct write same function 103 supported bit is set to one, then the device supports the SCT Write Same FUNCTION CODE field (see 8.3.2.3.2.3) set to 0103h.

9.10.5.17 Depopulation Capabilities

9.10.5.17.1 RESTORE ELEMENTS AND REBUILD SUPPORTED bit

A RESTORE ELEMENTS AND REBUILD SUPPORTED bit set to one indicates that the device supports the RESTORE ELEMENTS AND REBUILD command (see 7.35). A RESTORE ELEMENTS AND REBUILD SUPPORTED bit cleared to zero indicates that the device does not support the RESTORE ELEMENTS AND REBUILD command.

9.10.5.17.2 GET PHYSICAL ELEMENT STATUS SUPPORTED bit

A GET PHYSICAL ELEMENT STATUS SUPPORTED bit set to one indicates that the device supports the GET PHYSICAL ELEMENT STATUS command (see 7.12). A GET PHYSICAL ELEMENT STATUS SUPPORTED bit cleared to zero indicates that the device does not support the GET PHYSICAL ELEMENT STATUS command.

9.10.5.17.3 REMOVE ELEMENT AND TRUNCATE SUPPORTED bit

A REMOVE ELEMENT AND TRUNCATE SUPPORTED bit set to one indicates that the device supports the REMOVE ELEMENT AND TRUNCATE command (see 7.33). A REMOVE ELEMENT AND TRUNCATE SUPPORTED bit cleared to zero indicates that the device does not support the REMOVE ELEMENT AND TRUNCATE command.

9.10.5.18 DEPOPULATION TIME field

The DEPOPULATION TIME field indicates the maximum time in seconds from command acceptance of any REMOVE ELEMENT AND TRUNCATE command to completion of the actions specified in 4.26.3.2 as a result of repurposing depopulation.

9.10.5.19 Command Duration Limits feature settings

9.10.5.19.1 HIGH PRIORITY ENHANCEMENT SUPPORTED bit

If the HIGH PRIORITY ENHANCEMENT SUPPORTED bit (see table 252) is:

a) set to one, then the device supports the High Priority Enhancement feature (see 4.7.4); and
b) cleared to zero, then the device does not support the High Priority Enhancement feature.

9.10.5.19.2 COMMAND DURATION GUIDELINES SUPPORTED bit

For the following fields:

a) the PERFORMANCE VERSUS COMMAND DURATION GUIDELINES field (see 9.11.1.2);
b) the COMMAND DURATION GUIDELINE field (see 9.11.2.9); and
c) the COMMAND DURATION GUIDELINE POLICY field (see 9.11.2.4),

if the COMMAND DURATION GUIDELINES SUPPORTED bit (see table 252) is:

a) set to one, then the device supports these fields; and
b) cleared to zero, then the device does not support these fields.

If the COMMAND DURATION LIMITS SUPPORTED bit (see 9.10.5.19.3) is cleared to zero, then the COMMAND DURATION GUIDELINES SUPPORTED bit shall be cleared to zero.

9.10.5.19.3 COMMAND DURATION LIMITS SUPPORTED bit

If the COMMAND DURATION LIMITS SUPPORTED bit (see table 252) is set to one, the Command Duration Limits feature set (see 4.7) is supported. If the COMMAND DURATION LIMITS SUPPORTED bit is cleared to zero, the Command Duration Limits feature set is not supported, and the COMMAND DURATION LIMITS ENABLED bit shall be cleared to zero.

9.10.5.19.4 CDL MINIMUM TIME LIMIT field

The CDL MINIMUM TIME LIMIT field indicates the minimum non-zero time value, in microseconds, that the host may specify for time limits in a Command Duration Limits Descriptor (see 9.11.2).

9.10.5.19.5 CDL MAXIMUM TIME LIMIT field

The CDL MAXIMUM TIME LIMIT field indicates the maximum non-zero time value, in microseconds, that the host may specify for time limits in a Command Duration Limits Descriptor (see 9.11.2).

9.10.5.20 Vendor Specific Supported Capabilities

Vendor Specific Supported Capabilities QWord allows the device to indicate support for capabilities outside the scope of this standard. Bits 62:0 of the Vendor Specific Supported Capabilities QWord are vendor specific.

9.10.6 Current Settings (page 04h)

9.10.6.1 Overview

The Current Settings log page (see table 264) provides a mechanism for the device to report the current settings for feature sets, features, and other device capabilities.

Table 264 — Current Settings (Sheet 1 of 3)

Offset	Type	Bit	Content
0..7	QWord		Current Settings page information header
		Bit	**Description**
		63	Shall be set to one
		62:24	Reserved
		23:16	PAGE NUMBER field – shall be set to 04h
		15:0	REVISION NUMBER field (Word) – shall be set to 0001h
8..15	QWord		Current Settings
		Bit	**Description**
		63	Shall be set to one.
		62:23	Reserved
		22	HIGH PRIORITY ENHANCEMENT ENABLED bit (see 9.10.6.2.2)
		21	COMMAND DURATION LIMITS ENABLED bit (see 9.10.6.2.3)
		20	ROUNDING BEHAVIOR bit (see 9.10.6.2.4)
		19	FW ACTIVATION PENDING bit (see 9.10.6.2.5)
		18	SUCCESSFUL NCQ COMMAND SENSE DATA ENABLED bit (see 9.10.6.2.6)
		17	DLC ENABLED bit (see 9.10.6.2.7)
		16	DSN ENABLED bit (see 9.10.6.2.8)
		15	EPC ENABLED bit (see 9.10.6.2.9)
		14	Reserved
		13	VOLATILE WRITE CACHE ENABLED bit (see 9.10.6.2.10)
		12	Reserved
		11	REVERTING TO DEFAULTS ENABLED bit (see 9.10.6.2.11)
		10	SENSE DATA ENABLED bit (see 9.10.6.2.12)
		9	Reserved
		8	NON-VOLATILE WRITE CACHE bit (see 9.10.6.2.13)
		7	READ LOOK-AHEAD ENABLED bit (see 9.10.6.2.14)
		6	SMART ENABLED bit (see 9.10.6.2.15)
		5	Reserved
		4	Reserved
		3	PUIS ENABLED bit (see 9.10.6.2.16)
		2	APM ENABLED bit (see 9.10.6.2.17)
		1	FREE-FALL ENABLED bit (see 9.10.6.2.18)
		0	WRV ENABLED bit (see 9.10.6.2.19)

Table 264 — Current Settings (Sheet 2 of 3)

Offset	Type	Content	
16..23	QWord	Feature Settings	
		Bit	**Description**
		63	Contents of the QWord are valid
		62:16	Reserved
		17:16	POWER SOURCE field (see 9.10.6.3.1)
		15:8	APM LEVEL field (see 9.10.6.3.2)
		7:0	WRV MODE field (see 9.10.6.3.3)
24..31	QWord	DMA Host Interface Sector Times	
		Bit	**Description**
		63	Contents of the QWord are valid
		62:16	Reserved
		15:0	DMA SECTOR TIME field (see 9.10.6.4)
32..39	QWord	PIO Host Interface Sector Times	
		Bit	**Description**
		63	Contents of the QWord are valid
		62:16	Reserved
		15:0	PIO SECTOR TIME field (see 9.10.6.5)
40..47	QWord	Streaming minimum request size	
		Bit	**Description**
		63	Contents of the QWord are valid
		62:16	Reserved
		15:0	STREAM MIN REQUEST SIZE field (see 9.10.6.6)
48..55	QWord	Streaming access latency	
		Bit	**Description**
		63	Contents of the QWord are valid
		62:16	Reserved
		15:0	STREAM ACCESS LATENCY field (see 9.10.6.7)
56..63	QWord	Streaming Performance Granularity	
		Bit	**Description**
		63	Contents of the QWord are valid
		62:32	Reserved
		31:0	STREAM GRANULARITY field (see 9.10.6.8)
64..71	QWord	Free-fall Control Sensitivity	
		Bit	**Description**
		63	Contents of the QWord are valid
		62:8	Reserved
		7:0	FREE-FALL SENSITIVITY field (see 9.10.6.9)

Table 264 — Current Settings (Sheet 3 of 3)

Offset	Type	Content
72..79	QWord	Device Maintenance Schedule
		Bit **Description**
		63 Contents of the QWord are valid
		62:58 Reserved
		57:48 MINIMUM INACTIVE TIME IN MILLISECONDS field (see 9.10.6.10.3)
		47:32 TIME SCHEDULED FOR DEVICE MAINTENANCE field (see 9.10.6.10.1)
		31:16 TIME TO PERFORMANCE DEGRADATION field (see 9.10.6.10.2)
		15:0 MINIMUM INACTIVE TIME field (see 9.10.6.10.3)
80..87	QWord	Advanced Background Operations Settings
		Bit **Description**
		63 Contents of the QWord are valid
		62:8 Reserved
		7:0 ABO STATUS field (see 9.10.6.11.1)
88..511		Reserved

9.10.6.2 Current Settings

9.10.6.2.1 Overview

Current Settings indicate features, feature sets and command sets that are enabled.

9.10.6.2.2 HIGH PRIORITY ENHANCEMENT ENABLED bit

If the HIGH PRIORITY ENHANCEMENT ENABLED bit (see table 264) is set to one, then the High Priority Enhancement feature (see 4.7.4) is enabled. If the HIGH PRIORITY ENHANCEMENT ENABLED bit is cleared to zero, then the High Priority Enhancement feature set is disabled. The SET FEATURES Enable/Disable Command Duration Limits feature set subcommand (see 7.45.10) may be used to change the value of this bit. The value of the HIGH PRIORITY ENHANCEMENT ENABLED bit persists across power-on resets.

9.10.6.2.3 COMMAND DURATION LIMITS ENABLED bit

If the COMMAND DURATION LIMITS ENABLED bit (see table 264) is set to one, then the Command Duration Limits feature set is enabled. If the COMMAND DURATION LIMITS ENABLED bit is cleared to zero, then the Command Duration Limits feature set is disabled. The SET FEATURES Enable/Disable Command Duration Limits feature set subcommand (see 7.45.10) may be used to change the value of this bit. The value of the COMMAND DURATION LIMITS ENABLED bit persists across power-on resets.

9.10.6.2.4 ROUNDING BEHAVIOR bit

The ROUNDING BEHAVIOR bit indicates the rounding behavior for the Command Duration Limits feature set as described in 9.11.2.5 and 9.11.2.6.

9.10.6.2.5 Firmware activation is pending (FW ACTIVATION PENDING bit)

If the FW ACTIVATION PENDING bit (see table 264) is set to one, then the device has deferred microcode (see 7.7.2.1). If the FW ACTIVATION PENDING bit is cleared to zero, then no information is indicated.

9.10.6.2.6 SUCCESSFUL NCQ COMMAND SENSE DATA ENABLED bit

If the SUCCESSFUL NCQ COMMAND SENSE DATA ENABLED bit is set to one, the returning of sense data (see 4.24) for NCQ commands (see 4.15) that the device completes without an error using the Sense Data for Successful NCQ Commands log (see 9.28) is enabled (see 7.45.18). If the SUCCESSFUL NCQ COMMAND SENSE DATA ENABLED bit is cleared to zero, the returning of sense data for NCQ commands that the device completes without an error is disabled.

9.10.6.2.7 DLC ENABLED bit

If the DLC ENABLED bit is set to one, device life control is enabled (see 7.45.9). If the DLC ENABLED bit is cleared to zero, device life control is disabled.

9.10.6.2.8 The DSN feature set is enabled (DSN ENABLED bit)

If the DSN ENABLED bit (see table 264) is set to one, then the DSN feature set (see 4.8) is enabled (see 7.45.21.2). If the DSN ENABLED bit is cleared to zero, then the DSN feature set is disabled.

The IDENTIFY DEVICE data contains a copy of the DSN ENABLED bit (see IDENTIFY DEVICE data word 120 in table 57).

9.10.6.2.9 The EPC feature set is enabled (EPC ENABLED bit)

If the EPC ENABLED bit (see table 264) is set to one, then the EPC feature set is enabled (see 7.45.20.6). If the EPC ENABLED bit is enabled is cleared to zero, then the EPC feature set is disabled (see 7.45.20.7).

The IDENTIFY DEVICE data contains a copy of the EPC ENABLED bit (see IDENTIFY DEVICE data word 120 in table 57).

9.10.6.2.10 Volatile write cache is enabled (VOLATILE WRITE CACHE ENABLED bit)

If the VOLATILE WRITE CACHE ENABLED bit (see table 264) is set to one, then volatile write cache is enabled (see 7.45.3). If the VOLATILE WRITE CACHE ENABLED bit is cleared to zero, then volatile write cache is disabled.

The VOLATILE WRITE CACHE ENABLED bit is only valid if the VOLATILE WRITE CACHE SUPPORTED bit (see 9.10.5.2.13) is set to one (i.e., write cache is supported).

The IDENTIFY DEVICE data contains a copy of the VOLATILE WRITE CACHE ENABLED bit (see IDENTIFY DEVICE data word 85 in table 57).

9.10.6.2.11 Reverting to defaults is enabled (REVERTING TO DEFAULTS ENABLED bit)

If the REVERTING TO DEFAULTS ENABLED bit (see table 264) is set to one, then Reverting to defaults is enabled (see 7.45.14). If the REVERTING TO DEFAULTS ENABLED bit is cleared to zero, then Reverting to defaults is disabled.

9.10.6.2.12 Sense Data Reporting is enabled (SENSE DATA ENABLED bit)

If the SENSE DATA ENABLED bit (see table 264) is set to one, the Sense Data Reporting feature set (see 4.24) is enabled. If the SENSE DATA ENABLED bit is cleared to zero, the Sense Data Reporting feature set is disabled.

The IDENTIFY DEVICE data contains a copy of the SENSE DATA ENABLED bit (see IDENTIFY DEVICE data word 120 in table 57).

9.10.6.2.13 All write cache is non-volatile (NON-VOLATILE WRITE CACHE bit)

If the NON-VOLATILE WRITE CACHE bit (see table 264) is set to one, then all of the write cache on the device is non-volatile. If the NON-VOLATILE WRITE CACHE bit is cleared to zero, then the write cache may be volatile.

If the write cache changes from non-volatile to volatile, then the device should disable the volatile write cache.

The IDENTIFY DEVICE data contains a copy of the NON-VOLATILE WRITE CACHE bit (see IDENTIFY DEVICE data word 69 in table 57).

9.10.6.2.14 Read look-ahead is enabled (READ LOOK-AHEAD ENABLED bit)

If the READ LOOK-AHEAD ENABLED bit (see table 264) is set to one, then read look-ahead is enabled (see 7.45.13). If the READ LOOK-AHEAD ENABLED bit is cleared to zero, then read look-ahead is disabled. The READ LOOK-AHEAD ENABLED bit is valid if the READ LOOK-AHEAD SUPPORTED bit (see 9.10.5.2.12) is set to one indicating read look-ahead is supported.

The IDENTIFY DEVICE data contains a copy of the READ LOOK-AHEAD ENABLED bit (see IDENTIFY DEVICE data word 85 in table 57).

9.10.6.2.15 The SMART feature set is enabled (SMART ENABLED bit)

If the SMART ENABLED bit (see table 264) is set to one, then the SMART feature set is enabled (see 4.23). If the SMART ENABLED bit is cleared to zero, then the SMART feature set is disabled. The SMART ENABLED bit is valid if SMART bit (see 9.10.5.2.14) is set to one indicating SMART feature set is supported.

The IDENTIFY DEVICE data contains a copy of the SMART ENABLED bit (see IDENTIFY DEVICE data word 85 in table 57).

9.10.6.2.16 The PUIS feature set is enabled (PUIS ENABLED bit)

If the PUIS ENABLED bit (see table 264) is set to one, then the PUIS feature set is enabled (see 7.45.6). If the PUIS ENABLED bit is cleared to zero, then the PUIS feature set is disabled.

The PUIS ENABLED bit is only valid if the PUIS SUPPORTED bit (see 9.10.5.2.18) is set to one (i.e., the PUIS feature set is supported).

The IDENTIFY DEVICE data contains a copy of the PUIS ENABLED bit (see IDENTIFY DEVICE data word 86 in table 57).

9.10.6.2.17 The APM feature set is enabled (APM ENABLED bit)

If the APM ENABLED bit (see table 264) is set to one, then the APM feature set is enabled (see 7.45.5). If the APM ENABLED bit is cleared to zero, the APM feature set is disabled.

The IDENTIFY DEVICE data contains a copy of the APM ENABLED bit (see IDENTIFY DEVICE data word 86 in table 57).

9.10.6.2.18 The Free-fall Control feature set is enabled (FREE-FALL ENABLED bit)

If the FREE-FALL ENABLED bit (see table 264) is set to one, then the Free-fall Control feature set (see 4.10) is enabled. If the FREE-FALL ENABLED bit is cleared to zero, then the Free-fall Control feature set is disabled.

The IDENTIFY DEVICE data contains a copy of the FREE-FALL ENABLED bit (see IDENTIFY DEVICE data word 120 in table 57).

9.10.6.2.19 The Write-Read-Verify feature set is enabled (WRV ENABLED bit)

If the WRV ENABLED bit (see table 264) is set to one, then the Write-Read-Verify feature set (see 4.30) is enabled. If the WRV ENABLED bit is cleared to zero, then the Write-Read-Verify feature set is disabled.

The IDENTIFY DEVICE data contains a copy of the WRV ENABLED bit (see IDENTIFY DEVICE data word 120 in table 57).

9.10.6.3 Feature Settings

9.10.6.3.1 Power Source (POWER SOURCE field)

The POWER SOURCE field (see table 265) indicates the current source of power set by the host.

Table 265 — POWER SOURCE field

Value	Description
00b	Unknown
01b	Battery
10b	Not Battery
11b	Reserved

If the device has not processed a SET FEATURES command with the EPC Subcommand and the Set EPC Power Source function (see 7.45.20.8), then the device shall indicate a value of 00b (i.e., Unknown).

9.10.6.3.2 APM Level (APM LEVEL field)

The APM LEVEL field (see table 264) contains the current APM level setting (see table 126). Support of the APM LEVEL field is mandatory if the APM feature set (see 4.6) is supported. The APM LEVEL field is only valid if the APM SUPPORTED bit (see 9.10.5.2.19) is set to one and the APM ENABLED bit (see 9.10.6.2.17) is set to one.

The IDENTIFY DEVICE data contains a copy of the APM LEVEL field (see IDENTIFY DEVICE data word 91 in table 57).

9.10.6.3.3 Current mode of the Write-Read-Verify feature set (WRV MODE field)

The WRV MODE field (see table 264) contains the current mode of the Write-Read-Verify feature set, as set by the SET FEATURES Enable/Disable Write-Read-Verify subcommand. See 7.45.8 for more information on setting Write-Read-Verify mode.

The IDENTIFY DEVICE data contains a copy of the WRV MODE field (see IDENTIFY DEVICE data word 220 in table 57).

9.10.6.4 DMA Host Interface Sector Times (DMA SECTOR TIME field)

The DMA SECTOR TIME field (see table 264) 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 = the contents of the STREAM GRANULARITY field (see 9.10.6.8); and
y = Streaming Transfer Time for DMA mode.

The content of the DMA SECTOR TIME field may be affected by the host issuing a Set Maximum Host Interface Sector Times command (see 7.45.11). As a result, the host should determine the current contents of the DMA SECTOR TIME field after issuing a SET FEATURES command that may affect this field.

The DMA SECTOR TIME field is valid if the STREAMING SUPPORTED bit (see 9.10.5.2.24) is set to one. If the STREAMING SUPPORTED bit is cleared to zero, then the DMA SECTOR TIME field shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the DMA SECTOR TIME field (see IDENTIFY DEVICE data word 96 in table 57).

9.10.6.5 PIO Host Interface Sector Times (PIO SECTOR TIME field)

The PIO SECTOR TIME field (see table 264) 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 = the contents of the STREAM GRANULARITY field (see 9.10.6.8); and
y = Streaming Transfer Time for PIO mode.

The content of the PIO SECTOR TIME field may be affected by the host issuing a Set Maximum Host Interface Sector Times command (see 7.45.11). As a result, the host should determine the current contents of the PIO SECTOR TIME field after issuing a SET FEATURES command that may affect this field.

The PIO SECTOR TIME field is valid if the STREAMING SUPPORTED bit (see 9.10.5.2.24) is set to one. If the STREAMING SUPPORTED bit is cleared to zero, then the PIO SECTOR TIME field shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the PIO SECTOR TIME field (see IDENTIFY DEVICE data word 104 in table 57).

9.10.6.6 Streaming minimum request size (STREAM MIN REQUEST SIZE field)

The STREAM MIN REQUEST SIZE field (see table 264) 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.

The STREAM MIN REQUEST SIZE field is valid if the STREAMING SUPPORTED bit (see 9.10.5.2.24) is set to one. If the STREAMING SUPPORTED bit is cleared to zero, then the STREAM MIN REQUEST SIZE field shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the STREAM MIN REQUEST SIZE field (see IDENTIFY DEVICE data word 95 in table 57).

9.10.6.7 Streaming access latency (STREAM ACCESS LATENCY field)

The STREAM ACCESS LATENCY field (see table 264) 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 = the contents of the STREAM GRANULARITY field (see 9.10.6.8); and
y = Streaming Access Latency for DMA and PIO mode.

The content of the STREAM ACCESS LATENCY field may be affected by the host issuing a Set Maximum Host Interface Sector Times command (see 7.45.11). As a result, the host should determine the current contents of the STREAM ACCESS LATENCY field after issuing a SET FEATURES command that may affect this field.

The STREAM ACCESS LATENCY field is valid if the STREAMING SUPPORTED bit (see 9.10.5.2.24) is set to one. If the STREAMING SUPPORTED bit is cleared to zero, then the STREAM ACCESS LATENCY field shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the STREAM ACCESS LATENCY field (see IDENTIFY DEVICE data word 97 in table 57).

9.10.6.8 Streaming Performance Granularity (STREAM GRANULARITY field)

The STREAM GRANULARITY field (see table 264) defines the fixed unit of time that is used:

a) by the SET FEATURES subcommand Set Maximum Host Interface Sector Times (see 7.45.11) to compute the:
   A) DMA SECTOR TIME field (see 9.10.6.4);
   B) PIO SECTOR TIME Field (see 9.10.6.5); and
   C) STREAM ACCESS LATENCY field (see 9.10.6.7);
   and
b) 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 ms).

If contents of the STREAM GRANULARITY field are represented by the variable yy, 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) ((contents of the DMA SECTOR TIME field (see 9.10.6.4)) × (yy / 65 536)) microseconds; or
   B) ((contents of the PIO SECTOR TIME Field (see 9.10.6.5)) × (yy / 65 536)) microseconds;
c) the Streaming Access Latency shall be ((contents of the STREAM ACCESS LATENCY field (see 9.10.6.7)) × (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 (((contents of the PIO SECTOR TIME Field) × S / 65 536) + ((contents of the STREAM ACCESS LATENCY field)/ 256)) × yy microseconds; or
   B) for DMA (((contents of the DMA SECTOR TIME field) × S / 65 536) + ((contents of the STREAM ACCESS LATENCY field) / 256)) × yy microseconds.

The contents of the STREAM GRANULARITY field is vendor specific and fixed for a device.

The STREAM GRANULARITY field is valid if the STREAMING SUPPORTED bit (see 9.10.5.2.24) is set to one.

The IDENTIFY DEVICE data contains a copy of the STREAM GRANULARITY field (see IDENTIFY DEVICE data words 98..99 in table 57).

9.10.6.9 Free-fall Control Sensitivity (FREE-FALL SENSITIVITY field)

The FREE-FALL SENSITIVITY field (see table 264) indicates sensitivity of the free-fall detection in the Free-fall Control feature set (see 4.10). The sensitivity is selected on a scale from 00h to FFh. A value of zero selects the device manufacturer's recommended setting. Other values are vendor specific. The higher the sensitivity value, the more sensitive the device is to changes in acceleration.

The FREE-FALL SENSITIVITY field is valid if the FREE-FALL SUPPORTED bit (see 9.10.5.2.29) is set to one and the FREE-FALL ENABLED bit (see 9.10.6.2.18) is set to one.

The IDENTIFY DEVICE data contains a copy of the FREE-FALL SENSITIVITY field (see IDENTIFY DEVICE data word 53 in table 57).

9.10.6.10 Device Maintenance Schedule

9.10.6.10.1 TIME SCHEDULED FOR DEVICE MAINTENANCE field

The device shall set the TIME SCHEDULED FOR DEVICE MAINTENANCE field (see table 264) 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.

9.10.6.10.2 TIME TO PERFORMANCE DEGRADATION field

The device shall set the TIME TO PERFORMANCE DEGRADATION field (see table 264) 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.

9.10.6.10.3 MINIMUM INACTIVE TIME field and MINIMUM INACTIVE TIME IN MILLISECONDS field

The MINIMUM INACTIVE TIME field is a value in seconds. The MINIMUM INACTIVE TIME IN MILLISECONDS field is a value in milliseconds. The device shall set the MINIMUM INACTIVE TIME field (see table 264) and MINIMUM INACTIVE TIME IN MILLISECONDS field to the minimum time that the host should avoid sending commands. The sum of these fields indicates the minimum time that the device requires to make progress on internal maintenance.

9.10.6.11 Advanced Background Settings

9.10.6.11.1 Advanced Background Operations Status (ABO STATUS field)

The ADVANCED BACKGROUND OPERATION STATUS field indicates the type of advanced background operations, if any, that are being performed by the device, as defined in table 266.

Table 266 — ABO STATUS field

Code	Description
00h	No indication provided
01h	No advanced background operations are being performed.
02h	Advanced background operations are active and were started by the host.
03h	Advanced background operations are active and were started by the device.
04h..FFh	Reserved

9.10.7 Strings (page 05h)

9.10.7.1 Overview

The Strings log page (see table 267) provides a mechanism for the device to report ATA String based information.

Table 267 — Strings

Offset	Type	Content
0..7	QWord	Strings page information header
		Bit **Description**
		63 Shall be set to one
		62:24 Reserved
		23:16 PAGE NUMBER field – Shall be set to 05h
		15:0 REVISION NUMBER field (Word) – Shall be set to 0001h
8..27	ATA String	SERIAL NUMBER field (see 9.10.7.2)
28..31		Reserved
32..39	ATA String	FIRMWARE REVISION field (see 9.10.7.3)
40..47		Reserved
48..87	ATA String	MODEL NUMBER field (see 9.10.7.4)
88..95		Reserved
96..103	ATA String	ADDITIONAL PRODUCT IDENTIFIER field (see 9.10.7.5)
104..511		Reserved

9.10.7.2 SERIAL NUMBER field

The SERIAL NUMBER field contains the serial number of the device. The contents of the SERIAL NUMBER field is an ATA string of twenty bytes in the format defined by 3.4.9. 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 the serial number and model number (see 9.10.7.4) shall be unique for a given manufacturer.

The IDENTIFY DEVICE data contains a copy of the SERIAL NUMBER field (see IDENTIFY DEVICE data words 10..19 in table 57).

9.10.7.3 FIRMWARE REVISION field

The FIRMWARE REVISION field contains the firmware revision of the device. The contents of the FIRMWARE REVISION field is an ATA string of eight bytes in the format defined by 3.4.9. The device shall pad the string with spaces (20h), if necessary, to ensure that the string is the proper length.

The IDENTIFY DEVICE data contains a copy of the FIRMWARE REVISION field (see IDENTIFY DEVICE data words 23..26 in table 57).

9.10.7.4 MODEL NUMBER field

The MODEL NUMBER field contains the model number of the device. The contents of the MODEL NUMBER field is an ATA string of forty bytes in the format defined by 3.4.9. 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 the serial number (see 9.10.7.2) and the model number shall be unique for a given manufacturer.

The IDENTIFY DEVICE data contains a copy of the MODEL NUMBER field (see IDENTIFY DEVICE data words 27..46 in table 57).

9.10.7.5 ADDITIONAL PRODUCT IDENTIFIER field

The ADDITIONAL PRODUCT IDENTIFIER field contains the additional product identifier for the device. The contents of the ADDITIONAL PRODUCT IDENTIFIER field is an ATA string of eight bytes in the format defined by 3.4.9. 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 the ADDITIONAL PRODUCT IDENTIFIER field is reserved.

The IDENTIFY DEVICE data contains a copy of the ADDITIONAL PRODUCT IDENTIFIER field (see IDENTIFY DEVICE data words 170..173 in table 57).

9.10.8 Security (page 06h)

9.10.8.1 Overview

The Security log page (see table 268) provides a mechanism for the device to report Security based information.

Table 268 — Security (Sheet 1 of 2)

Offset	Type	Content	
0..7	QWord	Security page information header	
		Bit	**Description**
		63	Shall be set to one
		62:24	Reserved
		23:16	PAGE NUMBER field – shall be set to 06h
		15:0	REVISION NUMBER field (Word) – shall be set to 0001h
8..15	QWord	Master Password Identifier	
		Bit	**Description**
		63	Contents of the QWord are valid.
		62:16	Reserved
		15:0	MASTER PASSWORD IDENTIFIER field (see 9.10.8.2)
16..23	QWord	Security Status	
		Bit	**Description**
		63	Contents of the QWord are valid
		62:7	Reserved
		6	SECURITY SUPPORTED bit (see 9.10.8.3.1)
		5	MASTER PASSWORD CAPABILITY bit (see 9.10.8.3.2)
		4	ENHANCED SECURITY ERASE SUPPORTED bit (see 9.10.8.3.3)
		3	SECURITY COUNT EXPIRED bit (see 9.10.8.3.4)
		2	SECURITY FROZEN bit (see 9.10.8.3.5)
		1	SECURITY LOCKED bit (see 9.10.8.3.6)
		0	SECURITY ENABLED bit (see 9.10.8.3.7)
24..31	QWord	Time required for an Enhanced Erase mode SECURITY ERASE UNIT command	
		Bit	**Description**
		63	Contents of the QWord are valid
		62:16	Reserved
		15	ENHANCED SECURITY ERASE TIME FORMAT bit (see 9.10.8.4)
		14:0	ENHANCED SECURITY ERASE TIME field (see 9.10.8.4)

Table 268 — Security (Sheet 2 of 2)

Offset	Type	Content
32..39	QWord	Time required for a Normal Erase mode SECURITY ERASE UNIT command **Bit Description** 63 Contents of the QWord are valid 62:16 Reserved 15 NORMAL SECURITY ERASE TIME FORMAT bit (see 9.10.8.5) 14:0 NORMAL SECURITY ERASE TIME field (see 9.10.8.5)
40..47	QWord	Trusted Computing feature set **Bit Description** 63 Contents of the QWord are valid 62:1 Reserved 0 TRUSTED COMPUTING SUPPORTED bit (see 9.10.8.6)
48..55	QWord	Security Capabilities **Bit Description** 63 Contents of the QWord are valid 62:8 Reserved 7 RESTRICTED SANITIZE OVERRIDES SECURITY bit (see 9.10.8.7.8) 6 COMMANDS ALLOWED BY SANITIZE bit (see 9.10.8.7.7) 5 SANITIZE ANTIFREEZE LOCK SUPPORTED bit (see 9.10.8.7.5) 4 BLOCK ERASE SUPPORTED bit (see 9.10.8.7.1) 3 OVERWRITE SUPPORTED bit (see 9.10.8.7.2) 2 CRYPTO SCRAMBLE SUPPORTED bit (see 9.10.8.7.3) 1 SANITIZE SUPPORTED bit (see 9.10.8.7.4) 0 ENCRYPT ALL SUPPORTED bit (see 9.10.8.7.6)
56..511		Reserved

9.10.8.2 Master Password Identifier (MASTER PASSWORD IDENTIFIER field)

If the SECURITY SUPPORTED bit (see 9.10.8.3.1) is cleared to zero (i.e., if the Security feature set (see 4.22) is not supported) or the Master Password Identifier feature is not supported, then the MASTER PASSWORD IDENTIFIER field shall contain 0000h or FFFFh.

If the SECURITY SUPPORTED bit is set to one and the Master Password Identifier feature is supported, then the processing of a SECURITY SET PASSWORD command with the IDENTIFIER bit set to one (see 7.41), alters the contents of the MASTER PASSWORD IDENTIFIER field as described in 7.41.2.2 based on the model described in 4.22.10.

The IDENTIFY DEVICE data contains a copy of the MASTER PASSWORD IDENTIFIER field (see IDENTIFY DEVICE data word 92 in table 57).

9.10.8.3 Security Status

9.10.8.3.1 The Security feature set is supported (SECURITY SUPPORTED bit)

If the SECURITY SUPPORTED bit (see table 268) is set to one, then the Security feature set (see 4.22) is supported. If the SECURITY SUPPORTED bit is cleared to zero, then the Security feature set is not supported.

The IDENTIFY DEVICE data contains a copy of the SECURITY SUPPORTED bit (see IDENTIFY DEVICE data word 128 in table 57).

9.10.8.3.2 Master Password Capability (MASTER PASSWORD CAPABILITY bit)

The MASTER PASSWORD CAPABILITY bit (see table 268) indicates the Master Password Capability. If security is enabled (see 9.10.8.3.7), then:

a) the MASTER PASSWORD CAPABILITY bit cleared to zero indicates that the Master Password Capability is High; and
b) the MASTER PASSWORD CAPABILITY bit set to one indicates that the Master Password Capability is Maximum.

If security is disabled, then the MASTER PASSWORD CAPABILITY bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the MASTER PASSWORD CAPABILITY bit (see IDENTIFY DEVICE data word 128 in table 57).

9.10.8.3.3 Enhanced security erase supported (ENHANCED SECURITY ERASE SUPPORTED bit)

If the ENHANCED SECURITY ERASE SUPPORTED bit (see table 268) is set to one, the enhanced mode of the SECURITY ERASE UNIT command (see 7.39) is supported. If the ENHANCED SECURITY ERASE SUPPORTED bit is cleared to zero, the enhanced mode of the SECURITY ERASE UNIT command is not supported.

The IDENTIFY DEVICE data contains a copy of the ENHANCED SECURITY ERASE SUPPORTED bit (see IDENTIFY DEVICE data word 128 in table 57).

9.10.8.3.4 Security count expired (SECURITY COUNT EXPIRED bit)

If the SECURITY COUNT EXPIRED bit (see table 268) is set to one, the password attempt counter (see 4.22.9) has decremented to zero. If the SECURITY COUNT EXPIRED bit is cleared to zero, the password attempt counter is greater than zero.

The IDENTIFY DEVICE data contains a copy of the SECURITY COUNT EXPIRED bit (see IDENTIFY DEVICE data word 128 in table 57).

9.10.8.3.5 Security frozen (SECURITY FROZEN bit)

If the SECURITY FROZEN bit (see table 268) is set to one, security is frozen (see 4.22.5). If the SECURITY FROZEN bit is cleared to zero, security is not frozen.

The IDENTIFY DEVICE data contains a copy of the SECURITY FROZEN bit (see IDENTIFY DEVICE data word 128 in table 57).

9.10.8.3.6 Security locked (SECURITY LOCKED bit)

If the SECURITY LOCKED bit (see table 268) is set to one, security is locked. If the SECURITY LOCKED bit is cleared to zero, security is not locked.

The IDENTIFY DEVICE data contains a copy of the SECURITY LOCKED bit (see IDENTIFY DEVICE data word 128 in table 57).

9.10.8.3.7 Security enabled (SECURITY ENABLED bit)

If the SECURITY ENABLED bit (see table 268) is set to one, security has been enabled by setting a User password (see 4.22.3.2) via the SECURITY SET PASSWORD command (see 7.41). If the SECURITY ENABLED bit is cleared to zero, there is no valid User password.

If the Security feature set is not supported, the SECURITY ENABLED bit shall be cleared to zero. The SECURITY ENABLED bit is valid if the SECURITY SUPPORTED bit (see 9.10.8.3.1) is set to one indicating Security feature set is supported.

The IDENTIFY DEVICE data contains a copy of the SECURITY ENABLED bit (see IDENTIFY DEVICE data word 128 in table 57).

9.10.8.4 Time required for an Enhanced Erase mode SECURITY ERASE UNIT command (ENHANCED SECURITY ERASE TIME FIELD)

The ENHANCED SECURITY ERASE TIME field (see table 268) specifies the estimated time required for the SECURITY ERASE UNIT command to complete an enhanced mode erasure.

The ENHANCED SECURITY ERASE TIME FORMAT bit (see table 268) indicates the format used to express the time as follows:

a) if the ENHANCED SECURITY ERASE TIME FORMAT bit is cleared to zero, then the estimated time is defined in table 269; and
b) if the ENHANCED SECURITY ERASE TIME FORMAT bit is set to one, then the estimated time is defined in table 270.

If the Security feature set (see 4.22) is supported, then the ENHANCED SECURITY ERASE TIME field shall be supported. If the Security feature set is not supported, then the ENHANCED SECURITY ERASE TIME field shall be cleared to zero.

Table 269 — Short format ENHANCED SECURITY ERASE TIME field

Value	Time
0	Value not specified
1..254	(Value×2) minutes
255	>508 min

Table 270 — Extended format ENHANCED SECURITY ERASE TIME field

Value	Time
0	Value not specified
1..32766	(Value×2) minutes
32767	>65532 min

The IDENTIFY DEVICE data contains a copy of the ENHANCED SECURITY ERASE TIME field (see IDENTIFY DEVICE data word 90 in table 57).

9.10.8.5 Time required for a Normal Erase mode SECURITY ERASE UNIT command (NORMAL SECURITY ERASE TIME field)

The NORMAL SECURITY ERASE TIME field (see table 268) specifies the estimated time required for the SECURITY ERASE UNIT command to complete a normal mode erasure.

The NORMAL SECURITY ERASE TIME FORMAT bit (see table 268) indicates the format used to express the time as follows:

a) if the NORMAL SECURITY ERASE TIME FORMAT bit is cleared to zero, then the estimated time is defined in table 271; and
b) if the NORMAL SECURITY ERASE TIME FORMAT bit is set to one, then the estimated time is defined in table 272.

If the Security feature set (see 4.22) is supported, then the NORMAL SECURITY ERASE TIME field shall be supported. If the Security feature set is not supported, then the NORMAL SECURITY ERASE TIME field shall be cleared to zero.

Table 271 — Short format NORMAL SECURITY ERASE TIME field

Value	Time
0	Value not specified
1..254	(Value×2) min
255	>508 min

Table 272 — Extended format NORMAL SECURITY ERASE TIME field

Value	Time
0	Value not specified
1..32766	(Value×2) min
32767	>65 532 min

The IDENTIFY DEVICE data contains a copy of the NORMAL SECURITY ERASE TIME field (see IDENTIFY DEVICE data word 89 in table 57).

9.10.8.6 Trusted Computing feature set supported (TRUSTED COMPUTING SUPPORTED bit)

If the TRUSTED COMPUTING SUPPORTED bit (see table 268) is set to one, the Trusted Computing feature set (see 4.28) is supported. If the TRUSTED COMPUTING SUPPORTED bit is cleared to zero, the Trusted Computing feature set is not supported.

The IDENTIFY DEVICE data contains a copy of the TRUSTED COMPUTING SUPPORTED bit (see IDENTIFY DEVICE data word 48 in table 57).

9.10.8.7 Security Capabilities

9.10.8.7.1 BLOCK ERASE EXT command is supported (BLOCK ERASE SUPPORTED bit)

If the BLOCK ERASE SUPPORTED bit (see table 268) is set to one, the device supports the Sanitize Device feature set BLOCK ERASE EXT command (see 7.36.2). If the BLOCK ERASE SUPPORTED bit is cleared to zero, the device does not support the Sanitize Device feature set BLOCK ERASE EXT command.

The IDENTIFY DEVICE data contains a copy of the BLOCK ERASE SUPPORTED bit (see IDENTIFY DEVICE data word 59 in table 57).

9.10.8.7.2 OVERWRITE EXT command is supported (OVERWRITE SUPPORTED bit)

If the OVERWRITE SUPPORTED bit (see table 268) is set to one, the device supports the Sanitize Device feature set OVERWRITE EXT command (see 7.36.4). If the OVERWRITE SUPPORTED bit is cleared to zero, the device does not support the Sanitize Device feature set OVERWRITE EXT command.

The IDENTIFY DEVICE data contains a copy of the OVERWRITE SUPPORTED bit (see IDENTIFY DEVICE data word 59 in table 57).

9.10.8.7.3 CRYPTO SCRAMBLE EXT command is supported (CRYPTO SCRAMBLE SUPPORTED bit)

If the CRYPTO SCRAMBLE SUPPORTED bit (see table 268) is set to one, the device supports the Sanitize Device feature set CRYPTO SCRAMBLE EXT command (see 7.36.3). If the CRYPTO SCRAMBLE SUPPORTED bit is cleared to zero, the device does not support the Sanitize Device feature set CRYPTO SCRAMBLE EXT command.

The IDENTIFY DEVICE data contains a copy of the CRYPTO SCRAMBLE SUPPORTED bit (see IDENTIFY DEVICE data word 59 in table 57).

9.10.8.7.4 Sanitize Device feature set is supported (SANITIZE SUPPORTED bit)

If SANITIZE SUPPORTED bit (see table 268) is set to one, the device supports the Sanitize Device feature set (see 4.20). If SANITIZE SUPPORTED bit is cleared to zero, the device does not support the Sanitize Device feature set.

The IDENTIFY DEVICE data contains a copy of the SANITIZE SUPPORTED bit (see IDENTIFY DEVICE data word 59 in table 57).

9.10.8.7.5 SANITIZE ANTIFREEZE LOCK EXT command is supported (SANITIZE ANTIFREEZE SUPPORTED bit)

If the SANITIZE ANTIFREEZE LOCK SUPPORTED bit (see table 268) is set to one, the device supports the Sanitize Device feature set SANITIZE ANTIFREEZE LOCK command (see 7.36.5). If the SANITIZE ANTIFREEZE LOCK SUPPORTED bit is cleared to zero, the device does not support the Sanitize Device feature set SANITIZE ANTIFREEZE LOCK command.

The IDENTIFY DEVICE data contains a copy of the SANITIZE ANTIFREEZE LOCK SUPPORTED bit (see IDENTIFY DEVICE data word 59 in table 57).

9.10.8.7.6 Device Encrypts All User Data (ENCRYPT ALL SUPPORTED bit)

If the ENCRYPT ALL SUPPORTED bit (see table 268) is set to one, the device encrypts all user data on the device. If the ENCRYPT ALL SUPPORTED bit is cleared to zero, the device may not encrypt all user data on the device.

NOTE 10 — This standard does not provide a method to cryptographically authenticate the state of the ENCRYPT ALL SUPPORTED bit.

The IDENTIFY DEVICE data contains a copy of the ENCRYPT ALL SUPPORTED bit (see IDENTIFY DEVICE data word 69 in table 57).

9.10.8.7.7 COMMANDS ALLOWED BY SANITIZE bit

This bit shall be set to one.

The IDENTIFY DEVICE data contains a copy of the COMMANDS ALLOWED BY SANITIZE bit (see IDENTIFY DEVICE data word 59 in table 57).

9.10.8.7.8 RESTRICTED SANITIZE OVERRIDES SECURITY bit

The RESTRICTED SANITIZE OVERRIDES SECURITY bit indicates the interactions between the Sanitize Device feature set and the Security feature set as described in 4.20.5.

9.10.9 Parallel ATA (page 07h)

9.10.9.1 Overview

The Parallel ATA log page (see table 273) provides information about the Parallel ATA Transport.

Table 273 — Parallel ATA (Sheet 1 of 3)

Offset	Type	Content
0..7	QWord	Parallel ATA page information header **Bit Description** 63 Shall be set to one 62:24 Reserved 23:16 PAGE NUMBER field – shall be set to 07h 15:0 REVISION NUMBER field (Word) – shall be set to 0001h

Table 273 — Parallel ATA (Sheet 2 of 3)

Offset	Type	Content
8..15	QWord	Parallel ATA Capabilities
		Bit **Description**
		63 Shall be set to one
		62:39 Reserved
		38 IORDY SUPPORTED bit (see 9.10.9.2.1)
		37 IORDY DISABLE SUPPORTED bit (see 9.10.9.2.2)
		36 DMA SUPPORTED bit (see 9.10.9.2.3)
		35 MULTIWORD DMA MODE 2 ENABLED bit (see 9.10.9.2.4.2)
		34 MULTIWORD DMA MODE 1 ENABLED bit (see 9.10.9.2.4.3)
		33 MULTIWORD DMA MODE 0 ENABLED bit (see 9.10.9.2.4.4)
		32 MULTIWORD DMA MODE 2 SUPPORTED bit (see 9.10.9.2.4.5)
		31 MULTIWORD DMA MODE 1 SUPPORTED bit (see 9.10.9.2.4.6)
		30 MULTIWORD DMA MODE 0 SUPPORTED bit (see 9.10.9.2.4.7)
		29 UDMA MODE 6 ENABLED bit (see 9.10.9.2.5.2)
		28 UDMA MODE 5 ENABLED bit (see 9.10.9.2.5.3)
		27 UDMA MODE 4 ENABLED bit (see 9.10.9.2.5.4)
		26 UDMA MODE 3 ENABLED bit (see 9.10.9.2.5.5)
		25 UDMA MODE 2 ENABLED bit (see 9.10.9.2.5.6)
		24 UDMA MODE 1 ENABLED bit (see 9.10.9.2.5.7)
		23 UDMA MODE 0 ENABLED bit (see 9.10.9.2.5.8)
		22 UDMA MODE 6 SUPPORTED bit (see 9.10.9.2.5.9)
		21 UDMA MODE 5 SUPPORTED bit (see 9.10.9.2.5.10)
		20 UDMA MODE 4 SUPPORTED bit (see 9.10.9.2.5.11)
		19 UDMA MODE 3 SUPPORTED bit (see 9.10.9.2.5.12)
		18 UDMA MODE 2 SUPPORTED bit (see 9.10.9.2.5.13)
		17 UDMA MODE 1 SUPPORTED bit (see 9.10.9.2.5.14)
		16 UDMA MODE 0 SUPPORTED bit (see 9.10.9.2.5.15)
		15:0 Reserved
16..23	QWord	PIO Modes Supported
		Bit **Description**
		63 Shall be set to one
		62:2 Reserved
		1 PIO MODE 4 IS SUPPORTED bit (see 9.10.9.3.1)
		0 PIO MODE 3 IS SUPPORTED bit (see 9.10.9.3.2)
24..31	QWord	Multiword DMA transfer cycle time
		Bit **Description**
		63 Shall be set to one
		62:32 Reserved
		31:16 RECOMMENDED MULTIWORD CYCLE TIME field (see 9.10.9.4.1)
		15:0 MIN MULTIWORD CYCLE TIME field (see 9.10.9.4.2)

Table 273 — Parallel ATA (Sheet 3 of 3)

Offset	Type	Content
32..39	QWord	Minimum PIO transfer cycle time **Bit** **Description** 63 Shall be set to one 62:32 Reserved 31:16 MIN PIO TRANSFER TIME WITH IORDY field (see 9.10.9.5.1) 15:0 MIN PIO TRANSFER TIME WITHOUT IORDY field (see 9.10.9.5.2)
40..47	QWord	Set Transfer Mode **Bit** **Description** 63 Shall be set to one 62:8 Reserved 7:0 TRANSFER MODE field (see 9.10.9.6.1)
48..55	QWord	Parallel ATA Hardware Reset Result (see 9.10.9.2.6) **Bit** **Description** 63 Shall be set to one 62:56 Reserved 55 CBLID bit (see 9.10.9.2.6.1) 54:16 Reserved 15 D1 PDIAG bit (see 9.10.9.2.6.2) 14:10 Reserved 9:8 D1 DEVICE NUMBER DETECT field (see 9.10.9.2.6.3) 7 D0 PDIAG bit (see 9.10.9.2.6.4) 6 D0 DASP bit (see 9.10.9.2.6.5) 5 D0/D1 SELECTION bit (see 9.10.9.2.6.6) 4 D0 DIAGNOSTICS bit (see 9.10.9.2.6.7) 3:2 Reserved 1:0 D0 DEVICE NUMBER DETECT field (see 9.10.9.2.6.8)
56..511		Reserved

9.10.9.2 Parallel ATA Capabilities

9.10.9.2.1 IORDY supported (IORDY SUPPORTED bit)

For PATA devices, if the IORDY SUPPORTED bit (see table 273) is set to one, then the device supports the IORDY signal (see ATA8-APT). All PATA devices, except CFA-APT devices, shall set the IORDY SUPPORTED bit to one.

For SATA devices, the IORDY SUPPORTED bit shall be set to one.

The IDENTIFY DEVICE data contains a copy of the IORDY SUPPORTED bit (see IDENTIFY DEVICE data word 49 in table 57).

9.10.9.2.2 IORDY may be disabled (IORDY DISABLE SUPPORTED bit)

For PATA devices, if the IORDY DISABLE SUPPORTED bit (see table 273) is set to one, then the device supports the disabling of IORDY (see ATA8-APT) via the SET FEATURES command.

For SATA devices, the IORDY DISABLE SUPPORTED bit shall be set to one.

The IDENTIFY DEVICE data contains a copy of the IORDY DISABLE SUPPORTED bit (see IDENTIFY DEVICE data word 49 in table 57).

9.10.9.2.3 DMA supported (DMA SUPPORTED bit)

If the DMA SUPPORTED bit (see table 273) is set to one, then the device supports the DMA data transfer protocols. All devices, except CFA-APT devices, shall set the DMA SUPPORTED bit to one.

The IDENTIFY DEVICE data contains a copy of the DMA SUPPORTED bit (see IDENTIFY DEVICE data word 49 in table 57).

9.10.9.2.4 Multiword DMA

9.10.9.2.4.1 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.

9.10.9.2.4.2 Multiword DMA mode 2 is selected (MULTIWORD DMA MODE 2 ENABLED bit)

If the MULTIWORD DMA MODE 2 ENABLED bit (see table 273) is set to one, then Multiword DMA mode 2 is selected. If the MULTIWORD DMA MODE 2 ENABLED bit is cleared to zero, then Multiword DMA mode 2 is not selected.

If the MULTIWORD DMA MODE 1 ENABLED bit (see 9.10.9.2.4.3) is set to one or the MULTIWORD DMA MODE 0 ENABLED bit (see 9.10.9.2.4.4) is set to one, then the MULTIWORD DMA MODE 2 ENABLED bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the MULTIWORD DMA MODE 2 ENABLED bit (see IDENTIFY DEVICE data word 63 in table 57).

9.10.9.2.4.3 Multiword DMA mode 1 is selected (MULTIWORD DMA MODE 1 ENABLED bit)

If the MULTIWORD DMA MODE 1 ENABLED bit (see table 273) is set to one, then Multiword DMA mode 1 is selected. If the MULTIWORD DMA MODE 1 ENABLED bit is cleared to zero, then Multiword DMA mode 1 is not selected.

If the MULTIWORD DMA MODE 2 ENABLED bit (see 9.10.9.2.4.2) is set to one or the MULTIWORD DMA MODE 0 ENABLED bit (see 9.10.9.2.4.4) is set to one, then the MULTIWORD DMA MODE 1 ENABLED bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the MULTIWORD DMA MODE 1 ENABLED bit (see IDENTIFY DEVICE data word 63 in table 57).

9.10.9.2.4.4 Multiword DMA mode 0 is selected (MULTIWORD DMA MODE 0 ENABLED bit)

If the MULTIWORD DMA MODE 0 ENABLED bit (see table 273) is set to one, then Multiword DMA mode 0 is selected. If the MULTIWORD DMA MODE 0 ENABLED bit is cleared to zero, then Multiword DMA mode 0 is not selected.

If the MULTIWORD DMA MODE 2 ENABLED bit (see 9.10.9.2.4.2) is set to one or MULTIWORD DMA MODE 1 ENABLED bit (see 9.10.9.2.4.3) is set to one, then the MULTIWORD DMA MODE 0 ENABLED bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the MULTIWORD DMA MODE 0 ENABLED bit (see IDENTIFY DEVICE data word 63 in table 57).

9.10.9.2.4.5 Multiword DMA mode 2 and below are supported (MULTIWORD DMA MODE 2 SUPPORTED bit)

For PATA devices, if the MULTIWORD DMA MODE 2 SUPPORTED bit (see table 273) 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 the MULTIWORD DMA MODE 0 SUPPORTED bit (see 9.10.9.2.4.7) shall be set to one and the MULTIWORD DMA MODE 1 SUPPORTED bit (see 9.10.9.2.4.6) shall be set to one.

For SATA devices, the MULTIWORD DMA MODE 2 SUPPORTED bit shall be set to one.

The IDENTIFY DEVICE data contains a copy of the MULTIWORD DMA MODE 2 SUPPORTED bit (see IDENTIFY DEVICE data word 63 in table 57).

9.10.9.2.4.6 Multiword DMA mode 1 and below are supported (MULTIWORD DMA MODE 1 SUPPORTED bit)

For PATA devices, if the MULTIWORD DMA MODE 1 SUPPORTED bit (see table 273) 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 the MULTIWORD DMA MODE 0 SUPPORTED bit (see 9.10.9.2.4.7) shall be set to one.

For SATA devices, the MULTIWORD DMA MODE 1 SUPPORTED bit shall be set to one.

The IDENTIFY DEVICE data contains a copy of the MULTIWORD DMA MODE 1 SUPPORTED bit (see IDENTIFY DEVICE data word 63 in table 57).

9.10.9.2.4.7 Multiword DMA mode 0 is supported (MULTIWORD DMA MODE 0 SUPPORTED bit)

For PATA devices, if the MULTIWORD DMA MODE 0 SUPPORTED bit (see table 273) is set to one, then Multiword DMA mode 0 is supported.

For SATA devices, the MULTIWORD DMA MODE 0 SUPPORTED bit shall be set to one.

The IDENTIFY DEVICE data contains a copy of the MULTIWORD DMA MODE 0 SUPPORTED bit (see IDENTIFY DEVICE data word 63 in table 57).

9.10.9.2.5 Ultra DMA

9.10.9.2.5.1 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.

9.10.9.2.5.2 Ultra DMA mode 6 is selected (UDMA MODE 6 ENABLED bit)

If the UDMA MODE 6 ENABLED bit (see table 273) is set to one, then Ultra DMA mode 6 is selected. If the UDMA MODE 6 ENABLED bit is cleared to zero, then Ultra DMA mode 6 is not selected.

The UDMA MODE 6 ENABLED bit shall be cleared to zero, if the:

a) UDMA MODE 5 ENABLED bit (see 9.10.9.2.5.3) is set to one;
b) UDMA MODE 4 ENABLED bit (see 9.10.9.2.5.4) is set to one;
c) UDMA MODE 3 ENABLED bit (see 9.10.9.2.5.5) is set to one;
d) UDMA MODE 2 ENABLED bit (see 9.10.9.2.5.6) is set to one;
e) UDMA MODE 1 ENABLED bit (see 9.10.9.2.5.7) is set to one; or
f) UDMA MODE 0 ENABLED bit (see 9.10.9.2.5.8) is set to one.

The IDENTIFY DEVICE data contains a copy of the UDMA MODE 6 ENABLED bit (see IDENTIFY DEVICE data word 88 in table 57).

9.10.9.2.5.3 Ultra DMA mode 5 is selected (UDMA MODE 5 ENABLED bit)

If the UDMA MODE 5 ENABLED bit (see table 273) is set to one, then Ultra DMA mode 5 is selected. If the UDMA MODE 5 ENABLED bit is cleared to zero, then Ultra DMA mode 5 is not selected.

The UDMA MODE 5 ENABLED bit shall be cleared to zero, if the:

a) UDMA MODE 6 ENABLED bit (see 9.10.9.2.5.2) is set to one;
b) UDMA MODE 4 ENABLED bit (see 9.10.9.2.5.4) is set to one;
c) UDMA MODE 3 ENABLED bit (see 9.10.9.2.5.5) is set to one;
d) UDMA MODE 2 ENABLED bit (see 9.10.9.2.5.6) is set to one;
e) UDMA MODE 1 ENABLED bit (see 9.10.9.2.5.7) is set to one; or
f) UDMA MODE 0 ENABLED bit (see 9.10.9.2.5.8) is set to one.

The IDENTIFY DEVICE data contains a copy of the UDMA MODE 5 ENABLED bit (see IDENTIFY DEVICE data word 88 in table 57).

9.10.9.2.5.4 Ultra DMA mode 4 is selected (UDMA MODE 4 ENABLED bit)

If the UDMA MODE 4 ENABLED bit (see table 273) is set to one, then Ultra DMA mode 4 is selected. If the UDMA MODE 4 ENABLED bit is cleared to zero, then Ultra DMA mode 4 is not selected.

The UDMA MODE 4 ENABLED bit shall be cleared to zero, if the:

a) UDMA MODE 6 ENABLED bit (see 9.10.9.2.5.2) is set to one;
b) UDMA MODE 5 ENABLED bit (see 9.10.9.2.5.3) is set to one;
c) UDMA MODE 3 ENABLED bit (see 9.10.9.2.5.5) is set to one;
d) UDMA MODE 2 ENABLED bit (see 9.10.9.2.5.6) is set to one;
e) UDMA MODE 1 ENABLED bit (see 9.10.9.2.5.7) is set to one; or
f) UDMA MODE 0 ENABLED bit (see 9.10.9.2.5.8) is set to one.

The IDENTIFY DEVICE data contains a copy of the UDMA MODE 4 ENABLED bit (see IDENTIFY DEVICE data word 88 in table 57).

9.10.9.2.5.5 Ultra DMA mode 3 is selected (UDMA MODE 3 ENABLED bit)

If the UDMA MODE 3 ENABLED bit (see table 273) is set to one, then Ultra DMA mode 3 is selected. If the UDMA MODE 3 ENABLED bit is cleared to zero, then Ultra DMA mode 3 is not selected.

The UDMA MODE 3 ENABLED bit shall be cleared to zero, if the:

a) UDMA MODE 6 ENABLED bit (see 9.10.9.2.5.2) is set to one;
b) UDMA MODE 5 ENABLED bit (see 9.10.9.2.5.3) is set to one;
c) UDMA MODE 4 ENABLED bit (see 9.10.9.2.5.4) is set to one;
d) UDMA MODE 2 ENABLED bit (see 9.10.9.2.5.6) is set to one;
e) UDMA MODE 1 ENABLED bit (see 9.10.9.2.5.7) is set to one; or
f) UDMA MODE 0 ENABLED bit (see 9.10.9.2.5.8) is set to one.

The IDENTIFY DEVICE data contains a copy of the UDMA MODE 3 ENABLED bit (see IDENTIFY DEVICE data word 88 in table 57).

9.10.9.2.5.6 Ultra DMA mode 2 is selected (UDMA MODE 2 ENABLED bit)

If the UDMA MODE 2 ENABLED bit (see table 273) is set to one, then Ultra DMA mode 2 is selected. If the UDMA MODE 2 ENABLED bit is cleared to zero, then Ultra DMA mode 2 is not selected.

The UDMA MODE 2 ENABLED bit shall be cleared to zero, if the:

a) UDMA MODE 6 ENABLED bit (see 9.10.9.2.5.2) is set to one;
b) UDMA MODE 5 ENABLED bit (see 9.10.9.2.5.3) is set to one;
c) UDMA MODE 4 ENABLED bit (see 9.10.9.2.5.4) is set to one;
d) UDMA MODE 3 ENABLED bit (see 9.10.9.2.5.5) is set to one;
e) UDMA MODE 1 ENABLED bit (see 9.10.9.2.5.7) is set to one; or
f) UDMA MODE 0 ENABLED bit (see 9.10.9.2.5.8) is set to one.

The IDENTIFY DEVICE data contains a copy of the UDMA MODE 2 ENABLED bit (see IDENTIFY DEVICE data word 88 in table 57).

9.10.9.2.5.7 Ultra DMA mode 1 is selected (UDMA MODE 1 ENABLED bit)

If the UDMA MODE 1 ENABLED bit (see table 273) is set to one, then Ultra DMA mode 1 is selected. If the UDMA MODE 1 ENABLED bit is cleared to zero, then Ultra DMA mode 1 is not selected.

The UDMA MODE 1 ENABLED bit shall be cleared to zero, if the:

a) UDMA MODE 6 ENABLED bit (see 9.10.9.2.5.2) is set to one;
b) UDMA MODE 5 ENABLED bit (see 9.10.9.2.5.3) is set to one;
c) UDMA MODE 4 ENABLED bit (see 9.10.9.2.5.4) is set to one;
d) UDMA MODE 3 ENABLED bit (see 9.10.9.2.5.5) is set to one;
e) UDMA MODE 2 ENABLED bit (see 9.10.9.2.5.6) is set to one; or
f) UDMA MODE 0 ENABLED bit (see 9.10.9.2.5.8) is set to one.

The IDENTIFY DEVICE data contains a copy of the UDMA MODE 1 ENABLED bit (see IDENTIFY DEVICE data word 88 in table 57).

9.10.9.2.5.8 Ultra DMA mode 0 is selected (UDMA MODE 0 ENABLED bit)

If the UDMA MODE 0 ENABLED bit (see table 273) is set to one, then Ultra DMA mode 0 is selected. If the UDMA MODE 0 ENABLED bit is cleared to zero, then Ultra DMA mode 0 is not selected.

The UDMA MODE 0 ENABLED bit shall be cleared to zero, if the:

a) UDMA MODE 6 ENABLED bit (see 9.10.9.2.5.2) is set to one;
b) UDMA MODE 5 ENABLED bit (see 9.10.9.2.5.3) is set to one;
c) UDMA MODE 4 ENABLED bit (see 9.10.9.2.5.4) is set to one;
d) UDMA MODE 3 ENABLED bit (see 9.10.9.2.5.5) is set to one;
e) UDMA MODE 2 ENABLED bit (see 9.10.9.2.5.6) is set to one; or
f) UDMA MODE 1 ENABLED bit (see 9.10.9.2.5.7) is set to one.

The IDENTIFY DEVICE data contains a copy of the UDMA MODE 0 ENABLED bit (see IDENTIFY DEVICE data word 88 in table 57).

9.10.9.2.5.9 Ultra DMA mode 6 and below are supported (UDMA MODE 6 SUPPORTED bit)

For PATA devices, if the UDMA MODE 6 SUPPORTED bit (see table 273) is set to one, then Ultra DMA modes 6 and below are supported. If the UDMA MODE 6 SUPPORTED 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 the UDMA MODE 6 SUPPORTED bit is set to one, then the:

a) UDMA MODE 5 SUPPORTED bit (see 9.10.9.2.5.10) shall be set to one;
b) UDMA MODE 4 SUPPORTED bit (see 9.10.9.2.5.11) shall be set to one;
c) UDMA MODE 3 SUPPORTED bit (see 9.10.9.2.5.12) shall be set to one;
d) UDMA MODE 2 SUPPORTED bit (see 9.10.9.2.5.13) shall be set to one;
e) UDMA MODE 1 SUPPORTED bit (see 9.10.9.2.5.14) shall be set to one; and
f) UDMA MODE 0 SUPPORTED bit (see 9.10.9.2.5.15) shall be set to one.

For SATA devices, the UDMA MODE 6 SUPPORTED bit are supported may be set to one.

The IDENTIFY DEVICE data contains a copy of the UDMA MODE 6 SUPPORTED bit (see IDENTIFY DEVICE data word 88 in table 57).

9.10.9.2.5.10 Ultra DMA mode 5 and below are supported (UDMA MODE 5 SUPPORTED bit)

For PATA devices, if the UDMA MODE 5 SUPPORTED bit (see table 273) is set to one, then Ultra DMA modes 5 and below are supported. If the UDMA MODE 5 SUPPORTED 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 the UDMA MODE 5 SUPPORTED bit is set to one, then the:

a) UDMA MODE 4 SUPPORTED bit (see 9.10.9.2.5.11) shall be set to one;
b) UDMA MODE 3 SUPPORTED bit (see 9.10.9.2.5.12) shall be set to one;
c) UDMA MODE 2 SUPPORTED bit (see 9.10.9.2.5.13) shall be set to one;
d) UDMA MODE 1 SUPPORTED bit (see 9.10.9.2.5.14) shall be set to one; and
e) UDMA MODE 0 SUPPORTED bit (see 9.10.9.2.5.15) shall be set to one.

For SATA devices, the UDMA MODE 5 SUPPORTED bit shall be set to one.

The IDENTIFY DEVICE data contains a copy of the UDMA MODE 5 SUPPORTED bit (see IDENTIFY DEVICE data word 88 in table 57).

9.10.9.2.5.11 Ultra DMA mode 4 and below are supported (UDMA MODE 4 SUPPORTED bit)

For PATA devices, if the UDMA MODE 4 SUPPORTED bit (see table 273) is set to one, then Ultra DMA modes 4 and below are supported. If the UDMA MODE 4 SUPPORTED 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 the UDMA MODE 4 SUPPORTED bit is set to one, then the:

a) UDMA MODE 3 SUPPORTED bit (see 9.10.9.2.5.12) shall be set to one;
b) UDMA MODE 2 SUPPORTED bit (see 9.10.9.2.5.13) shall be set to one;
c) UDMA MODE 1 SUPPORTED bit (see 9.10.9.2.5.14) shall be set to one; and
d) UDMA MODE 0 SUPPORTED bit (see 9.10.9.2.5.15) shall be set to one.

For SATA devices, the UDMA MODE 4 SUPPORTED bit shall be set to one.

The IDENTIFY DEVICE data contains a copy of the UDMA MODE 4 SUPPORTED bit (see IDENTIFY DEVICE data word 88 in table 57).

9.10.9.2.5.12 Ultra DMA mode 3 and below are supported (UDMA MODE 3 SUPPORTED bit)

For PATA devices, if the UDMA MODE 3 SUPPORTED bit (see table 273) is set to one, then Ultra DMA modes 3 and below are supported. If the UDMA MODE 3 SUPPORTED 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 the UDMA MODE 3 SUPPORTED bit is set to one, then the:

a) UDMA MODE 2 SUPPORTED bit (see 9.10.9.2.5.13) shall be set to one;
b) UDMA MODE 1 SUPPORTED bit (see 9.10.9.2.5.14) shall be set to one; and
c) UDMA MODE 0 SUPPORTED bit (see 9.10.9.2.5.15) shall be set to one.

For SATA devices, the UDMA MODE 3 SUPPORTED bit shall be set to one.

The IDENTIFY DEVICE data contains a copy of the UDMA MODE 3 SUPPORTED bit (see IDENTIFY DEVICE data word 88 in table 57).

9.10.9.2.5.13 Ultra DMA mode 2 and below are supported (UDMA MODE 2 SUPPORTED bit)

For PATA devices, if the UDMA MODE 2 SUPPORTED bit (see table 273) is set to one, then Ultra DMA modes 2 and below are supported. If the UDMA MODE 2 SUPPORTED 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 the UDMA MODE 2 SUPPORTED bit is set to one, then the:

a) UDMA MODE 1 SUPPORTED bit (see 9.10.9.2.5.14) shall be set to one; and
b) UDMA MODE 0 SUPPORTED bit (see 9.10.9.2.5.15) shall be set to one.

For SATA devices, the UDMA MODE 2 SUPPORTED bit shall be set to one.

The IDENTIFY DEVICE data contains a copy of the UDMA MODE 2 SUPPORTED bit (see IDENTIFY DEVICE data word 88 in table 57).

9.10.9.2.5.14 Ultra DMA mode 1 and below are supported (UDMA MODE 1 SUPPORTED bit)

For PATA devices, if the UDMA MODE 1 SUPPORTED bit (see table 273) is set to one, then Ultra DMA modes 1 and below are supported. If the UDMA MODE 1 SUPPORTED 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 the UDMA MODE 1 SUPPORTED bit is set to one, then the UDMA MODE 0 SUPPORTED bit (see 9.10.9.2.5.15) shall be set to one.

For SATA devices, the UDMA MODE 1 SUPPORTED bit shall be set to one.

The IDENTIFY DEVICE data contains a copy of the UDMA MODE 1 SUPPORTED bit (see IDENTIFY DEVICE data word 88 in table 57).

9.10.9.2.5.15 Ultra DMA mode 0 is supported (UDMA MODE 0 SUPPORTED bit)

For PATA devices, if the UDMA MODE 0 SUPPORTED bit (see table 273) is set to one, then Ultra DMA mode 0 is supported. If the UDMA MODE 0 SUPPORTED bit is cleared to zero, then Ultra DMA mode 0 is not supported.

For SATA devices, the UDMA MODE 0 SUPPORTED bit shall be set to one.

The IDENTIFY DEVICE data contains a copy of the UDMA MODE 0 SUPPORTED bit (see IDENTIFY DEVICE data word 88 in table 57).

9.10.9.2.6 Parallel ATA hardware reset result

9.10.9.2.6.1 CBLID bit

If the device is a PATA device and the CBLID bit (see table 273) is:

a) cleared to zero, then the device detected the CBLID– below V_{iL} (see ATA8-APT); or
b) set to one, then the device detected the CBLID– above V_{iHB} (see ATA8-APT).

The CBLID bit shall be set to one or cleared to zero 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 or SMART READ LOG 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).

The contents of the CBLID bit shall changed only during the processing of a PATA hardware reset.

For SATA devices, the CBLID bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the CBLID bit (see IDENTIFY DEVICE data word 93 in table 57).

9.10.9.2.6.2 D1 PDIAG bit

If the device is a PATA device and the D1 PDIAG bit (see table 273) is:

a) cleared to zero, then Device 1 did not detect the assertion of PDIAG–; or
b) set to one, then Device 1 detected the assertion of PDIAG–.

PATA Device 0 shall clear the D1 PDIAG bit to zero and PATA Device 1 shall set the D1 PDIAG bit as described in this subclause as the result of a hardware reset (see ATA8-APT).

The contents of the D1 PDIAG bit shall changed only during the processing of a PATA hardware reset.

For SATA devices, the D1 PDIAG bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the D1 PDIAG bit (see IDENTIFY DEVICE data word 93 in table 57).

9.10.9.2.6.3 D1 DEVICE NUMBER DETECT field

For PATA devices, the contents of the D1 DEVICE NUMBER DETECT field (see table 273) indicate how the device number of Device 1 were detected using the coded values shown in table 274.

Table 274 — PATA device number detected coded values

Code	Description
00b	Reserved
01b	A jumper was used
10b	The CSEL signal was used
11b	Some other method was used or the method is unknown

PATA Device 0 shall clear the D1 DEVICE NUMBER DETECT field to zero and PATA Device 1 shall set the D1 DEVICE NUMBER DETECT field as described in this subclause as the result of a hardware reset (see ATA8-APT).

The contents of the D1 DEVICE NUMBER DETECT field shall changed only during the processing of a PATA hardware reset.

For SATA devices, the D1 DEVICE NUMBER DETECT field shall be set to 00b.

The IDENTIFY DEVICE data contains a copy of the D1 DEVICE NUMBER DETECT field (see IDENTIFY DEVICE data word 93 in table 57).

9.10.9.2.6.4 D0 PDIAG bit

If the device is a PATA device and the D0 PDIAG bit (see table 273) is:

a) cleared to zero, then Device 0 did not detect the assertion of PDIAG–; or
b) set to one, then Device 0 detected the assertion of PDIAG–.

PATA Device 1 shall clear the D0 PDIAG bit to zero and PATA Device 0 shall set the D0 PDIAG bit as described in this subclause as the result of a hardware reset (see ATA8-APT).

The contents of the D0 PDIAG bit shall changed only during the processing of a PATA hardware reset.

For SATA devices, the D0 PDIAG bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the D0 PDIAG bit (see IDENTIFY DEVICE data word 93 in table 57).

9.10.9.2.6.5 D0 DASP bit

If the device is a PATA device and the D0 DASP bit (see table 273) is:

a) cleared to zero, then Device 0 did not detect the assertion of DASP–; or
b) set to one, then Device 0 detected the assertion of DASP–.

PATA Device 1 shall clear the D0 DASP bit to zero and PATA Device 0 shall set the D0 DASP bit as described in this subclause as the result of a hardware reset (see ATA8-APT).

The contents of the D0 DASP bit shall changed only during the processing of a PATA hardware reset.

For SATA devices, the D0 DASP bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the D0 DASP bit (see IDENTIFY DEVICE data word 93 in table 57).

9.10.9.2.6.6 D0/D1 SELECTION bit

If the device is a PATA device and the D0/D1 SELECTION bit (see table 273) is:

a) cleared to zero, then Device 0 does not respond when Device 1 is selected; or
b) set to one, then Device 0 responds when Device 1 is selected.

PATA Device 1 shall clear the D0/D1 SELECTION bit to zero and PATA Device 0 shall set the D0/D1 SELECTION bit as described in this subclause as the result of a hardware reset (see ATA8-APT).

The contents of the D0/D1 SELECTION bit shall changed only during the processing of a PATA hardware reset.

For SATA devices, the D0/D1 SELECTION bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the D0/D1 SELECTION bit (see IDENTIFY DEVICE data word 93 in table 57).

9.10.9.2.6.7 D0 DIAGNOSTICS bit

If the device is a PATA device and the D0 DIAGNOSTICS bit (see table 273) is:

a) cleared to zero, then Device 0 did not detect the assertion of DASP–; or
b) set to one, then Device 0 detected the assertion of DASP–.

PATA Device 1 shall clear the D0 DIAGNOSTICS bit to zero and PATA Device 0 shall set the D0 DIAGNOSTICS bit as described in this subclause as the result of a hardware reset (see ATA8-APT).

The contents of the D0 DIAGNOSTICS bit shall changed only during the processing of a PATA hardware reset.

For SATA devices, the D0 DIAGNOSTICS bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the D0 DIAGNOSTICS bit (see IDENTIFY DEVICE data word 93 in table 57).

9.10.9.2.6.8 D0 DEVICE NUMBER DETECT field

For PATA devices, the contents of the D1 DEVICE NUMBER DETECT field (see table 273) indicate how the device number of Device 0 were detected using the coded values shown in table 274 (see 9.10.9.2.6.3).

PATA Device 1 shall clear the D0 DEVICE NUMBER DETECT field to zero and PATA Device 0 shall set the D0 DEVICE NUMBER DETECT field as described in this subclause as the result of a hardware reset (see ATA8-APT).

The contents of the D0 DEVICE NUMBER DETECT field shall changed only during the processing of a PATA hardware reset.

For SATA devices, the D0 DEVICE NUMBER DETECT field shall be set to 00b.

The IDENTIFY DEVICE data contains a copy of the D0 DEVICE NUMBER DETECT field (see IDENTIFY DEVICE data word 93 in table 57).

9.10.9.3 PIO Modes Supported

9.10.9.3.1 PIO Mode 4 is supported (PIO MODE 4 IS SUPPORTED bit)

For PATA devices, if the PIO MODE 4 IS SUPPORTED bit (see table 273) is set to one, then the device supports PIO mode 4. See ATA8-APT for more information.

For SATA devices, the PIO MODE 4 IS SUPPORTED bit shall be set to one.

The IDENTIFY DEVICE data contains a copy of the PIO MODE 4 IS SUPPORTED bit (see IDENTIFY DEVICE data word 64 in table 57).

9.10.9.3.2 PIO Mode 3 is supported (PIO MODE 3 IS SUPPORTED bit)

For PATA devices, if the PIO MODE 3 IS SUPPORTED bit (see table 273) 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 the PIO MODE 3 IS SUPPORTED bit to one. See ATA8-APT for more information.

For SATA devices, the PIO MODE 3 IS SUPPORTED bit shall be set to one.

The IDENTIFY DEVICE data contains a copy of the PIO MODE 3 IS SUPPORTED bit (see IDENTIFY DEVICE data word 64 in table 57).

9.10.9.4 Multiword DMA transfer cycle time

9.10.9.4.1 Manufacturer's recommended Multiword DMA transfer cycle time (RECOMMENDED MULTIWORD CYCLE TIME field)

For PATA devices:

a) the RECOMMENDED MULTIWORD CYCLE TIME field (see table 273) 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 command (see 7.21) or WRITE DMA command (see 7.58) for any location on the media under nominal conditions);
b) any PATA device that sets the MULTIWORD DMA MODE 1 SUPPORTED bit (see 9.10.9.2.4.6) to one shall support the RECOMMENDED MULTIWORD CYCLE TIME field;
c) the value in the RECOMMENDED MULTIWORD CYCLE TIME field shall not be less than the Minimum Multiword DMA transfer cycle time (see 9.10.9.4.2);
d) if a host runs at a faster cycle rate by operating at a cycle time of less than the value in the RECOMMENDED MULTIWORD CYCLE TIME field, 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, the RECOMMENDED MULTIWORD CYCLE TIME field shall be set to 78h (i.e., 120 ns).

The IDENTIFY DEVICE data contains a copy of the RECOMMENDED MULTIWORD CYCLE TIME field (see IDENTIFY DEVICE data word 66 in table 57).

9.10.9.4.2 Minimum Multiword DMA transfer cycle time (MIN MULTIWORD CYCLE TIME field)

For PATA devices, the MIN MULTIWORD CYCLE TIME field (see table 273) is defined as the minimum Multiword DMA transfer cycle time per word. The MIN MULTIWORD CYCLE TIME 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, the MIN MULTIWORD CYCLE TIME field shall be set to 78h (i.e., 120 ns).

Any PATA device that sets the MULTIWORD DMA MODE 1 SUPPORTED bit (see 9.10.9.2.4.6) to one shall support this field, and the value in the RECOMMENDED MULTIWORD CYCLE TIME field shall not be less than the minimum cycle time for the fastest DMA mode supported by the device.

The IDENTIFY DEVICE data contains a copy of the RECOMMENDED MULTIWORD CYCLE TIME field (see IDENTIFY DEVICE data word 65 in table 57).

9.10.9.5 Minimum PIO transfer cycle time

9.10.9.5.1 Minimum PIO transfer cycle time with IORDY flow control (MIN PIO TRANSFER TIME WITH IORDY field)

For PATA devices, the MIN PIO TRANSFER TIME WITH IORDY field (see table 273) is defined as the minimum PIO transfer with IORDY (see ATA8-APT) flow control cycle time. The MIN PIO TRANSFER TIME WITH IORDY 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, the MIN PIO TRANSFER TIME WITH IORDY field shall be set to 78h (i.e., 120 ns).

All devices except CFA-APT devices shall support PIO mode 3 and shall support the MIN PIO TRANSFER TIME WITH IORDY field, and the value in the MIN PIO TRANSFER TIME WITH IORDY field shall be the fastest defined PIO mode supported by the device (i.e., PIO mode 3 or PIO mode 4). The maximum value reported in this field shall be B4h (i.e., 180 ns).

The IDENTIFY DEVICE data contains a copy of the MIN PIO TRANSFER TIME WITH IORDY field (see IDENTIFY DEVICE data word 68 in table 57).

9.10.9.5.2 Minimum PIO transfer cycle time without flow control (MIN PIO TRANSFER TIME WITHOUT IORDY field)

For PATA devices, the MIN PIO TRANSFER TIME WITHOUT IORDY field (see table 273) is defined as the minimum PIO transfer without IORDY (see ATA8-APT) flow control cycle time. The MIN PIO TRANSFER TIME WITHOUT IORDY 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, the MIN PIO TRANSFER TIME WITH IORDY field shall be set to 78h (i.e., 120 ns).

Any device that supports PIO mode 3 or PIO mode 4 shall support the MIN PIO TRANSFER TIME WITHOUT IORDY field. The value in the MIN PIO TRANSFER TIME WITHOUT IORDY field shall not be less than the value reported in the MIN PIO TRANSFER TIME WITH IORDY field (see 9.10.9.5.1).

The IDENTIFY DEVICE data contains a copy of the MIN PIO TRANSFER TIME WITHOUT IORDY field (see IDENTIFY DEVICE data word 67 in table 57).

9.10.9.6 Set Transfer Mode

9.10.9.6.1 TRANSFER MODE field

The TRANSFER MODE field (see table 273) is set by the set transfer mode subcommand (see 7.45.4) of the SET FEATURES command. The contents of the TRANSFER MODE field indicate the current transfer mechanism used by the device (see table 125).

9.10.10 Serial ATA (page 08h)

9.10.10.1 Serial ATA log overview

The Serial ATA log page (see table 275) provides information about the Serial ATA Transport.

Table 275 — Serial ATA (Sheet 1 of 3)

Offset	Type	Content	
0..7	QWord	Serial ATA page information header	
		Bit	**Description**
		63	Shall be set to one
		62:24	Reserved
		23:16	PAGE NUMBER field – shall be set to 08h
		15:0	REVISION NUMBER field (Word) – shall be set to 0001h

Table 275 — Serial ATA (Sheet 2 of 3)

Offset	Type	Content	
8..15	QWord	SATA Capabilities	
		Bit	**Description**
		63	Shall be set to one
		62:34	Reserved for Serial ATA
		33	OUT OF BAND TEMPERATURE CHANGE REPORTING SUPPORTED bit (see 9.10.10.2.31)
		32	OUT OF BAND MANAGEMENT INTERFACE SUPPORTED bit (see 9.10.10.2.30)
		31	POWER DISABLE FEATURE ALWAYS ENABLED bit (see 9.10.10.2.29)
		30	POWER DISABLE FEATURE SUPPORTED bit (see 9.10.10.2.28)
		29	REBUILD ASSIST SUPPORTED bit (see 9.10.10.2.27)
		28	DIPM SSP PRESERVATION SUPPORTED bit (see 9.10.10.2.26)
		27	HYBRID INFORMATION SUPPORTED bit (see 9.10.10.2.23)
		26	DEVSLEEP TO REDUCEDPWRSTATE CAPABILITY SUPPORTED bit (see 9.10.10.2.24)
		25	DEVICE SLEEP SUPPORTED bit (see 9.10.10.2.22)
		24	NCQ AUTOSENSE SUPPORTED bit (see 9.10.10.2.21)
		23	SOFTWARE SETTINGS PRESERVATION SUPPORTED bit (see 9.10.10.2.20)
		22	HARDWARE FEATURE CONTROL SUPPORTED bit (see 9.10.10.2.19)
		21	IN-ORDER DATA DELIVERY SUPPORTED bit (see 9.10.10.2.18)
		20	DEVICE INITIATED POWER MANAGEMENT SUPPORTED bit (see 9.10.10.2.17)
		19	DMA SETUP AUTO-ACTIVATION SUPPORTED bit (see 9.10.10.2.16)
		18	NONZERO BUFFER OFFSETS SUPPORTED bit (see 9.10.10.2.15)
		17	SEND AND RECEIVE QUEUED COMMANDS SUPPORTED bit (see 9.10.10.2.14)
		16	NCQ QUEUE MANAGEMENT COMMAND SUPPORTED bit (see 9.10.10.2.13)
		15	NCQ STREAMING SUPPORTED bit (see 9.10.10.2.12)
		14	READ LOG DMA EXT AS EQUIVALENT TO READ LOG EXT SUPPORTED bit (see 9.10.10.2.11)
		13	DEVICE AUTOMATIC PARTIAL TO SLUMBER TRANSITIONS SUPPORTED bit (see 9.10.10.2.10)
		12	HOST AUTOMATIC PARTIAL TO SLUMBER TRANSITIONS SUPPORTED bit (see 9.10.10.2.9)
		11	NCQ PRIORITY INFORMATION SUPPORTED bit (see 9.10.10.2.8)
		10	UNLOAD WHILE NCQ COMMANDS ARE OUTSTANDING SUPPORTED bit (see 9.10.10.2.7)
		9	SATA PHY EVENT COUNTERS LOG SUPPORTED bit (see 9.10.10.2.6)
		8	RECEIPT OF HOST INITIATED POWER MANAGEMENT REQUESTS SUPPORTED bit (see 9.10.10.2.5)
		7	NCQ FEATURE SET SUPPORTED bit (see 9.10.10.2.4)
		6:3	Reserved for Serial ATA
		2	SATA GEN3 SIGNALING SPEED SUPPORTED bit (see 9.10.10.2.3)
		1	SATA GEN2 SIGNALING SPEED SUPPORTED bit (see 9.10.10.2.2)
		0	SATA GEN1 SIGNALING SPEED SUPPORTED bit (see 9.10.10.2.1)

Table 275 — Serial ATA (Sheet 3 of 3)

Offset	Type	Content
16..23	QWord	Current SATA Settings **Bit Description** 63 Shall be set to one 62:14 Reserved for Serial ATA 13 HYBRID ENABLED bit (see 9.10.10.3.12) 12 REBUILD ASSIST ENABLED bit (see 9.10.10.3.11) 11 POWER DISABLE FEATURE ENABLED bit (see 9.10.10.3.10) 10 DEVICE SLEEP ENABLED bit (see 9.10.10.3.9) 9 AUTOMATIC PARTIAL TO SLUMBER TRANSITIONS ENABLED bit (see 9.10.10.3.8) 8 SOFTWARE SETTINGS PRESERVATION ENABLED bit (see 9.10.10.3.7) 7 HARDWARE FEATURE CONTROL IS ENABLED bit (see 9.10.10.3.6) 6 IN-ORDER DATA DELIVERY ENABLED bit (see 9.10.10.3.5) 5 DEVICE INITIATED POWER MANAGEMENT ENABLED bit (see 9.10.10.3.4) 4 DMA SETUP AUTO-ACTIVATION ENABLED bit (see 9.10.10.3.3) 3 NONZERO BUFFER OFFSETS ENABLED bit (see 9.10.10.3.2) 2:0 CURRENT NEGOTIATED SERIAL ATA SIGNAL SPEED field (see 9.10.10.3.1)
24..39		Reserved for Serial ATA
40..41	Word	CURRENT HARDWARE FEATURE CONTROL IDENTIFIER field (see 9.10.10.4)
42..43	Word	SUPPORTED HARDWARE FEATURE CONTROL IDENTIFIER field (see 9.10.10.5)
44..47		Reserved for Serial ATA
48..55	QWord	Device Sleep Timing Variables **Bit Description** 63 DEVSLP TIMING VARIABLES SUPPORTED bit (see 9.10.10.6.1) 62:16 Reserved for Serial ATA 15:8 DEVSLEEP EXIT TIMEOUT field (DETO) (see 9.10.10.6.2) 7:5 Reserved for Serial ATA 4:0 MINIMUM DEVSLP ASSERTION TIME field (MDAT) (see 9.10.10.6.3)
56..511		Reserved for SATA

9.10.10.2 SATA Capabilities

9.10.10.2.1 SATA GEN1 SIGNALING SPEED SUPPORTED bit

If the SATA GEN1 SIGNALLING SPEED SUPPORTED bit is set to one, then the device supports the Gen1 signaling rate of 1.5 Gb/s (see SATA 3.5).

The IDENTIFY DEVICE data contains a copy of the SATA GEN1 SIGNALLING SPEED SUPPORTED bit (see IDENTIFY DEVICE data word 76 in table 57).

9.10.10.2.2 SATA GEN2 SIGNALING SPEED SUPPORTED bit

If the SATA GEN2 SIGNALLING SPEED SUPPORTED bit is set to one, then the device supports the Gen2 signaling rate of 3.0 Gb/s (see SATA 3.5).

The IDENTIFY DEVICE data contains a copy of the SATA GEN2 SIGNALLING SPEED SUPPORTED bit (see IDENTIFY DEVICE data word 76 in table 57).

9.10.10.2.3 SATA GEN3 SIGNALING SPEED SUPPORTED bit

If the SATA GEN3 SIGNALLING SPEED SUPPORTED bit is set to one, then the device supports the Gen3 signaling rate of 6.0 Gb/s (see SATA 3.5).

The IDENTIFY DEVICE data contains a copy of the SATA GEN3 SIGNALLING SPEED SUPPORTED bit (see IDENTIFY DEVICE data word 76 in table 57).

9.10.10.2.4 NCQ FEATURE SET SUPPORTED bit

If the NCQ FEATURE SET SUPPORTED bit is set to one, the device supports the NCQ feature set.

The IDENTIFY DEVICE data contains a copy of the NCQ FEATURE SET SUPPORTED bit (see IDENTIFY DEVICE data word 76 in table 57).

9.10.10.2.5 RECEIPT OF HOST INITIATED POWER MANAGEMENT REQUESTS SUPPORTED bit

If the RECEIPT OF HOST INITIATED POWER MANAGEMENT REQUESTS SUPPORTED bit is set to one, the device supports Partial and Slumber interface power management states that are initiated by the host (see SATA 3.5).

If the RECEIPT OF HOST INITIATED POWER MANAGEMENT REQUESTS SUPPORTED bit is cleared to zero, then the DEVICE INITIATED POWER MANAGEMENT SUPPORTED bit (see 9.10.10.2.17) shall be set to one.

The IDENTIFY DEVICE data contains a copy of the RECEIPT OF HOST INITIATED POWER MANAGEMENT REQUESTS SUPPORTED bit (see IDENTIFY DEVICE data word 76 in table 57).

Devices support host-initiated interface power management, or device-initiated interface power management (see 9.10.10.2.17).

9.10.10.2.6 SATA PHY EVENT COUNTERS LOG SUPPORTED bit

If the SATA PHY EVENT COUNTERS LOG SUPPORTED bit is set to one, the device supports the SATA Phy Event Counters log (see 9.16).

The IDENTIFY DEVICE data contains a copy of the SATA PHY EVENT COUNTERS LOG SUPPORTED bit (see IDENTIFY DEVICE data word 76 in table 57).

9.10.10.2.7 UNLOAD WHILE NCQ COMMANDS ARE OUTSTANDING SUPPORTED bit

If the UNLOAD WHILE NCQ COMMANDS ARE OUTSTANDING SUPPORTED bit is set to one, then the device supports moving the heads to a safe position upon reception of the IDLE IMMEDIATE command (see 7.15) with the Unload Feature specified while NCQ commands are outstanding. If the NCQ FEATURE SET SUPPORTED bit (see 9.10.10.2.4) is cleared to zero, then the UNLOAD WHILE NCQ COMMANDS ARE OUTSTANDING SUPPORTED bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the UNLOAD WHILE NCQ COMMANDS ARE OUTSTANDING SUPPORTED bit (see IDENTIFY DEVICE data word 76 in table 57).

9.10.10.2.8 NCQ PRIORITY INFORMATION SUPPORTED bit

If the NCQ PRIORITY INFORMATION SUPPORTED bit is set to one, the device supports the PRIO field in the READ FPDMA QUEUED command (see 7.23) and WRITE FPDMA QUEUED command (see 7.61), and optimization based on this information. If the NCQ FEATURE SET SUPPORTED bit (see 9.10.10.2.4) is cleared to zero, then the NCQ PRIORITY INFORMATION SUPPORTED bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the NCQ PRIORITY INFORMATION SUPPORTED bit (see IDENTIFY DEVICE data word 76 in table 57).

9.10.10.2.9 HOST AUTOMATIC PARTIAL TO SLUMBER TRANSITIONS SUPPORTED bit

If the HOST AUTOMATIC PARTIAL TO SLUMBER TRANSITIONS SUPPORTED bit is set to one, then the device supports host automatic partial to slumber transitions. If the RECEIPT OF HOST INITIATED POWER MANAGEMENT REQUESTS SUPPORTED bit is cleared to zero, then the HOST AUTOMATIC PARTIAL TO SLUMBER TRANSITIONS SUPPORTED bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the HOST AUTOMATIC PARTIAL TO SLUMBER TRANSITIONS SUPPORTED bit (see IDENTIFY DEVICE data word 76 in table 57).

9.10.10.2.10 DEVICE AUTOMATIC PARTIAL TO SLUMBER TRANSITIONS SUPPORTED bit

If the DEVICE AUTOMATIC PARTIAL TO SLUMBER TRANSITIONS SUPPORTED bit is set to one, the device supports device automatic partial to slumber transitions and may asynchronously transition from Partial to Slumber, if enabled (see 7.45.16.7). If the DEVICE AUTOMATIC PARTIAL TO SLUMBER TRANSITIONS SUPPORTED bit is cleared to zero (i.e., device initiating interface power management is not supported), then the DEVICE AUTOMATIC PARTIAL TO SLUMBER TRANSITIONS ENABLED bit (see 9.10.10.3.8) shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the DEVICE AUTOMATIC PARTIAL TO SLUMBER TRANSITIONS SUPPORTED bit (see IDENTIFY DEVICE data word 76 in table 57).

9.10.10.2.11 READ LOG DMA EXT AS EQUIVALENT TO READ LOG EXT SUPPORTED bit

If the READ LOG DMA EXT AS EQUIVALENT TO READ LOG EXT SUPPORTED bit is set to one, then the READ LOG DMA EXT command (see 7.25) and the READ LOG EXT command (see 7.24) may be used in all cases with identical results. If the GPL DMA SUPPORTED bit (see 9.10.5.2.31) is cleared to zero, then the READ LOG DMA EXT AS EQUIVALENT TO READ LOG EXT SUPPORTED bit shall be cleared to zero. If the NCQ FEATURE SET SUPPORTED bit (see 9.10.10.2.4) is cleared to zero, then the READ LOG DMA EXT AS EQUIVALENT TO READ LOG EXT SUPPORTED bit shall be cleared to zero.

If the READ LOG DMA EXT AS EQUIVALENT TO READ LOG EXT SUPPORTED bit is cleared to zero and the device indicates command acceptance for a READ LOG DMA EXT command to read the NCQ Command Error log (see 9.14) or the SATA Phy Event Counters log (see 9.16), then the device shall return command aborted.

The IDENTIFY DEVICE data contains a copy of the READ LOG DMA EXT AS EQUIVALENT TO READ LOG EXT SUPPORTED bit (see IDENTIFY DEVICE data word 76 in table 57).

9.10.10.2.12 NCQ STREAMING SUPPORTED bit

If the NCQ STREAMING SUPPORTED bit is set to one, then the device supports NCQ Streaming. See SATA 3.5 for additional details. If the NCQ FEATURE SET SUPPORTED bit (see 9.10.10.2.4) is cleared to zero, then the NCQ STREAMING SUPPORTED bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the NCQ STREAMING SUPPORTED bit (see IDENTIFY DEVICE data word 77 in table 57).

9.10.10.2.13 NCQ QUEUE MANAGEMENT COMMAND SUPPORTED bit

If the NCQ QUEUE MANAGEMENT COMMAND SUPPORTED bit is set to one, then the device supports the NCQ NON-DATA command (see 7.17). If if the NCQ FEATURE SET SUPPORTED bit (see 9.10.10.2.4) is cleared to zero, then the NCQ QUEUE MANAGEMENT COMMAND SUPPORTED bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the NCQ QUEUE MANAGEMENT COMMAND SUPPORTED bit (see IDENTIFY DEVICE data word 77 in table 57).

9.10.10.2.14 SEND AND RECEIVE QUEUED COMMANDS SUPPORTED bit

If the SEND AND RECEIVE QUEUED COMMANDS SUPPORTED bit is set to one, then the device supports the RECEIVE FPDMA QUEUED command (see 7.32) and the SEND FPDMA QUEUED command (see 7.43). If the NCQ FEATURE SET SUPPORTED bit (see 9.10.10.2.4) is cleared to zero, then the SEND AND RECEIVE QUEUED COMMANDS SUPPORTED bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the SEND AND RECEIVE QUEUED COMMANDS SUPPORTED bit (see IDENTIFY DEVICE data word 77 in table 57).

9.10.10.2.15 NONZERO BUFFER OFFSETS SUPPORTED bit

If the NONZERO BUFFER OFFSETS SUPPORTED bit is set to one, the device supports the use of nonzero buffer offsets for commands in the NCQ feature set (see 4.15). See SATA 3.5 for more information.

The IDENTIFY DEVICE data contains a copy of the NONZERO BUFFER OFFSETS SUPPORTED bit (see IDENTIFY DEVICE data word 78 in table 57).

9.10.10.2.16 DMA SETUP AUTO-ACTIVATION SUPPORTED bit

If the DMA SETUP AUTO-ACTIVATION SUPPORTED bit is set to one, the device supports the use of the DMA Setup FIS Auto-Activate optimization. See SATA 3.5 for more information.

The IDENTIFY DEVICE data contains a copy of the DMA SETUP AUTO-ACTIVATION SUPPORTED bit (see IDENTIFY DEVICE data word 78 in table 57).

9.10.10.2.17 DEVICE INITIATED POWER MANAGEMENT SUPPORTED bit

If the DEVICE INITIATED POWER MANAGEMENT SUPPORTED bit is set to one, the device supports device initiated power management (DIPM) requests. If the DEVICE INITIATED POWER MANAGEMENT SUPPORTED bit is cleared to zero, the device does not support device initiated power management requests.

Devices shall support either host-initiated interface power management or device-initiated interface power management. If the RECEIPT OF HOST INITIATED POWER MANAGEMENT REQUESTS SUPPORTED bit (see 9.10.10.2.5) is cleared to zero, then the DEVICE INITIATED POWER MANAGEMENT SUPPORTED bit shall be set to one.

The IDENTIFY DEVICE data contains a copy of the DEVICE INITIATED POWER MANAGEMENT SUPPORTED bit (see IDENTIFY DEVICE data word 78 in table 57).

9.10.10.2.18 IN-ORDER DATA DELIVERY SUPPORTED bit

If the IN-ORDER DATA DELIVERY SUPPORTED bit is set to one, the device supports guaranteed in-order data delivery for nonzero buffer offsets in commands in the NCQ feature set (see 4.15). See SATA 3.5 for more information.

The IDENTIFY DEVICE data contains a copy of the IN-ORDER DATA DELIVERY SUPPORTED bit (see IDENTIFY DEVICE data word 78 in table 57).

9.10.10.2.19 HARDWARE FEATURE CONTROL SUPPORTED bit

If the HARDWARE FEATURE CONTROL SUPPORTED bit is set to one, the device supports an extended use of Hardware Feature Control (see 4.21). If the HARDWARE FEATURE CONTROL SUPPORTED bit is cleared to zero, the device does not support an extended use of Hardware Feature Control and the HARDWARE FEATURE CONTROL IS ENABLED bit (see 9.10.10.3.6) shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the HARDWARE FEATURE CONTROL SUPPORTED bit (see IDENTIFY DEVICE data word 78 in table 57).

9.10.10.2.20 SOFTWARE SETTINGS PRESERVATION SUPPORTED bit

If the SOFTWARE SETTINGS PRESERVATION SUPPORTED bit is set to one, the device supports the SSP feature set (see 4.25). If the SOFTWARE SETTINGS PRESERVATION SUPPORTED bit is cleared to zero, the device does not support the SSP feature set.

The IDENTIFY DEVICE data contains a copy of the SOFTWARE SETTINGS PRESERVATION SUPPORTED bit (see IDENTIFY DEVICE data word 78 in table 57).

9.10.10.2.21 NCQ AUTOSENSE SUPPORTED bit

If the NCQ AUTOSENSE SUPPORTED bit is set to one, the device supports NCQ Autosense (see 9.14). If the NCQ AUTOSENSE SUPPORTED bit is cleared to zero, the device does not support NCQ Autosense (see 9.14). If the NCQ FEATURE SET SUPPORTED bit (see 9.10.10.2.4) is cleared to zero, the NCQ AUTOSENSE SUPPORTED bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the NCQ AUTOSENSE SUPPORTED bit (see IDENTIFY DEVICE data word 78 in table 57).

9.10.10.2.22 DEVICE SLEEP SUPPORTED bit

If the DEVICE SLEEP SUPPORTED bit is set to one, then:

a) the device supports the Device Sleep feature;
b) the device shall support the IDENTIFY DEVICE data log;
c) the DEVSLP TIMING VARIABLES SUPPORTED bit shall be set to one (see 9.10.10.6.1); and
d) the POWER DISABLE FEATURE ALWAYS ENABLED bit shall be cleared to zero (see 9.10.10.2.29).

If the DEVICE SLEEP SUPPORTED bit is cleared to zero, the device does not support the Device Sleep feature. If the DEVICE SLEEP SUPPORTED bit is cleared to zero, the host should ignore the DEVSLEEP TO REDUCEDPWRSTATE CAPABILITY SUPPORTED bit and the DEVSLP TIMING VARIABLES SUPPORTED bit.

The IDENTIFY DEVICE data contains a copy of the DEVICE SLEEP SUPPORTED bit (see IDENTIFY DEVICE data word 78 in table 57).

9.10.10.2.23 HYBRID INFORMATION SUPPORTED bit

If the HYBRID INFORMATION SUPPORTED bit is set to one, then the device supports the hybrid information feature (see 4.12). If the device does not support the hybrid information feature, then the HYBRID INFORMATION SUPPORTED bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the HYBRID INFORMATION SUPPORTED bit (see IDENTIFY DEVICE data word 78 in table 57).

9.10.10.2.24 DEVSLEEP TO REDUCEDPWRSTATE CAPABILITY SUPPORTED bit

If the DEVSLEEP TO REDUCEDPWRSTATE CAPABILITY SUPPORTED bit is set to one, then:

a) the device supports maintaining whether the device was in Partial or Slumber after detection of assertion, and subsequent detection of negation, of DEVSLP (see SATA 3.5); and
b) the DEVICE SLEEP SUPPORTED bit shall be set to one (see 9.10.10.2.22).

If the DEVSLEEP TO REDUCEDPWRSTATE CAPABILITY SUPPORTED bit is cleared to zero, the device does not support remembering whether the device was in Partial or Slumber after detection of assertion, and subsequent detection of negation, of DEVSLP.

The IDENTIFY DEVICE data contains a copy of the DEVSLEEP TO REDUCEDPWRSTATE CAPABILITY SUPPORTED bit (see IDENTIFY DEVICE data word 77 in table 57).

9.10.10.2.25 HYBRID INFORMATION SUPPORTED bit

If the HYBRID INFORMATION SUPPORTED bit is set to one, then the device supports the Hybrid Information feature (see 4.12). If the device does not support the hybrid information feature, then the HYBRID INFORMATION SUPPORTED bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the HYBRID INFORMATION SUPPORTED bit (see IDENTIFY DEVICE data word 78 in table 57).

9.10.10.2.26 DIPM SSP PRESERVATION SUPPORTED bit

If the DIPM SSP PRESERVATION SUPPORTED bit is set to one, then the device supports persistence of the Device Initiated Interface Power Management enable/disable setting via Software Settings Preservation.

The IDENTIFY DEVICE data contains a copy of the DIPM SSP PRESERVATION SUPPORTED bit (see IDENTIFY DEVICE data word 78 in in table 57).

9.10.10.2.27 REBUILD ASSIST SUPPORTED bit

If the REBUILD ASSIST SUPPORTED bit is set to one, the device supports the Rebuild Assist feature set (see 4.19). If the REBUILD ASSIST SUPPORTED bit is cleared to zero, the device does not support the Rebuild Assist feature set.

If the NCQ FEATURE SET SUPPORTED bit (see 9.10.10.2.4) is cleared to zero, the REBUILD ASSIST SUPPORTED bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the REBUILD ASSIST SUPPORTED bit (see IDENTIFY DEVICE data word 78 in table 57).

9.10.10.2.28 POWER DISABLE FEATURE SUPPORTED bit

If the POWER DISABLE FEATURE SUPPORTED bit is set to one, the device supports the Power Disable feature.

If the POWER DISABLE FEATURE SUPPORTED bit is cleared to zero, then:

a) the device does not support the Power Disable feature;
b) the POWER DISABLE FEATURE ALWAYS ENABLED bit shall be cleared to zero (see 9.10.10.2.29); and
c) the POWER DISABLE FEATURE ENABLED bit shall be cleared to zero (see 9.10.10.3.10).

The IDENTIFY DEVICE data contains a copy of the POWER DISABLE FEATURE SUPPORTED bit (see IDENTIFY DEVICE data word 78 in table 57).

9.10.10.2.29 POWER DISABLE FEATURE ALWAYS ENABLED bit

If the POWER DISABLE FEATURE ALWAYS ENABLED bit is set to one, then:

a) the Power Disable feature is always enabled;
b) the DEVICE SLEEP SUPPORTED bit shall be cleared to zero (see 9.10.10.2.22).
c) the POWER DISABLE FEATURE ENABLED bit shall be set to one (see 9.10.10.3.10).
d) the value of the POWER DISABLE FEATURE ALWAYS ENABLED bit and the value of the POWER DISABLE FEATURE ENABLED bit shall persist across all resets.

If the POWER DISABLE FEATURE ALWAYS ENABLED bit is cleared to zero and the POWER DISABLE FEATURE SUPPORTED bit is set to one (see 9.10.10.2.28), then the Power Disable feature may be enabled using the SET FEATURES Enable/Disable Power Disable Feature subcommand (see 7.45.16.11).

The IDENTIFY DEVICE data contains a copy of the POWER DISABLE FEATURE ALWAYS ENABLED bit (see IDENTIFY DEVICE data word 77 in table 57).

9.10.10.2.30 OUT OF BAND MANAGEMENT INTERFACE SUPPORTED bit

If the OUT OF BAND MANAGEMENT INTERFACE SUPPORTED bit is set to one, then the device supports the out of band management interface (see 4.16). If the OUT OF BAND MANAGEMENT INTERFACE SUPPORTED bit is cleared to zero, then the device does not support the out of band management interface.

The IDENTIFY DEVICE data contains a copy of the OUT OF BAND MANAGEMENT INTERFACE SUPPORTED bit (see IDENTIFY DEVICE data word 77 in table 57).

9.10.10.2.31 OUT OF BAND TEMPERATURE CHANGE REPORTING SUPPORTED bit

If the OUT OF BAND TEMPERATURE CHANGE REPORTING SUPPORTED bit is set to one, then the device supports the MINIMUM REPORTING INTERVAL field, the CHANGE UP field, and the CHANGE DOWN field in the temperature attribute control descriptor (see 9.33.7).

If the OUT OF BAND TEMPERATURE CHANGE REPORTING SUPPORTED bit is cleared to zero, then the MINIMUM REPORTING INTERVAL field, the CHANGE UP field, and the CHANGE DOWN field in the temperature attribute control descriptor are reserved.

9.10.10.3 Current SATA Settings

9.10.10.3.1 CURRENT NEGOTIATED SERIAL ATA SIGNAL SPEED field

The CURRENT NEGOTIATED SERIAL ATA SIGNAL SPEED field (see table 276) is a coded value that indicates the Serial ATA Phy speed at which the device is currently communicating.

Table 276 — CURRENT NEGOTIATED SERIAL ATA SIGNAL SPEED field

Code	Description
000b	Reporting of current signalling speed is not supported
001b	Current signalling speed is Gen1
010b	Current signalling speed is Gen2
011b	Current signalling speed is Gen3
100b..111b	Reserved

NOTE 11 — In the case of system configurations that have more than one Phy link in the data path (e.g., port multiplier), the indicated speed is only relevant for the link between the device Phy and its immediate host Phy. It is possible for each link in the data path to negotiate a different Serial ATA signaling speed.

The IDENTIFY DEVICE data contains a copy of the CURRENT NEGOTIATED SERIAL ATA SIGNAL SPEED bit (see IDENTIFY DEVICE data word 77 in table 57).

9.10.10.3.2 NONZERO BUFFER OFFSETS ENABLED bit

If the NONZERO BUFFER OFFSETS ENABLED bit is set to one, then device support for the use of nonzero buffer offsets for commands in the NCQ feature set (see 4.15) is enabled. See SATA 3.5 for more information.

The IDENTIFY DEVICE data contains a copy of the NONZERO BUFFER OFFSETS ENABLED bit (see IDENTIFY DEVICE data word 79 in table 57).

9.10.10.3.3 DMA SETUP AUTO-ACTIVATION ENABLED bit

If the DMA SETUP AUTO-ACTIVATION ENABLED bit is set to one, then the device support for use of the DMA Setup FIS Auto-Activate optimization is enabled. See SATA 3.5 for more information.

The IDENTIFY DEVICE data contains a copy of the DMA SETUP AUTO-ACTIVATION ENABLED bit (see IDENTIFY DEVICE data word 79 in table 57).

9.10.10.3.4 DEVICE INITIATED POWER MANAGEMENT ENABLED bit

If the DEVICE INITIATED POWER MANAGEMENT ENABLED bit is set to one, then device support for initiating power management requests to the host is enabled. If the DEVICE INITIATED POWER MANAGEMENT ENABLED bit is set to one, then the device may initiate power management transition requests. If the DEVICE INITIATED POWER MANAGEMENT ENABLED bit is cleared to zero, then the device shall not initiate interface power management requests to the host. The DEVICE INITIATED POWER MANAGEMENT ENABLED bit shall be cleared to zero by default.

The IDENTIFY DEVICE data contains a copy of the DEVICE INITIATED POWER MANAGEMENT ENABLED bit (see IDENTIFY DEVICE data word 79 in table 57).

9.10.10.3.5 IN-ORDER DATA DELIVERY ENABLED bit

If the IN-ORDER DATA DELIVERY ENABLED bit is set to one, then device support for guaranteed in-order data delivery when nonzero buffer offsets are used for commands in the NCQ feature set (see 4.15) is enabled. See SATA 3.5 for more information.

The IDENTIFY DEVICE data contains a copy of the IN-ORDER DATA DELIVERY ENABLED bit (see IDENTIFY DEVICE data word 79 in table 57).

9.10.10.3.6 HARDWARE FEATURE CONTROL IS ENABLED bit

If the HARDWARE FEATURE CONTROL IS ENABLED bit is set to one, then device support for the supported extended use of Hardware Feature Control (see 4.21) is enabled. If the HARDWARE FEATURE CONTROL IS ENABLED bit is cleared to zero, then the supported extended use, if any, of Hardware Feature Control is disabled. See SATA 3.5 for more information.

The IDENTIFY DEVICE data contains a copy of the HARDWARE FEATURE CONTROL IS ENABLED bit (see IDENTIFY DEVICE data word 79 in table 57).

9.10.10.3.7 SOFTWARE SETTINGS PRESERVATION ENABLED bit

If the SOFTWARE SETTINGS PRESERVATION ENABLED bit is set to one, then the SSP feature set (see 4.25) is enabled. If the device supports the SSP feature set, then the SOFTWARE SETTINGS PRESERVATION ENABLED bit shall be set to one after a power on reset has been processed. If the device does not support the SSP feature set (i.e., if the SOFTWARE SETTINGS PRESERVATION SUPPORTED bit (see 9.10.10.2.20) is cleared to zero), then the SOFTWARE SETTINGS PRESERVATION ENABLED bit shall be cleared to zero.

The IDENTIFY DEVICE data contains a copy of the SOFTWARE SETTINGS PRESERVATION ENABLED bit (see IDENTIFY DEVICE data word 79 in table 57).

9.10.10.3.8 AUTOMATIC PARTIAL TO SLUMBER TRANSITIONS ENABLED bit

If the AUTOMATIC PARTIAL TO SLUMBER TRANSITIONS ENABLED bit is set to one, then the device may asynchronously transition from Partial to Slumber.

The IDENTIFY DEVICE data contains a copy of the AUTOMATIC PARTIAL TO SLUMBER TRANSITIONS ENABLED bit (see IDENTIFY DEVICE data word 79 in table 57).

9.10.10.3.9 DEVICE SLEEP ENABLED bit

If the DEVICE SLEEP ENABLED bit is set to one, the Device Sleep feature is enabled. If the DEVICE SLEEP ENABLED bit is cleared to zero, the Device Sleep feature is disabled.

The IDENTIFY DEVICE data contains a copy of the DEVICE SLEEP ENABLED bit (see IDENTIFY DEVICE data word 79 in table 57).

9.10.10.3.10 POWER DISABLE FEATURE ENABLED bit

If the POWER DISABLE FEATURE ENABLED bit is set to one, the Power Disable feature is enabled. If the POWER DISABLE FEATURE ENABLED bit is cleared to zero, the Power Disable feature is disabled.

If the POWER DISABLE FEATURE ALWAYS ENABLED bit is cleared to zero (see 9.10.10.2.29), after processing:

a) a power-on reset, the value of the POWER DISABLE FEATURE ENABLED bit shall be cleared to zero;
b) a hardware reset, the value of the POWER DISABLE FEATURE ENABLED bit shall not be changed; and
c) a software reset, the value of the POWER DISABLE FEATURE ENABLED bit shall not be changed.

The IDENTIFY DEVICE data contains a copy of the POWER DISABLE FEATURE ENABLED bit (see IDENTIFY DEVICE data word 79 in table 57).

9.10.10.3.11 REBUILD ASSIST ENABLED bit

If the REBUILD ASSIST ENABLED bit is set to one, the Rebuild Assist feature set (see 4.19) is enabled (see 9.20). If the REBUILD ASSIST ENABLED bit is cleared to zero, the Rebuild Assist feature set is disabled.

The REBUILD ASSIST ENABLED bit may be set to one only if the REBUILD ASSIST SUPPORTED is set to one (see 9.10.10.2.27).

The IDENTIFY DEVICE data contains a copy of the REBUILD ASSIST ENABLED bit (see IDENTIFY DEVICE data word 79 in table 57).

9.10.10.3.12 HYBRID INFORMATION ENABLED bit

The IDENTIFY DEVICE data contains a copy of the HYBRID INFORMATION ENABLED bit (see IDENTIFY DEVICE data word 79 in table 57)

9.10.10.4 CURRENT HARDWARE FEATURE CONTROL IDENTIFIER field

If the CURRENT HARDWARE FEATURE CONTROL IDENTIFIER field is nonzero, then table 132 describes the current Hardware Feature Control behavior. If the CURRENT HARDWARE FEATURE CONTROL IDENTIFIER field is cleared to zero, then the current Hardware Feature Control behavior shall be DSS, DAS, or none.

9.10.10.5 SUPPORTED HARDWARE FEATURE CONTROL IDENTIFIER field

The SUPPORTED HARDWARE FEATURE CONTROL IDENTIFIER field (see table 132) indicates the value that is permitted for the CURRENT HARDWARE FEATURE CONTROL IDENTIFIER field (see 9.10.10.4).

9.10.10.6 Device Sleep Timing Variables

9.10.10.6.1 DEVSLP TIMING VARIABLES SUPPORTED bit

If the DEVSLP TIMING VARIABLES SUPPORTED bit is set to one, the device supports the Device Sleep Timing Variables. If the DEVSLP TIMING VARIABLES SUPPORTED bit is cleared to zero, the device may not support the Device Sleep Timing Variables.

9.10.10.6.2 DEVSLEEP EXIT TIMEOUT field

The DEVSLEEP EXIT TIMEOUT field (i.e., DETO in SATA 3.5) contains the maximum time, in ms, from when DEVSLP (see SATA 3.5) is negated, to when the device shall be ready to detect OOB signals (see SATA 3.5). If the DEVSLEEP EXIT TIMEOUT field is cleared to zero, the host should use 20 ms as the DevSleep Exit Timeout value.

See SATA 3.5 for more information.

9.10.10.6.3 MINIMUM DEVSLP ASSERTION TIME field

The MINIMUM DEVSLP ASSERTION TIME field (i.e., MDAT in SATA 3.5) contains the minimum time, in ms, that the host shall assert DEVSLP, after it has been asserted. If the MINIMUM DEVSLP ASSERTION TIME field is cleared to zero, the host should use 10 ms as the Minimum DevSleep Assertion Time value.

See SATA 3.5 for more information.

9.11 Command Duration Limits log (Log Address 18h)

9.11.1 Command Duration Limits log overview

9.11.1.1 Command Duration Limits log format

The Command Duration Limits log is:

a) supported if the Command Duration Limits feature set (see 4.7) is supported;
b) readable and writable by the host when the Command Duration Limits feature set is supported, even if the Command Duration Limits feature set is disabled; and
c) non-volatile.

If:

a) a log command attempts to write the Command Duration Limits log; and
b) the log data contains invalid values or reserved values,

then the device shall return command aborted with the additional sense code set to INVALID FIELD IN PARAMETER LIST (see 6.8.18) for that command.

Table 277 describes the contents of the Command Duration Limits log.

Table 277 — Command Duration Limits Log (page 0)

Offset	Type	Description
0	Byte	Performance versus Command Duration Guidelines **Bit Description** 7:4 Reserved 3:0 PERFORMANCE VERSUS COMMAND DURATION GUIDELINES field (see 9.11.1.2)
1..63		Reserved
64..95		Command Duration Limits Descriptor r1 (see 9.11.2)
96..127		Command Duration Limits Descriptor r2 (see 9.11.2)
128..159		Command Duration Limits Descriptor r3 (see 9.11.2)
160..191		Command Duration Limits Descriptor r4 (see 9.11.2)
192.223		Command Duration Limits Descriptor r5 (see 9.11.2)
224..255		Command Duration Limits Descriptor r6 (see 9.11.2)
256..287		Command Duration Limits Descriptor r7 (see 9.11.2)
288..319		Command Duration Limits Descriptor w1 (see 9.11.2)
320..351		Command Duration Limits Descriptor w2 (see 9.11.2)
352..383		Command Duration Limits Descriptor w3 (see 9.11.2)
384..415		Command Duration Limits Descriptor w4 (see 9.11.2)
416.447		Command Duration Limits Descriptor w5 (see 9.11.2)
448.479		Command Duration Limits Descriptor w6 (see 9.11.2)
480..511		Command Duration Limits Descriptor w7 (see 9.11.2)

9.11.1.2 PERFORMANCE VERSUS COMMAND DURATION GUIDELINES field

If the COMMAND DURATION GUIDELINES SUPPORTED bit (see 9.10.5.19.2) is:

a) set to one, then the PERFORMANCE VERSUS COMMAND DURATION GUIDELINES field (see table 278) specifies the maximum percentage increase in average command completion times that are caused by actions that the device performs based on the contents of the COMMAND DURATION GUIDELINE field (see 9.11.2.9); and
b) is cleared to zero, then the PERFORMANCE VERSUS COMMAND DURATION GUIDELINES field shall be:
   A) set to 0h; and
   B) if a write log command sets a value other than 0h, then that command shall be process as a command that contains an invalid value (see 9.11.1.1).

Table 278 — PERFORMANCE VERSUS COMMAND DURATION GUIDELINES field

Value	Maximum Percentage Performance Decrease [a]
0h	0%
1h	0.5%
2h	1.0%
3h	1.5%
4h	2.0%
5h	2.5%
6h	3%
7h	4%
8h	5%
9h	8%
Ah	10%
Bh	15%
Ch	20%
Dh..Fh	Reserved

[a] Values in the PERFORMANCE VERSUS COMMAND DURATION GUIDELINES field specify the maximum allowed percentage increase in average command completion times.

9.11.2 Command Duration Limits Descriptor

9.11.2.1 Command Duration Limits Descriptor overview

Table 279 describes the Command Duration Limits Descriptor. If Command Duration Limits Descriptor is not supported, then that Command Duration Limits Descriptor shall be cleared to zero.

Table 279 — Command Duration Limits Descriptor

Offset	Type	Description
0..3	DWord	Command Limits Descriptor **Bit Description** 31:12 Reserved 11:8 INACTIVE TIME LIMIT POLICY field (see 9.11.2.2) 7:4 ACTIVE TIME LIMIT POLICY field (see 9.11.2.3) 3:0 COMMAND DURATION GUIDELINE POLICY field (see 9.11.2.4)
4..7	DWord	ACTIVE TIME LIMIT field (see 9.11.2.5)
8..11	DWord	INACTIVE TIME LIMIT field (see 9.11.2.6)
12	Byte	COMMAND DURATION LIMITS STATISTIC A SELECTOR field (see 9.11.2.7)
13	Byte	COMMAND DURATION LIMITS STATISTIC B SELECTOR field (see 9.11.2.8)
14..15		Reserved
16..19	DWord	COMMAND DURATION GUIDELINE field (see 9.11.2.9)
20..31		Reserved

9.11.2.2 INACTIVE TIME LIMIT POLICY field

Table 280 defines the device policy, if the inactive time (see 4.7) for a command that is subject to the Command Duration Limits feature set is greater than the INACTIVE TIME LIMIT field (see 9.11.2.6).

Table 280 — INACTIVE TIME LIMIT POLICY field

Value	Description
0h	The device ignores the INACTIVE TIME LIMIT field.
1h..Ch	Reserved
Dh	The device completes the command without error with the additional sense code set to DATA CURRENTLY UNAVAILABLE (see 6.8.6).
Eh	Reserved
Fh	The device returns command aborted with the additional sense code set to COMMAND TIMEOUT BEFORE PROCESSING (see 6.8.4).

9.11.2.3 ACTIVE TIME LIMIT POLICY field

Table 281 defines the device policy, if the active time (see 4.7) for a command that is subject to the Command Duration Limits feature set is greater than the ACTIVE TIME LIMIT field (see 9.11.2.5).

Table 281 — ACTIVE TIME LIMIT POLICY field

Value	Description
0h	The device ignores the ACTIVE TIME LIMIT field.
1h..Ch	Reserved
Dh	The device completes the command without error with the additional sense code set to DATA CURRENTLY UNAVAILABLE (see 6.8.6).
Eh	Reserved
Fh	The device returns command aborted with the additional sense code set to COMMAND TIMEOUT DURING PROCESSING (see 6.8.5).

9.11.2.4 COMMAND DURATION GUIDELINE POLICY field

Table 282 defines the device policy during the processing of a command that is subject to the Command Duration Limits feature set (see 4.7) with a non-zero COMMAND DURATION GUIDELINE field (see 9.11.2.9) that the device has been unable to achieve.

Table 282 — COMMAND DURATION GUIDELINE POLICY field

Value	Description
0h	The device shall complete that command at the earliest possible time consistent with the non-zero contents of the COMMAND DURATION GUIDELINE field.
1h [a]	If the preferred length of time for command completion specified by the COMMAND DURATION GUIDELINE field has not been met and that command's COMMAND DURATION LIMITS INDEX field (see 4.7) is less than seven, then the device shall process that command using the Command Duration Limits Descriptor selected by one plus the contents of that command's COMMAND DURATION LIMITS INDEX field.
2h	The device shall process that command as if the command had specified zero in the COMMAND DURATION LIMITS INDEX field.
3h..Ch	Reserved
Dh [b]	The device shall complete the command without error with the additional sense code set to DATA CURRENTLY UNAVAILABLE (see 6.8.6).
Eh	Reserved
Fh [b]	The device shall return command aborted with the additional sense code set to COMMAND TIMEOUT BEFORE PROCESSING (see 6.8.4).

[a] If a write log command that sets this value in Command Duration Limits Descriptor r7 (see table 277) or Command Duration Limits Descriptor w7, then that command shall be processed as a command that contains an invalid value (see 9.11.1.1).

[b] If a write log command that sets this value in a Command Duration Limits Descriptor in which the ACTIVE TIME LIMIT field (see 9.11.2.5) is not cleared to zero or the INACTIVE TIME LIMIT field (see 9.11.2.6) is not cleared to zero, then that command shall be processed as a command that contains an invalid value.

9.11.2.5 ACTIVE TIME LIMIT field

The ACTIVE TIME LIMIT field specifies the maximum active time (see 4.7) that the device shall allow for a command that selected this Command Duration Limits Descriptor, in microseconds.

An ACTIVE TIME LIMIT field cleared to zero indicates that there is no active time limit.

If the Command Duration Limits log is written, and the value of this field is non-zero and is:

a) less than the CDL MINIMUM TIME LIMIT field (see 9.10.5.19.4), and the ROUNDING BEHAVIOR bit (see 9.10.6.2.4) is:
   A) cleared to zero, then the device shall return command aborted for the command that was used to write the Command Duration Limits log; and
   B) set to one, then the device shall set the ACTIVE TIME LIMIT field to the value of the CDL MINIMUM TIME LIMIT field (i.e., round up to the minimum allowed); and
b) greater than the CDL MAXIMUM TIME LIMIT field and the ROUNDING BEHAVIOR bit is:
   A) cleared to zero, then the device shall return command aborted with the additional sense code set to INVALID FIELD IN PARAMETER LIST (see 6.8.18) for the command that was used to write the Command Duration Limits log; and
   B) set to one, then the device shall set the ACTIVE TIME LIMIT field to the value of the CDL MAXIMUM TIME LIMIT field (i.e., round down to the maximum allowed).

9.11.2.6 INACTIVE TIME LIMIT field

The INACTIVE TIME LIMIT field specifies the maximum inactive time (see 4.7) that the device shall allow for a command that selected this Command Duration Limits Descriptor, in microseconds.

An INACTIVE TIME LIMIT field cleared to zero indicates that there is no inactive time limit.

If the Command Duration Limits log is written, and the value of this field is non-zero and is:

a) less than the CDL MINIMUM TIME LIMIT field (see 9.10.5.19.4), and the ROUNDING BEHAVIOR bit (see 9.10.6.2.4) is:
   A) cleared to zero, then the device shall return command aborted for the command that was used to write the Command Duration Limits log; and
   B) set to one, then the device shall set the INACTIVE TIME LIMIT field to the value of the CDL MINIMUM TIME LIMIT field (i.e., round up to the minimum allowed); and
b) greater than the CDL MAXIMUM TIME LIMIT field and the ROUNDING BEHAVIOR bit is:
   A) cleared to zero, then the device shall return command aborted with the additional sense code set to INVALID FIELD IN PARAMETER LIST (see 6.8.18) for the command that was used to write the Command Duration Limits log; and
   B) set to one, then the device shall set the INACTIVE TIME LIMIT field to the value of the CDL MAXIMUM TIME LIMIT field (i.e., round down to the maximum allowed).

9.11.2.7 COMMAND DURATION LIMITS STATISTIC A SELECTOR field

For the Command Duration Limits Statistic A device statistic (see 9.5.4.4) that is associated with this Command Duration Limits Descriptor (e.g., Command Duration Limits Statistic A for Command Duration Limits Descriptor w2 if this is Command Duration Limits Descriptor w2), the COMMAND DURATION LIMITS STATISTIC A SELECTOR field (see table 283) specifies the conditions associated with this Command Duration Limits Descriptor (e.g., the processing of requirements in the INACTIVE TIME LIMIT POLICY field) that result in the device statistic being incremented.

Table 283 — COMMAND DURATION LIMITS STATISTIC SELECTOR field

Code	Description
00h	No device statistics are modified based on this Command Duration Limits Descriptor.
01h	The device statistic shall be incremented if the device processes the requirements in the INACTIVE TIME LIMIT POLICY field (see 9.11.2.6).
02h	The device statistic shall be incremented if the device processes the requirements in the ACTIVE TIME LIMIT POLICY field (see 9.11.2.5).
03h	The device statistic shall be incremented if the device processes the requirements in: a) the INACTIVE TIME LIMIT POLICY field; or b) the ACTIVE TIME LIMIT POLICY field.
04h..FFh	Reserved

9.11.2.8 COMMAND DURATION LIMITS STATISTIC B SELECTOR field

For the Command Duration Limits Statistic B device statistic (see 9.5.4.5) that is associated with this Command Duration Limits Descriptor (e.g., Command Duration Limits Statistic B for Command Duration Limits Descriptor r5 if this is Command Duration Limits Descriptor r5), the COMMAND DURATION LIMITS STATISTIC B SELECTOR field (see table 283) specifies the conditions associated with this Command Duration Limits Descriptor (e.g., the processing of requirements in the ACTIVE TIME LIMIT POLICY field) that result in the device statistic being incremented.

9.11.2.9 COMMAND DURATION GUIDELINE field

The COMMAND DURATION GUIDELINE field specifies the preferred length of time for the completion of a command that selects this Command Duration Limits Descriptor. The device processes the COMMAND DURATION GUIDELINE field in a given Command Duration Limits Descriptor based on comparisons to the non-zero values in the COMMAND DURATION GUIDELINE fields in other Command Duration Limits Descriptors.

The preferred length of time for the command completion is specified as the non-zero number of microseconds to be added to fastest time for completion of a read command for which the device is able to return the requested data only by accessing the media. Although the COMMAND DURATION GUIDELINE field contains a time based value, this standard requires only that:

a) the length of time with which the device completes commands that select a Command Duration Limits Descriptor is:
   A) faster for smaller values in the COMMAND DURATION GUIDELINE field; and
   B) slower for larger values in the COMMAND DURATION GUIDELINE field,
   in comparison to the values in the COMMAND DURATION GUIDELINE field of other Command Duration Limits Descriptors; and
b) larger magnitudes of the difference between the values in the COMMAND DURATION GUIDELINE fields in two different Command Duration Limits Descriptors result in larger probabilities of differences between the length of time of command completions for commands that select those descriptors.

A COMMAND DURATION GUIDELINE field cleared to zero indicates that no command completion guidance is provided by this Command Duration Limits Descriptor.

> EXAMPLE - A host may specify a set of command duration guidelines that is independent of a device's performance characteristics by specifying one in the COMMAND DURATION GUIDELINE field of the Command Duration Limits Descriptor or Descriptors associated with the most rapid preferred command completion. For all other Command Duration Limits Descriptors, COMMAND DURATION GUIDELINE field is specified as the preferred command completion length of time minus the average seek time for a hypothetical, average hard disk drive. The magnitude relationships computed in this way provide inputs that are useful to the device.

The contents of the PERFORMANCE VERSUS COMMAND DURATION GUIDELINES field (see 9.11.1.2) may affect the timing relationships between the processing of queued commands based on the contents of the COMMAND

DURATION GUIDELINE field values and the COMMAND DURATION GUIDELINE POLICY field values in the Command Duration Limits Descriptors selected by those queued commands.

The contents of the COMMAND DURATION GUIDELINE field shall not be affected by ROUNDING BEHAVIOR bit (see 9.10.6.2.4), the CDL MINIMUM TIME LIMIT field (see 9.10.5.19.4), or the CDL MAXIMUM TIME LIMIT field.

9.12 LBA Status log (Log Address 19h)

9.12.1 Overview

The LBA Status log contains the LBA status for all user accessible LBAs (see 4.1).

The LBA Status log may be affected by the processing of a device configuration changing command.

See table 284 for the defined log pages.

Table 284 — Defined LBA Status log pages

Log Page	Description
0000h	Number of LBA Valid Ranges (see 9.12.2)
0001h	LBA Status (see 9.12.3)
0002h	LBA Status (see 9.12.3)
0003h	LBA Status (see 9.12.3)
…	…
n	LBA Status (see 9.12.3)

The list of LBA status descriptors are returned:

a) in LBA ascending order with no overlapping LBAs; and
b) with no gaps (i.e., LBA status descriptors with a zero value in the NUMBER OF LOGICAL BLOCKS field) between LBA status descriptors.

Each LBA Status log page contains up to 31 LBA status descriptors.

If the final (i.e., page n) LBA Status log page contains less than 31 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.

The maximum size of the LBA Status log shall be reported in the General Purpose Log Directory (see 9.2). If the LBA Status log defines fewer pages than those reported in the General Purpose Log Directory, then the device shall return zeroes for the data in additional pages.

If this log is not able to return LBA status for all LBAs, then the last LBA Status Descriptor (see table 287) shall indicate that the remaining LBA statuses are unknown (i.e., the TRIM STATUS bit is cleared to zero).

9.12.2 Number of LBA Valid Ranges log page (Page 0000h)

The Number of LBA Valid Ranges log page (see table 285) contains the number of LBA status descriptors that contain valid LBA status.

Table 285 — Number of Valid LBA Ranges log page

Offset	Type	Description
0..7	QWord	Number of LBA Status Descriptors The Number of LBA Status Descriptors is the number of valid LBA Status Descriptors contained in the LBA Status log.
8..511	Byte	Reserved

9.12.3 LBA Status log pages

The LBA Status log pages (see table 286) contain:

a) header fields that specify:
   A) the first (i.e., lowest numbered) LBA contained within that LBA Status log page; and
   B) the last (i.e., highest numbered) LBA 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 cleared to zero.

The FIRST LOGICAL BLOCK ADDRESS field in each subsequent LBA Status log page shall be set to one plus the LAST LOGICAL BLOCK ADDRESS field of the LBA Status log page with a page number that is one less than the page number of this LBA Status log page.

Table 286 — LBA Status log page

Offset	Type	Description
0..7	QWord	FIRST LOGICAL BLOCK ADDRESS field The FIRST LOGICAL BLOCK ADDRESS field contains the LBA in LBA Status Descriptor 0 returned in this LBA Status log page.
8..15	QWord	LAST LOGICAL BLOCK ADDRESS field The LAST LOGICAL BLOCK ADDRESS field contains 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 0
32..47		LBA Status Descriptor 1
…		…
496..511		LBA Status Descriptor (30)

9.12.4 LBA Status Descriptor

The content of the LBA Status Descriptor is shown in table 287.

Table 287 — LBA Status Descriptor

Offset	Type	Description
n..n+7	QWord	STARTING LOGICAL BLOCK ADDRESS field
n+8..n+11	DWord	NUMBER OF LOGICAL BLOCKS field
n+12..n+13	Word	LBA Range Status **Bit Description** 15:1 Reserved 0 TRIM STATUS bit
n+14..n+15	Word	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 7.5.3.3). 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 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.

Adjacent LBA Status Descriptors may or may not have different values for the TRIM STATUS bit.

9.13 LPS Mis-alignment log (Log Address 0Dh)

Table 288 and table 289 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 may be affected by the processing of a device configuration changing command.

The LPS Mis-alignment log is not affected by Long Physical Sector Alignment Error Reporting Control (see 7.45.19).

Table 288 — LPS Mis-alignment log (log page 0)

Offset	Type	Description
0..7	QWord	Structure Version
		Bit **Description**
		63:32 Reserved
		31:16 Number of mis-aligned logical sectors contained in this log
		15:0 Revision number – shall be set to 0001h
8..15	QWord	Mis-aligned sector 0
		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
16..23	QWord	Mis-aligned sector 1
		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 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 289 — 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

9.14 NCQ Command Error log (Log Address 10h)

9.14.1 Overview

The NCQ Command Error log describes the most recent NCQ command failure, is at least one log page in length, and is defined in table 290. Devices supporting the NCQ feature set (see 4.15) shall support log address 10h (i.e., NCQ Command Error). Multiple commands (see 9.10.10.2.11) may be used to read the NCQ Command Error log. For zoned devices (see ZAC-2), this log is two pages long.

Table 290 — NCQ Command Error log (Sheet 1 of 2)

Offset	Description
0	**Bit Name** 7 NQ bit (see 9.14.3) 6 UNL bit (see 9.14.4) 5 DEFERRED ERROR bit (see 9.14.6) 0 = Current information (see 4.24.2) 1 = Deferred error (see 4.24.2) 4:0 NCQ TAG field (see 9.14.2)
1	Reserved
2	STATUS field (see 9.14.5)
3	ERROR field (see 9.14.5)
4	LBA field (7:0) (see 9.14.5)
5	LBA field (15:8) (see 9.14.5)
6	LBA field (23:16) (see 9.14.5)
7	DEVICE field (see 9.14.5)
8	LBA field (31:24) (see 9.14.5)
9	LBA field (39:32) (see 9.14.5)
10	LBA field (47:40) (see 9.14.5)
11	Reserved
12	COUNT field (7:0) (see 9.14.5)
13	COUNT field (15:8) (see 9.14.5)
14	SENSE KEY field (see 9.14.6)
15	ADDITIONAL SENSE CODE field (see 9.14.6)
16	ADDITIONAL SENSE CODE QUALIFIER field (see 9.14.6)
17	FINAL LBA IN ERROR field (7:0) (see 9.14.7)
18	FINAL LBA IN ERROR field (15:8) (see 9.14.7)
19	FINAL LBA IN ERROR field (23:16) (see 9.14.7)
20	FINAL LBA IN ERROR field (31:24) (see 9.14.7)
21	FINAL LBA IN ERROR field (39:32) (see 9.14.7)
22	FINAL LBA IN ERROR field (47:40) (see 9.14.7)
23..255	Reserved
256..510	Vendor Specific
511	Checksum (see 9.14.8)

Table 290 — NCQ Command Error log (Sheet 2 of 2)

Offset	Description
512	WRITE POINTER VALID field (7:0) (see 9.14.9)
513	WRITE POINTER VALID field (15:8) (see 9.14.9)
514	WRITE POINTER VALID field (23:16) (see 9.14.9)
515	WRITE POINTER VALID field (31:24) (see 9.14.9)
516	WRITE POINTER[0] field (7:0) (see 9.14.10)
517	WRITE POINTER[0] field (15:8) (see 9.14.10)
518	WRITE POINTER[0] field (23:16) (see 9.14.10)
519	WRITE POINTER[0] field (31:24) (see 9.14.10)
520	WRITE POINTER[0] field (39:32) (see 9.14.10)
521	WRITE POINTER[0] field (47:40) (see 9.14.10)
…	…
702	WRITE POINTER[31] field (7:0) (see 9.14.10)
703	WRITE POINTER[31] field (15:8) (see 9.14.10)
704	WRITE POINTER[31] field (23:16) (see 9.14.10)
705	WRITE POINTER[31] field (31:24) (see 9.14.10)
706	WRITE POINTER[31] field (39:32) (see 9.14.10)
707	WRITE POINTER[31] field (47:40) (see 9.14.10)
708..1 022	Reserved
1 023	WRITE POINTER CHECKSUM field (see 9.14.11)

9.14.2 NCQ TAG field

If the NQ bit is cleared to zero, then the NCQ TAG field contains the NCQ Tag (see 4.15.1) corresponding to the NCQ command (see 4.15.1) that failed.

9.14.3 NQ bit

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 an NCQ command.

9.14.4 UNL bit

The Unload (UNL) bit set to one indicates that the error condition was the result of receiving an IDLE IMMEDIATE command with the Unload Feature specified (see 4.15.3). The UNL bit cleared to zero indicates that the reason for the error was not the reception of an IDLE IMMEDIATE command with the Unload Feature specified. If the most recent command was an Unload Immediate command, then the device shall not load the heads when reading the NCQ Command Error log.

If the UNL bit 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, the value of the STATUS field, ERROR field, and LBA field (7:0) in the NCQ Command Error log shall be set as follows:

Status: The BUSY bit (see ATA8-APT) shall be cleared to zero and the ERROR bit (see 6.2.8) 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 returned command completion without error.

Shall be set to 4Ch if the unload was not accepted or has failed.

9.14.5 Return Fields

The STATUS field, ERROR field, LBA field and COUNT field indicate the error that caused the device to stop processing NCQ commands.

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.

9.14.6 NCQ Autosense

If the device supports NCQ Autosense (i.e., the NCQ AUTOSENSE SUPPORTED bit (see 9.10.10.2.21) is set to one), then:

a) the DEFERRED ERROR bit shall be set as defined in 4.24.2;
b) the SENSE KEY field shall be set as defined in SPC-5;
c) the ADDITIONAL SENSE CODE field shall be set as defined in SPC-5; and
d) the ADDITIONAL SENSE CODE QUALIFIER field shall be set as defined in SPC-5.

If the device does not support NCQ Autosense (i.e., the NCQ AUTOSENSE SUPPORTED bit (see 9.10.10.2.21) is cleared to zero), then:

a) the DEFERRED ERROR bit shall be cleared to zero;
b) the SENSE KEY field shall be cleared to zero;
c) the ADDITIONAL SENSE CODE field shall be cleared to zero; and
d) the ADDITIONAL SENSE CODE QUALIFIER field shall be cleared to zero.

9.14.7 FINAL LBA IN ERROR field

If:

a) the REBUILD ASSIST ENABLED bit is set to one (see 9.10.10.3.11);
b) the command that completes with an error is a READ FPDMA QUEUED command (see 7.23) or a WRITE FPDMA QUEUED command (see 7.61); and
c) the additional sense code is either MULTIPLE READ ERRORS (see 6.8.27) or MULTIPLE WRITE ERRORS (see 6.8.28),

then the FINAL LBA IN ERROR field shall contain the LBA of the last logical block (i.e., the highest numbered LBA) in a sequence of contiguous unrecovered logical blocks (see 4.19).

Otherwise, the FINAL LBA IN ERROR field shall be cleared to zero.

9.14.8 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 eight-bit unsigned arithmetic and overflow shall be ignored. The sum of the first 512 bytes of the data structure shall be zero.

9.14.9 WRITE POINTER VALID field

For each write command to a zone with a valid write pointer (see ZAC-2) that is terminated as the result of an NCQ command failure, based on the tag associated with that command (e.g, tag n):

a) the corresponding bit in the WRITE POINTER VALID field (e.g. bit n) shall be set to one; and
b) the corresponding WRITE POINTER[0..31] field (e.g., the WRITE POINTER[n] field) shall be set to the value of the write pointer at the time the write command was terminated.

EXAMPLE - If a write command with tag 3 is terminated, bit 3 of the WRITE POINTER VALID field is set to one, and WRITE POINTER[3] field contains the value of the write pointer at the time the write command was terminated.

The WRITE POINTER VALID field bits associated with all other tags shall be cleared to zero, and the contents of the corresponding WRITE POINTER[0..31] fields are invalid.

9.14.10 WRITE POINTER[0..31] fields

Each WRITE POINTER[0..31] field shall contain a valid or invalid write pointer as described in 9.14.9.

9.14.11 WRITE POINTER CHECKSUM field

The WRITE POINTER CHECKSUM field contains the two's complement sum of bytes 512..1 022 in the data structure. Each byte shall be added using eight-bit unsigned arithmetic and overflow shall be ignored. The sum of bytes 512..1 023 in the data structure is zero.

9.15 Read Stream Error log (Log Address 22h)

Table 291 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 field shall contain the total number of Read Stream Errors detected since the most recent read of the Read Stream Error log that returned command completion without error. This error count may be greater than 31. However, only the most recent 31 errors are represented by entries in the log. If the Read Stream Error Count reaches the 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 command with the LBA field (7:0) set to 22h, a device shall clear the:

a) Read Stream Error log:
b) ERROR LOG INDEX field to zero; and
c) READ STREAM ERROR COUNT field to zero.

If 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 4.17.4), then the device may clear the content of the Read Stream Error log. For a PATA device, the log is also cleared during the 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 7.45.16.6), otherwise the Read Stream Error log is preserved.

Table 291 — Read Stream Error log

Offset	Type	Description
0	Byte	DATA STRUCTURE VERSION field
1	Byte	ERROR LOG INDEX field
2..3	Word	READ STREAM ERROR COUNT field
4..15	Byte	Reserved
16..31	Byte	Read Stream Error log Entry 1
32..47	Byte	Read Stream Error log Entry 2
48..63	Byte	Read Stream Error log Entry 3
64..511	Byte	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 COUNT field shall contain the number of uncorrected logical sector entries reportable to the host. This value may exceed 31.

The ERROR LOG INDEX field indicates the error log data structure representing the most recent error. Only values one through 31 are valid.

Table 292 defines the format of each entry in the Read Stream Error log.

Table 292 — Stream Error Log Entry

Offset	Description
0	FEATURE field (7:0)
1	FEATURE field (15:8)
2	STATUS field
3	ERROR field
4	LBA field (7:0)
5	LBA field (15:8)
6	LBA field (23:16)
7	LBA field (31:24)
8	LBA field (39:32)
9	LBA field (47:40)
10..11	Reserved
12	COUNT field (7:0)
13	COUNT field (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 9.23), 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.

9.16 SATA Phy Event Counters log (Log Address 11h)

9.16.1 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 host 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 293.

Table 293 — SATA Phy Event Counters log Format

Offset	Type	Description
0..3	bytes	Reserved
4..5	word	Counter 0 Identifier
6..Counter 0 Length+5	bytes	Counter 0 Value
…		…
n..n+1	word	Counter x Identifier
n+2..Counter x Length+n+1	bytes	Counter x Value
…		…
508..510	bytes	Reserved
511	byte	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 3.5).

If the SATA Phy Event Counters log is read and the FEATURE field set to 0001h, the device shall return the current counter values for the command and then reset all Phy event counter values.

9.16.2 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 3.5.

9.16.3 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 3.5 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 eight bits, then upon reaching the maximum value of FFh, that counter shall be one-extended to FFFFh). The counter shall stop (i.e., not wrap to zero) after reaching the maximum value.

9.16.4 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.

9.16.5 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.

9.17 SATA NCQ Non-Data log (Log Address 12h)

9.17.1 Overview

To determine the supported NCQ NON-DATA subcommands and their respective features, hosts read log address 12h. This log shall be supported if the NCQ NON-DATA command is supported (i.e., the NCQ QUEUE MANAGEMENT COMMAND SUPPORTED bit (see 9.10.10.2.13) is set to one). Table 294 defines the 512 bytes that make up the SATA NCQ Non-Data log.

Table 294 — SATA NCQ Non-Data log (log page 00h) (Sheet 1 of 3)

Offset	Type	Description
0..3	DWord	NCQ Non-Data subcommand 0h features
		Bit **Description**
		31:5 Reserved
		4 SUPPORTS ABORT SELECTED TTAG AT bit (see 9.17.6)
		3 SUPPORTS ABORT NON-STREAMING AT bit (see 9.17.5)
		2 SUPPORTS ABORT STREAMING AT bit (see 9.17.4)
		1 SUPPORTS ABORT ALL AT bit (see 9.17.3)
		0 SUPPORTS ABORT NCQ QUEUE bit (see 9.17.2)
4..7	DWord	NCQ Non-Data subcommand 1h features
		Bit **Description**
		31:3 Reserved
		2 SUPPORTS RDNC bit (see 9.17.9)
		1 SUPPORTS WDNC bit (see 9.17.8)
		0 SUPPORTS DEADLINE HANDLING bit (see 9.17.7)
8..11	DWord	NCQ Non-Data subcommand 2h features
		Bit **Description**
		31:1 Reserved
		0 SUPPORTS HYBRID DEMOTE BY SIZE bit (see 9.17.10)
12..15	DWord	NCQ Non-Data subcommand 3h features
		Bit **Description**
		31:1 Reserved
		0 SUPPORTS HYBRID CHANGE BY LBA RANGE bit (see 9.17.11)
16..19	DWord	NCQ Non-Data subcommand 4h features
		Bit **Description**
		31:1 Reserved
		0 SUPPORTS HYBRID CONTROL bit (see 9.17.12)
20..23	DWord	NCQ Non-Data subcommand 5h features
		Bit **Description**
		31:1 Reserved
		0 QUEUED SET FEATURES SUPPORTED bit (see 9.17.13)

Table 294 — SATA NCQ Non-Data log (log page 00h) (Sheet 2 of 3)

Offset	Type	Description
24..27	DWord	NCQ Non-Data subcommand 6h features **Bit Description** 31:1 Reserved 0 QUEUED ZERO EXT SUPPORTED bit (see 9.17.14)
28..31	DWord	NCQ Non-Data subcommand 7h features **Bit Description** 31:1 Reserved 0 SUPPORTS ZAC MANAGEMENT OUT bit (see 9.17.15)
32..35	DWord	NCQ Non-Data subcommand 8h features **Bit Description** 31:2 Reserved 1 SUPPORTS D/OW bit (see 9.17.17) 0 SUPPORTS DURABLE/ORDERED WRITE NOTIFICATION bit (see 9.17.16)
36..39	DWord	NCQ Non-Data subcommand 9h features **Bit Description** 31:1 Reserved 0 Subcommand 9h supported
40..43	DWord	NCQ Non-Data subcommand Ah features **Bit Description** 31:1 Reserved 0 Subcommand Ah supported
44..47	DWord	NCQ Non-Data subcommand Bh features **Bit Description** 31:1 Reserved 0 Subcommand Bh supported
48..51	DWord	NCQ Non-Data subcommand Ch features **Bit Description** 31:1 Reserved 0 Subcommand Ch supported
52..55	DWord	NCQ Non-Data subcommand Dh features **Bit Description** 31:1 Reserved 0 Subcommand Dh supported
56..59	DWord	NCQ Non-Data subcommand Eh features **Bit Description** 31:1 Reserved 0 Subcommand Eh supported

Table 294 — SATA NCQ Non-Data log (log page 00h) (Sheet 3 of 3)

Offset	Type	Description
60..63	DWord	NCQ Non-Data subcommand Fh features
		Bit **Description**
		31:1 Reserved
		0 Subcommand Fh supported
64..511		Reserved

9.17.2 SUPPORTS ABORT NCQ QUEUE bit

If the SUPPORTS ABORT NCQ QUEUE bit is set to one, the device supports the ABORT NCQ QUEUE command (see 7.17.11). If the SUPPORTS ABORT NCQ QUEUE bit is cleared to zero, the device does not support the ABORT NCQ QUEUE command.

9.17.3 SUPPORTS ABORT ALL AT bit

If the SUPPORTS ABORT ALL AT bit is set to one, the device supports the value of Abort All (see table 76) in the ABORT TYPE field of the ABORT NCQ QUEUE command (see 7.17.11). If the SUPPORTS ABORT ALL AT bit is cleared to zero, the device does not support the value of Abort All in the ABORT TYPE field of the ABORT NCQ QUEUE command.

9.17.4 SUPPORTS ABORT STREAMING AT bit

If the SUPPORTS ABORT STREAMING AT bit is set to one, the device supports the value of Abort Streaming (see table 76) in the ABORT TYPE field of the ABORT NCQ QUEUE command (see 7.17.11). If the SUPPORTS ABORT STREAMING AT bit is cleared to zero, the device does not support the value of Abort Streaming in the ABORT TYPE field of the ABORT NCQ QUEUE command.

9.17.5 SUPPORTS ABORT NON-STREAMING AT bit

If the SUPPORTS ABORT NON-STREAMING AT bit is set to one, the device supports the value of Abort Non-Streaming (see table 76) in the ABORT TYPE field of the ABORT NCQ QUEUE command (see 7.17.11). If the SUPPORTS ABORT NON-STREAMING AT bit is cleared to zero, the device does not support the value of Abort Non-Streaming in the ABORT TYPE field of the ABORT NCQ QUEUE command.

9.17.6 SUPPORTS ABORT SELECTED TTAG AT bit

If the SUPPORTS ABORT SELECTED TTAG AT bit is set to one, the device supports the value of Abort Selected (see table 76) in the ABORT TYPE field of the ABORT NCQ QUEUE command (see 7.17.11). If the SUPPORTS ABORT SELECTED TTAG AT bit is cleared to zero, the device does not support the value of Abort Selected in the ABORT TYPE field of the ABORT NCQ QUEUE command.

9.17.7 SUPPORTS DEADLINE HANDLING bit

If the SUPPORTS DEADLINE HANDLING bit is set to one, the device supports the DEADLINE HANDLING command (see 7.17.12). If the SUPPORTS DEADLINE HANDLING bit is cleared to zero, the device does not support the DEADLINE HANDLING command.

9.17.8 SUPPORTS WDNC bit

If the SUPPORTS WDNC bit is set to one, the device supports the WDNC bit (see 7.17.12.3.2) of the DEADLINE HANDLING command (see 7.17.12). If the SUPPORTS WDNC bit is cleared to zero, the device does not support the WDNC bit of the DEADLINE HANDLING command.

9.17.9 SUPPORTS RDNC bit

If the SUPPORTS RDNC bit is set to one, the device supports the RDNC bit (see 7.17.12.3.3) of the DEADLINE HANDLING command (see 7.17.12). If the SUPPORTS RDNC bit is cleared to zero, the device does not support the RDNC bit of the DEADLINE HANDLING command.

9.17.10 SUPPORTS HYBRID DEMOTE BY SIZE bit

If the SUPPORTS HYBRID DEMOTE BY SIZE bit is set to one, then the device supports the HYBRID DEMOTE BY SIZE command (see 7.17.8). If the supports HYBRID DEMOTE BY SIZE bit is cleared to zero, then the device does not support the HYBRID DEMOTE BY SIZE command.

9.17.11 SUPPORTS HYBRID CHANGE BY LBA RANGE bit

If the SUPPORTS HYBRID CHANGE BY LBA RANGE bit is set to one, then the device supports the HYBRID CHANGE BY LBA RANGE command (see 7.17.9). If the SUPPORTS HYBRID CHANGE BY LBA RANGE bit is cleared to zero, then the device does not support the HYBRID CHANGE BY LBA RANGE command.

9.17.12 SUPPORTS HYBRID CONTROL bit

If the SUPPORTS HYBRID CONTROL bit is set to one, then the device supports the HYBRID CONTROL command (see 7.17.10). If the SUPPORTS HYBRID CONTROL bit is cleared to zero, then the device does not support the HYBRID CONTROL command.

9.17.13 QUEUED SET FEATURES SUPPORTED bit

If the QUEUED SET FEATURES SUPPORTED bit is set to one, the device supports the SET FEATURES subcommand of the NCQ NON-DATA command (see 7.17.3.2). If the QUEUED SET FEATURES SUPPORTED bit is cleared to zero, the device does not support the SET FEATURES subcommand of the NCQ NON-DATA command.

9.17.14 QUEUED ZERO EXT SUPPORTED bit

If the QUEUED ZERO EXT SUPPORTED bit is set to one, the device supports the ZERO EXT subcommand of the NCQ NON-DATA command (see 7.17.3.2). If the QUEUED ZERO EXT SUPPORTED bit is cleared to zero, the device does not support the ZERO EXT subcommand of the NCQ NON-DATA command.

9.17.15 SUPPORTS ZAC MANAGEMENT OUT bit

If the SUPPORTS ZAC MANAGEMENT OUT bit is set to one, then the device supports the ZAC MANAGEMENT OUT subcommand of the NCQ NON-DATA command (see 7.17.3.2). If the SUPPORTS ZAC MANAGEMENT OUT bit is cleared to zero, then the device does not support the ZAC MANAGEMENT OUT subcommand of the NCQ NON-DATA command.

9.17.16 SUPPORTS DURABLE/ORDERED WRITE NOTIFICATION bit

If the SUPPORTS DURABLE/ORDERED WRITE NOTIFICATION bit is set to one, then the device supports the DURABLE/ORDERED WRITE NOTIFICATION command (see 7.17.13). If the SUPPORTS DURABLE/ORDERED WRITE NOTIFICATION bit is cleared to zero, then the device does not support the DURABLE/ORDERED WRITE NOTIFICATION command.

9.17.17 SUPPORTS D/OW bit

If the SUPPORTS D/OW bit is set to one, then the device supports the D/OW bit (see 7.17.13.3.2) of the DURABLE/ORDERED WRITE NOTIFICATION command. If the SUPPORTS D/OW bit is cleared to zero, then the device does not support the D/OW bit of the DURABLE/ORDERED WRITE NOTIFICATION command.

9.18 SATA NCQ Send and Receive log (Log Address 13h)

9.18.1 Overview

To determine the supported SEND FPDMA QUEUED subcommands, RECEIVE FPDMA QUEUED subcommands, and their respective features, the host reads log address 13h. This log shall be supported if the SEND AND RECEIVE QUEUED COMMANDS SUPPORTED bit (see 9.10.10.2.14) is set to one. Table 295 defines the 512 bytes that make up the SATA NCQ Send and Receive log.

Table 295 — SATA NCQ Send and Receive log (log page 00h)

Offset	Type	Description
0..3	DWord	Subcommands supported
		Bit Description
		31:3 Reserved
		2 QUEUED DATA SET MANAGEMENT XL SUPPORTED bit (see 9.18.2)
		1 SUPPORTS HYBRID EVICT bit (see 9.18.3)
		0 QUEUED DATA SET MANAGEMENT SUPPORTED bit (see 9.18.4)
4..7	DWord	Data Set Management features supported
		Bit Description
		31:1 Reserved
		0 QUEUED DATA SET MANAGEMENT SUPPORTS TRIM bit (see 9.18.5)
8..11	DWord	Supports Read Log
		Bit Description
		31:3 Reserved
		2 QUEUED READ LOG DMA EXT FEATURE FIELD SUPPORTED bit (see 9.18.6)
		1 SEQUENTIAL QUEUED READ LOG DMA EXT SUPPORTED bit (see 9.18.7)
		0 QUEUED READ LOG DMA EXT SUPPORTED bit (see 9.18.8)
12..15	DWord	Supports Write Log
		Bit Description
		31:2 Reserved
		1 SEQUENTIAL QUEUED WRITE LOG DMA EXT SUPPORTED bit (see 9.18.9)
		0 QUEUED WRITE LOG DMA EXT SUPPORTED bit (see 9.18.10)
16..19	DWord	Supports ZAC Management Log
		Bit Description
		31:2 Reserved
		1 SUPPORTS ZAC MANAGEMENT IN bit (see 9.18.11)
		0 SUPPORTS ZAC MANAGEMENT OUT bit (see 9.18.12)
20..511		Reserved

9.18.2 QUEUED DATA SET MANAGEMENT XL SUPPORTED bit

If the QUEUED DATA SET MANAGEMENT XL SUPPORTED bit set to one, the device supports the DATA SET MANAGEMENT XL subcommand of the SEND FPDMA QUEUED command (see 7.43.3.2). If the QUEUED DATA SET MANAGEMENT XL SUPPORTED bit is cleared to zero, the device does not support the DATA SET MANAGEMENT XL subcommand of the SEND FPDMA QUEUED command.

9.18.3 SUPPORTS HYBRID EVICT bit

If the SUPPORTS HYBRID EVICT bit is set to one, then the device supports the HYBRID EVICT command (see 7.43.8). If the SUPPORTS HYBRID EVICT bit is cleared to zero, then the device does not support the HYBRID EVICT command.

9.18.4 QUEUED DATA SET MANAGEMENT SUPPORTED bit

If the QUEUED DATA SET MANAGEMENT SUPPORTED bit is set to one, the device supports the DATA SET MANAGEMENT subcommand of the SEND FPDMA QUEUED command (see 7.43.3.2). If the QUEUED DATA SET MANAGEMENT SUPPORTED bit is cleared to zero, the device does not support the DATA SET MANAGEMENT subcommand of the SEND FPDMA QUEUED command.

9.18.5 QUEUED DATA SET MANAGEMENT SUPPORTS TRIM bit

If the QUEUED DATA SET MANAGEMENT SUPPORTS TRIM bit is set to one, the device supports the TRIM bit in the DATA SET MANAGEMENT subcommand of the SEND FPDMA QUEUED command (see 7.43.3.2). If the QUEUED DATA SET MANAGEMENT SUPPORTS TRIM bit is cleared to zero, the device does not support the TRIM bit in the DATA SET MANAGEMENT subcommand of the SEND FPDMA QUEUED command.

9.18.6 QUEUED READ LOG DMA EXT FEATURE FIELD SUPPORTED bit

If the QUEUED READ LOG DMA EXT FEATURE FIELD SUPPORTED bit is set to one, the device supports the READ LOG DMA EXT subcommand of the RECEIVE FPDMA QUEUED command (see 7.32.3.2) with encapsulation of the READ LOG DMA EXT FEATURE field (see 7.25.6). If the QUEUED READ LOG DMA EXT FEATURE FIELD SUPPORTED bit is cleared to zero, the device does not support the READ LOG DMA EXT subcommand of the RECEIVE FPDMA QUEUED command with encapsulation of the READ LOG DMA EXT FEATURE field (see SATA 3.5).

9.18.7 SEQUENTIAL QUEUED READ LOG DMA EXT SUPPORTED bit

If the SEQUENTIAL QUEUED READ LOG DMA EXT SUPPORTED bit is set to one, the device supports the READ LOG DMA EXT subcommand of the RECEIVE FPDMA QUEUED command (see 7.32.3.2) as a sequential NCQ command (see 4.15.5). If the SEQUENTIAL QUEUED READ LOG DMA EXT SUPPORTED bit is cleared to zero, the device does not support the READ LOG DMA EXT subcommand of the RECEIVE FPDMA QUEUED command as a sequential NCQ command.

9.18.8 QUEUED READ LOG DMA EXT SUPPORTED bit

If the QUEUED READ LOG DMA EXT SUPPORTED bit is set to one, the device supports the READ LOG DMA EXT subcommand of the RECEIVE FPDMA QUEUED command (see 7.32.3.2). If the QUEUED READ LOG DMA EXT SUPPORTED bit is cleared to zero, the device does not support the READ LOG DMA EXT subcommand of the RECEIVE FPDMA QUEUED command.

The QUEUED READ LOG DMA EXT SUPPORTED bit shall be set to one if:

a) the SEQUENTIAL QUEUED READ LOG DMA EXT SUPPORTED bit (see 9.18.7) is set to one; or
b) the QUEUED READ LOG DMA EXT FEATURE FIELD SUPPORTED bit (see 9.18.6) is set to one.

9.18.9 SEQUENTIAL QUEUED WRITE LOG DMA EXT SUPPORTED bit

If the SEQUENTIAL QUEUED WRITE LOG DMA EXT SUPPORTED bit is set to one, the device supports the WRITE LOG DMA EXT subcommand of the SEND FPDMA QUEUED command (see 7.43.3.2) as a sequential NCQ command (see 4.15.5). If the SEQUENTIAL QUEUED WRITE LOG DMA EXT SUPPORTED bit is cleared to zero, the device does not support the WRITE LOG DMA EXT subcommand of the SEND FPDMA QUEUED command as a sequential NCQ command.

9.18.10 QUEUED WRITE LOG DMA EXT SUPPORTED bit

If the QUEUED WRITE LOG DMA EXT SUPPORTED bit is set to one, the device supports the WRITE LOG DMA EXT subcommand of the SEND FPDMA QUEUED command (see 7.43.3.2). If the QUEUED WRITE LOG DMA EXT SUPPORTED bit is cleared to zero, the device does not support the WRITE LOG DMA EXT command of the SEND FPDMA QUEUED command.

The QUEUED WRITE LOG DMA EXT SUPPORTED bit shall be set to one if the SEQUENTIAL QUEUED WRITE LOG DMA EXT SUPPORTED bit (see 9.18.9) is set to one.

9.18.11 SUPPORTS ZAC MANAGEMENT IN bit

If the SUPPORTS ZAC MANAGEMENT IN bit is set to one, then the device supports the ZAC MANAGEMENT IN subcommand of the RECEIVE FPDMA QUEUED command (see 7.32.3.2). If the SUPPORTS ZAC MANAGEMENT IN bit is cleared to zero, then the device does not support the ZAC MANAGEMENT IN command of the RECEIVE FPDMA QUEUED command.

9.18.12 SUPPORTS ZAC MANAGEMENT OUT bit

If the SUPPORTS ZAC MANAGEMENT OUT bit is set to one, then the device supports the ZAC MANAGEMENT OUT subcommand of the SEND FPDMA QUEUED command (see 7.43.3.2). If the SUPPORTS ZAC MANAGEMENT OUT bit is cleared to zero, then the device does not support the ZAC MANAGEMENT OUT command of the SEND FPDMA QUEUED command.

9.19 Hybrid Information log (Log Address 14h)

9.19.1 Hybrid Information log overview

If the Hybrid Information feature is supported (see 4.12), then the Hybrid Information log shall be supported.

The Hybrid Information log consists of one page (see table 296). The log is read-only. Reading the log shall not cause the device to change power management state.

Table 296 — Hybrid Information Log data

Offset	Description	Reference
0..63	Hybrid Information Header	9.19.2
64..79	Hybrid Information Descriptor (priority 0)	9.19.3
	...	
48+(16xN)..63+(16xN)	Hybrid Information Descriptor (maximum priority (N))	9.19.3
64+(16xN)..511	Padding	

Data transfer lengths shall be non-zero multiples of 512 bytes. Pad bytes shall be appended to meet this requirement. Pad bytes shall have a value of 00h.

N is the the number of hybrid information descriptors (see 9.19.2.2) reported in the Hybrid Information Header.

9.19.2 Hybrid Information Header

9.19.2.1 Hybrid Information Header Overview

Table 297 describes the contents of the Hybrid Information Header.

Table 297 — Hybrid Information Header

Offset	Type	Description	Reference
0..1	Word	**Bits Description** 15:4 Reserved 3:0 NUMBER OF HYBRID INFORMATION DESCRIPTORS field	 9.19.2.2
2	Byte	ENABLED field	9.19.2.3
3	Byte	HYBRID HEALTH field	9.19.2.4
4	Byte	DIRTY LOW THRESHOLD field	9.19.2.5
5	Byte	DIRTY HIGH THRESHOLD field	9.19.2.6
6	Byte	OPTIMAL WRITE GRANULARITY field	9.19.2.7
7	Byte	**Bits Description** 7:4 Reserved 3:0 MAXIMUM CACHING PRIORITY LEVEL field	 9.19.2.8
8	Byte	POWER CONDITION field	9.19.2.9
9	Byte	NON-VOLATILE CACHE ENABLED field	9.19.2.10
10	Byte	SUPPORTED OPTIONS field	9.19.2.11
11		Reserved	
12..15	DWord	TIME SINCE ENABLED field	9.19.2.12
16..23	QWord	NVM SIZE field	9.19.2.13
24..31	QWord	ENABLE COUNT field	9.19.2.14
32..33	Word	Bits Description 15:5 Reserved 4:0 MAXIMUM EVICTION COMMANDS field	 9.19.2.15
34..35	Word	MAXIMUM EVICTION DATA BLOCKS field	9.19.2.16
36..63		Reserved	

9.19.2.2 NUMBER OF HYBRID INFORMATION DESCRIPTORS field

The NUMBER OF HYBRID INFORMATION DESCRIPTORS field indicates the the number of Hybrid Information descriptors that follow the header.

9.19.2.3 ENABLED field

Table 298 indicates the value that the device shall indicate in IDENTIFY DEVICE in each case.

Table 298 — ENABLED field

Value	Description	Hybrid information enabled [a]
00h	Hybrid information feature set Disabled	0
80h	Hybrid information feature set disable on process	0
FFh	Hybrid information feature set enabled	1
All other values	Reserved	

[a] HYBRID INFORMATION ENABLED bit (see 9.10.10.3.12)

9.19.2.4 HYBRID HEALTH field

9.19.2.4.1 HYBRID HEALTH field overview

Table 299 describes the values of the HYBRID HEALTH field, including several indicators of the health of the non-volatile cache. If the non-volatile cache is healthy, the HYBRID HEALTH field should be zero.

Table 299 — HYBRID HEALTH field

Bit	Description	Reference
7:4	Reserved	
3	DATA LOSS bit	9.19.2.4.2
2	READ ONLY bit	9.19.2.4.3
1	NVM SIZE CHANGED bit	9.19.2.4.4
0	UNUSABLE bit	9.19.2.4.5

9.19.2.4.2 DATA LOSS bit

If the DATA LOSS bit is set to one, then some of the data in the non-volatile cache has become inaccessible since the Hybrid Information log was most recently read.

If the DATA LOSS bit is cleared to zero, then no data loss has been detected in the non-volatile cache since the Hybrid Information log was most recently read.

9.19.2.4.3 READ ONLY bit

If the READ ONLY bit is set to one, then the non-volatile cache is read only.

If the READ ONLY bit is cleared to zero, then the non-volatile cache may be read or written.

9.19.2.4.4 NVM SIZE CHANGED bit

If the NVM SIZE CHANGED bit is set to one, then the device has changed the NVM Size of the non-volatile cache since the Hybrid Information log was most recently read.

If the NVM SIZE CHANGED bit is cleared to zero, then the device has not changed the NVM Size of the non-volatile cache since the Hybrid Information log was most recently read.

9.19.2.4.5 UNUSABLE bit

If the UNUSABLE bit is set to one, then the non-volatile cache is no longer usable.

If the UNUSABLE bit is cleared to zero, then the non-volatile cache is usable.

9.19.2.5 DIRTY LOW THRESHOLD field

The DIRTY LOW THRESHOLD field indicates the threshold for the amount of dirty user logical sectors in the non-volatile cache that sync operations should stop. For additional information, see the HYBRID CONTROL command (see 7.17.10).

9.19.2.6 DIRTY HIGH THRESHOLD field

The DIRTY HIGH THRESHOLD field indicates the threshold for the amount of dirty user logical sectors in the non-volatile cache that sync operations should begin. For additional information, see the HYBRID CONTROL command (see 7.17.10).

9.19.2.7 OPTIMAL WRITE GRANULARITY field

The OPTIMAL WRITE GRANULARITY field indicates the optimal number of logical sectors for the host to write to the non-volatile cache, expressed as a power of two. If the field contains FFh, then the optimal write granularity is not indicated.

EXAMPLE - 0 indicates 20 = 1 logical sector, 1 indicates 21 = 2 logical sectors, 2 indicates 22 = 4 logical sectors.

9.19.2.8 MAXIMUM CACHING PRIORITY LEVEL field

The MAXIMUM CACHING PRIORITY LEVEL field indicates the maximum supported value of the REQUESTED CACHING PRIORITY LEVEL field (see 7.17.8.4.3). The MAXIMUM CACHING PRIORITY LEVEL shall be non-zero.

9.19.2.9 POWER CONDITION field

The POWER CONDITION field indicates the current power condition that the CHECK POWER MODE command would report in normal outputs (see 7.3).

9.19.2.10 NON-VOLATILE CACHE ENABLED field

The NON-VOLATILE CACHE ENABLED field indicates whether or not the non-volatile cache is usable by the host or the device.

If the NON-VOLATILE CACHE ENABLED field is set to FFh, then the non-volatile cache is enabled for use by the host and the device.

If the NON-VOLATILE CACHE ENABLED field is cleared to 00h, then the non-volatile cache shall not be used by either the host or the device.

9.19.2.11 SUPPORTED OPTIONS field

9.19.2.11.1 SUPPORTED OPTIONS field overview

The SUPPORTED OPTIONS field (see table 300) indicates that optional behaviors are supported.

Table 300 — SUPPORTED OPTIONS field

Bit	Description
7:2	Reserved
1	SUPPORTS AVOID HYBRID SPINUP bit (see 9.19.2.11.2)
0	MAX PRIORITY BEHAVIOR bit (see 9.19.2.11.3)

9.19.2.11.2 SUPPORTS AVOID HYBRID SPINUP bit

If the SUPPORTS AVOID HYBRID SPINUP bit is set to one, then the device supports the AVOID HYBRID SPINUP bit of the HYBRID CHANGE BY LBA RANGE command to control the movement of logical sectors into the non-volatile cache if a command specifies a hybrid caching priority level other than the MAXIMUM CACHING PRIORITY LEVEL field (see 9.19.2.8). If the SUPPORTS AVOID HYBRID SPINUP bit is cleared to zero, then the device shall ignore the setting of the AVOID HYBRID SPINUP bit in the HYBRID CHANGE BY LBA RANGE command (see 7.17.9) and process that command as if the AVOID HYBRID SPINUP bit were cleared to zero.

9.19.2.11.3 MAX PRIORITY BEHAVIOR bit

If the MAX PRIORITY BEHAVIOR bit is set to one, then the device shall:

a) insert logical sectors into the non-volatile cache if a command specifies the maximum caching priority level;

b) abort any command that specifies the maximum caching priority level if there are not enough available logical sectors in the non-volatile cache;
c) support the HYBRID EVICT command (see 7.43.8); and
d) support the HYBRID CHANGE BY LBA RANGE command (see 7.17.9).

If the MAX PRIORITY BEHAVIOR bit is cleared to zero, then the device should insert logical sectors into the non-volatile cache if a command specifies the maximum caching priority level.

9.19.2.12 TIME SINCE ENABLED field

The TIME SINCE ENABLED field indicates the number of power-on hours since the Hybrid Information feature was enabled. This is an unsigned integer. This field shall be cleared to zero each time the Hybrid Information feature is disabled.

9.19.2.13 NVM SIZE field

The NVM SIZE field indicates the number of logical sectors that comprise the non-volatile cache.

NOTE 12 — The value of the NVM SIZE field may vary over time because of vendor specific factors.

9.19.2.14 ENABLE COUNT field

The ENABLE COUNT field contains an unsigned integer that is incremented by one each time the device successfully enables the Hybrid Information feature (see 4.12).

9.19.2.15 MAXIMUM EVICTION COMMANDS field

The MAXIMUM EVICTION COMMANDS field indicates the maximum number of HYBRID EVICT commands (see 7.43.8) that the device supports in the command queue at the same time. A value of zero indicates that the device does not limit the number of HYBRID EVICT commands in the queue.

9.19.2.16 MAXIMUM EVICTION DATA BLOCKS field

The MAXIMUM EVICTION DATA BLOCKS field limits the maximum number of data blocks that may be specified in a single HYBRID EVICT command (see 7.43.8).

9.19.3 Hybrid Information Descriptor

9.19.3.1 Hybrid Information Descriptor overview

Table 301 describes the Hybrid Information Descriptor. There shall be one Hybrid Information Descriptor returned for each supported caching priority level, in order of increasing caching priority level.

Table 301 — Hybrid Information Descriptor

Byte	Type	Description	Reference
0	Byte	CACHING PRIORITY field	9.19.3.2
1	Byte	CONSUMED NVM SIZE FRACTION field	9.19.3.3
2	Byte	CONSUMED MAPPING RESOURCES FRACTION field	9.19.3.4
3	Byte	CONSUMED NVM SIZE FOR DIRTY DATA FRACTION field	9.19.3.5
4	Byte	CONSUMED MAPPING RESOURCES FOR DIRTY DATA FRACTION field	9.19.3.6
5..15		Reserved	

9.19.3.2 CACHING PRIORITY field

The CACHING PRIORITY field indicates the caching priority that this descriptor represents.

9.19.3.3 CONSUMED NVM SIZE FRACTION field

The value of the CONSUMED NVM SIZE FRACTION field, when divided by 255, indicates the fraction of the NVM Size for this caching priority's logical sectors that are currently consumed (i.e., used).

The value is an unsigned integer from 00h to FFh. The value 00h indicates that no NVM Size is currently consumed. The value FFh indicates that all of the NVM Size is currently consumed.

$$\text{Consumed Capacity Fraction} = \frac{A \times 255}{B}$$

where:

A is the current number of logical sectors associated with this priority; and

B is NVM Size (see 9.19.2.13)

9.19.3.4 CONSUMED MAPPING RESOURCES FRACTION field

The value of the CONSUMED MAPPING RESOURCES FRACTION field divided by 255 indicates the fraction of the mapping resources for this CACHING PRIORITY's logical sectors in the non-volatile cache that are currently consumed. The value is an unsigned integer from 00h to FFh.

The value 00h indicates that no mapping resources are currently consumed. The value FFh indicates that all of the mapping resources are currently consumed.

9.19.3.5 CONSUMED NVM SIZE FOR DIRTY DATA FRACTION field

The value of the CONSUMED NVM SIZE FOR DIRTY DATA FRACTION field divided by 255 indicates the fraction of the maximum NVM Size for this caching priority's data that is currently marked as dirty data. The value is an unsigned integer from 00h to FFh. The value 00h indicates that no NVM Size is currently consumed. The value FFh indicates that all of the NVM Size is currently consumed.

$$\text{Consumed NVM Size for Dirty Data Fraction} = \frac{A \times 255}{B}$$

where:

A is the current NVM Size consumed by dirty data associated with this hybrid priority; and

B is NVM Size (see 9.19.2.13)

9.19.3.6 CONSUMED MAPPING RESOURCES FOR DIRTY DATA FRACTION field

The value of the CONSUMED MAPPING RESOURCES FOR DIRTY DATA FRACTION field divided by 255 indicates the fraction of the mapping resources for this caching priority's data in the non-volatile cache that are currently consumed for mapping dirty data. The value is an unsigned integer from 00h to FFh. The value 00h indicates that no mapping resources are currently consumed that relate to dirty data. The value FFh indicates that all of the mapping resources are currently consumed that relate to dirty data.

9.20 Rebuild Assist log (Log Address 15h)

9.20.1 Overview

The Rebuild Assist log (see table 302) provides information about the Rebuild Assist feature set (see 4.19). If the REBUILD ASSIST SUPPORTED bit is set to one (see 9.10.10.2.27), the Rebuild Assist log shall be supported.

Table 302 — Rebuild Assist log (log page 00h)

Offset	Type	Description
0	Byte	Flag bits **Bit Description** 7:1 Reserved 0 MANAGE REBUILD ASSIST bit (see 9.20.2)
1..6		Reserved
7	Byte	PHYSICAL ELEMENT LENGTH field (p) (see 9.20.3)
8..7+p	Bytes	DISABLE PHYSICAL ELEMENT MASK field (see 9.20.4)
8+p..7+(2*p)	Bytes	DISABLED PHYSICAL ELEMENTS field (see 9.20.5)
8+(2*p)..511		Reserved

If:

a) the device processes a command to write to the Rebuild Assist log;
b) the REBUILD ASSIST SUPPORTED bit is set to one (see 9.10.10.2.27); and
c) the MANAGE REBUILD ASSIST bit is cleared to zero (see 9.20.2),

then the device shall:

1) disable the Rebuild Assist feature set as follows:
   A) clear the REBUILD ASSIST ENABLED bit to zero (see 9.10.10.3.11);
   B) set the PHYSICAL ELEMENT LENGTH field to a non-zero value (see 9.20.3);
   C) set the DISABLED PHYSICAL ELEMENT MASK field to a vendor specific value (see 9.20.4); and
   D) clear the DISABLED PHYSICAL ELEMENTS field to zero (see 9.20.5);
2) ignore all other data written to the Rebuild Assist log by that command; and
3) return command completion without error.

If:

a) the device processes a command to write to the Rebuild Assist log;
b) the REBUILD ASSIST SUPPORTED bit is set to one; and
c) the MANAGE REBUILD ASSIST bit is set to one,

then:

1) if:
   A) the device is unable to enable the Rebuild Assist feature set;
   B) the host attempts to set any bits to one in the DISABLED PHYSICAL ELEMENTS field that are cleared to zero in the DISABLED PHYSICAL ELEMENT MASK field; or
   C) the host attempts to set all bits to one in the DISABLED PHYSICAL ELEMENTS field that are set to one in the DISABLED PHYSICAL ELEMENT MASK field (i.e., attempt to disable all physical elements),

   then the device shall return command aborted;
2) the device shall enable the Rebuild Assist feature set (see 4.19.2);
3) if the device successfully enabled the Rebuild Assist feature set, the device shall logically OR the DISABLED PHYSICAL ELEMENTS field with any prior DISABLED PHYSICAL ELEMENTS field that the device was using (e.g., the host is allowed to add bits but not allowed clear bits in the field) and save the new value of the DISABLED PHYSICAL ELEMENTS field; and
4) the device shall set the REBUILD ASSIST ENABLED bit to one.

If the device processes a command to read from the Rebuild Assist log and REBUILD ASSIST SUPPORTED bit is set to one and the REBUILD ASSIST ENABLED bit is:

a) cleared to zero, then the device shall return the current values for all fields; or
b) set to one, then the device:
   A) shall set the MANAGE REBUILD ASSIST bit to one;
   B) may set additional bits in the DISABLED PHYSICAL ELEMENTS field; and
   C) shall not clear any bits in the DISABLED PHYSICAL ELEMENTS field that were previously set by the host.

9.20.2 MANAGE REBUILD ASSIST ENABLED bit

Table 303 describes the use of the MANAGE REBUILD ASSIST bit.

Table 303 — MANAGE REBUILD ASSIST bit

Log operation	MANAGE REBUILD ASSIST bit	Description
read	0 or 1	copy of the REBUILD ASSIST ENABLED bit (see 9.10.10.3.11)
write	0	host request to disable the Rebuild Assist feature set
write	1	host request to enable the Rebuild Assist feature set [a]
[a] If the REBUILD ASSIST SUPPORTED bit is cleared to zero (see 9.10.10.2.27), the Rebuild Assist feature set shall not be enabled.		

9.20.3 PHYSICAL ELEMENT LENGTH field

The PHYSICAL ELEMENT LENGTH field indicates the number of bytes in the DISABLED PHYSICAL ELEMENT MASK field and the number of bytes in the DISABLED PHYSICAL ELEMENTS field.

During the processing of a write to the Rebuild Assist log, the device shall ignore the PHYSICAL ELEMENT LENGTH field.

9.20.4 DISABLED PHYSICAL ELEMENT MASK field

The DISABLED PHYSICAL ELEMENT MASK field indicates which bits in the DISABLED PHYSICAL ELEMENTS field are supported.

During the processing of a write to the Rebuild Assist log, the device shall ignore the DISABLED PHYSICAL ELEMENT MASK field.

9.20.5 DISABLED PHYSICAL ELEMENTS field

The DISABLED PHYSICAL ELEMENTS field specifies if physical elements shall be disabled.

Each bit that is set to one in the DISABLED PHYSICAL ELEMENTS field specifies that LBAs associated with this physical element shall respond to read commands and write commands as if the associated LBAs have predicted errors (see 4.19.3.3 and 4.19.3.5).

Each bit that is cleared to zero in the DISABLED PHYSICAL ELEMENTS field specifies that LBAs associated with this physical element shall respond to read commands and write commands as if the associated LBAs do not have predicted errors.

9.21 Selective Self-Test log (Log Address 09h)

9.21.1 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 304 defines the content of the Selective Self-Test log.

Table 304 — Selective Self-Test log

Offset	Type	Field Name	Read/Write
0..1	Word	REVISION NUMBER (see 9.21.2)	R/W
2..9	QWord	TEST SPAN 1 STARTING LBA (see 9.21.3)	R/W
10..17	QWord	TEST SPAN 1 ENDING LBA (see 9.21.3)	R/W
18..25	QWord	TEST SPAN 2 STARTING LBA (see 9.21.3)	R/W
26..33	QWord	TEST SPAN 2 ENDING LBA (see 9.21.3)	R/W
34..41	QWord	TEST SPAN 3 STARTING LBA (see 9.21.3)	R/W
42..49	QWord	TEST SPAN 3 ENDING LBA (see 9.21.3)	R/W
50..57	QWord	TEST SPAN 4 STARTING LBA (see 9.21.3)	R/W
58..65	QWord	TEST SPAN 4 ENDING LBA (see 9.21.3)	R/W
66..73	QWord	TEST SPAN 5 STARTING LBA (see 9.21.3)	R/W
74..81	QWord	TEST SPAN 5 ENDING LBA (see 9.21.3)	R/W
82..337		Reserved	Reserved
338..491		Vendor specific	Vendor specific
492..499	QWord	CURRENT LBA UNDER TEST (see 9.21.4)	Read [a]
500..501	Word	CURRENT SPAN UNDER TEST (see 9.21.5)	Read [a]
502..503	Word	FEATURE FLAGS (see 9.21.6)	R/W
504..507		Vendor specific	Vendor specific
508..509	Word	SELECTIVE SELF-TEST PENDING TIME (see 9.21.7)	R/W
510		Reserved	Reserved
511		CHECKSUM (see 9.21.8)	R/W

[a] This field shall be ignored by the device, if written by the host.

9.21.2 REVISION NUMBER field

The value of the revision number shall be 01h. This value shall be written by the host and returned unmodified by the device.

9.21.3 Test span starting LBA and ending LBA

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.

9.21.4 CURRENT LBA UNDER TEST field

The device shall modify the value returned in the CURRENT LBA UNDER TEST field to contain the LBA of the logical sector currently under test at least once every 65 536 logical sectors tested. After the self-test including the off-line scan between test spans has been completed, a zero the CURRENT LBA UNDER TEST field shall be cleared to zero.

9.21.5 CURRENT SPAN UNDER TEST field

As the self-test progresses, the device shall modify returned in the CURRENT SPAN UNDER TEST field to contain the test span number of the current span being tested. If an off-line scan between test spans is selected, the CURRENT SPAN UNDER TEST field is set to a value greater than five during the off-line scan. After the self-test including the off-line scan between test spans has been completed, the CURRENT SPAN UNDER TEST field shall be cleared to zero.

9.21.6 FEATURE FLAGS field

The FEATURE FLAGS field defines the features of Selective self-test to be processed (see table 305).

Table 305 — FEATURE FLAGS field

Bit	Name	Description
5:15		Reserved
4	OFF-LINE SCAN ACTIVE	If set to one, off-line scan after selective test is active. [a]
3	OFF-LINE SCAN PENDING	If set to one, off-line scan after selective test is pending. [a]
2		Vendor specific
1	PERFORM OFF-LINE SCAN	If set to one, perform off-line scan after selective test. [b]
0		Vendor specific

[a] This bit shall be cleared to zero by the host and the device shall modify this bit as the test progresses.
[b] This bit shall be written by the host and returned unmodified by the device.

9.21.7 SELECTIVE SELF-TEST PENDING TIME field

The SELECTIVE SELF-TEST PENDING TIME field contains the time in minutes from power-on to the resumption of the off-line testing if OFF-LINE SCAN PENDING bit (see table 305) is set to one. At the expiration of this time, the device sets the OFF-LINE SCAN ACTIVE bit (see table 305) to one, and resumes the off-line scan that had begun before power-down.

9.21.8 CHECKSUM field

The contents of the CHECKSUM field are defined in 9.22.6.

9.22 Summary SMART Error log (Log Address 01h)

9.22.1 Overview

Table 306 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, and 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). If the device supports the Comprehensive SMART Error log (see 9.4), then the Summary SMART Error log duplicates the most recent five error entries in the Comprehensive SMART Error log. The Summary SMART Error log supports 28-bit addressing only.

Table 306 — 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

9.22.2 SMART error log version

The value of the SMART error log version byte shall be 01h.

9.22.3 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.

9.22.4 Error log data structure

9.22.4.1 Overview

An Error log data structure shall contain the most recent 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 307 describes the content of a valid Error log data structure.

Table 307 — 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

9.22.4.2 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 308. 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 308 — 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 field (7:0) when the Command was initiated
n+2	Content of the COUNT field (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.

9.22.4.3 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 308. 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 309.

Table 309 — Error data structure

Offset	Description
n	Reserved
n+1	Content of the ERROR field (7:0) after command completion occurred
n+2	Content of the COUNT field (7:0) after command completion occurred
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 byte shall contain a value indicating the state of the device when the command was initiated or the reset occurred as described in table 310.

Table 310 — State 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 while the device was in the Sleep mode (see 4.17.4).

Standby indicates the command or reset for which the error being reported was received while the device was in the Standby mode (see 4.17.4).

Active/Idle indicates the command or reset for which the error being reported was received while the device was in the Active mode or Idle mode (see 4.17.4).

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 or SMART self-test.

The Life timestamp word shall contain the power-on lifetime of the device in hours when command completion occurred.

9.22.5 Device error count

The Device error count word shall contain the total number of errors attributable to the device that have been reported by the device during the life of the device including: uncorrectable errors, ID not found errors for which the LBA requested was valid, servo errors, and 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). If the maximum value for this word is reached, the count shall remain at the maximum value if additional errors are encountered and logged.

9.22.6 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.

9.23 Write Stream Error log (Log Address 21h)

Table 311 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 field shall contain the total number of Write Stream Errors detected since the most recent read of the Write Stream Error log that returned command completion without error. This error count may be greater than 31. However, only the most recent 31 errors are represented by entries in the log. If the Write Stream Error Count reaches the maximum value, then after the next error is detected the Write Stream Error Count shall remain at the maximum value.

During processing of a read log command with the LBA field (7:0) set to 21h, a device shall clear the:

a) Write Stream Error log;
b) ERROR LOG INDEX field to zero; and
c) WRITE STREAM ERROR COUNT field to zero.

If the Error Log Index is zero, 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 4.17.4), then the device may clear the content of the Write Stream Error log. For a PATA device, the log is also cleared during the processing a hardware reset. For a SATA device, the log is cleared on a hardware reset if Software Settings Preservation is disabled (see 7.45.16.6), otherwise the log is preserved.

Table 311 — Write Stream Error log

Offset	Type	Description
0	Byte	DATA STRUCTURE VERSION field
1	Byte	ERROR LOG INDEX field
2..3	Word	WRITE STREAM ERROR COUNT field
4..15	Byte	Reserved
16..31	Byte	Write Stream Error log Entry 1
32..47	Byte	Write Stream Error log Entry 2
48..63	Byte	Write Stream Error log Entry 3
64..511	Byte	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 COUNT field shall contain the number of WRITE STREAM EXT command (see 7.67) entries since the most recent power-on reset, hardware reset, or since this log was most recently read.

The ERROR LOG INDEX field indicates the error log data structure representing the most recent error. Only values one through 31 are valid.

Table 292 defines the format of each Write Stream Error log Entry.

9.24 Current Device Internal Status Data log (Log Address 24h)

9.24.1 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 9.24.2); and
b) zero or more Current Device Internal Status Data pages (i.e., log pages 1..n) (see 9.24.3).

The number of log pages indicated in the General Purpose Log Directory (i.e., log 00h):

a) may change as a result of processing:
   A) a power on reset; or
   B) a download microcode activation;
b) shall not change from the completion of processing a power on reset until:
   A) a subsequent power on reset; or
   B) a download microcode activation;
   and
c) shall be the largest number of pages of Internal Status Data that the device is capable of returning.

The device shall return data for all pages with page numbers less than the log size reported in the General Purpose Log Directory for this log (i.e., 24h). The data beyond the highest numbered page in data area 3 is not specified by this standard.

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 the FEATURE field set to 0001h and shall not change until the device processes:

a) a subsequent read of the Current Device Internal Status Data log with bit 0 in the FEATURE field set to one;
b) a download microcode activation;
c) a power on reset; or
d) a software reset.

The current device internal status data may be retrieved by one or more reads of log pages within the range of 0..n.

The Current Device Internal Status Data log consists of three areas.

9.24.2 Current Device Internal Status Data header page

9.24.2.1 Current Device Internal Status Data header page overview

The Current Device Internal Status Data header is described in table 312.

Table 312 — Current Device Internal Status Data header (page 0)

Offset	Type	Description
0	Byte	LOG ADDRESS field (see 9.24.2.2)
1..3	Bytes	Reserved
4..7	DWord	Organization identifier (see 9.24.2.3) **Bit** **Description** 31:24 Reserved 23:0 IEEE AOI field
8..9	Word	DEVICE INTERNAL STATUS DATA AREA 1 LAST LOG PAGE field (see 9.24.2.4)
10..11	Word	DEVICE INTERNAL STATUS DATA AREA 2 LAST LOG PAGE field (see 9.24.2.5)
12..13	Word	DEVICE INTERNAL STATUS DATA AREA 3 LAST LOG PAGE field (see 9.24.2.6)
14..381	Bytes	Reserved
382	Byte	SAVED DATA AVAILABLE field (see 9.24.2.7)
383	Byte	SAVED DATA GENERATION NUMBER field (see 9.24.2.8)
384..511	Bytes	REASON IDENTIFIER field (see 9.24.2.9)

9.24.2.2 LOG ADDRESS field

The LOG ADDRESS field shall be set to 24h.

9.24.2.3 Organization identifier

9.24.2.3.1 IEEE AOI field

The IEEE AOI field shall contain an AOI assigned by the IEEE-SA Registration Authority to the organization that is able to interpret the Current Device Internal Status Data in this log.

The IEEE AOI field shall contain an AOI assigned by the IEEE-SA Registration Authority to the organization that is associated with the vendor specific data (see table 313) in the Current Device Internal Status Data in this log.

9.24.2.4 DEVICE INTERNAL STATUS DATA AREA 1 LAST LOG PAGE field

The DEVICE INTERNAL STATUS DATA AREA 1 LAST LOG PAGE field contains the value of the highest numbered log page of Device Internal Status data area 1 within the Device Internal Status data pages.

If the Device Internal Status data area 1 does not contain data, the DEVICE INTERNAL STATUS DATA AREA 1 LAST LOG PAGE field shall be cleared to zero. If the DEVICE INTERNAL STATUS DATA AREA 1 LAST LOG PAGE field is not cleared to zero, the Device Internal Status data area 1:

a) begins at page one; and
b) ends at the page indicated by the DEVICE INTERNAL STATUS DATA AREA 1 LAST LOG PAGE field.

9.24.2.5 DEVICE INTERNAL STATUS DATA AREA 2 LAST LOG PAGE field

The DEVICE INTERNAL STATUS DATA AREA 2 LAST LOG PAGE field contains the value of the highest numbered page of Device Internal Status data area 2 within the Device Internal Status data pages.

The value in the DEVICE INTERNAL STATUS DATA AREA 2 LAST LOG PAGE field shall be greater than or equal to the value in the DEVICE INTERNAL STATUS DATA AREA 1 LAST LOG PAGE field. If the DEVICE INTERNAL STATUS DATA AREA 2 LAST LOG PAGE field is not cleared to zero, then the Device Internal Status data area 2:

a) begins at page one; and
b) ends at the page indicated in DEVICE INTERNAL STATUS DATA AREA 2 LAST LOG PAGE field.

9.24.2.6 DEVICE INTERNAL STATUS DATA AREA 3 LAST LOG PAGE field

The DEVICE INTERNAL STATUS DATA AREA 3 LAST LOG PAGE field contains the value of the highest numbered page of Device Internal Status data area 3 within the Device Internal Status data pages.

The value in the DEVICE INTERNAL STATUS DATA AREA 3 LAST LOG PAGE field shall be greater than or equal to the value in the INTERNAL STATUS DATA AREA 2 LAST LOG PAGE field. If the DEVICE INTERNAL STATUS DATA AREA 3 LAST LOG PAGE field is not cleared to zero, then the Device Internal Status data area 3:

a) begins at page one; and
b) ends at the page indicated in DEVICE INTERNAL STATUS DATA AREA 3 LAST LOG PAGE field.

9.24.2.7 SAVED DATA AVAILABLE field

If the Saved Device Internal Status Data log is supported, the SAVED DATA AVAILABLE field shall contain the value of the SAVED DATA AVAILABLE field in the Saved Device Internal Status Data log (see 9.25.2.3).

If the Saved Device Internal Status Data log is not supported, the SAVED DATA AVAILABLE field shall be reserved.

9.24.2.8 SAVED DATA GENERATION NUMBER field

If the Saved Device Internal Status Data log is supported, 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 9.25.2.4).

If the Saved Device Internal Status Data log is not supported, the SAVED DATA GENERATION NUMBER field shall be reserved.

9.24.2.9 REASON IDENTIFIER field

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.

9.24.3 Current Device Internal Status data pages

The Current Device Internal Status Data log pages (see table 313) shall represent the device internal state.

Table 313 — Current Device Internal Status Data (pages 1..n)

Offset	Type	Description
0..511	Bytes	Vendor Specific

9.24.4 Examples of data area usage

The structure of Device Internal Status log pages is shown in figure 12.

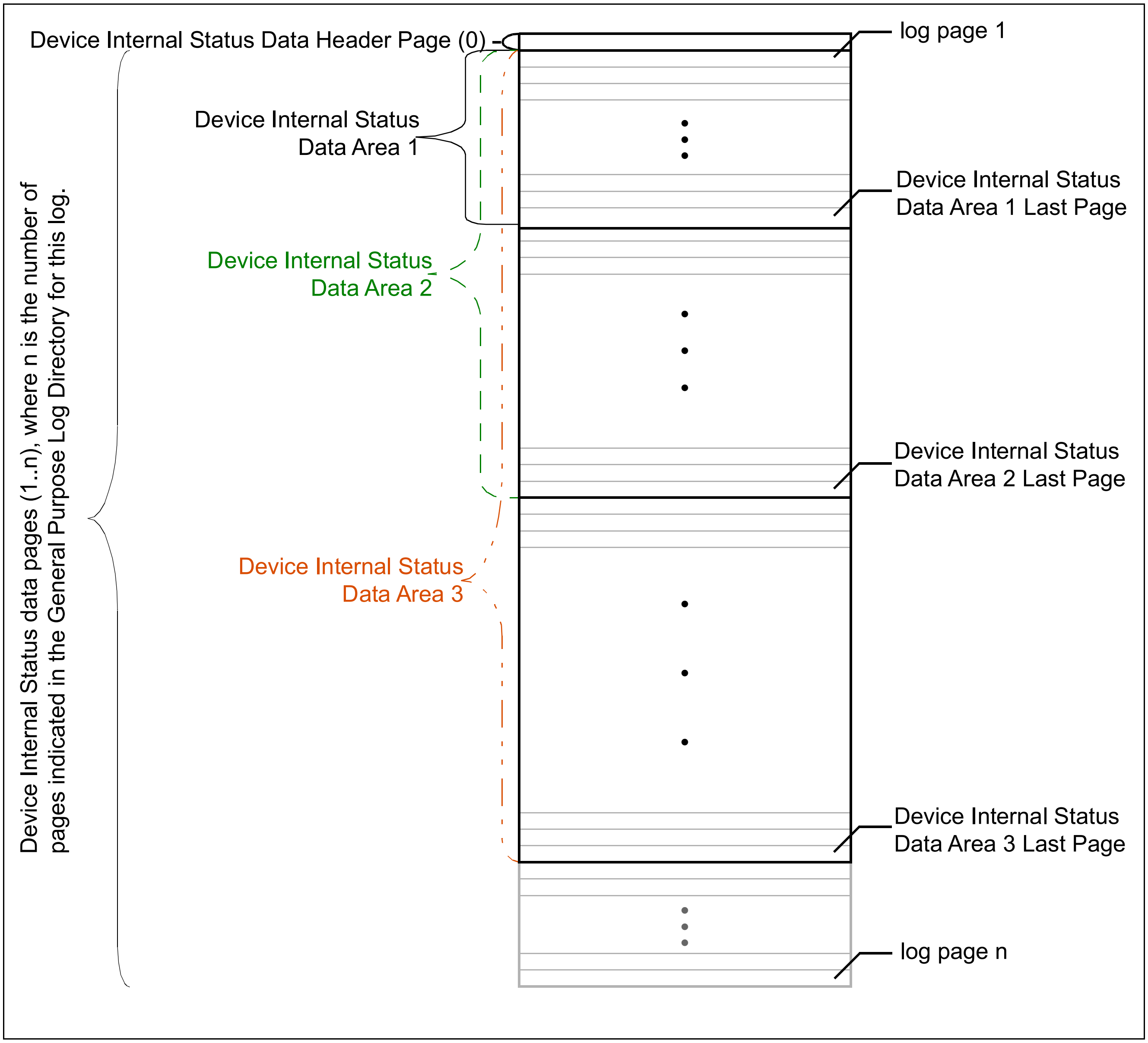

Figure 12 — Example of a Device Internal Status log with data in all three data areas

Figure 13 is an example of a Device Internal Status log with no data.

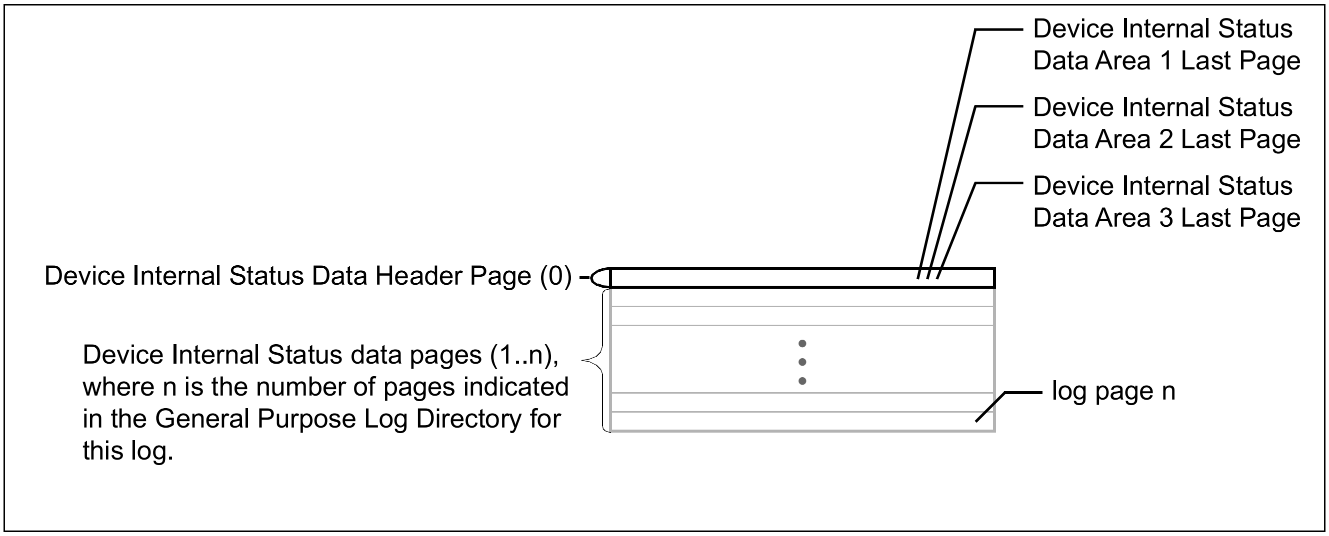

Figure 13 — Example of a Device Internal Status log with no data

Figure 14 is an example of a Device Internal Status log with no data in Device Internal Status Data Area 1, data in Device Internal Status Data Area 2, and no additional data in Device Internal Status Data Area 3.

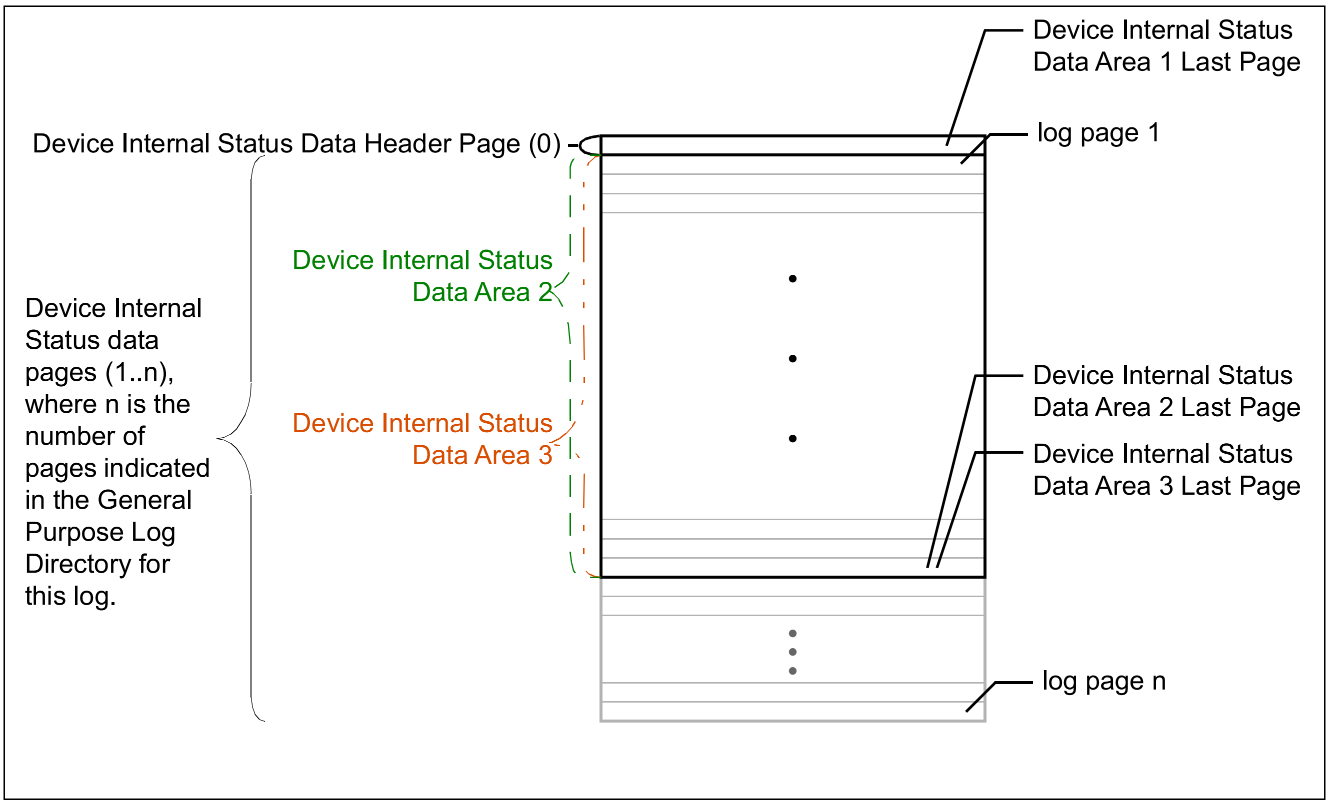

Figure 14 — Example of a Device Internal Status log with mixed data areas

9.25 Saved Device Internal Status Data log (Log Address 25h)

9.25.1 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 9.25.2); and
b) zero or more Saved Device Internal Status Data pages (i.e., log pages 1..n) (see 9.25.3).

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.

9.25.2 Saved Device Internal Status Data header page

9.25.2.1 Saved Device Internal Status Data header page overview

The Saved Device Internal Status Data header is described in table 314.

Table 314 — Saved Device Internal Status Data header (page 0)

Offset	Type	Description
0	Byte	LOG ADDRESS field (see 9.25.2.2)
1..3	Bytes	Reserved
4..7	DWord	Organization identifier (see 9.24.2.3) **Bit** **Description** 31:24 Reserved 23:0 IEEE AOI field
8..9	Word	DEVICE INTERNAL STATUS DATA AREA 1 LAST LOG PAGE field (see 9.24.2.4)
10..11	Word	DEVICE INTERNAL STATUS DATA AREA 2 LAST LOG PAGE field (see 9.24.2.5)
12..13	Word	DEVICE INTERNAL STATUS DATA AREA 3 LAST LOG PAGE field (see 9.24.2.6)
14..381	Bytes	Reserved
382	Byte	SAVED DATA AVAILABLE field (see 9.25.2.3)
383	Byte	SAVED DATA GENERATION NUMBER field (see 9.25.2.4)
384..511	Bytes	REASON IDENTIFIER field (see 9.24.2.9)

9.25.2.2 LOG ADDRESS field

The LOG ADDRESS field shall be set to 25h.

9.25.2.3 SAVED DATA AVAILABLE field

If the SAVED DATA AVAILABLE field is cleared to zero, the Saved Device Internal Status Data log does not contain saved Device Internal Status Data. If the SAVED DATA AVAILABLE field is set to one, 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, the SAVED DATA AVAILABLE field shall be cleared to zero.

If the device saves Saved Device Internal Status Data in the Saved Device Internal Status Data log, the SAVED DATA AVAILABLE field shall be set to one.

9.25.2.4 SAVED DATA GENERATION NUMBER field

The SAVED DATA GENERATION NUMBER field shall contain a value that is incremented each time the device initiates a capture of the internal device state into the Saved Device Internal Status Data.

9.25.3 Current Device Internal Status data pages

The Saved Device Internal Status Data log pages (see table 315) shall represent the device internal state.

Table 315 — Saved Device Internal Status Data (pages 1..n)

Offset	Type	Description
0..511	Bytes	Vendor Specific

9.26 Device Statistics Notifications log (Log Address 0Ah)

The Device Statistics Notifications log pages are used to configure and report changes in conditions on individually monitored device statistics from the Device Statistics log pages (see 9.5).

Notifications take the form of an additional sense code response (see 4.8.2) to a REQUEST SENSE DATA EXT command (see 7.34). The Summary page (i.e., page 00h) of the Device Statistics Notifications log (see table 317) contains a list of the triggered monitor status of all Device Statistics log pages.

If the device processes a WRITE LOG EXT command (see 7.68) or a WRITE LOG DMA EXT command (see 7.63) that includes the Summary page of the Device Statistics Notifications log, then the device shall return command aborted.

The Definition pages of the Device Statistics Notifications log, starting at page 01h of the Device Statistics Notifications log (see table 319), specify all definition entries. A definition entry consists of:

a) the log page of device statistic;
b) the offset of the device statistic within the log page;
c) a threshold value; and
d) flags specifying the notification condition.

The Definition pages of the Device Statistics Notifications log shall be readable and writable

If an unsupported or reserved Device Statistics Notifications log page is requested, then 512 bytes of all zeros shall be returned for that page.

Table 316 contains a list of defined Device Statistics Notifications log pages.

Table 316 — Device Statistics Notifications pages

Page	Description
00h	Summary page (see table 317)
01h	Definition page 1 (see table 319)
…	…
n	Definition page n (see table 319)
n+1..FFh	Reserved

Table 317 defines the Summary page of the Device Statistics Notifications log that consists of a list of the device statistics whose Device Statistic Conditions have been matched.

Table 317 — Summary page of the Device Statistics Notifications log

Offset	Type	Description
0..7	QWord	Device Statistics Notifications Information Header
		Bit **Description** 63 1 = The DSN feature set is enabled 0 = The DSN feature set is disabled 62 1 = There are more than 126 DSN Match Entries [a] 0 = There are 126 or less DSN Match Entries 61:24 Reserved 23:16 Page number. Shall be set to 00h 15:0 Revision number. Shall be set to 0001h
		DSN Match Entries
8..11	DWord	DSN Match Entry 0 (see table 318)
12..15	DWord	DSN Match Entry 1 (see table 318)
…		…
508..511	DWord	DSN Match Entry 125 (see table 318)

[a] If bit 62 is set to one, the host should check all device statistics (see 9.5) for a DEVICE STATISTICS FLAGS field (see table 224) in which the MONITORED CONDITION MET bit is set to one.

Table 318 defines the format of a DSN Match Entry.

Table 318 — DSN Match Entry

Offset	Type	Description
0..1	Word	CORRESPONDING OFFSET field
2	Byte	CORRESPONDING PAGE field
3	Byte	Monitored Condition Cause
		Bit **Description** 7:2 Reserved 1 1 = This Device Statistic is valid 0 = This Device Statistic is invalid 0 1 = This Device Statistic matches the threshold condition 0 = This Device Statistic does not match the threshold condition

The CORRESPONDING PAGE field indicates the page number of the Device Statistics log (see 9.5) referred to by this DSN Match Entry.

The CORRESPONDING OFFSET field indicates the byte offset to the first byte of device statistic within the corresponding page referred to by this DSN Match Entry.

Table 319 defines the format for Definition pages of the Device Statistics Notifications log (e.g., pages 01h..07h). Each Threshold value is specified in the units of the Device Statistic at the equivalent offset.

Table 319 — Definition pages of the Device Statistics Notifications log

Offset	Type	Description
0..7	QWord	Device Statistics Location 1
		Bit **Description** 63:32 Reserved 31:24 The Device Statistics log page (see table 222) for Device Statistics Location 1 23:9 Reserved 8:0 The byte offset to the first byte of the Device Statistic for Device Statistics Location 1
8..15	QWord	Device Statistics Condition Definition 1
		Bit **Description** 63:56 DSN CONDITION FLAGS field (see table 320) 55:0 Threshold value for Device Statistic Location 1
…		…
496..503	QWord	Device Statistics Location 32
		Bit **Description** 63:32 Reserved 31:24 The Device Statistics log page (see table 222) for Device Statistics Location 32 23:9 Reserved 8:0 The byte offset to the first byte of the Device Statistic for Device Statistics Location 32
504..511	QWord	Device Statistics Condition Definition 32
		Bit **Description** 63:56 DSN CONDITION FLAGS field (see table 320) 55:0 Threshold value for Device Statistic Location 32

Table 320 defines the format for the DSN CONDITION FLAGS field.

Table 320 — DSN CONDITION FLAGS field

Bits	Field	Changeable	Description
63	NOTIFICATION ENABLED	Yes	1 = This Notification is enabled. 0 = This Notification is not enabled.
62:60	VALUE COMPARISON TYPE	Yes	**Value** **Description** 000b Does not trigger on any Device Statistic value update 001b Triggers on every update of the Device Statistic value 010b Triggers on the Device Statistic value equal to threshold value 011b Triggers on the Device Statistic value less than the threshold value 100b Triggers on the Device Statistic value greater than the threshold value all others Reserved
59	NON-VALIDITY TRIGGER	Yes	1 = Triggers on Invalid Device Statistic 0 = Does not trigger on Invalid Device Statistic
58	VALIDITY TRIGGER	Yes	1 = Triggers on Valid Device Statistic 0 = Does not trigger on Valid Device Statistic
57:56			Reserved

9.27 Pending Defects log (Log Address 0Ch)

9.27.1 Overview

The Pending Defects log contains an unsorted list of logical sectors for which the device has detected an uncorrectable media error.

The PendingDefects log may be affected by the processing of a device configuration changing command.

9.27.2 Detection of an uncorrectable media error

An uncorrectable media error may be detected by the device while accessing the media (e.g., processing a command, background activities, and device-initiated processes that are outside the scope of this standard).

9.27.3 Adding descriptors to the Pending Defects log

If an uncorrectable media error is detected on a logical sector and the uncorrectable media error is:

a) not a flagged uncorrectable media error (see 7.68), then that logical sector shall be added to the Pending Defects log; and
b) a flagged uncorrectable media error, then that logical sector shall not be added to the Pending Defects log.

Logical sectors that are specified by a WRITE UNCORRECTABLE EXT command (see 7.68) should not be added to the Pending Defects log during the processing of the WRITE UNCORRECTABLE EXT command.

A logical sector may be added to the log if that logical sector is in the same physical sector as another logical sector that is added to the log.

9.27.4 Removing descriptors from the Pending Defects log

A logical sector shall be removed from the log if the device:

a) writes that logical sector without error; or
b) reads that logical sector without error.

A logical sector may be removed from the log if the logical sector has been trimmed (see 7.5.3.3).

A sanitize operation (see 4.20.4) removes all descriptors from the Pending Defects log.

A logical sector may be removed from the log if that logical sector is in the same physical sector as another logical sector that is removed from the log.

9.27.5 Contents of the Pending Defects log

The size of the log may change as a result of a power on reset or activating new firmware (e.g. DOWNLOAD MICROCODE command).

Table 321 defines the format of the Pending Defects log for page 0. Table 322 defines the format of all subsequent pages of the log. The size (i.e., number of pages) of the Pending Defects log is indicated in the General Purpose Directory log (see 9.2).

Table 321 — Pending Defects log (page 0)

Offset	Type	Description
0..3	DWord	NUMBER OF LOG DESCRIPTORS field (see 9.27.6)
4..15		Reserved
16..31	Bytes	Pending Defects Log descriptor 0 (see 9.27.7)
32..47	Bytes	Pending Defects Log descriptor 1
…		…
496..511	Bytes	Pending Defects Log descriptor 30

Table 322 — Pending Defects log (page 1..n)

Offset	Type	Description
0..15	Bytes	Pending Defects Log descriptor 31 + ((log page number–1) × 32)
16..31	Bytes	Pending Defects Log descriptor 32 + ((log page number–1) × 32)
…		…
496..511	Bytes	Pending Defects Log descriptor 62 + ((log page number–1) × 32)

9.27.6 NUMBER OF LOG DESCRIPTORS field

The NUMBER OF LOG DESCRIPTORS field indicates the number of Pending Defects descriptors in the Pending Defects log. If the value of the NUMBER OF LOG DESCRIPTORS field is greater than or equal to FFFEh, then:

a) the device shall not add more Pending Defects descriptors to the log; and
b) the NUMBER OF LOG DESCRIPTORS field shall not be changed.

There shall be no unused Pending Defects descriptors (see 9.27.7) included in the range specified by the NUMBER OF LOG DESCRIPTORS field.

The number of Pending Defects descriptors in the Pending Defects log is vendor specific.

9.27.7 Pending Defects descriptor format

Each Pending Defects descriptor indicates a logical sector that is associated with an uncorrectable media error. Unused Pending Defects descriptors shall be cleared to zero. Table 323 defines the format of each Pending Defects descriptor.

Table 323 — Pending Defects descriptor format

Offset	Type	Description
0..3	DWord	POWER ON HOURS field
4..7		Reserved
8..15	QWord	LBA field

At the time that a Pending Defects descriptor is created, the device shall set the POWER ON HOURS field to:

a) the current value of the Power On Hours device statistic (see 9.5.6.4), if the Power On Hours device statistic is supported and is valid; and
b) FFFF_FFFFh if the Power On Hours device statistic is not supported or is not valid.

The LBA field indicates the LBA that is associated with an uncorrectable media error (see 9.27.2).

9.28 Sense Data for Successful NCQ Commands log (Log address 0Fh)

9.28.1 Overview

The Sense Data for Successful NCQ Commands log returns sense data, if any, provided by one or more NCQ commands before their command completion without error. This log is 1 024 bytes in length (i.e., two pages), shall be supported if the SUCCESSFUL NCQ COMMAND SENSE DATA SUPPORTED bit is set to one (see 9.10.5.2.40), and is defined in table 324.

Table 324 — Sense Data for Successful NCQ Commands log pages 0 and 1

Offset	Type	Description
0..7	QWord	Sense Data for Successful Queued Commands header **Bit Description** 63:24 Reserved 23:16 LOG PAGE NUMBER field - shall be set to 0Fh 15:0 REVISION NUMBER field (Word) - shall be set to 0001h
8	Byte	SENSE DATA VALID field (7:0) (see 9.28.2.2)
9	Byte	SENSE DATA VALID field (15:8) (see 9.28.2.2)
10	Byte	SENSE DATA VALID field (23:16) (see 9.28.2.2)
11	Byte	SENSE DATA VALID field (31:24) (see 9.28.2.2)
12 to 13	Word	SENSE DATA VALID field (47:32) (see 9.28.2.3) **Bit Description** 15 DEVICE STATISTICS NOTIFICATION ACTIVE bit (see 9.28.2.3.2) 14:0 Reserved
14 to 31	Bytes	Reserved
32 to 55	Bytes	Successful Sense Data descriptor for tag 0 (see 9.28.3)
56 to 79	Bytes	Successful Sense Data descriptor for tag 1 (see 9.28.3)
80 to 103	Bytes	Successful Sense Data descriptor for tag 2 (see 9.28.3)
…	…	…
464 to 487	Bytes	Successful Sense Data descriptor for tag 18 (see 9.28.3)
488 to 511	Bytes	Successful Sense Data descriptor for tag 19 (see 9.28.3)
512 to 535	Bytes	Successful Sense Data descriptor for tag 20 (see 9.28.3)
536 to 559	Bytes	Successful Sense Data descriptor for tag 21 (see 9.28.3)
560 to 583	Bytes	Successful Sense Data descriptor for tag 22 (see 9.28.3)
…	…	…
728 to 751	Bytes	Successful Sense Data descriptor for tag 29 (see 9.28.3)
752 to 775	Bytes	Successful Sense Data descriptor for tag 30 (see 9.28.3)
776 to 799	Bytes	Successful Sense Data descriptor for tag 31 (see 9.28.3)
800..1 023	Bytes	Reserved

9.28.2 SENSE DATA VALID field

9.28.2.1 Overview

Individual bits in the SENSE DATA VALID field indicate conditions associated with the successful completion of an NCQ command (see 4.15) that are the result of:

a) sense data being returned with the NCQ command in the associated Successful Sense Data descriptor (see 9.28.3) for SENSE DATA VALID field (31:0) (see 9.28.2.2); and
b) the availability of notification sense data (e.g., DSN notification sense data (see 4.8.2)) for SENSE DATA VALID field (47:32) (see 9.28.2.3).

The SENSE DATA VALID field shall be cleared to zero if:

a) the SENSE DATA SUPPORTED bit (see 9.10.5.2.28) is cleared to zero;
b) the SENSE DATA ENABLED bit (see 9.10.6.2.12) is cleared to zero;
c) the NCQ FEATURE SET SUPPORTED bit (see 9.10.10.2.4) is cleared to zero;
d) the NCQ AUTOSENSE SUPPORTED bit (see 9.10.10.2.21) is cleared to zero;
e) the QUEUED READ LOG DMA EXT SUPPORTED bit (see 9.18.8) is cleared to zero; or
f) the SUCCESSFUL NCQ COMMAND SENSE DATA SUPPORTED bit (see 9.10.5.2.40) is cleared to zero.

9.28.2.2 Successful NCQ command sense data

Each bit in the SENSE DATA VALID field (31:0) indicates whether an associated Successful Sense Data descriptor (see 9.28.3) contains valid data. If a bit in the SENSE DATA VALID field (31:0) is:

a) cleared to zero, then the associated Successful Sense Data descriptor does not contain valid data; or
b) set to one, then the associated Successful Sense Data descriptor contains valid data.

EXAMPLE - If bit 0 of the sense data value field is set to one, the Successful Sense Data descriptor for tag 0 contains valid data. If bit 11 of the sense data value field is set to one, the Successful Sense Data descriptor for tag 11 contains valid data.

The conditions that cause a bit in the SENSE DATA VALID field (31:0) to be set to one or cleared to zero are defined in 4.13.7. If a bit in the SENSE DATA VALID field (31:0) is cleared to zero, the associated Successful Sense Data descriptor shall be cleared to zero.

9.28.2.3 Successful NCQ command notification sense data

9.28.2.3.1 Overview

Each bit in the SENSE DATA VALID field (47:32) indicates a notification condition that may be reported by overwriting other sense data if the command that is completing without an error is not an NCQ command. For an NCQ command (see 4.15), the equivalent notification sets a bit in the SENSE DATA VALID field (47:32) and does not overwrite other sense data.

9.28.2.3.2 DEVICE STATISTICS NOTIFICATION ACTIVE bit

If the DEVICE STATISTICS NOTIFICATION ACTIVE bit is set to one, the device is reporting changes based on DSN Condition Definitions that have been met (see 4.8.2). If the DEVICE STATISTICS NOTIFICATION ACTIVE bit is cleared to zero, the device is not reporting changes based on DSN Condition Definitions that have been met.

9.28.3 Successful Sense Data descriptor

9.28.3.1 Overview

If the bit in the SENSE DATA VALID field (31:0) (see 9.28.2.2) associated with a Successful Sense Data descriptor is cleared to zero, then the contents of that descriptor are reserved. If the bit in the SENSE DATA VALID field (31:0) associated with a Successful Sense Data descriptor is set to one, then that descriptor contains the information shown table 325.

Table 325 — Successful Sense Data descriptor format

Offset	Type	Description
0	Byte	SENSE KEY field (see 9.28.3.2)
1	Byte	ADDITIONAL SENSE CODE field (see 9.28.3.2)
2	Byte	ADDITIONAL SENSE CODE QUALIFIER field (see 9.28.3.2)
3	Byte	COMMAND field (see 9.28.3.3)
4	Byte	FEATURE field (7:0) (see 9.28.3.3)
5	Byte	FEATURE field (15:8) (see 9.28.3.3)
6	Byte	COUNT field (7:0) (see 9.28.3.3)
7	Byte	COUNT field (15:8) (see 9.28.3.3)
8	Byte	LBA field (7:0) (see 9.28.3.4)
9	Byte	LBA field (15:8) (see 9.28.3.4)
10	Byte	LBA field (23:16) (see 9.28.3.4)
11	Byte	LBA field (31:24) (see 9.28.3.4)
12	Byte	LBA field (39:32) (see 9.28.3.4)
13	Byte	LBA field (47:40) (see 9.28.3.4)
14	Byte	INFORMATION field (7:0) (see 9.28.3.5)
15	Byte	INFORMATION field (15:8) (see 9.28.3.5)
16 to 23	Bytes	Reserved

9.28.3.2 Sense data fields

The SENSE KEY field, ADDITIONAL SENSE CODE field, and ADDITIONAL SENSE CODE QUALIFIER field contain the values defined for the Sense Data Reporting feature set (see 4.24).

9.28.3.3 Command related fields

The COMMAND field, FEATURE field, and COUNT field contain copies of the fields in the command inputs for the command that completed without an error and returned sense data.

9.28.3.4 LBA field

If definition of the sense data to be returned when a command completes without an error includes an LBA value, then the LBA field contains the defined value. Otherwise, the LBA field contains a copy of the LBA field in the command inputs for the command that completed without an error and returned sense data.

9.28.3.5 INFORMATION field

If definition of the sense data to be returned when a command completes without an error includes an information value, then the INFORMATION field contains the defined value. Otherwise, the INFORMATION field is reserved.

9.29 Sector Configuration log (Log Address 2Fh)

9.29.1 Overview

The Sector Configuration log contains Sector Configuration descriptors (see 9.29.2.2). The Sector Configuration descriptors describe sector configurations. The sector configuration is specified using the SET SECTOR CONFIGURATION EXT command (see 7.46).

The Sector Configuration log may be affected by the processing of a device configuration changing command.

9.29.2 Sector Configuration descriptors (log page 00h)

9.29.2.1 Log page format

Table 326 defines log page 00h of the Sector Configuration log.

Table 326 — Sector Configuration descriptors (log page 00h)

Offset	Type	Description
0..15	Bytes	Sector Configuration descriptor 0 (see 9.29.2.2)
16..31	Bytes	Sector Configuration descriptor 1 (see 9.29.2.2)
…	…	…
112..127	Bytes	Sector Configuration descriptor 7 (see 9.29.2.2)
128..511	Bytes	Reserved

9.29.2.2 Sector Configuration descriptor

9.29.2.2.1 Overview

Table 327 defines a Sector Configuration descriptor.

Table 327 — Sector Configuration descriptor

Offset	Type	Description
0	Byte	Sector Configuration descriptor flags **Bit Description** 7 DESCRIPTOR VALID bit (see 9.29.2.2.2) 6:0 Reserved
1	Byte	LOGICAL TO PHYSICAL SECTOR RELATIONSHIP SETTING field (see 9.29.2.2.3)
2..3	Word	DESCRIPTOR CHECK field (see 9.29.2.2.4)
4..7	DWord	LOGICAL SECTOR SIZE SETTING field (see 9.29.2.2.5)
8..15	Bytes	Reserved

9.29.2.2.2 DESCRIPTOR VALID bit

If the DESCRIPTOR VALID bit is set to one, descriptor contains valid information. If the DESCRIPTOR VALID bit is cleared to zero, descriptor does not contain valid information.

9.29.2.2.3 LOGICAL TO PHYSICAL SECTOR RELATIONSHIP SETTING field

The LOGICAL TO PHYSICAL SECTOR RELATIONSHIP SETTING field indicates the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP field (see 9.10.4.3.4) setting to be used when a SET SECTOR CONFIGURATION command (see 7.46) that specifies this Sector Configuration descriptor is processed.

9.29.2.2.4 DESCRIPTOR CHECK field

The DESCRIPTOR CHECK field indicates a value that is compared to the COMMAND CHECK field in a SET SECTOR CONFIGURATION command (see 7.46). The value in the DESCRIPTOR CHECK field shall not be equal to the value in the DESCRIPTOR CHECK field in any other valid Sector Configuration Descriptor in this device.

9.29.2.2.5 LOGICAL SECTOR SIZE SETTING field

The LOGICAL SECTOR SIZE SETTING field indicates the device logical sector size setting to be set when a SET SECTOR CONFIGURATION command is processed (see 9.10.4.4).

9.30 Mutate Configurations log (Log Address 42h)

9.30.1 Overview

The Mutate Configurations log is a read-only log that:

a) indicates the configurations supported by the device for the MUTATE EXT command (see 7.16) based on the current device configuration; and
b) may span more than one log page.

The Mutate Configurations log may be affected by the processing of a device configuration changing command.

Table 328 defines the format of the Mutate Configurations log.

Table 328 — Mutate Configurations log

Offset	Type	Description
0..15		Mutate Configurations header (see 9.30.3)
16..79		Mutate Configuration descriptor 0 (see 9.30.4)
80..143		Mutate Configuration descriptor 1 (see 9.30.4)
...	...	...
		Mutate Configuration descriptor N (see 9.30.4)
		Zero padding (see 9.30.2)

9.30.2 Zero padding

The total bytes input from the device to the host shall be:

$512 \times pc$

where:

pc is the contents of the LOG PAGE COUNT field in the command inputs for the command reading the log.

The device shall insert as many bytes cleared to zero after Mutate Configuration descriptor N (see table 328) as are required to make the total bytes input from the device to the host equal of $512 \times pc$.

9.30.3 Mutate Configurations header

9.30.3.1 Overview

Table 329 defines the format of the Mutate Configurations header.

Table 329 — Mutate Configurations header

Offset	Type	Description
0..1	Word	NUMBER OF CONFIGURATIONS field (see 9.30.3.2)
2..15		Reserved

9.30.3.2 NUMBER OF CONFIGURATIONS field

The NUMBER OF CONFIGURATIONS field indicates the number of Mutate Configuration descriptors (see 9.30.4) that are in the log.

9.30.4 Mutate Configuration descriptor

9.30.4.1 Overview

Table 330 defines the format of the Mutate Configuration descriptor.

Table 330 — Mutate Configuration descriptor

Offset	Type	Description
0..3	DWord	CONFIGURATION IDENTIFIER field (see 9.30.4.2)
4	Byte	SCHEMA TYPE field (see 9.30.4.3)
5..6		Reserved
7	Byte	**Bit** **Description** 7:4 Reserved 3:0 LOGICAL TO PHYSICAL SECTOR RELATIONSHIP field (see 9.30.4.4)
8..11	DWord	LOGICAL SECTOR SIZE field (see 9.30.4.5)
12..15		Reserved
16..23	QWord	**Bit** **Description** 63:48 Reserved 47:0 DESIGNED ACCESSIBLE CAPACITY field (see 9.30.4.6)
24..39		Reserved
40..63		Schema type specific information (see 9.30.4.7)

9.30.4.2 CONFIGURATION IDENTIFIER field

In a Mutate Configuration descriptor, the CONFIGURATION IDENTIFIER field (see table 331) indicates the value that the host sets in the REQUESTED CONFIGURATION IDENTIFIER field to specify the use of that Mutate Configuration descriptor.

Table 331 — CONFIGURATION IDENTIFIER field

Value	Description	SCHEMA TYPE field (see table 332)
0000_0000h	Elementary non-zoned with 512 bytes of user data in each logical sector [a]	01h
0000_0001h	Elementary Host Aware Zones feature set (see ZAC-2) with 512 bytes of user data in each logical sector [a]	02h
0000_0002h	Elementary Host Managed Zones feature set (see ZAC-2) with 512 bytes of user data in each logical sector [a]	03h
0000_0003h	Elementary Zone Domains feature set (see ZAC-2), optionally with the Zone Realms feature set (see ZAC-2), with 512 bytes of user data in each logical sector [a]	04h
0000_0004h..0000_00FFh	Reserved	
0000_0100h	Elementary non-zoned with 4 096 bytes of user data in each logical sector [b]	01h
0000_0101h	Elementary Host Aware Zones feature set (see ZAC-2) with 4 096 bytes of user data in each logical sector [b]	02h
0000_0102h	Elementary Host Managed Zones feature set (see ZAC-2) with 4 096 bytes of user data in each logical sector [b]	03h
0000_0103h	Elementary Zone Domains feature set (see ZAC-2), optionally with the Zone Realms feature set (see ZAC-2), with 4 096 bytes of user data in each logical sector [b]	04h
0000_0104h..0000_FFFFh	Reserved	
0001_0000h..FFFF_FFFFh	Vendor Specific	

[a] In this Mutate Configuration descriptor, the LOGICAL SECTOR SIZE field shall be set to 0000_0200h and the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP field shall be set to 0h or 3h.
[b] In this Mutate Configuration descriptor, the LOGICAL SECTOR SIZE field shall be set to 0000_1000h and the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP field shall be set to 0h.

9.30.4.3 SCHEMA TYPE field

In a Mutate Configuration descriptor, the SCHEMA TYPE field (see table 332) indicates the overall format described by that Mutate Configuration descriptor.

Table 332 — SCHEMA TYPE field

Value	Description	Schema Type Specific information (see table 330)
00h	Reserved	
01h	This Mutate Configuration descriptor does not define any zones (i.e., none of the requirements in ZAC-2 apply).	Reserved
02h	This Mutate Configuration descriptor defines the zones that use the Host Aware Zones feature set (see ZAC-2).	See 9.30.4.7.2
03h	This Mutate Configuration descriptor defines the zones that use the Host Managed Zones feature set (see ZAC-2).	See 9.30.4.7.3
04h	This Mutate Configuration descriptor defines zones that use the Zone Domains feature set (see ZAC-2) and optionally the Zone Realms feature set (see ZAC-2).	See 9.30.4.7.4
05h..FFh	Reserved	

9.30.4.4 LOGICAL TO PHYSICAL SECTOR RELATIONSHIP field

If this Mutate Configuration descriptor is specified (see 9.30.4.2), then the device shall set the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP field in the IDENTIFY DEVICE data log (see 9.10.4.3.4) to the value in the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP field in this descriptor.

9.30.4.5 LOGICAL SECTOR SIZE field

If this Mutate Configuration descriptor is specified (see 9.30.4.2), then the device shall set the LOGICAL SECTOR SIZE field in the IDENTIFY DEVICE data log (see 9.10.4.4) to the value in the LOGICAL SECTOR SIZE field in this descriptor.

9.30.4.6 DESIGNED ACCESSIBLE CAPACITY field

If this Mutate Configuration descriptor is specified (see 9.30.4.2), then the device shall set the ACCESSIBLE CAPACITY field in the IDENTIFY DEVICE data log (see 9.10.4.2) to the value in the DESIGNED ACCESSIBLE CAPACITY field in this descriptor.

The value returned is affected by the value of the REQUEST MAXIMUM ACCESSIBLE CAPACITY bit (see 7.16.3.2) and the condition of the media that contains the user data being initialized.

9.30.4.7 Schema type specific information

9.30.4.7.1 Overview

Some values in the SCHEMA TYPE field require specific values to be returned in bytes 40..63 of the Mutate Configuration descriptor (see 9.30.4) as described in (see table 332) and in the subclauses of 9.30.4.7.

9.30.4.7.2 Host aware zones schema type specific information

9.30.4.7.2.1 Overview

Table 333 defines the schema type specific information in a Mutate Configuration descriptor if the SCHEMA TYPE field is set to 02h.

Table 333 — Host aware zones schema type specific information

Offset	Type	Description
0	Byte	LOW LBA CONVENTIONAL ZONES PERCENTAGE field (see 9.30.4.7.2.2)
1	Byte	HIGH LBA CONVENTIONAL ZONES PERCENTAGE field (see 9.30.4.7.2.3)
2..11	Reserved	
12..15	DWord	LOGICAL SECTORS PER ZONE field (see 9.30.4.7.2.4)
16..23	Reserved	

9.30.4.7.2.2 LOW LBA CONVENTIONAL ZONES PERCENTAGE field

The LOW LBA CONVENTIONAL ZONES PERCENTAGE field indicates the approximate percentage of the zones formatted as conventional zones (see ZAC-2) starting with LBA 0.

The units for the LOW LBA CONVENTIONAL ZONES PERCENTAGE field are tenths of a percent (e.g., 0 indicates 0%, 1 indicates 0.1%, 10 indicates 1.0%, 255 indicates 25.5%).

The actual number of zones formatted as conventional zones depends on several factors (e.g., the number of logical sectors in a zone). Zones that are not formatted as conventional zones are formatted as sequential write preferred write pointer zones (see ZAC-2).

9.30.4.7.2.3 HIGH LBA CONVENTIONAL ZONES PERCENTAGE field

The HIGH LBA CONVENTIONAL ZONES PERCENTAGE field indicates the approximate percentage of the zones formatted as conventional zones (see ZAC-2) ending with the largest valued LBA formatted.

The units for the LOW LBA CONVENTIONAL ZONES PERCENTAGE field are tenths of a percent (e.g., 0 indicates 0%, 1 indicates 0.1%, 10 indicates 1.0%, 255 indicates 25.5%).

The actual number of zones formatted as conventional zones depends on several factors (e.g., the number of logical sectors in a zone). Zones that are not formatted as conventional zones are formatted as sequential write preferred write pointer zones (see ZAC-2).

9.30.4.7.2.4 LOGICAL SECTORS PER ZONE field

The LOGICAL SECTORS PER ZONE field indicates the number of logical sectors in each zone. A LOGICAL SECTORS PER ZONE field set to zero indicates that the number of logical blocks in a zone is not reported.

9.30.4.7.3 Host managed zones schema type specific information

9.30.4.7.3.1 Overview

Table 334 defines the schema type specific information in a Mutate Configuration descriptor if the SCHEMA TYPE field is set to 03h.

Table 334 — Host managed zones schema type specific information

Offset	Type	Description
0	Byte	LOW LBA CONVENTIONAL ZONES PERCENTAGE field (see 9.30.4.7.3.2)
1	Byte	HIGH LBA CONVENTIONAL ZONES PERCENTAGE field (see 9.30.4.7.3.3)
2..11	Reserved	
12..15	DWord	LOGICAL SECTORS PER ZONE field (see 9.30.4.7.2.4)
16..23	Reserved	

9.30.4.7.3.2 LOW LBA CONVENTIONAL ZONES PERCENTAGE field

The LOW LBA CONVENTIONAL ZONES PERCENTAGE field indicates the approximate percentage of the zones formatted as conventional zones (see ZAC-2) starting with LBA 0.

The units for the LOW LBA CONVENTIONAL ZONES PERCENTAGE field are tenths of a percent (e.g., 0 indicates 0%, 1 indicates 0.1%, 10 indicates 1.0%, 255 indicates 25.5%).

The actual number of zones formatted as conventional zones depends on several factors (e.g., the number of logical sectors in a zone). Zones that are not formatted as conventional zones are formatted as sequential write required write pointer zones (see ZAC-2).

9.30.4.7.3.3 HIGH LBA CONVENTIONAL ZONES PERCENTAGE field

The HIGH LBA CONVENTIONAL ZONES PERCENTAGE field indicates the approximate percentage of the zones formatted as conventional zones (see ZAC-2) ending with the largest valued LBA formatted.

The units for the LOW LBA CONVENTIONAL ZONES PERCENTAGE field are tenths of a percent (e.g., 0 indicates 0%, 1 indicates 0.1%, 10 indicates 1.0%, 255 indicates 25.5%).

The actual number of zones formatted as conventional zones depends on several factors (e.g., the number of logical sectors in a zone). Zones that are not formatted as conventional zones are formatted as sequential write required write pointer zones (see ZAC-2).

9.30.4.7.4 Zone domains and zone realms schema type specific information

9.30.4.7.4.1 Overview

Table 335 defines the schema type specific information in a Mutate Configuration descriptor if the SCHEMA TYPE field is set to 04h.

Table 335 — Zone domains and zone realms schema type specific information

Offset	Type	Description
0	Byte	**Bit** **Description** 7:4 ZONE TYPE FOR ZONE DOMAIN field 0 (see 9.30.4.7.4.2) 3:0 ZONE TYPE FOR ZONE DOMAIN field 1 (see 9.30.4.7.4.2)
1	Byte	**Bit** **Description** 7:4 ZONE TYPE FOR ZONE DOMAIN field 2 (see 9.30.4.7.4.2) 3:0 ZONE TYPE FOR ZONE DOMAIN field 3 (see 9.30.4.7.4.2)
2..11	Reserved	
12..15	DWord	LOGICAL SECTORS PER ZONE field (see 9.30.4.7.2.4)
16..23	QWord	**Bit** **Description** 63:48 Reserved 47:0 DESIGNED ZONED MAXIMUM ADDRESS field (see 9.30.4.7.4.3)

9.30.4.7.4.2 ZONE TYPE FOR ZONE DOMAIN field

Each ZONE TYPE FOR ZONE DOMAIN field indicates the zone type (see ZAC-2) for zones in the indicated zone domain (e.g., the contents of ZONE TYPE FOR ZONE DOMAIN field 0 indicate the zone type for zones in zone domain 0). A ZONE TYPE FOR ZONE DOMAIN field cleared to zero indicates that:

a) the indicated zone domain is not included in the format;
b) more than one zone type is part of the format for the indicated zone domain; or
c) the zone type is not reported for the indicated zone domain.

If the SCHEMA TYPE field is set to 04h in the Mutate Configuration descriptor specified by a MUTATE EXT command, then successful processing of that command shall result zone domain 0 containing zones that have the properties specified by ZAC-2 for zone domain 0 at the time of manufacture.

9.30.4.7.4.3 DESIGNED ZONED MAXIMUM ADDRESS field

If this Mutate Configuration descriptor is specified (see 9.30.4.2), the DESIGNED ZONED MAXIMUM ADDRESS field indicates the value that the device is designed to return in the MAXIMUM LBA field returned by the REPORT ZONES EXT command (see ZAC-2).

9.31 Concurrent Positioning Ranges log (Log Address 47h)

9.31.1 Concurrent Positioning Ranges log overview

For a device that is capable of positioning for more than one data transfer (e.g., seeking) at the same time, the Concurrent Positioning Ranges log indicates the sets of contiguous LBAs within each one of which positioning is possible at the same time.

If one read command or one write command specifies the transferring of data using more than one of the indicated sets of contiguous LBAs (i.e., the LBA range descriptors in table 336), the device may require additional time to complete the command (e.g., as much time as the sum of the times for individual commands that transfer the same data without using more than one set of contiguous LBAs per command).

The Concurrent Positioning Ranges log may be affected by the processing of a device configuration changing command.

Table 336 describes the contents of the Concurrent Positioning Ranges log.

Table 336 — Concurrent Positioning Ranges log

Offset	Description
0..63	Concurrent Positioning Ranges header (see 9.31.2)
64..95	LBA range descriptor 0 (see 9.31.3)
96..127	LBA range descriptor 1 (see 9.31.3)
...	
64+(N×32)..95+(N×32)	LBA range descriptor N (see 9.31.3)
96+(N×32)..1 023 [a]	Padding
Key: N is the contents of the NUMBER OF LBA RANGES field (see 9.31.2.2) minus one.	
[a] If the Concurrent Positioning Ranges log contains less than seven LBA ranges (i.e., if N is less than 15), then 1 023 is replaced by 511.	

9.31.2 Concurrent Positioning Ranges header

9.31.2.1 Concurrent Positioning Ranges header overview

Table 337 describes the contents of the Concurrent Positioning Ranges header.

Table 337 — Concurrent Positioning Ranges header

Offset	Type	Description
0	Byte	NUMBER OF LBA RANGES field (see 9.31.2.2)
1..63	Reserved	

9.31.2.2 NUMBER OF LBA RANGES field

The NUMBER OF LBA RANGES field indicates the number of sets of contiguous LBAs configured in the device, with positioning for a data transfer (e.g., seeking) being possible in every set at the same time

9.31.3 LBA range descriptor

9.31.3.1 LBA range descriptor overview

The Concurrent Positioning Ranges log shall contain one LBA range descriptor for each LBA range for which the device is capable of positioning for a data transfer at the same time that positioning is occurring in any other LBA range configured on the device (e.g. one actuator). Table 338 describes the format of each LBA range descriptor.

Table 338 — LBA range descriptor

Offset	Type	Description
0	Byte	LBA RANGE NUMBER field (see 9.31.3.2)
1	Byte	NUMBER OF STORAGE ELEMENTS field (see 9.31.3.3)
2..7	Reserved	
8..15	QWord	**Bit** **Description** 63..48 Reserved 47:0 LOWEST LBA field (see 9.31.3.4)
16..23	QWord	NUMBER OF LBAS field (see 9.31.3.5)
24..31	Reserved	

9.31.3.2 LBA RANGE NUMBER field

The LBA RANGE NUMBER field indicates the number of the LBA range described by this LBA range descriptor. LBA range numbers start at zero and are incremented by one for each successive LBA range.

9.31.3.3 NUMBER OF STORAGE ELEMENTS field

The NUMBER OF STORAGE ELEMENTS field indicates the number of storage elements associated with this LBA range descriptor.

A NUMBER OF STORAGE ELEMENTS field cleared to zero indicates that no information is reported for the number of storage elements associated with this LBA range descriptor.

9.31.3.4 LOWEST LBA field

The LOWEST LBA field indicates the lowest LBA associated with this LBA range descriptor.

9.31.3.5 NUMBER OF LBAS field

The NUMBER OF LBAS field indicates the number of logical sectors that are accessible using this LBA range descriptor.

The NUMBER OF LBAS field shall not be cleared to zero.

9.31.4 Padding

The total bytes input from the device to the host shall be:

a) 512, if the NUMBER OF LBA RANGES field (see 9.31.2.2) contains a value that is less than 15; and
b) 1 024, if the NUMBER OF LBA RANGES field contains a value that is between 15 and 29, inclusive.

9.31.5 Example Concurrent Positioning Ranges log

Figure 15 shows an example relationship between values in the Concurrent Positioning Ranges log and four sets of contiguous LBAs (e.g., a device that has four actuators).

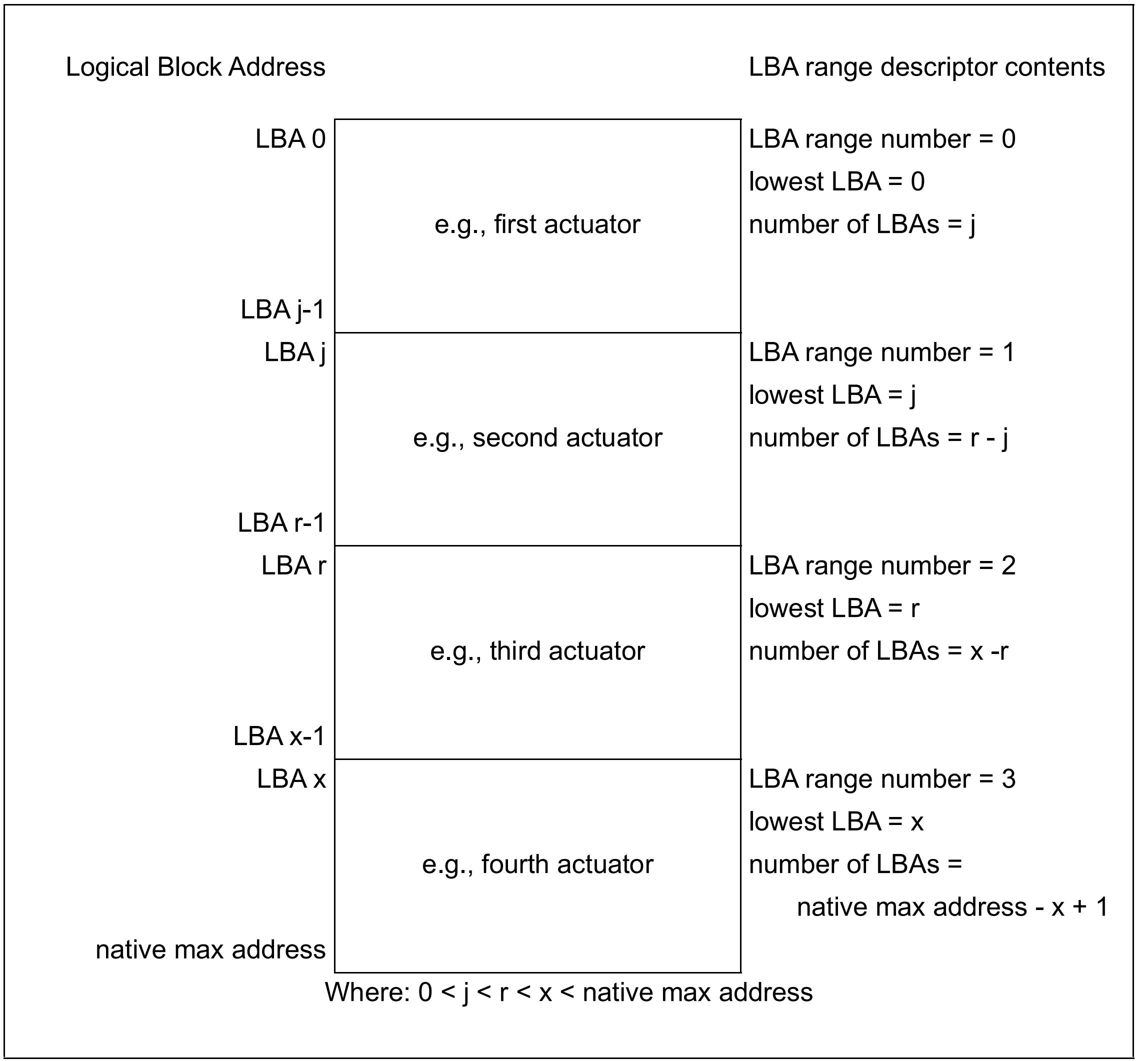

Figure 15 — Example for Concurrent Positioning Ranges log with 4 LBA ranges

9.32 Sense Data log (Log Address 53h)

9.32.1 Overview

The Sense Data log contains the most recent sense data returned by a command that is not an NCQ command, is one log page in length, and is defined in Table 339. Devices that set the NON-NCQ REBUILD ASSIST SUPPORTED bit (see 9.10.5.2.50) to one shall support log address 53h (i.e., the Sense Data log).

Table 339 — Sense Data log (Sheet 1 of 2)

Offset	Type	Description
0	Byte	**Bit Name** 7..6 Reserved 5 DEFERRED ERROR bit (see 9.32.2) 0 = Current information (see 4.24.2) 1 = Deferred error (see 4.24.2) 4:0 Reserved
1		Reserved
2	Byte	STATUS field (see 9.32.3)
3	Byte	ERROR field (see 9.32.3)
4	Byte	LBA field (7:0) (see 9.32.3)
5	Byte	LBA field (15:8) (see 9.32.3)
6	Byte	LBA field (23:16) (see 9.32.3)
7	Byte	DEVICE field (see 9.32.3)
8	Byte	LBA field (31:24) (see 9.32.3)
9	Byte	LBA field (39:32) (see 9.32.3)
10	Byte	LBA field (47:40) (see 9.32.3)
11		Reserved
12	Byte	COUNT field (7:0) (see 9.32.3)
13	Byte	COUNT field (15:8) (see 9.32.3)
14	Byte	SENSE KEY field (see 9.32.4)
15	Byte	ADDITIONAL SENSE CODE field (see 9.32.4)

[a] These bits contain the same information as bits 47:24 in the LBA field of REQUEST SENSE DATA EXT Normal Output (see table 355).

Table 339 — Sense Data log (Sheet 2 of 2)

Offset	Type	Description
16	Byte	ADDITIONAL SENSE CODE QUALIFIER field (see 9.32.4)
17	Byte	FINAL LBA IN ERROR field (7:0) (see 9.32.5)
18	Byte	FINAL LBA IN ERROR field (15:8) (see 9.32.5)
19	Byte	FINAL LBA IN ERROR field (23:16) (see 9.32.5)
20	Byte	FINAL LBA IN ERROR field (31:24) (see 9.32.5)
21	Byte	FINAL LBA IN ERROR field (39:32) (see 9.32.5)
22	Byte	FINAL LBA IN ERROR field (47:40) (see 9.32.5)
23..255		Reserved
256..259	DWord	**Bit Description** 31:8 Vendor specific [a] 7:0 Vendor specific
260..510		Vendor Specific
511	Byte	Checksum (see 9.32.6)

[a] These bits contain the same information as bits 47:24 in the LBA field of REQUEST SENSE DATA EXT Normal Output (see table 355).

9.32.2 DEFERRED ERROR bit

The DEFERRED ERROR bit shall be set as defined in 4.24.2.

9.32.3 Return Fields

The STATUS field, ERROR field, LBA field, DEVICE field, and COUNT field contain the error outputs (see 10.3) for the command that set the SENSE DATA AVAILABLE bit (see 6.2.9) to one.

9.32.4 SENSE KEY field, ADDITIONAL SENSE CODE field, and ADDITIONAL SENSE CODE QUALIFIER field

The SENSE KEY field, ADDITIONAL SENSE CODE field, and ADDITIONAL SENSE CODE QUALIFIER field shall be set to values that are defined in this standard and SPC-5.

9.32.5 FINAL LBA IN ERROR field

If:

a) the NON-NCQ REBUILD ASSIST SUPPORTED bit is set to one (see 9.10.5.2.49);
b) the REBUILD ASSIST ENABLED bit is set to one (see 9.10.10.3.11);
c) the command that completes with an error is a READ DMA EXT command (see 7.22), a WRITE DMA EXT command (see 7.59), or a WRITE DMA FUA EXT command (see 7.60); and
d) the additional sense code is MULTIPLE READ ERRORS (see 6.8.27) or MULTIPLE WRITE ERRORS (see 6.8.28),

then the FINAL LBA IN ERROR field shall contain the LBA of the last logical sector (i.e., the highest numbered LBA) in a sequence of contiguous unrecovered logical sectors (see 4.19).

Otherwise, the FINAL LBA IN ERROR field shall be cleared to zero.

9.32.6 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 eight-bit unsigned arithmetic and overflow shall be ignored. The sum of the first 512 bytes of the data structure shall be zero.

9.33 Out Of Band Management Control log (Log Address 16h)

9.33.1 Out Of Band Management Control log overview

The Out Of Band Management Control log (see table 340) is one page in length that contains parameters that control the reporting of out of band attributes as defined in SFF-8609 over the out of band management interface (see 4.16).

The log is readable and writeable.

The persistence of the content of the Out Of Band Management Control log across resets is specified by the VOLATILE bit in the log.

Table 340 — Out Of Band Management Control Log

Offset	Type	Description
0..2		Reserved
3	Byte	**Bit** **Description** 7:4 Reserved 3:0 NUMBER OF VALID DESCRIPTORS field (N) (see 9.33.2)
4	Byte	**Bit** **Description** 7 REPORTING ENABLED bit (see 9.33.3) 6 VOLATILE bit (see 9.33.4) 5:0 Reserved
5		Reserved
6..7	Word	PROTOCOL REVISION field (see 9.33.5)
8..39		first attribute control descriptor (see 9.33.6)
		second attribute control descriptor (see 9.33.6)
		...
8+(32×(N-1))..7+(32×N)		Nth attribute control descriptor (see 9.33.6)
8+(32×N)..511		Reserved

9.33.2 NUMBER OF VALID DESCRIPTORS field

The NUMBER OF VALID DESCRIPTORS field specifies the number of valid attribute control descriptors contained in the log.

9.33.3 REPORTING ENABLED bit

The REPORTING ENABLED bit set to one specifies that the device shall enable the transfer of attribute information over the out of band management interface (see SFF-8609), based on fields in the attribute control descriptors in this log. The REPORTING ENABLED bit cleared to zero specifies that the device shall not transfer any information over the out of band management interface. If the CURRENT HARDWARE FEATURE CONTROL IDENTIFIER field (see 9.10.10.4) is or becomes non-zero, then this bit shall be cleared to zero and shall not be changeable by writing to this log (i.e., writing to the REPORTING ENABLED bit shall be ignored).

If the REPORTING ENABLED bit is changed from one to zero by writing to this log, then the device transfers the stopping transmission packet (see SFF-8609).

If the REPORTING ENABLED bit is changed from zero to one by writing to this log, then the device transfers the protocol revision code packet (see SFF-8609).

9.33.4 VOLATILE bit

The VOLATILE bit specifies if the contents of the Out Of Band Management Control log page is persistent across a hardware reset and power on reset. If the VOLATILE bit is set to one, then the contents of the log page shall:

a) not persist across a hardware reset and power on reset; and
b) after that reset:
   A) be set to the contents of the log page the most recent time this log was written with the VOLATILE bit cleared to zero; or
   B) be set to the manufacturer default log page values, if the log page has never been written with the VOLATILE bit cleared to zero.

If the VOLATILE bit is cleared to zero, then the contents of the Out Of Band Management Control log page shall persist across any resets.

9.33.5 PROTOCOL REVISION CODE field

The PROTOCOL REVISION CODE field specifies the revision of SFF-8609 specification implemented. The SFF-8609 revision code consists of two numeric values separated by a period (e.g., SFF-8609 Revision 1.2). The PROTOCOL REVISION CODE field is encoded such that the first byte (i.e., most significant byte) of this field contains the numerical value of the revision that precedes the period and the second byte (i.e., least significant byte) of this field contains the numerical value of the revision that follows the period (e.g., SFF-8609 Revision 1.2 is encoded as 0102h). This field shall not be changeable by writing to this log (i.e., writing to the PROTOCOL REVISION CODE field shall be ignored).

9.33.6 Attribute Control Descriptor

9.33.6.1 Attribute Control Descriptor Overview

The attribute control descriptors contains a list of descriptors that controls if the attribute identified by the descriptor identifier is transferred over the out of band management interface and other related control settings.

Table 341 defines the format of the attribute control descriptor.

Table 341 — Attribute control descriptor format

Offset	Type	Description
0	Byte	**Bit Description** 7:4 Reserved 3:0 DESCRIPTOR IDENTIFIER field (see 9.33.6.2)
1		Reserved
2..31		attribute control descriptor specific

9.33.6.2 DESCRIPTOR IDENTIFIER field

The DESCRIPTOR IDENTIFIER field specifies the attribute associated with this descriptor. Table 342 defines the values of the DESCRIPTOR IDENTIFIER field.

Table 342 — DESCRIPTOR IDENTIFIER field

Value [a]	Description	Reference
0h	Temperature attribute control	9.33.7
all others	Restricted for SFF-8609	

[a] The code values are the same as the Data Code values in the Data Type Definition (see SFF-8609)

The attribute control descriptor specific parameters contain parameters that control the reporting of the specific descriptor type (i.e., attribute) based on the descriptor identifier.

9.33.7 Temperature attribute control descriptor format

9.33.7.1 Temperature attribute control descriptor format Overview

Table 343 defines the format of the Temperature attribute control descriptor.

Table 343 — Temperature attribute control descriptor format

Offset	Type	Description
0	Byte	**Bit Description** 7:1 Reserved 0 DESCRIPTOR IDENTIFIER field (see 9.33.6.2)
1..3		Reserved
4	Byte	**Bit Description** 7:4 Reserved 3:0 TEMPERATURE REPORTING ENABLED bit (see 9.33.7.2)
5	Byte	REPORTING INTERVAL field (see 9.33.7.3)
6	Byte	MINIMUM REPORTING INTERVAL field (see 9.33.7.4)
7	Byte	**Bit Description** 7:4 CHANGE UP field (see 9.33.7.4) 3:0 CHANGE DOWN field (see 9.33.7.4)
8	Byte	**Bit Description** 7:2 Reserved 1:0 TEST MODE field (see 9.33.7.5)
9		Reserved
10	Byte	TEST MODE TEMPERATURE field (see 9.33.7.6)
11.31		Reserved

9.33.7.2 TEMPERATURE REPORTING ENABLED bit

The TEMPERATURE REPORTING ENABLED bit set to one specifies that reporting of this attribute is enabled over the out of band management interface. The TEMPERATURE REPORTING ENABLED bit cleared to zero specifies that reporting of this attribute is not enabled.

9.33.7.3 REPORTING INTERVAL field

The REPORTING INTERVAL field specifies the interval in seconds (i.e., how often) that the device should transfer this attribute over the out of band management interface as described in this subclause. The interval is from the start of the transfer of this attribute over the out of band management interface to the start of the next transfer of this attribute. If the device processes a General Purpose Logging feature set command that sets the REPORTING INTERVAL field to zero, then the device shall return command aborted with the additional sense code set to INVALID FIELD IN PARAMETER LIST (see 6.8.18).

9.33.7.4 MINIMUM REPORTING INTERVAL field, CHANGE UP field, and CHANGE DOWN field

If the OUT OF BAND TEMPERATURE CHANGE REPORTING SUPPORTED bit (see 9.10.10.2.31) is set to one, then the MINIMUM REPORTING INTERVAL field specifies the minimum time in seconds that shall elapse between the start of the transfer of this attribute over the out of band management interface and the start of the next transfer of this attribute, without regard for whether the transfer of this attribute is the result of a value in the REPORTING INTERVAL field, the CHANGE UP field, or the CHANGE DOWN field.

If the OUT OF BAND TEMPERATURE CHANGE REPORTING SUPPORTED bit is set to one and the device processes a General Purpose Logging feature set command that set the MINIMUM REPORTING INTERVAL field to a value greater than or equal to REPORTING INTERVAL field, then the device shall return command aborted with the additional sense code set to INVALID FIELD IN PARAMETER LIST (see 6.8.18).

If the OUT OF BAND TEMPERATURE CHANGE REPORTING SUPPORTED bit is set to one and the CHANGE UP field is:

a) cleared to zero, then no amount of increase in temperature shall result in the device transferring this attribute, except as specified by the REPORTING INTERVAL field; or
b) set to a non-zero value, then an increase in temperature from the most recent time the attribute was transferred that is greater than or equal to the number of degrees Celsius specified in the CHANGE UP field shall result in the device transferring this attribute as described in this subclause.

If the OUT OF BAND TEMPERATURE CHANGE REPORTING SUPPORTED bit is set to one and the CHANGE DOWN field is:

a) cleared to zero, then no amount of decrease in temperature shall result in the device transferring this attribute, except as specified by the REPORTING INTERVAL field; or
b) set to a non-zero value, then an decrease in temperature from the most recent time the attribute was transferred that is greater than or equal to the number of degrees Celsius specified in the CHANGE DOWN field shall result in the device transferring this attribute as described in this subclause.

The device shall transfer this attribute over the out of band management interface, if:

a) the TEMPERATURE REPORTING ENABLED bit is set to one;
b) the interval since the most recent transfer of this attribute is greater than or equal to the minimum reporting interval, if non-zero; and
c) at least one of the following conditions is met:
   A) the interval since the most recent transfer of this attribute is greater than or equal to the reporting interval;
   B) a temperature increase has occurred that is greater than or equal to the non-zero value in the CHANGE UP field; or
   C) a temperature decrease has occurred that is greater than or equal to the non-zero value in the CHANGE DOWN field.

If the OUT OF BAND TEMPERATURE CHANGE REPORTING SUPPORTED bit is set to one and the device processes a General Purpose Logging feature set command that:

a) clears the MINIMUM REPORTING INTERVAL field to zero; and
b) sets:
   A) the CHANGE UP field to a non-zero value; or
   B) the CHANGE DOWN field to a non-zero value,

then the device shall return command aborted with the additional sense code set to INVALID FIELD IN PARAMETER LIST (see 6.8.18).

9.33.7.5 TEST MODE field

The TEST MODE field enables a test mode for this attribute that allows for simulating temperature conditions as described in table 344.

If the TEST MODE field is set to a non-zero value and the device processes General Purpose Logging feature set command that changes any of the changeable fields in this descriptor, then the device should restart the test mode as if the TEST MODE field was just changed to another non-zero value (e.g., if a test mode sequence is in progress, and the device processes a General Purpose Logging feature set command that changes the REPORTING INTERVAL field, then the device should restart the test mode sequence using the new reporting interval value.

Table 344 — TEST MODE field

Value [a]	Description
00b	Test mode is disabled and the device should transfer the actual temperature of the Serial ATA device over the out of band management interface based on other fields in this descriptor.
01b	A test mode is enabled and the device should transfer a sequence of incrementing temperature values expressed in two's complement over the out of band management interface. If the device is transferring the attribute information, then the device shall start at the temperature specified in the TEST MODE TEMPERATURE field and increment the reported temperature by one every reporting interval (i.e., based on the REPORTING INTERVAL field). Once the temperature being reported reaches 7Fh (i.e., 127 degrees Celsius), the device shall stop incrementing the reported temperature value and continue to report this value until: a) the test mode is disabled (i.e., TEST MODE field is cleared to 00b); b) the test mode is changed to a different test mode; or c) one of the following occurs: A) software reset; B) power-on reset; or C) a hard reset.
10b	A test mode is enabled and the device should transfer a sequence of decrementing temperature values expressed in two's complement over the out of band management interface. If the device is transferring the attribute information, then the device shall start at the temperature specified in the TEST MODE TEMPERATURE field and decrement the reported temperature by one every reporting interval (i.e., based on the REPORTING INTERVAL field). Once the temperature being reported reaches 80h (i.e., -128 degrees Celsius), the device shall stop decrementing the reported temperature value and continue to report this value until: a) the test mode is disabled (i.e., TEST MODE field is cleared to 00b); b) the test mode is changed to a different test mode; or c) one of the following occurs: A) software reset; B) power-on reset; or C) a hard reset.
11b	A test mode is enabled and the device should transfer the temperature specified in the TEST MODE TEMPERATURE field over the out of band management interface for every reporting interval (i.e., based on the REPORTING INTERVAL field).

[a] If a test mode is enabled (i.e., TEST MODE field is set to non-zero value), and the device stopped transferring this attribute information as part of a change to the PM2: Standby (see 4.17.4.4) state, then as a result of the device returning to the PM0: Active (see 4.17.4.2) state or the PM1: Idle (see 4.17.4.3) state the device should continue transferring this attribute information from where the transer left off in the test mode (e.g., if the device was transferring a sequence of incrementing temperatures as part of the TEST MODE field being set to 01b and 75 degrees Celsius was the most recent temperature transferred prior to a changing to a standby mode, then after changing back to an active mode or idle mode, the device should resume transferring the temperature continuing at 76 degrees Celsius.)

9.33.7.6 TEST MODE TEMPERATURE field

The TEST MODE TEMPERATURE field specifies the temperature in degrees Celsius in two's complement notation used in test modes specified by the TEST MODE field. This field is ignored if the TEST MODE field is cleared to 00b.

10 Normal and Error Outputs

10.1 Overview

The commands listed in clause 7 each have subclauses labeled Normal Outputs and Error Outputs. Subclauses 10.2 and 10.3 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 10 shall also apply to the command.

The references preceding each table indicate each command that generates the output in the table.

10.2 Normal Outputs

The tables in this subclause specify the Normal Outputs a command returns.

Table 345 specifies the normal outputs for the commands defined in 7.10, 7.12, 7.13, 7.14, 7.15, 7.16, 7.19, 7.21, 7.26, 7.30, 7.33, 7.37, 7.38, 7.39, 7.40, 7.41, 7.42, 7.45, 7.45.20, 7.45.20.2, 7.45.20.3, 7.45.20.4, 7.45.20.5, 7.45.20.7, 7.45.20.8, 7.46, 7.47, 7.48.2, 7.48.4, 7.49, 7.50, 7.56, 7.58, 7.64, 7.68, and 7.69.

Table 345 — Generic Normal Output (No LBA Return Value) for Normal Output

Field	Description
ERROR	N/A
COUNT	N/A
LBA	N/A
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A or ALIGNMENT ERROR bit – See 6.2.2 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 346 specifies the normal outputs for the commands defined in 7.7 and 7.8.

Table 346 — Download Microcode Normal Output

Field	Description
ERROR	N/A
COUNT	If Download with offsets and save microcode for immediate and future use was specified (see 7.7), then this field contains a value as specified in table 43. Otherwise, this field is N/A.
LBA	N/A
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A or ALIGNMENT ERROR bit – See 6.2.2 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 347 specifies the normal outputs for the commands defined in 7.3.

Table 347 — Check Power Mode Normal Output (Sheet 1 of 2)

Field	Description
ERROR	N/A
COUNT	**Value** **Description** 00h Device is in the: a) PM2:Standby state (see 4.17.4) and the EPC feature set (see 4.9) 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 4.9.2). 01h Device is in the PM2:Standby state, the EPC feature set is enabled, and the device is in the Standby_y power condition (see 4.9.2). 02h..3Fh Reserved 40h..41h Obsolete 42h..7Fh Reserved 80h Device is in the a) PM1:Idle state (see 4.17.4) 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. 81h Device is in the PM1:Idle state, the EPC feature set is enable, and the device is in the Idle_a power condition (see 4.9.2). 82h Device is in the PM1:Idle state, the EPC feature set is enabled, and the device is in the Idle_b power condition (see 4.9.2). 83h Device is in the PM1:Idle state, the EPC feature set is enabled, and the device is in the Idle_c power condition (see 4.9.2). 84h..FEh Reserved FFh Device is in the PM0:Active state or PM1:Idle state.

Table 347 — Check Power Mode Normal Output (Sheet 2 of 2)

Field	Description
LBA	If the LOW POWER STANDBY SUPPORTED bit is set to one (see 9.10.5.2.36), then this field is as described in this table. Otherwise this field is N/A. **Bit** **Description** 27:20 Device is waiting to enter a lower power condition: **Value** **Description** 00h Standby_z 01h Standby_y 02h..80h Reserved 81h Idle_a 82h Idle_b 83h Idle_c 84h..FEh Reserved FFh Device is not waiting to enter a lower power condition 19 Device is held in the current power condition 18:0 Reserved
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit** **Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 348 specifies the normal outputs for the commands defined in 7.4, 7.28, and 7.66.

Table 348 — Stream Normal Output

Field	Description
ERROR	N/A
COUNT	Reserved
LBA	Reserved
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit** **Description** 7:6 Transport Dependent – See 6.2.11 5 STREAM ERROR bit – See 6.2.10 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A or ALIGNMENT ERROR bit – See 6.2.2 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 349 specifies the normal outputs for the command defined in 7.9.

Table 349 — Device Signatures for Normal Output

Field	Description						
ERROR	Diagnostic Results – The diagnostic code as described in table 46 is returned.						
COUNT	**Bits**	**ATA device [a]**	**Host Managed Zoned device [a]**	**Reserved for SATA [a]**		**Obsolete [a]**	
	COUNT field (7:0)	01h	01h	01h	01h	01h	N/A
LBA	LBA field (27:24)	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
	LBA field (23:16)	00h	ABh	C3h	96h	EBh	AAh
	LBA field (15:8)	00h	CDh	3Ch	69h	14h	CEh
	LBA field (7:0)	01h	01h	01h	01h	01h	N/A
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved						
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 Shall be cleared to zero.						

[a] Values not specified in one of these columns are reserved.

Table 350 specifies the normal outputs for the commands defined in 7.15.

Table 350 — IDLE Unload Normal Output

Field	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 6.2.11 3:0 Reserved
STATUS	**Bit** **Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 351 specifies the normal outputs for the commands defined in 7.48.3.

Table 351 — SMART Return Status Normal Output

Field	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. 2CF4h The device has detected a threshold exceeded condition All Other Values Undefined 7:0 N/A
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit** **Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 352 specifies the normal outputs for the commands defined in 7.2.2, 7.2.3, 7.2.4, 7.5, 7.11, 7.22, 7.24, 7.27, 7.31, 7.43, 7.52, 7.49, 7.59, 7.60, 7.62, and 7.65.

Table 352 — Generic Extended Normal Output

Field	Description
ERROR	Reserved
COUNT	Reserved
LBA	Reserved
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A or ALIGNMENT ERROR bit – See 6.2.2 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 353 specifies the normal outputs for the commands defined in 7.17.11, 7.17.12, 7.23, 7.32, 7.43, and 7.61.

Table 353 — NCQ Command Acceptance Normal Output

Field	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 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 354 specifies the normal outputs for the commands defined in 7.17.11, 7.17.12, 7.23, 7.32, 7.43, and 7.61.

Table 354 — NCQ Normal Output

Field	Description
SATA STATUS	Transport Dependent
ERROR	Shall be cleared to zero
STATUS	**Bit** **Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A or ALIGNMENT ERROR bit – See 6.2.2 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8
SACTIVE	**Bit** **Description** 31:0 Transport dependent completion indicator

Table 355 specifies the normal outputs for the commands defined in 7.34.

Table 355 — REQUEST SENSE DATA EXT Normal Output

Field	Description
ERROR	Reserved
COUNT	Reserved
LBA	**Bit** **Description** 47:24 Vendor Specific 23:21 Reserved 20 DEFERRED ERROR bit – See 7.34.4 0 = Current information (see 4.24.2) 1 = Deferred error (see 4.24.2) 19:16 SENSE KEY field – See 7.34.4 15:8 ADDITIONAL SENSE CODE field – See 7.34.4 7:0 ADDITIONAL SENSE CODE QUALIFIER field – See 7.34.4
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit** **Description** 7:6 Transport Dependent – See 6.2.11 5:2 Reserved 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 356 specifies the normal outputs for the GET NATIVE MAX ADDRESS command defined in 7.2.2.

Table 356 — GET NATIVE MAX ADDRESS EXT Normal Output

Field	Description
ERROR	Reserved
COUNT	Reserved
LBA	Maximum LBA
DEVICE	**Bit** **Description** 7:4 N/A 3:0 Reserved
STATUS	**Bit** **Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 357 specifies the normal outputs for the commands defined in 7.36.

Table 357 — Sanitize Device Normal Output

Field	Description
ERROR	Reserved
COUNT	**Bit Description** 15 SANITIZE OPERATION COMPLETED WITHOUT ERROR bit – the contents of the Sanitize Operation Completed Without Error value (see 4.20.7) 14 1 = the device is in the SD2: Sanitize Operation In Progress state (see 4.20.10.4) 0 = the device is not in the SD2: Sanitize Operation In Progress state 13 1 = the device is in the SD1: Sanitize Frozen state (see 4.20.10.3) 0 = the device is not in the SD1: Sanitize Frozen state 12 SANITIZE ANTIFREEZE bit – the contents of the Sanitize Antifreeze value (see 4.20.9) 11:0 Reserved
LBA	**Bit Description** 47:16 Reserved 15:0 SANITIZE PROGRESS INDICATION field – This value indicates the fraction complete of the sanitize operation while the device is in the SD2: Sanitize Operation In Progress state (see 4.20.10.4). The value is a numerator that has 65_536 (1_0000h) as the denominator. This value shall be set to FFFFh if the device is not in the SD2: Sanitize Operation In Progress state (i.e., a sanitize operation is not in process).
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 358 specifies the normal outputs for the commands defined in 7.35.

Table 358 — Restore Physical Elements Normal Output

Field	Description
ERROR	Reserved
COUNT	DEPOPULATED BEFORE PROCESSING field (15:0) – the number of physical elements that were depopulated before processing of the RESTORE ELEMENTS AND REBUILD command was started
LBA	**Bit Description** 47:32 DEPOPULATED BEFORE PROCESSING field (31:16) – the number of physical elements that were depopulated before processing of the RESTORE ELEMENTS AND REBUILD command was started 31:0 DEPOPULATED AFTER PROCESSING field – the number of physical elements that are depopulated after processing of the RESTORE ELEMENTS AND REBUILD command has completed
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

10.3 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 ENABLED bit set to one (see 7.45.17), then the device notifies the host of additional information by setting the SENSE DATA AVAILABLE bit in the STATUS field to one.

Table 359 specifies the error outputs for the commands defined in 7.1.9.

Table 359 — Unsupported Command Error

Field	Description
ERROR	**Bit Description** 7:3 N/A 2 ABORT bit – 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 6.2.11 5:2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 360 specifies the error outputs for the command defined in 7.3.

Table 360 — Check Power Mode Abort Error

Field	Description
ERROR	**Bit Description** 7:3 N/A 2 ABORT bit – 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 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4:2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 361 specifies the error outputs for the commands defined in 7.2.2, 7.2.4, 7.14, 7.15, 7.33, 7.34, 7.35.5, 7.38, 7.40, 7.45.1.5, 7.45.20.2.4, 7.45.20.3.4, 7.45.20.4.5, 7.45.20.5.4, 7.46, 7.47, 7.48.3, 7.49, 7.50, and 7.68.

Table 361 — Generic Abort wo/ICRC Error

Field	Description
ERROR	**Bit Description** 7:3 N/A 2 ABORT bit – 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 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 362 specifies the error outputs for the commands defined in 7.7, 7.13.5, 7.19, 7.37, 7.39, 7.41, 7.42, and 7.56.

Table 362 — Generic Abort Error

Field	Description
ERROR	**Bit Description** 7 INTERFACE CRC bit – See 6.3.5 6:3 N/A 2 ABORT bit – 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 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 363 specifies the error outputs for the commands defined in 7.52 and 7.54.

Table 363 — Trusted Abort Error

Field	Description
ERROR	**Bit Description** 7 INTERFACE CRC bit – See 6.3.5 6:3 N/A 2 ABORT bit – 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 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 364 specifies the error outputs for the commands defined in 7.4.

Table 364 — Configure Stream Error

Field	Description
ERROR	**Bit Description** 7:3 N/A 2 ABORT bit – 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 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 STREAM ERROR bit – See 6.2.10 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 365 specifies the error outputs for the commands defined in 7.10.

Table 365 — Flush Cache Error

Field	Description
ERROR	**Bit Description** 7:3 N/A 2 ABORT bit – See 6.3.2 1:0 N/A
COUNT	N/A
LBA	LBA of First Unrecoverable Error – See 6.7.2
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 366 specifies the error outputs for the commands defined in 7.11.

Table 366 — Flush Cache Ext Error

Field	Description
ERROR	**Bit Description** 7:3 N/A 2 ABORT bit – See 6.3.2 1:0 N/A
COUNT	Reserved
LBA	LBA of First Unrecoverable Error – See 6.7.2
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 367 specifies the error outputs for the commands defined in 7.22.

Table 367 — Read DMA Ext Error

Field	Description
ERROR	**Bit Description** 7 INTERFACE CRC bit – See 6.3.5 6 UNCORRECTABLE ERROR bit – See 6.3.6 5 Obsolete 4 ID NOT FOUND bit – See 6.3.4 3 Obsolete 2 ABORT bit – See 6.3.2 1:0 Obsolete
COUNT	Reserved
LBA	LBA of First Unrecoverable Error – See 6.7.2
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 368 specifies the error outputs for the commands defined in 7.24.

Table 368 — Read Log Ext Error

Field	Description
ERROR	**Bit Description** 7 INTERFACE CRC bit – See 6.3.5 6 UNCORRECTABLE ERROR bit – See 6.3.6 5 N/A 4 ID NOT FOUND bit – See 6.3.4 3 N/A 2 ABORT bit – 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 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 369 specifies the error outputs for the commands defined in 7.21, 7.26, and 7.30.

Table 369 — Read PIO Error

Field	Description
ERROR	**Bit Description** 7 INTERFACE CRC bit – See 6.3.5 6 UNCORRECTABLE ERROR bit – See 6.3.6 5 Obsolete 4 ID NOT FOUND bit – See 6.3.4 3 Obsolete 2 ABORT bit – See 6.3.2 1:0 Obsolete
COUNT	N/A
LBA	LBA of First Unrecoverable Error – See 6.7.2
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 370 specifies the error outputs for the commands defined in 7.28.

Table 370 — Read Stream Error

Field	Description
ERROR	**Bit Description** 7 INTERFACE CRC bit – See 6.3.5 6 UNCORRECTABLE ERROR bit – See 6.3.6 5 Obsolete 4 ID NOT FOUND bit – See 6.3.4 3 Obsolete 2 ABORT bit – See 6.3.2 1 Obsolete 0 COMMAND COMPLETION TIME OUT bit – See 6.3.3
COUNT	Length of stream error – number of contiguous logical sectors containing potentially bad data, beginning with the LBA indicated in the LBA field
LBA	LBA of the lowest numbered unrecoverable error
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 STREAM ERROR bit – See 6.2.10 4 DEFERRED WRITE ERROR bit – See 6.2.5 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 371 specifies the error outputs for the commands defined in 7.48.4.

Table 371 — Write Log Error

Field	Description
ERROR	**Bit Description** 7 INTERFACE CRC bit – See 6.3.5 6:5 N/A 4 ID NOT FOUND bit – See 6.3.4 3 N/A 2 ABORT bit – 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 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 372 specifies the error outputs for the commands defined in 7.5 and 7.62.

Table 372 — Write Log Ext Error or Data Set Management Error

Field	Description
ERROR	**Bit Description** 7 INTERFACE CRC bit – See 6.3.5 6:5 N/A 4 ID NOT FOUND bit – See 6.3.4 3 N/A 2 ABORT bit – 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 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 373 specifies the error outputs for the commands defined in 7.59, 7.60, and 7.65.

Table 373 — Write Extended Error

Field	Description
ERROR	**Bit** **Description** 7 INTERFACE CRC bit – See 6.3.5 6:5 Obsolete 4 ID NOT FOUND bit – See 6.3.4 3 Obsolete 2 ABORT bit – See 6.3.2 1 Obsolete 0 N/A
COUNT	Reserved
LBA	LBA of First Unrecoverable Error – See 6.7.2
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit** **Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 374 specifies the error outputs for the commands defined in 7.66.

Table 374 — Write Stream Error

Field	Description
ERROR	**Bit Description** 7 INTERFACE CRC bit – See 6.3.5 6:5 Obsolete 4 ID NOT FOUND bit – See 6.3.4 3 Obsolete 2 ABORT bit – See 6.3.2 1 Obsolete 0 COMMAND COMPLETION TIME OUT bit – See 6.3.3
COUNT	Length of stream error – number of contiguous logical sectors containing potentially bad data, beginning with the LBA indicated in the LBA field.
LBA	LBA of the lowest numbered unrecoverable error
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 STREAM ERROR bit – See 6.2.10 4 DEFERRED WRITE ERROR bit – See 6.2.5 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8.

Table 375 specifies the error outputs for the command defined in 7.68.

Table 375 — Non-Data Write Extended Error

Field	Description
ERROR	**Bit** **Description** 7 Reserved 6:5 Obsolete 4 ID NOT FOUND bit – See 6.3.4 3 Obsolete 2 ABORT bit – See 6.3.2 1 Obsolete 0 N/A
COUNT	Reserved
LBA	LBA of First Unrecoverable Error – See 6.7.2
DEVICE	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit** **Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 376 specifies the error outputs for the commands defined in 7.18.

Table 376 — NOP Error

Field	Description
ERROR	**Bit Description** 7:3 N/A 2 ABORT bit – 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 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 377 specifies the error outputs for the command defined in 7.48.2.

Table 377 — SMART Read Log

Field	Description
ERROR	**Bit Description** 7 INTERFACE CRC bit – See 6.3.5 6 UNCORRECTABLE ERROR bit – See 6.3.6 5 N/A 4 ID NOT FOUND bit – See 6.3.4 3 N/A 2 ABORT bit – 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 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 378 specifies the error outputs for the commands defined in 7.27 and 7.31.

Table 378 — Read PIO Extended Error

Field	Description
ERROR	**Bit Description** 7 INTERFACE CRC bit – See 6.3.5 6 UNCORRECTABLE ERROR bit – See 6.3.6. 5 N/A 4 ID NOT FOUND bit – See 6.3.4 3 N/A 2 ABORT bit – See 6.3.2 1 N/A 0 Obsolete
COUNT	Reserved
LBA	LBA of First Unrecoverable Error – See 6.7.2
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 379 specifies the error outputs for the command defined in 7.2.3.

Table 379 — SET ACCESSIBLE MAX ADDRESS EXT Error

Field	Description
ERROR	**Bit Description** 7:5 N/A 4 ID NOT FOUND bit – See 6.3.4 3 N/A 2 ABORT bit – 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 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 380 specifies the error outputs for the command defined in 7.64.

Table 380 — Write Error

Field	Description
ERROR	**Bit Description** 7 INTERFACE CRC bit – See 6.3.5 6:5 Obsolete 4 ID NOT FOUND bit – See 6.3.4 3 Obsolete 2 ABORT bit – See 6.3.2 1 Obsolete 0 N/A
COUNT	N/A
LBA	LBA of First Unrecoverable Error – See 6.7.2
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 381 specifies the error outputs for the commands defined in 7.58.

Table 381 — Write DMA Error

Field	Description
ERROR	**Bit Description** 7 INTERFACE CRC bit – See 6.3.5 6:5 Obsolete 4 ID NOT FOUND bit – See 6.3.4 3 Obsolete 2 ABORT bit – See 6.3.2 1:0 Obsolete
COUNT	N/A
LBA	LBA of First Unrecoverable Error – See 6.7.2
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 382 specifies the error outputs for the commands defined in 7.23.6 and 7.61.6.

Table 382 — NCQ Command Acceptance Error

Field	Description
ERROR	**Bit Description** 7 INTERFACE CRC bit – See 6.3.5 6:3 N/A 2 ABORT bit – 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 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Table 383 specifies the error outputs for the commands defined in 7.5.5, 7.17.8.7, 7.17.9.6, 7.17.10.6, 7.17.11.6, 7.17.12.6, 7.23.6, 7.25.5, 7.32.6, 7.43.8.6, 7.45.1.5, 7.61.6, 7.63.5, and 7.69.5.

Table 383 — Generic NCQ Command Aborted Error

Field	Description
SATA STATUS	Transport Dependent
ERROR	**Bit** **Description** 7 INTERFACE CRC bit – See 6.3.5 6:5 Obsolete 4 ID NOT FOUND bit – See 6.3.4 3 Obsolete 2 ABORT bit – See 6.3.2 1:0 Obsolete
STATUS	**Bit** **Description** 7 Shall be cleared to zero 6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Shall be cleared to zero. 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8
SACTIVE	**Bit** **Description** 31:0 Transport dependent completion indicator

Table 384 specifies the error outputs for the commands defined in 7.23.6.

Table 384 — NCQ Read Command Aborted Error

Field	Description
SATA STATUS	Transport Dependent
ERROR	**Bit Description** 7 INTERFACE CRC bit – See 6.3.5 6 UNCORRECTABLE ERROR bit – See 6.3.6 5 Obsolete 4 ID NOT FOUND bit – See 6.3.4 3 Obsolete 2 ABORT bit – See 6.3.2 1:0 Obsolete
STATUS	**Bit Description** 7 Shall be cleared to zero 6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Shall be cleared to zero. 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8
SACTIVE	**Bit Description** 31:0 Transport dependent completion indicator

Table 385 specifies the error outputs for the commands defined in 7.36.

Table 385 — Sanitize Device Error

Field	Description
ERROR	**Bit Description** 7:3 Reserved 2 ABORT bit – See 6.3.2 1:0 Reserved
COUNT	Reserved
LBA	**Bit Description** 47:8 Reserved 7:0 SANITIZE DEVICE ERROR REASON field **Value Description** 00h Reason not reported or sanitize device command failed 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 value in the Sanitize Device FEATURE field 03h Device is in the SD1: Sanitize Frozen state (see 4.20.10.3) 04h SANITIZE FREEZE LOCK command failed as a result of the Sanitize Antifreeze Lock value (see 4.20.9) being set to one 05h..FFh Reserved
DEVICE	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.11 3:0 Reserved
STATUS	**Bit Description** 7:6 Transport Dependent – See 6.2.11 5 DEVICE FAULT bit – See 6.2.6 4 N/A 3 Transport Dependent – See 6.2.11 2 N/A 1 SENSE DATA AVAILABLE bit – See 6.2.9 0 ERROR bit – See 6.2.8

Annex A
(informative)

Command Set Summary

Table A.1 provides information on which command codes are currently defined. Table A.2 provides a list of all of the commands in order of command code with the required use for each. Table A.3 provides a summary of all commands in alphabetical order with the required use for each. Table A.4 provides the assignment history of each opcode by ATA standard. Table A.5 provides the assignment history of each SET FEATURES code by ATA standard.

.

Table A.1 — Command Code Usage Matrix

	x0h	x1h	x2h	x3h	x4h	x5h	x6h	x7h	x8h	x9h	xAh	xBh	xCh	xDh	xEh	xFh
0xh	C	R	R	A	R	R	C	C[a]	O[a]	R	R	C	R	R	R	R
1xh	O	E	C[a]	E	E	E	E	E	E	E	E	E	E	E	E	E
2xh	C	O	O	O	C	C	O	O	R	O[a]	C	C	R	R	R	C
3xh	C	O	O	O	C	C	O	O	A	O[a]	C	C	O	C	O	C
4xh	C	O	C	R	C[a]	C	R	C	R	R	Z[a]	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	C	C	C	S	S	R	R	R	R	R	R	R	R
7xh	O	E	E	E	E	E	E	C	C	E	E	E	C[a]	C[a]	C[a]	E
8xh	V	V	V	V	V	V	V	A	V	V	V	V	V	V	V	V
9xh	C	O	C	C	E	E	C	E	E	E	V	R	R	R	R	Z[a]
Axh	O[a]	O[a]	O	R	R	R	R	R	R	R	R	R	R	R	R	R
Bxh	C	O	C[a]	R	C	R	O	A	A	A	A	A	R	R	R	R
Cxh	A	V	V	V	O[a]	O[a]	O[a]	O	C	O	C	O	O	A	O[a]	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
A = Reserved for CFA
S = Reserved for Serial ATA
Z = Defined by ZAC-2

[a] This entry has changed from ACS-4.

Table A.2 — Command codes (sorted by command code) (Sheet 1 of 5)

Command	Command Code	ATA device	Protocol	Argument
NOP	00h	O	ND	28-bit
Reserved	01h..02h			
Reserved for CFA	03h			
Reserved	04h..05h			
DATA SET MANAGEMENT	06h	O	DM	48-bit
DATA SET MANAGEMENT XL	07h	O	DM	48-bit
Obsolete	08h			
Reserved	09h..0Ah			
REQUEST SENSE DATA EXT	0Bh	O	ND	48-bit
Reserved	0Ch..0Fh			
Obsolete	10h			
Retired	11h			
GET PHYSICAL ELEMENT STATUS	12h	O	DM	48-bit
Retired	13h..1Fh			
READ SECTOR(S)	20h	O	PI	28-bit
Obsolete	21h..23h			
READ SECTOR(S) EXT	24h	O	PI	48-bit
READ DMA EXT	25h	O	DM	48-bit
Obsolete	26h..27h			
Reserved	28h			
Obsolete	29h			
READ STREAM DMA EXT	2Ah	O	DM	48-bit
READ STREAM EXT	2Bh	O	PI	48-bit
Reserved	2Ch..2Eh			
READ LOG EXT	2Fh	M	PI	48-bit
WRITE SECTOR(S)	30h	O	PO	28-bit
Obsolete	31h..33h			
WRITE SECTOR(S) EXT	34h	O	PO	48-bit
WRITE DMA EXT	35h	O	DM	48-bit
Obsolete	36h..37h			
Reserved for CFA	38h			

Key:

ND – Non-Data command
PI – PIO Data-In command
PO – PIO Data-Out command
DM – DMA command
DMQ – DMA QUEUED command
DD – EXECUTE DEVICE DIAGNOSTIC command
VS – Vendor specific

M – Mandatory
O – Optional
N – Use prohibited
V – Vendor specific implementation
E – Retired
B – Obsolete
R – Reserved

Table A.2 — Command codes (sorted by command code) (Sheet 2 of 5)

Command	Command Code	ATA device	Protocol	Argument
Obsolete	39h			
WRITE STREAM DMA EXT	3Ah	O	DM	48-bit
WRITE STREAM EXT	3Bh	O	PO	48-bit
Obsolete	3Ch			
WRITE DMA FUA EXT	3Dh	O	DM	48-bit
Obsolete	3Eh			
WRITE LOG EXT	3Fh	M	PO	48-bit
READ VERIFY SECTOR(S)	40h	O	ND	28-bit
Obsolete	41h			
READ VERIFY SECTOR(S) EXT	42h	O	ND	48-bit
Reserved	43h			
ZERO EXT	44h	O	ND	48-bit
WRITE UNCORRECTABLE EXT	45h	O	ND	48-bit
Reserved	46h			
READ LOG DMA EXT	47h	O	DM	48-bit
Reserved	48h..49h			
ZAC Management In (see ZAC-2)	4Ah	O	DM	48-bit
Reserved	4Bh..4Fh			
Obsolete	50h			
CONFIGURE STREAM	51h	O	ND	48-bit
Reserved	52h..56h			
WRITE LOG DMA EXT	57h	O	DM	48-bit
Reserved	58h..5Ah			
TRUSTED NON-DATA	5Bh	O	ND	28-bit
TRUSTED RECEIVE	5Ch	O	PI	28-bit
TRUSTED RECEIVE DMA	5Dh	O	DM	28-bit
TRUSTED SEND	5Eh	O	PO	28-bit
TRUSTED SEND DMA	5Fh	O	DM	28-bit
READ FPDMA QUEUED	60h	O	DMQ	48-bit
WRITE FPDMA QUEUED	61h	O	DMQ	48-bit
Reserved	62h			
NCQ NON-DATA	63h	O	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
DD – EXECUTE DEVICE DIAGNOSTIC command
VS – Vendor specific

M – Mandatory
O – Optional
N – Use prohibited
V – Vendor specific implementation
E – Retired
B – Obsolete
R – Reserved

Table A.2 — Command codes (sorted by command code) (Sheet 3 of 5)

Command	Command Code	ATA device	Protocol	Argument
SEND FPDMA QUEUED	64h	O	DMQ	48-bit
RECEIVE FPDMA QUEUED	65h	O	DMQ	48-bit
Reserved	66h..6Fh			
Obsolete	70h			
Retired	71h..76h			
SET DATE & TIME EXT	77h	O	ND	48-bit
ACCESSIBLE MAX ADDRESS CONFIGURATION	78h	O	ND	48-bit
Retired	79h..7Bh			
REMOVE ELEMENT AND TRUNCATE	7Ch	O	ND	48-bit
RESTORE ELEMENTS AND REBUILD	7Dh	O	ND	48-bit
REMOVE ELEMENT AND MODIFY ZONES (see ZAC-2)	7Eh	O	ND	48-bit
Retired	7Fh			
Vendor Specific	80h..86h		VS	
Reserved for CFA	87h			
Vendor Specific	88h..8Fh		VS	
EXECUTE DEVICE DIAGNOSTIC	90h	M	DD	28-bit
Obsolete	91h			
DOWNLOAD MICROCODE	92h	O	PO/ND	28-bit
DOWNLOAD MICROCODE DMA	93h	O	DM/ND	28-bit
Retired	94h..95h			
MUTATE EXT	96h	O	ND	48-bit
Retired	97h..99h			
Vendor Specific	9Ah		VS	
Reserved	9Bh..9Eh			
ZAC Management Out (see ZAC-2)	9Fh	O	DM/ND	48-bit
Obsolete	A0h..A2h			
Reserved	A3h..AFh			
SMART	B0h	O	ND	
Obsolete	B1h			
SET SECTOR CONFIGURATON EXT	B2h	O	ND	48-bit
Reserved	B3h			
Sanitize Device	B4h	O	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
DD – EXECUTE DEVICE DIAGNOSTIC command
VS – Vendor specific

M – Mandatory
O – Optional
N – Use prohibited
V – Vendor specific implementation
E – Retired
B – Obsolete
R – Reserved

Table A.2 — Command codes (sorted by command code) (Sheet 4 of 5)

Command	Command Code	ATA device	Protocol	Argument
Reserved	B5h			
Obsolete	B6h			
Reserved for CFA	B7h..BBh			
Reserved	BCh..BFh			
Reserved for CFA	C0h			
Vendor Specific	C1h..C3h		VS	
Obsolete	C4h..C7h			
READ DMA	C8h	O	DM	28-bit
Obsolete	C9h			
WRITE DMA	CAh	O	DM	28-bit
Obsolete	CBh..CCh			
Reserved for CFA	CDh			
Obsolete	CEh			
Reserved	CFh			
Reserved	D0h			
Obsolete	D1h			
Reserved	D2h..D9h			
Obsolete	DAh			
Retired	DBh..DDh			
Obsolete	DEh..DFh			
STANDBY IMMEDIATE	E0h	M	ND	28-bit
IDLE IMMEDIATE	E1h	M	ND	28-bit
STANDBY	E2h	M	ND	28-bit
IDLE	E3h	M	ND	28-bit
READ BUFFER	E4h	O	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
DD – EXECUTE DEVICE DIAGNOSTIC command
VS – Vendor specific

M – Mandatory
O – Optional
N – Use prohibited
V – Vendor specific implementation
E – Retired
B – Obsolete
R – Reserved

Table A.2 — Command codes (sorted by command code) (Sheet 5 of 5)

Command	Command Code	ATA device	Protocol	Argument
CHECK POWER MODE	E5h	M	ND	28-bit
SLEEP	E6h	M	ND	28-bit
FLUSH CACHE	E7h	O	ND	28-bit
WRITE BUFFER	E8h	O	PO	28-bit
READ BUFFER DMA	E9h	O	DM	28-bit
FLUSH CACHE EXT	EAh	O	ND	28-bit
WRITE BUFFER DMA	EBh	O	DM	28-bit
IDENTIFY DEVICE	ECh	M	PI	28-bit
Obsolete	EDh..EEh			
SET FEATURES	EFh	M	ND	28-bit
Vendor Specific	F0h		VS	
SECURITY SET PASSWORD	F1h	O	PO	28-bit
SECURITY UNLOCK	F2h	O	PO	28-bit
SECURITY ERASE PREPARE	F3h	O	ND	28-bit
SECURITY ERASE UNIT	F4h	O	PO	28-bit
SECURITY FREEZE LOCK	F5h	O	ND	28-bit
SECURITY DISABLE PASSWORD	F6h	O	PO	28-bit
Vendor Specific	F7h		VS	
Obsolete	F8h..F9h			
Vendor Specific	FAh..FFh		VS	

Key:

ND – Non-Data command
PI – PIO Data-In command
PO – PIO Data-Out command
DM – DMA command
DMQ – DMA QUEUED command
DD – EXECUTE DEVICE DIAGNOSTIC command
VS – Vendor specific

M – Mandatory
O – Optional
N – Use prohibited
V – Vendor specific implementation
E – Retired
B – Obsolete
R – Reserved

Table A.3 — Command codes (sorted by command name) (Sheet 1 of 3)

Command	Command Code	ATA device	Protocol	Argument
ACCESSIBLE MAX ADDRESS CONFIGURATION	78h	O	ND	48-bit
CHECK POWER MODE	E5h	M	ND	28-bit
CONFIGURE STREAM	51h	O	ND	48-bit
DATA SET MANAGEMENT	06h	O	DM	48-bit
DATA SET MANAGEMENT XL	07h	O	DM	48-bit
DOWNLOAD MICROCODE	92h	O	PO/ND	28-bit
DOWNLOAD MICROCODE DMA	93h	O	DM/ND	28-bit
EXECUTE DEVICE DIAGNOSTIC	90h	M	DD	28-bit
FLUSH CACHE	E7h	O	ND	28-bit
FLUSH CACHE EXT	EAh	O	ND	28-bit
GET PHYSICAL ELEMENT STATUS	12h	O	DM	48-Bit
IDENTIFY DEVICE	ECh	M	PI	28-bit
IDLE	E3h	M	ND	28-bit
IDLE IMMEDIATE	E1h	M	ND	28-bit
MUTATE EXT	96h	O	ND	48-bit
NCQ NON-DATA	63h	O	ND	48-bit
NOP	00h	O	ND	28-bit
Obsolete	08h, 10h, 21h..23h, 26h..27h, 29h, 31h..33h, 36h..37h, 39h, 3Ch, 3Eh, 41h, 50h, 70h, 91h, A0h..A2h, B1h, B6h, C4h..C7h, C9h, CBh..CCh, CEh, D1h, DAh, DEh..DFh, EDh..EEh, F8h..F9h			
READ BUFFER	E4h	O	PI	28-bit
READ BUFFER DMA	E9h	O	DM	28-bit
READ DMA	C8h	O	DM	28-bit
READ DMA EXT	25h	O	DM	48-bit
READ FPDMA QUEUED	60h	O	DMQ	48-bit
READ LOG DMA EXT	47h	O	DM	48-bit
READ LOG EXT	2Fh	M	PI	48-bit
READ SECTOR(S)	20h	O	PI	28-bit
READ SECTOR(S) EXT	24h	O	PI	48-bit
READ STREAM DMA EXT	2Ah	O	DM	48-bit
READ STREAM EXT	2Bh	O	PI	48-bit

Key:

ND – Non-Data command
PI – PIO Data-In command
PO – PIO Data-Out command
DM – DMA command
DMQ – DMA QUEUED command
DD – EXECUTE DEVICE DIAGNOSTIC command
VS – Vendor specific

M – Mandatory
O – Optional
N – Use prohibited
V – Vendor specific implementation
E – Retired
B – Obsolete
R – Reserved

Table A.3 — Command codes (sorted by command name) (Sheet 2 of 3)

Command	Command Code	ATA device	Protocol	Argument
READ VERIFY SECTOR(S)	40h	O	ND	28-bit
READ VERIFY SECTOR(S) EXT	42h	O	ND	48-bit
RECEIVE FPDMA QUEUED	65h	O	DMQ	48-bit
REMOVE ELEMENT AND MODIFY ZONES (see ZAC-2)	7Eh	O	ND	48-bit
REMOVE ELEMENT AND TRUNCATE	7Ch	O	ND	48-bit
REQUEST SENSE DATA EXT	0Bh	O	ND	48-bit
RESTORE ELEMENTS AND REBUILD	7Dh	O	ND	48-Bit
Reserved	01h..02h, 04h..05h, 09h..0Ah, 0Ch..0Fh, 28h, 2Ch..2Eh, 43h, 46h, 48h..49h, 4Bh..4Fh, 52h..56h, 58h..5Ah, 62h, 66h..6Fh, 9Bh..9Eh, A3h..AFh, B3h, B5h, BCh..BFh, CFh, D0h, D2h..D9h			
Reserved for CFA	03h, 38h, 87h, B7h..BBh, C0h, CDh			
Retired	11h, 13h..1Fh, 71h..76h, 79h..7Bh, 7Eh..7Fh, 94h..99h, DBh..DDh			
Sanitize Device	B4h	O	ND	48-bit
SECURITY DISABLE PASSWORD	F6h	O	PO	28-bit
SECURITY ERASE PREPARE	F3h	O	ND	28-bit
SECURITY ERASE UNIT	F4h	O	PO	28-bit
SECURITY FREEZE LOCK	F5h	O	ND	28-bit
SECURITY SET PASSWORD	F1h	O	PO	28-bit
SECURITY UNLOCK	F2h	O	PO	28-bit
SEND FPDMA QUEUED	64h	O	DMQ	48-bit
SET DATE & TIME EXT	77h	O	ND	48-bit
SET FEATURES	EFh	M	ND	28-bit
SET SECTOR CONFIGURATON EXT	B2h	O	ND	48-bit
SLEEP	E6h	M	ND	28-bit
SMART	B0h	O	ND	
STANDBY	E2h	M	ND	28-bit
STANDBY IMMEDIATE	E0h	M	ND	28-bit
TRUSTED NON-DATA	5Bh	O	ND	28-bit
TRUSTED RECEIVE	5Ch	O	PI	28-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	V – Vendor specific implementation
DMQ – DMA QUEUED command	E – Retired
DD – EXECUTE DEVICE DIAGNOSTIC command	B – Obsolete
VS – Vendor specific	R – Reserved

Table A.3 — Command codes (sorted by command name) (Sheet 3 of 3)

Command	Command Code	ATA device	Protocol	Argument
TRUSTED RECEIVE DMA	5Dh	O	DM	28-bit
TRUSTED SEND	5Eh	O	PO	28-bit
TRUSTED SEND DMA	5Fh	O	DM	28-bit
Vendor Specific	80h..86h, 88h..8Fh, 9Ah, C1h..C3h, F0h, F7h, FAh..FFh			
WRITE BUFFER	E8h	O	PO	28-bit
WRITE BUFFER DMA	EBh	O	DM	28-bit
WRITE DMA	CAh	O	DM	28-bit
WRITE DMA EXT	35h	O	DM	48-bit
WRITE DMA FUA EXT	3Dh	O	DM	48-bit
WRITE FPDMA QUEUED	61h	O	DMQ	48-bit
WRITE LOG DMA EXT	57h	O	DM	48-bit
WRITE LOG EXT	3Fh	M	PO	48-bit
WRITE SECTOR(S)	30h	O	PO	28-bit
WRITE SECTOR(S) EXT	34h	O	PO	48-bit
WRITE STREAM DMA EXT	3Ah	O	DM	48-bit
WRITE STREAM EXT	3Bh	O	PO	48-bit
WRITE UNCORRECTABLE EXT	45h	O	ND	48-bit
ZAC Management In (see ZAC-2)	4Ah	O	DM	48-bit
ZAC Management Out (see ZAC-2)	9Fh	O	DM/ND	48-bit
ZERO EXT	44h	O	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
DD – EXECUTE DEVICE DIAGNOSTIC command
VS – Vendor specific

M – Mandatory
O – Optional
N – Use prohibited
V – Vendor specific implementation
E – Retired
B – Obsolete
R – Reserved

Table A.4 — Historical Command Assignments (Sheet 1 of 9)

Opcode	Command Name	ATA								ACS			
			2	3	4	5	6	7	8	2	3	4	5
00h	NOP	C	C	C	C	C	C	C	C	C	C	C	C
01h		R	R	R	R	R	R	R	R	R	R	R	R
02h		R	R	R	R	R	R	R	R	R	R	R	R
03h	Reserved for CFA	R	R	R	C	C	C	C	C	C	A	A	A
04h		R	R	R	R	R	R	R	R	R	R	R	R
05h		R	R	R	R	R	R	R	R	R	R	R	R
06h	DATA SET MANAGEMENT	R	R	R	R	R	R	R	R	C	C	C	C
07h	DATA SET MANAGEMENT XL	R	R	R	R	R	R	R	R	R	R	C	C
08h	ATAPI Soft Reset / DEVICE RESET	R	R	C	C	C	C	C	C	C	C	O	O
09h		R	R	R	R	R	R	R	R	R	R	R	R
0Ah		R	R	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	C	C
0Ch		R	R	R	R	R	R	R	R	R	R	R	R
0Dh		R	R	R	R	R	R	R	R	R	R	R	R
0Eh		R	R	R	R	R	R	R	R	R	R	R	R
0Fh		R	R	R	R	R	R	R	R	R	R	R	R
10h	RECALIBRATE	C	C	C	O	O	O	O	O	O	O	O	O
11h	RECALIBRATE	C	C	O	E	E	E	E	E	E	E	E	E
12h	RECALIBRATE	C	C	O	E	E	E	E	E	E	E	E	E
13h	RECALIBRATE	C	C	O	E	E	E	E	E	E	E	E	E
14h	RECALIBRATE	C	C	O	E	E	E	E	E	E	E	E	E
15h	RECALIBRATE	C	C	O	E	E	E	E	E	E	E	E	E
16h	RECALIBRATE	C	C	O	E	E	E	E	E	E	E	E	E
17h	RECALIBRATE	C	C	O	E	E	E	E	E	E	E	E	E
18h	RECALIBRATE	C	C	O	E	E	E	E	E	E	E	E	E
19h	RECALIBRATE	C	C	O	E	E	E	E	E	E	E	E	E
1Ah	RECALIBRATE	C	C	O	E	E	E	E	E	E	E	E	E
1Bh	RECALIBRATE	C	C	O	E	E	E	E	E	E	E	E	E
1Ch	RECALIBRATE	C	C	O	E	E	E	E	E	E	E	E	E
1Dh	RECALIBRATE	C	C	O	E	E	E	E	E	E	E	E	E
1Eh	RECALIBRATE	C	C	O	E	E	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 CFA
- F – If the device does not support the CFA feature set (see ACS-2), this command code is vendor specific
- M – Reserved for the Media Card Pass Through Command feature set
- S – Reserved for Serial ATA
- Z – Defined by ZAC-2

[a] This command definition is new to ACS-5.

Table A.4 — Historical Command Assignments (Sheet 2 of 9)

Opcode	Command Name	ATA								ACS			
			2	3	4	5	6	7	8	2	3	4	5
1Fh	RECALIBRATE	C	C	O	E	E	E	E	E	E	E	E	E
20h	READ SECTORS	C	C	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	O	O
22h	READ LONG	C	C	C	O	O	O	O	O	O	O	O	O
23h	READ LONG WITHOUT RETRY	C	C	C	O	O	O	O	O	O	O	O	O
24h	READ SECTORS EXT	R	R	R	R	R	C	C	C	C	C	C	C
25h	READ DMA EXT	R	R	R	R	R	C	C	C	C	C	C	C
26h	READ DMA QUEUED EXT	R	R	R	R	R	C	C	C	O	O	O	O
27h	READ NATIVE MAX ADDRESS EXT	R	R	R	R	R	C	C	C	C	O	O	O
28h		R	R	R	R	R	R	R	R	R	R	R	R
29h	READ MULTIPLE EXT	R	R	R	R	R	C	C	C	C	C	O	O
2Ah	READ STREAM DMA	R	R	R	R	R	R	C	C	C	C	C	C
2Bh	READ STREAM EXT	R	R	R	R	R	R	C	C	C	C	C	C
2Ch		R	R	R	R	R	R	R	R	R	R	R	R
2Dh		R	R	R	R	R	R	R	R	R	R	R	R
2Eh		R	R	R	R	R	R	R	R	R	R	R	R
2Fh	READ LOG EXT	R	R	R	R	R	C	C	C	C	C	C	C
30h	WRITE SECTORS	C	C	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	O	O
32h	WRITE LONG	C	C	C	O	O	O	O	O	O	O	O	O
33h	WRITE LONG WITHOUT RETRY	C	C	C	O	O	O	O	O	O	O	O	O
34h	WRITE SECTORS EXT	R	R	R	R	O	C	C	C	C	C	C	C
35h	WRITE DMA EXT	R	R	R	R	R	C	C	C	C	C	C	C
36h	WRITE DMA QUEUED EXT	R	R	R	R	R	C	C	C	O	O	O	O
37h	SET NATIVE MAX ADDRESS EXT	R	R	R	R	R	C	C	C	C	O	O	O
38h	Reserved for CFA	R	R	R	C	C	C	C	C	C	A	A	A
39h	WRITE MULTIPLE EXT	R	R	R	R	R	C	C	C	C	C	O	O
3Ah	WRITE STREAM DMA	R	R	R	R	R	R	C	C	C	C	C	C
3Bh	WRITE STREAM EXT	R	R	R	R	R	R	C	C	C	C	C	C
3Ch	WRITE VERIFY	C	C	C	O	O	O	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 commands
A – Reserved for CFA
F – If the device does not support the CFA feature set (see ACS-2), this command code is vendor specific
M – Reserved for the Media Card Pass Through Command feature set
S – Reserved for Serial ATA
Z – Defined by ZAC-2

[a] This command definition is new to ACS-5.

Table A.4 — Historical Command Assignments (Sheet 3 of 9)

Opcode	Command Name	ATA								ACS			
			2	3	4	5	6	7	8	2	3	4	5
3Dh	WRITE DMA FUA EXT	R	R	R	R	R	R	C	C	C	C	C	C
3Eh	WRITE DMA QUEUED FUA EXT	R	R	R	R	R	R	C	C	O	O	O	O
3Fh	WRITE LOG EXT	R	R	R	R	R	C	C	C	C	C	C	C
40h	READ VERIFY SECTORS	C	C	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	O	O
42h	READ VERIFY SECTORS EXT	R	R	R	R	R	C	C	C	C	C	C	C
43h		R	R	R	R	R	R	R	R	R	R	R	R
44h	ZERO EXT	R	R	R	R	R	R	R	R	R	R	C	C
45h	WRITE UNCORRECTABLE EXT	R	R	R	R	R	R	R	C	C	C	C	C
46h		R	R	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	C	C
48h		R	R	R	R	R	R	R	R	R	R	R	R
49h		R	R	R	R	R	R	R	R	R	R	R	R
4Ah	ZAC Management In	R	R	R	R	R	R	R	R	R	R	Z	Z
4Bh		R	R	R	R	R	R	R	R	R	R	R	R
4Ch		R	R	R	R	R	R	R	R	R	R	R	R
4Dh		R	R	R	R	R	R	R	R	R	R	R	R
4Eh		R	R	R	R	R	R	R	R	R	R	R	R
4Fh		R	R	R	R	R	R	R	R	R	R	R	R
50h	FORMAT TRACK	C	C	C	O	O	O	O	O	O	O	O	O
51h	CONFIGURE STREAM	R	R	R	R	R	R	C	C	C	C	C	C
52h		R	R	R	R	R	R	R	R	R	R	R	R
53h		R	R	R	R	R	R	R	R	R	R	R	R
54h		R	R	R	R	R	R	R	R	R	R	R	R
55h		R	R	R	R	R	R	R	R	R	R	R	R
56h		R	R	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	C	C
58h		R	R	R	R	R	R	R	R	R	R	R	R
59h		R	R	R	R	R	R	R	R	R	R	R	R
5Ah		R	R	R	R	R	R	R	R	R	R	R	R
5Bh	TRUSTED NON-DATA	R	R	R	R	R	R	R	C	C	C	C	C
5Ch	TRUSTED RECEIVE	R	R	R	R	R	R	R	C	C	C	C	C

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- A – Reserved for CFA
- F – If the device does not support the CFA feature set (see ACS-2), this command code is vendor specific
- M – Reserved for the Media Card Pass Through Command feature set
- S – Reserved for Serial ATA
- Z – Defined by ZAC-2

[a] This command definition is new to ACS-5.

Table A.4 — Historical Command Assignments (Sheet 4 of 9)

Opcode	Command Name	ATA							ACS			
			2	3	4	5	6	7	8	2	3	4	5
5Dh	TRUSTED RECEIVE DMA	R	R	R	R	R	R	R	C	C	C	C	C
5Eh	TRUSTED SEND	R	R	R	R	R	R	R	C	C	C	C	C
5Fh	TRUSTED SEND DMA	R	R	R	R	R	R	R	C	C	C	C	C
60h	READ FPDMA QUEUED	R	R	R	R	R	R	S	C	C	C	C	C
61h	WRITE FPDMA QUEUED	R	R	R	R	R	R	S	C	C	C	C	C
62h	SATA (reserved)	R	R	R	R	R	R	S	S	S	S	S	S
63h	NCQ NON-DATA	R	R	R	R	R	R	S	S	S	C	C	C
64h	SEND FPDMA QUEUED	R	R	R	R	R	R	S	S	S	C	C	C
65h	RECEIVE FPDMA QUEUED	R	R	R	R	R	R	S	S	S	C	C	C
66h	SATA (reserved)	R	R	R	R	R	R	S	S	S	S	S	S
67h	SATA (reserved)	R	R	R	R	R	R	S	S	S	S	S	S
68h	SATA (reserved)	R	R	R	R	R	R	S	S	S	S	S	S
69h	SATA (reserved)	R	R	R	R	R	R	S	S	S	S	S	S
6Ah	SATA (reserved)	R	R	R	R	R	R	S	S	S	S	S	S
6Bh	SATA (reserved)	R	R	R	R	R	R	S	S	S	S	S	S
6Ch	SATA (reserved)	R	R	R	R	R	R	S	S	S	S	S	S
6Dh	SATA (reserved)	R	R	R	R	R	R	S	S	S	S	S	S
6Eh	SATA (reserved)	R	R	R	R	R	R	S	S	S	S	S	S
6Fh	SATA (reserved)	R	R	R	R	R	R	S	S	S	S	S	S
70h	SEEK	C	C	C	C	C	C	O	O	O	O	O	O
71h	SEEK	C	C	O	E	E	E	E	E	E	E	E	E
72h	SEEK	C	C	O	E	E	E	E	E	E	E	E	E
73h	SEEK	C	C	O	E	E	E	E	E	E	E	E	E
74h	SEEK	C	C	O	E	E	E	E	E	E	E	E	E
75h	SEEK	C	C	O	E	E	E	E	E	E	E	E	E
76h	SEEK	C	C	O	E	E	E	E	E	E	E	E	E
77h	SET DATE & TIME EXT	C	C	O	E	E	E	E	E	E	C	C	C
78h	ACCESSIBLE MAX ADDRESS CONFIGURATION	C	C	O	E	E	E	E	E	E	C	C	C
79h	SEEK	C	C	O	E	E	E	E	E	E	E	E	E
7Ah	SEEK	C	C	O	E	E	E	E	E	E	E	E	E
7Bh	SEEK	C	C	O	E	E	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 CFA
F – If the device does not support the CFA feature set (see ACS-2), this command code is vendor specific
M – Reserved for the Media Card Pass Through Command feature set
S – Reserved for Serial ATA
Z – Defined by ZAC-2

[a] This command definition is new to ACS-5.

Table A.4 — Historical Command Assignments (Sheet 5 of 9)

Opcode	Command Name	ATA								ACS		
			2	3	4	5	6	7	8	2	3	4	5
7Ch	REMOVE ELEMENT AND TRUNCATE	C	C	O	E	E	E	E	E	E	E	C	C
7Dh	RESTORE ELEMENTS AND REBUILD	C	C	O	E	E	E	E	E	E	E	E	C [a]
7Eh	SEEK	C	C	O	E	E	E	E	E	E	E	E	E
7Fh	SEEK	C	C	O	E	E	E	E	E	E	E	E	E
80h	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
81h	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
82h	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
83h	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
84h	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
85h	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
86h	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
87h	(vendor specific) / Reserved for CFA	V	V	V	F	F	F	F	F	F	A	A	A
88h	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
89h	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
8Ah	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
8Bh	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
8Ch	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
8Dh	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
8Eh	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
8Fh	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
90h	EXECUTE DEVICE DIAGNOSTICS	C	C	C	C	C	C	C	C	C	C	C	C
91h	INITIALIZE DEVICE PARAMETERS	C	C	C	C	C	O	O	O	O	O	O	O
92h	DOWNLOAD MICROCODE	R	C	C	C	C	C	C	C	C	C	C	C
93h	DOWNLOAD MICROCODE DMA	R	R	R	R	R	R	R	R	C	C	C	C
94h	STANDBY IMMEDIATE	C	C	C	E	E	E	E	E	E	E	E	E
95h	IDLE IMMEDIATE	C	C	C	E	E	E	E	E	E	E	E	E
96h	MUTATE	C	C	C	E	E	E	E	E	E	E	E	C [a]
97h	IDLE	C	C	C	E	E	E	E	E	E	E	E	E
98h	CHECK POWER MODE	C	C	C	E	E	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 CFA
F – If the device does not support the CFA feature set (see ACS-2), this command code is vendor specific
M – Reserved for the Media Card Pass Through Command feature set
S – Reserved for Serial ATA
Z – Defined by ZAC-2

[a] This command definition is new to ACS-5.

Table A.4 — Historical Command Assignments (Sheet 6 of 9)

Opcode	Command Name	ATA								ACS			
			2	3	4	5	6	7	8	2	3	4	5
99h	SLEEP	C	C	C	E	E	E	E	E	E	E	E	E
9Ah	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
9Bh		R	R	R	R	R	R	R	R	R	R	R	R
9Ch		R	R	R	R	R	R	R	R	R	R	R	R
9Dh		R	R	R	R	R	R	R	R	R	R	R	R
9Eh		R	R	R	R	R	R	R	R	R	R	R	R
9Fh	ZAC Management Out	R	R	R	R	R	R	R	R	R	R	Z	Z
A0h	PACKET	R	R	C	C	C	C	C	C	C	C	O	O
A1h	IDENTIFY PACKET DEVICE	R	R	C	C	C	C	C	C	C	C	O	O
A2h	SERVICE	R	R	C	C	C	C	C	C	O	O	O	O
A3h		R	R	R	R	R	R	R	R	R	R	R	R
A4h		R	R	R	R	R	R	R	R	R	R	R	R
A5h		R	R	R	R	R	R	R	R	R	R	R	R
A6h		R	R	R	R	R	R	R	R	R	R	R	R
A7h		R	R	R	R	R	R	R	R	R	R	R	R
A8h		R	R	R	R	R	R	R	R	R	R	R	R
A9h		R	R	R	R	R	R	R	R	R	R	R	R
AAh		R	R	R	R	R	R	R	R	R	R	R	R
ABh		R	R	R	R	R	R	R	R	R	R	R	R
ACh		R	R	R	R	R	R	R	R	R	R	R	R
ADh		R	R	R	R	R	R	R	R	R	R	R	R
AEh		R	R	R	R	R	R	R	R	R	R	R	R
AFh		R	R	R	R	R	R	R	R	R	R	R	R
B0h	SMART	R	R	C	C	C	C	C	C	C	C	C	C
B1h	DEVICE CONFIGURATION	R	R	R	R	R	C	C	C	C	O	O	O
B2h	SET SECTOR CONFIGURATON EXT	R	R	R	R	R	R	R	R	R	R	C	C
B3h		R	R	R	R	R	R	R	R	R	R	R	R
B4h	Sanitize Device	R	R	R	R	R	R	R	R	C	C	C	C
B5h		R	R	R	R	R	R	R	R	R	R	R	R
B6h	NV CACHE	R	R	R	R	R	R	R	C	C	O	O	O
B7h	Reserved for CFA	R	R	R	R	A	A	A	A	A	A	A	A
B8h	Reserved for CFA	R	R	R	R	A	A	A	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 commands
A – Reserved for CFA
F – If the device does not support the CFA feature set (see ACS-2), this command code is vendor specific
M – Reserved for the Media Card Pass Through Command feature set
S – Reserved for Serial ATA
Z – Defined by ZAC-2

[a] This command definition is new to ACS-5.

Table A.4 — Historical Command Assignments (Sheet 7 of 9)

Opcode	Command Name	ATA								ACS			
			2	3	4	5	6	7	8	2	3	4	5
B9h	Reserved for CFA	R	R	R	R	A	A	A	A	A	A	A	A
BAh	Reserved for CFA	R	R	R	R	A	A	A	A	A	A	A	A
BBh	Reserved for CFA	R	R	R	R	A	A	A	A	A	A	A	A
BCh	Reserved	R	R	R	R	A	A	A	R	R	R	R	R
BDh	Reserved	R	R	R	R	A	A	A	R	R	R	R	R
BEh	Reserved	R	R	R	R	A	A	A	R	R	R	R	R
BFh	Reserved	R	R	R	R	A	A	A	R	R	R	R	R
C0h	(vendor specific) / CFA ERASE SECTORS	V	V	V	F	F	F	F	F	F	F	F	F
C1h	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
C2h	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
C3h	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
C4h	READ MULTIPLE	C	C	C	C	C	C	C	C	C	C	O	O
C5h	WRITE MULTIPLE	C	C	C	C	C	C	C	C	C	C	O	O
C6h	SET MULTIPLE MODE	C	C	C	C	C	C	C	C	C	C	O	O
C7h	READ DMA QUEUED	R	R	R	C	C	C	C	C	O	O	O	O
C8h	READ DMA	C	C	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	O	O
CAh	WRITE DMA	C	C	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	O	O
CCh	WRITE DMA QUEUED	R	R	R	C	C	C	C	C	O	O	O	O
CDh	Reserved for CFA	R	R	R	C	C	C	C	C	C	A	A	A
CEh	WRITE MULTIPLE FUA EXT	R	R	R	R	R	R	C	C	C	C	O	O
CFh		R	R	R	R	R	R	R	R	R	R	R	R
D0h		R	R	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	O	O
D2h	Reserved for the Media Card Pass Through Command feature set	R	R	R	R	R	M	M	M	R	R	R	R
D3h	Reserved for the Media Card Pass Through Command feature set	R	R	R	R	R	M	M	M	R	R	R	R
D4h	Reserved for the Media Card Pass Through Command feature set	R	R	R	R	R	M	M	M	R	R	R	R
D5h		R	R	R	R	R	R	R	R	R	R	R	R
D6h		R	R	R	R	R	R	R	R	R	R	R	R

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[a] This command definition is new to ACS-5.

Table A.4 — Historical Command Assignments (Sheet 8 of 9)

Opcode	Command Name	ATA							ACS			
			2	3	4	5	6	7	8	2	3	4	5
D7h		R	R	R	R	R	R	R	R	R	R	R	R
D8h		R	R	R	R	R	R	R	R	R	R	R	R
D9h		R	R	R	R	R	R	R	R	R	R	R	R
DAh	GET MEDIA STATUS	R	R	R	C	C	C	C	O	O	O	O	O
DBh	ACKNOWLEDGE MEDIA CHANGE	C	C	O	E	E	E	E	E	E	E	E	E
DCh	BOOT POST BOOT	C	C	O	E	E	E	E	E	E	E	E	E
DDh	BOOT PRE BOOT	C	C	O	E	E	E	E	E	E	E	E	E
DEh	MEDIA LOCK	C	C	C	C	C	C	C	O	O	O	O	O
DFh	MEDIA UNLOCK	C	C	C	C	C	C	C	O	O	O	O	O
E0h	STANDBY IMMEDIATE	C	C	C	C	C	C	C	C	C	C	C	C
E1h	IDLE IMMEDIATE	C	C	C	C	C	C	C	C	C	C	C	C
E2h	STANDBY	C	C	C	C	C	C	C	C	C	C	C	C
E3h	IDLE	C	C	C	C	C	C	C	C	C	C	C	C
E4h	READ BUFFER	C	C	C	C	C	C	C	C	C	C	C	C
E5h	CHECK POWER MODE	C	C	C	C	C	C	C	C	C	C	C	C
E6h	SLEEP	C	C	C	C	C	C	C	C	C	C	C	C
E7h	FLUSH CACHE	R	R	R	C	C	C	C	C	C	C	C	C
E8h	WRITE BUFFER	C	C	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	C	C
EAh	FLUSH CACHE EXT	R	R	R	R	R	C	C	C	C	C	C	C
EBh	WRITE BUFFER DMA	R	R	R	R	R	R	R	R	C	C	C	C

Key:
C – a defined command
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F – If the device does not support the CFA feature set (see ACS-2), this command code is vendor specific
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Z – Defined by ZAC-2

[a] This command definition is new to ACS-5.

Table A.4 — Historical Command Assignments (Sheet 9 of 9)

Opcode	Command Name	ATA								ACS			
			2	3	4	5	6	7	8	2	3	4	5
ECh	IDENTIFY DEVICE	C	C	C	C	C	C	C	C	C	C	C	C
EDh	MEDIA EJECT	R	C	C	C	C	C	C	O	O	O	O	O
EEh	IDENTIFY DEVICE DMA	R	R	C	O	O	O	O	O	O	O	O	O
EFh	SET FEATURES	C	C	C	C	C	C	C	C	C	C	C	C
F0h	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
F1h	SECURITY SET PASSWORD	V	V	C	C	C	C	C	C	C	C	C	C
F2h	SECURITY UNLOCK	V	V	C	C	C	C	C	C	C	C	C	C
F3h	SECURITY ERASE PREPARE	V	V	C	C	C	C	C	C	C	C	C	C
F4h	SECURITY ERASE UNIT	V	V	C	C	C	C	C	C	C	C	C	C
F5h	SECURITY FREEZE LOCK	V	V	C	C	C	C	C	C	C	C	C	C
F6h	SECURITY DISABLE PASSWORD	V	V	C	C	C	C	C	C	C	C	C	C
F7h	(vendor specific)	V	V	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	O	O
F9h	SET MAX ADDRESS	V	V	V	C	C	C	C	C	C	O	O	O
FAh	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
FBh	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
FCh	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
FDh	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
FEh	(vendor specific)	V	V	V	V	V	V	V	V	V	V	V	V
FFh	(vendor specific)	V	V	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 CFA
F – If the device does not support the CFA feature set (see ACS-2), this command code is vendor specific
M – Reserved for the Media Card Pass Through Command feature set
S – Reserved for Serial ATA
Z – Defined by ZAC-2

[a] This command definition is new to ACS-5.

Table A.5 — Historical SET FEATURE Code Assignments (Sheet 1 of 9)

Feature Code	Description	ATA								ACS			
			2	3	4	5	6	7	8	2	3	4	5
00h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
01h	Enable 8-bit data transfers	C	C	O	E	F	F	F	F	F	A	A	A
02h	Enable write cache	V	V	C	C	C	C	C	C	C	C	C	C
03h	Set transfer mode	C	C	C	C	C	C	C	C	C	C	C	C
04h	Enable all automatic defect reassignment	R	R	C	O	O	O	O	O	O	O	O	O
05h	Enable advanced power management	R	R	R	C	C	C	C	C	C	C	C	C
06h	Enable Power-Up in Standby feature set	R	R	R	R	C	C	C	C	C	C	C	C
07h	Power-up in Standby feature set device spin-up	R	R	R	R	C	C	C	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	O	O	O
0Ah	Enable CFA power mode 1	R	R	R	R	C	C	C	C	C	A	A	A
0Bh	Enable Write-Read-Verify feature set	R	R	R	R	R	R	R	C	C	C	C	C
0Ch	Enable device life control	R	R	R	R	R	R	R	R	R	R	C	C
0Dh	Enable/Disable Command Duration Limits feature set	R	R	R	R	R	R	R	R	R	R	R	C
0Eh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
0Fh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
10h	Enable use of SATA feature	R	R	R	R	R	R	S	C	C	C	C	C
11h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
12h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
13h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
14h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
15h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
16h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
17h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
18h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
19h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R

Key:
A – Reserved for CFA
C – a defined command
E – a retired command
F – If the device does not support the CFA feature set, this command code is Reserved
O – Obsolete
R – Reserved, undefined in current specifications
S – Reserved for Serial ATA
T – Reserved for Technical Report T13/DT1696 (Time-Limited Commands)
V – Vendor specific command
Z – Reserved for ZAC-2

[a] This set feature definition is new to ACS-5.

Table A.5 — Historical SET FEATURE Code Assignments (Sheet 2 of 9)

Feature Code	Description	ATA								ACS			
			2	3	4	5	6	7	8	2	3	4	5
1Ah	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
1Bh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
1Ch	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
1Dh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
1Eh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
1Fh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
20h	Obsolete	R	R	R	R	R	R	T	T	T	O	O	O
21h	Obsolete	R	R	R	R	R	R	T	T	T	O	O	O
22h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
23h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
24h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
25h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
26h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
27h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
28h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
29h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
2Ah	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
2Bh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
2Ch	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
2Dh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
2Eh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
2Fh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
30h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
31h	Disable Media Status Notification	R	R	R	C	C	C	C	O	O	O	O	O
32h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
33h	Disable retry	V	V	C	C	O	O	O	O	O	O	O	O
34h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
35h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
36h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
37h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
38h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
39h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R

Key:
A – Reserved for CFA
C – a defined command
E – a retired command
F – If the device does not support the CFA feature set, this command code is Reserved
O – Obsolete
R – Reserved, undefined in current specifications
S – Reserved for Serial ATA
T – Reserved for Technical Report T13/DT1696 (Time-Limited Commands)
V – Vendor specific command
Z – Reserved for ZAC-2

[a] This set feature definition is new to ACS-5.

Table A.5 — Historical SET FEATURE Code Assignments (Sheet 3 of 9)

Feature Code	Description	ATA								ACS			
			2	3	4	5	6	7	8	2	3	4	5
3Ah	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
3Bh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
3Ch	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
3Dh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
3Eh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
3Fh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
40h	Reserved	R	R	R	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	C	C	C
42h	Enable Automatic Acoustic Management feature set	R	R	R	R	R	C	C	C	O	O	O	O
43h	Set Maximum Host Interface Sector Times	R	R	R	R	R	R	C	C	C	C	C	C
44h	Vendor specific length of ECC on read long/write long commands	C	C	C	O	O	O	O	O	O	O	O	O
45h	Set rate basis	R	R	R	R	R	R	R	R	R	R	C	C
46h	Reserved for ZAC-2	R	R	R	R	R	R	R	R	R	R	R	Z[a]
47h	Reserved for ZAC-2	R	R	R	R	R	R	R	R	R	R	R	Z[a]
48h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
49h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
4Ah	Extended Power Conditions	R	R	R	R	R	R	R	R	C	C	C	C
4Bh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
4Ch	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
4Dh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
4Eh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
4Fh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
50h	Advanced Background Operation Control	R	R	R	R	R	R	R	R	R	R	C	C
51h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
52h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
53h	Reserved	R	R	R	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	O	O	O

Key:
A – Reserved for CFA
C – a defined command
E – a retired command
F – If the device does not support the CFA feature set, this command code is Reserved
O – Obsolete
R – Reserved, undefined in current specifications
S – Reserved for Serial ATA
T – Reserved for Technical Report T13/DT1696 (Time-Limited Commands)
V – Vendor specific command
Z – Reserved for ZAC-2

[a] This set feature definition is new to ACS-5.

Table A.5 — Historical SET FEATURE Code Assignments (Sheet 4 of 9)

Feature Code	Description	ATA								ACS			
			2	3	4	5	6	7	8	2	3	4	5
55h	Disable read look-ahead feature	C	C	C	C	C	C	C	C	C	C	C	C
56h	Vendor Specific	R	R	R	R	R	R	R	V	V	V	V	V
57h	Vendor Specific	R	R	R	R	R	R	R	V	V	V	V	V
58h	Vendor Specific	R	R	R	R	R	R	R	V	V	V	V	V
59h	Vendor Specific	R	R	R	R	R	R	R	V	V	V	V	V
5Ah	Vendor Specific	R	R	R	R	R	R	R	V	V	V	V	V
5Bh	Vendor Specific	R	R	R	R	R	R	R	V	V	V	V	V
5Ch	Vendor Specific	R	R	R	R	R	R	R	V	V	V	V	V
5Dh	Enable release interrupt	R	R	R	C	C	C	C	C	O	O	O	O
5Eh	Enable SERVICE interrupt	R	R	R	C	C	C	C	C	O	O	O	O
5Fh	Reserved	R	R	R	R	R	R	R	R	R	O	O	O
60h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
61h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
62h	Long Physical Sector Alignment Error Reporting Control	R	R	R	R	R	R	R	R	C	C	C	C
63h	Enable/Disable the DSN feature set	R	R	R	R	R	R	R	R	R	C	C	C
64h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
65h	Reserved	R	R	R	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	C	C	C
67h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
68h	Reserved	R	R	R	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	C	C	C
6Ah	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
6Bh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
6Ch	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
6Dh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
6Eh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
6Fh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R

Key:
- A – Reserved for CFA
- C – a defined command
- E – a retired command
- F – If the device does not support the CFA feature set, this command code is Reserved
- O – Obsolete
- R – Reserved, undefined in current specifications
- S – Reserved for Serial ATA
- T – Reserved for Technical Report T13/DT1696 (Time-Limited Commands)
- V – Vendor specific command
- Z – Reserved for ZAC-2

[a] This set feature definition is new to ACS-5.

Table A.5 — Historical SET FEATURE Code Assignments (Sheet 5 of 9)

Feature Code	Description	ATA							ACS			
			2	3	4	5	6	7	8	2	3	4	5
70h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
71h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
72h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
73h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
74h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
75h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
76h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
77h	Disable ECC	V	V	C	O	O	O	O	O	O	O	O	O
78h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
79h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
7Ah	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
7Bh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
7Ch	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
7Dh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
7Eh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
7Fh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
80h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
81h	Disable 8-bit data transfers	C	C	O	E	F	F	F	F	F	F	F	F
82h	Disable write cache	V	V	C	C	C	C	C	C	C	C	C	C
83h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
84h	Disable all automatic defect reassignment	R	R	C	O	O	O	O	O	O	O	O	O
85h	Disable advanced power management	R	R	R	C	C	C	C	C	C	C	C	C
86h	Disable Power-Up in Standby feature set	R	R	R	R	C	C	C	C	C	C	C	C
87h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
88h	Enable ECC	V	V	C	C	C	O	O	O	O	O	O	O
89h	If the device is a CFA-APT, then this subcommand is reserved for CFA; otherwise this subcommand is reserved for Address Offset Reserved Area Boot Method.	R	R	R	R	C	C	C	C	C	C	C	C

Key:
- A – Reserved for CFA
- C – a defined command
- E – a retired command
- F – If the device does not support the CFA feature set, this command code is Reserved
- O – Obsolete
- R – Reserved, undefined in current specifications
- S – Reserved for Serial ATA
- T – Reserved for Technical Report T13/DT1696 (Time-Limited Commands)
- V – Vendor specific command
- Z – Reserved for ZAC-2

[a] This set feature definition is new to ACS-5.

Table A.5 — Historical SET FEATURE Code Assignments (Sheet 6 of 9)

Feature Code	Description	ATA								ACS			
			2	3	4	5	6	7	8	2	3	4	5
8Ah	Disable CFA power mode 1	R	R	R	R	C	C	F	F	F	A	A	A
8Bh	Disable Write-Read-Verify feature set	R	R	R	R	R	R	R	C	C	C	C	C
8Ch	Disable device life control	R	R	R	R	R	R	R	R	R	R	C	C
8Dh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
8Eh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
8Fh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
90h	Disable use of SATA feature	R	R	R	R	R	R	S	C	C	C	C	C
91h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
92h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
93h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
94h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
95h	Enable Media Status Notification	R	R	R	C	C	C	C	O	O	O	O	O
96h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
97h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
98h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
99h	Enable retries	V	V	C	O	O	O	O	O	O	O	O	O
9Ah	Set device maximum average current	R	R	C	O	O	O	O	O	O	O	O	O
9Bh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
9Ch	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
9Dh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
9Eh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
9Fh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
A0h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
A1h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
A2h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
A3h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
A4h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
A5h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
A6h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
A7h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R

Key:
- A – Reserved for CFA
- C – a defined command
- E – a retired command
- F – If the device does not support the CFA feature set, this command code is Reserved
- O – Obsolete
- R – Reserved, undefined in current specifications
- S – Reserved for Serial ATA
- T – Reserved for Technical Report T13/DT1696 (Time-Limited Commands)
- V – Vendor specific command
- Z – Reserved for ZAC-2

[a] This set feature definition is new to ACS-5.

Table A.5 — Historical SET FEATURE Code Assignments (Sheet 7 of 9)

Feature Code	Description	ATA							ACS			
			2	3	4	5	6	7	8	2	3	4	5
A8h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
A9h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
AAh	Enable read look-ahead features	C	C	C	C	C	C	C	C	C	C	C	C
ABh	Set maximum prefetch using the COUNT field value	V	V	C	O	O	O	O	O	O	O	O	O
ACh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
ADh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
AEh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
AFh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
B0h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
B1h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
B2h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
B3h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
B4h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
B5h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
B6h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
B7h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
B8h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
B9h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
BAh	Reserved	R	R	R	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	O	O	O
BCh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
BDh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
BEh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
BFh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
C0h	Reserved	R	R	R	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	C	C	C
C2h	Disable Automatic Acoustic Management feature set	R	R	R	R	R	C	C	C	O	O	O	O

Key:
A – Reserved for CFA
C – a defined command
E – a retired command
F – If the device does not support the CFA feature set, this command code is Reserved
O – Obsolete
R – Reserved, undefined in current specifications
S – Reserved for Serial ATA
T – Reserved for Technical Report T13/DT1696 (Time-Limited Commands)
V – Vendor specific command
Z – Reserved for ZAC-2

[a] This set feature definition is new to ACS-5.

Table A.5 — Historical SET FEATURE Code Assignments (Sheet 8 of 9)

Feature Code	Description	ATA								ACS			
			2	3	4	5	6	7	8	2	3	4	5
C3h	Enabled/Disable the Sense Data Reporting feature set	R	R	R	R	R	R	R	R	C	C	C	C
C4h	Enable/Disable sense data return for successful NCQ commands	R	R	R	R	R	R	R	R	R	R	C	C
C5h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
C6h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
C7h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
C8h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
C9h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
CAh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
CBh	Reserved	R	R	R	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	C	C	C
CDh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
CEh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
CFh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
D0h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
D1h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
D2h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
D3h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
D4h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
D5h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
D6h	Vendor Specific	R	R	R	R	R	R	R	V	V	V	V	V
D7h	Vendor Specific	R	R	R	R	R	R	R	V	V	V	V	V
D8h	Vendor Specific	R	R	R	R	R	R	R	V	V	V	V	V
D9h	Vendor Specific	R	R	R	R	R	R	R	V	V	V	V	V
DAh	Vendor Specific	R	R	R	R	R	R	R	V	V	V	V	V
DBh	Vendor Specific	R	R	R	R	R	R	R	V	V	V	V	V
DCh	Vendor Specific	R	R	R	R	R	R	R	V	V	V	V	V
DDh	Disable release interrupt	R	R	R	C	C	C	C	C	O	O	O	O
DEh	Disable SERVICE interrupt	R	R	R	C	C	C	C	C	O	O	O	O
DFh	Reserved	R	R	R	R	R	R	R	R	R	O	O	O
E0h	Vendor specific	R	R	R	R	R	R	O	O	O	O	O	O

Key:
- A – Reserved for CFA
- C – a defined command
- E – a retired command
- F – If the device does not support the CFA feature set, this command code is Reserved
- O – Obsolete
- R – Reserved, undefined in current specifications
- S – Reserved for Serial ATA
- T – Reserved for Technical Report T13/DT1696 (Time-Limited Commands)
- V – Vendor specific command
- Z – Reserved for ZAC-2

[a] This set feature definition is new to ACS-5.

Table A.5 — Historical SET FEATURE Code Assignments (Sheet 9 of 9)

Feature Code	Description	ATA								ACS		
			2	3	4	5	6	7	8	2	3	4	5
E1h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
E2h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
E3h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
E4h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
E5h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
E6h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
E7h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
E8h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
E9h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
EAh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
EBh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
ECh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
EDh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
EEh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
EFh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
F0h		R	R	R	R	A	A	A	A	A	A	A	A
F1h		R	R	R	R	A	A	A	A	A	A	A	A
F2h		R	R	R	R	A	A	A	A	A	A	A	A
F3h		R	R	R	R	A	A	A	A	A	A	A	A
F4h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
F5h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
F6h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
F7h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
F8h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
F9h	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
FAh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
FBh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
FCh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
FDh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
FEh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R
FFh	Reserved	R	R	R	R	R	R	R	R	R	R	R	R

Key:
A – Reserved for CFA
C – a defined command
E – a retired command
F – If the device does not support the CFA feature set, this command code is Reserved
O – Obsolete
R – Reserved, undefined in current specifications
S – Reserved for Serial ATA
T – Reserved for Technical Report T13/DT1696 (Time-Limited Commands)
V – Vendor specific command
Z – Reserved for ZAC-2

[a] This set feature definition is new to ACS-5.

Annex B
(informative)

How to Use SCT Commands

B.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 supports this feature set, this data is interpreted as an SCT command request, an SCT command response, SCT command status, or SCT command data.

Figure B.1 is an example flowchart that shows how to process SCT commands using SMART READ LOG commands and SMART WRITE LOG commands.

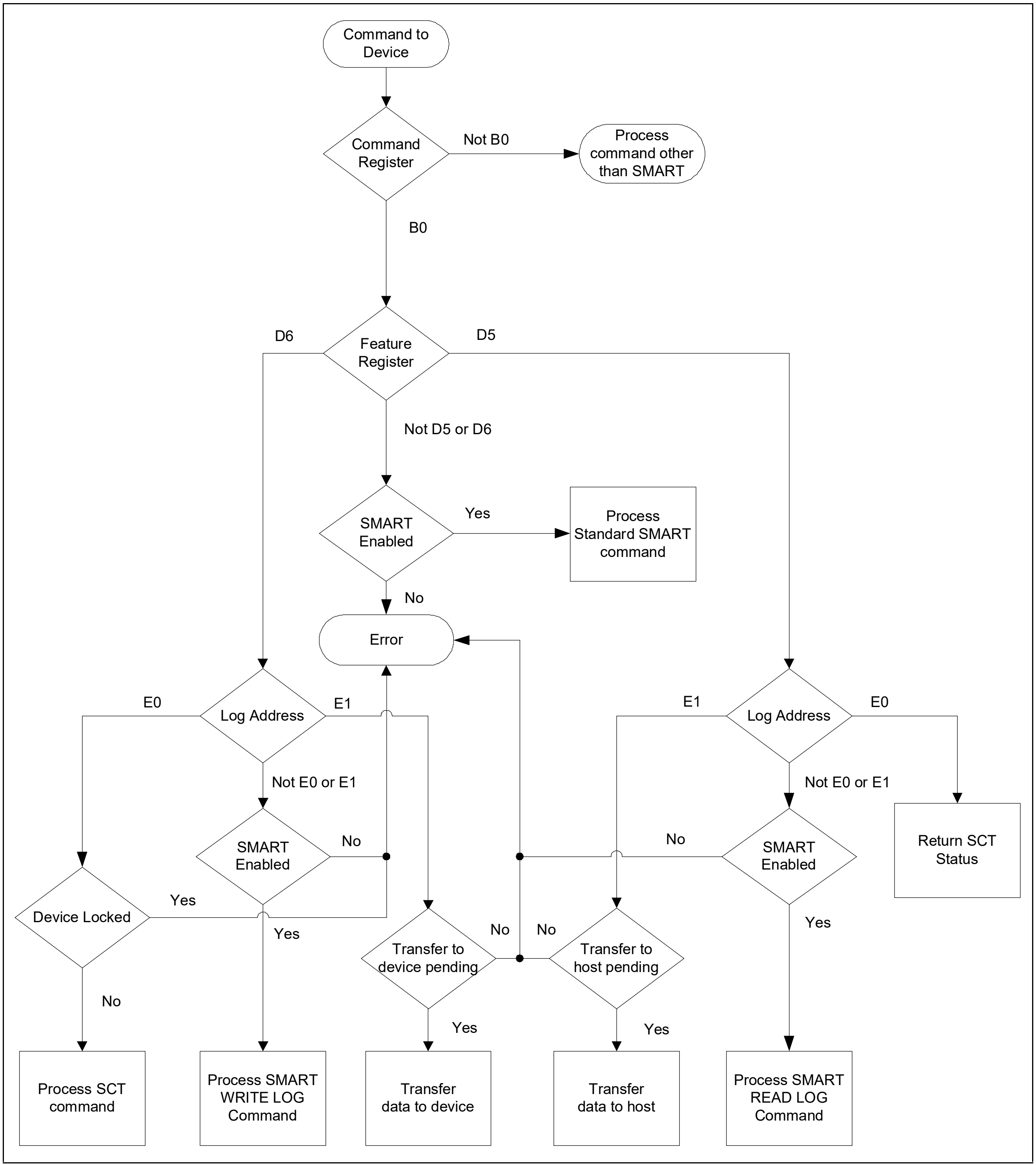

Figure B.1 — Example flowchart for SCT commands

B.2 Examples of Log Page Command Sequences

In these examples, Command Completion is the status returned by a read log command or write log command to the requested log address. Foreground command examples that do not require data transfer to begin processing the command, return command completion as a part of the write log command response. The host may request SCT Status for additional information.

Figure B.2 shows an example of a foreground write same with a repeating write pattern.

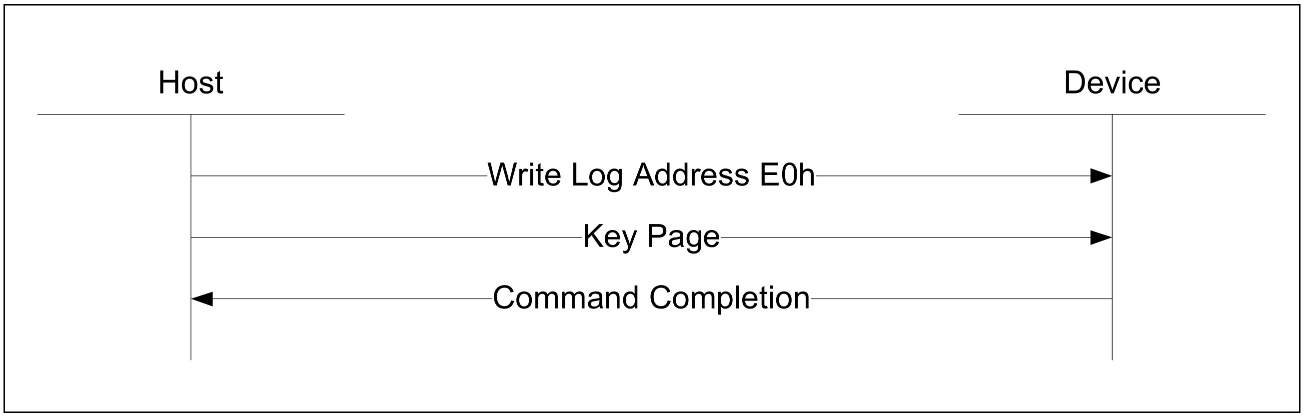

Figure B.2 — Example sequence for foreground write same with a repeating write pattern

Figure B.3 shows an example of a foreground write same with a repeating pattern.

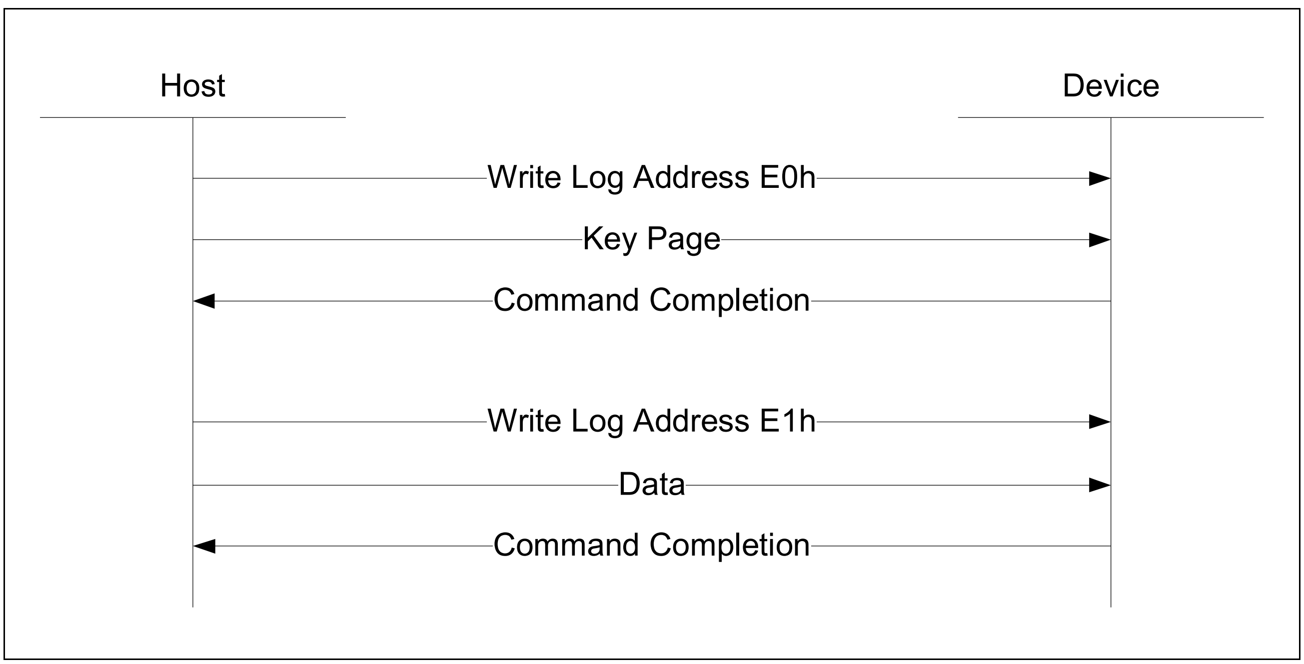

Figure B.3 — Example sequence for foreground write same with a repeating pattern

Figure B.4 shows an example command sequence for writing data to a device using an SCT command with no background activity.

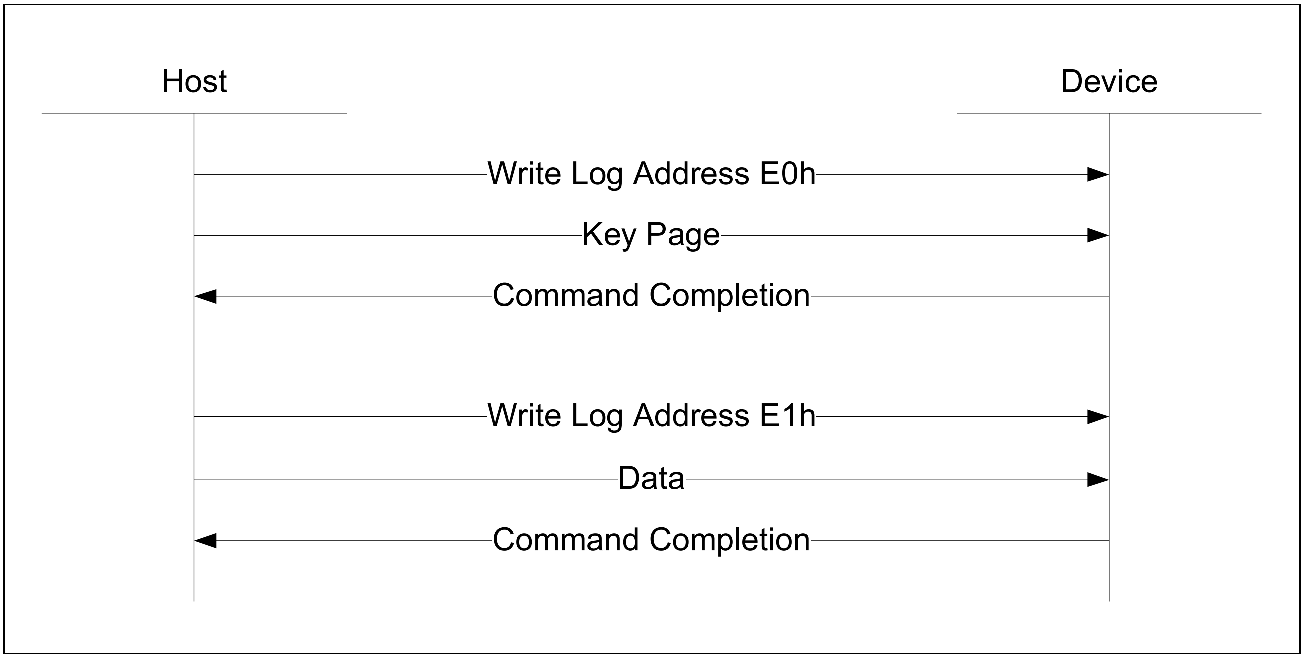

Figure B.4 — Example sequence for writing data using an SCT command with no background activity

Figure B.5 shows an example command sequence for reading data from a device using an SCT command with no background activity.

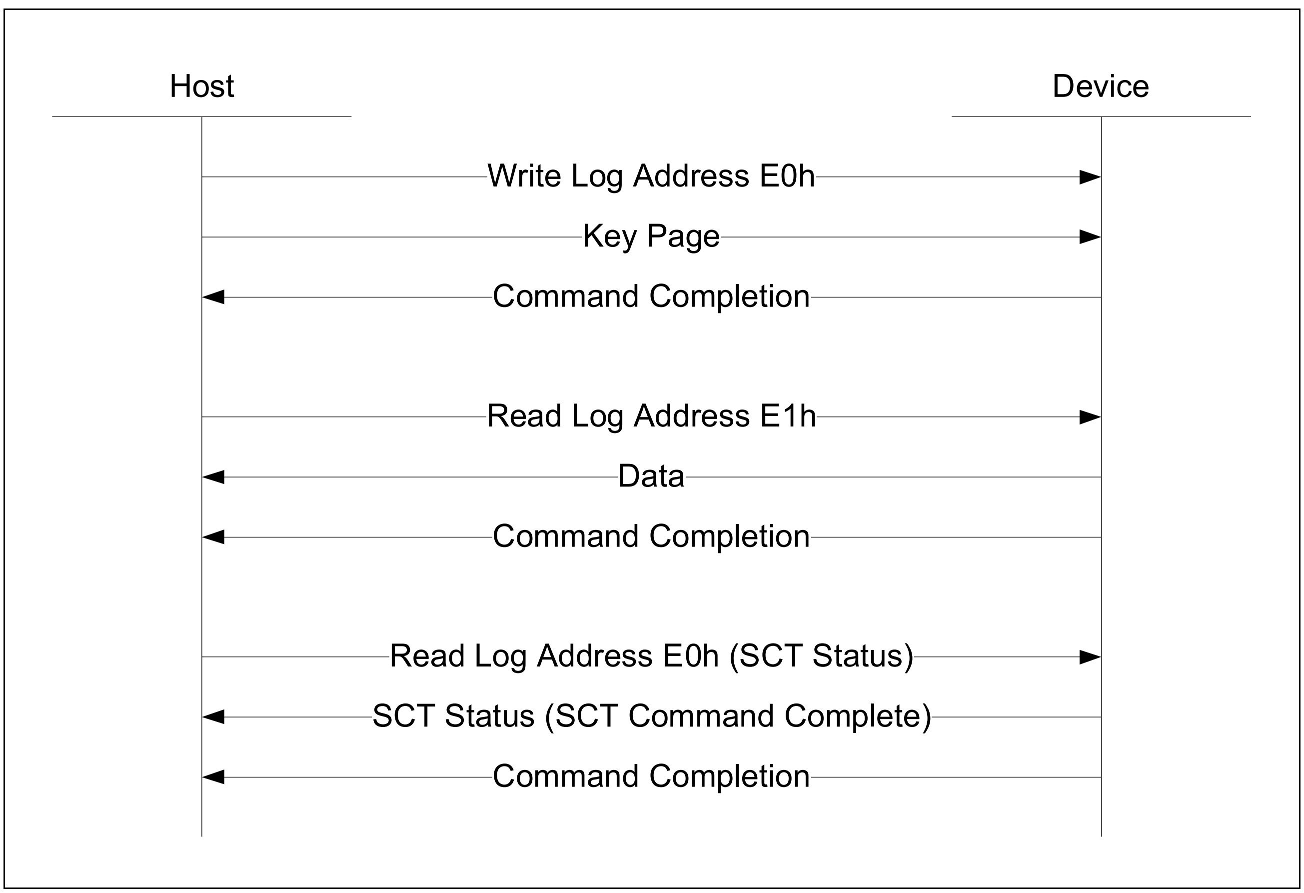

Figure B.5 — Example sequence for reading data using an SCT command with no background activity

Figure B.6 shows an example command sequence for issuing a Log page command that does not transfer data and has no background activity.

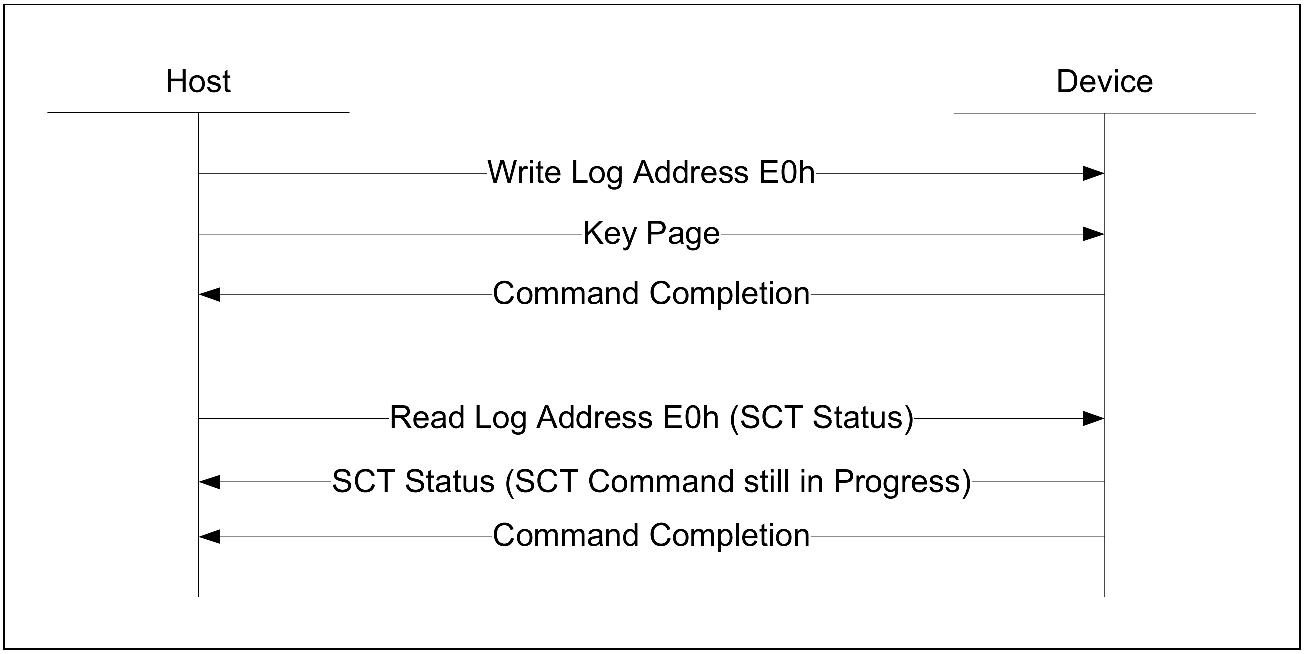

Figure B.6 — Example sequence for a Non-Data SCT command with no background activity

Figure B.7 shows an example command sequence for issuing an SCT command that writes data in the background.

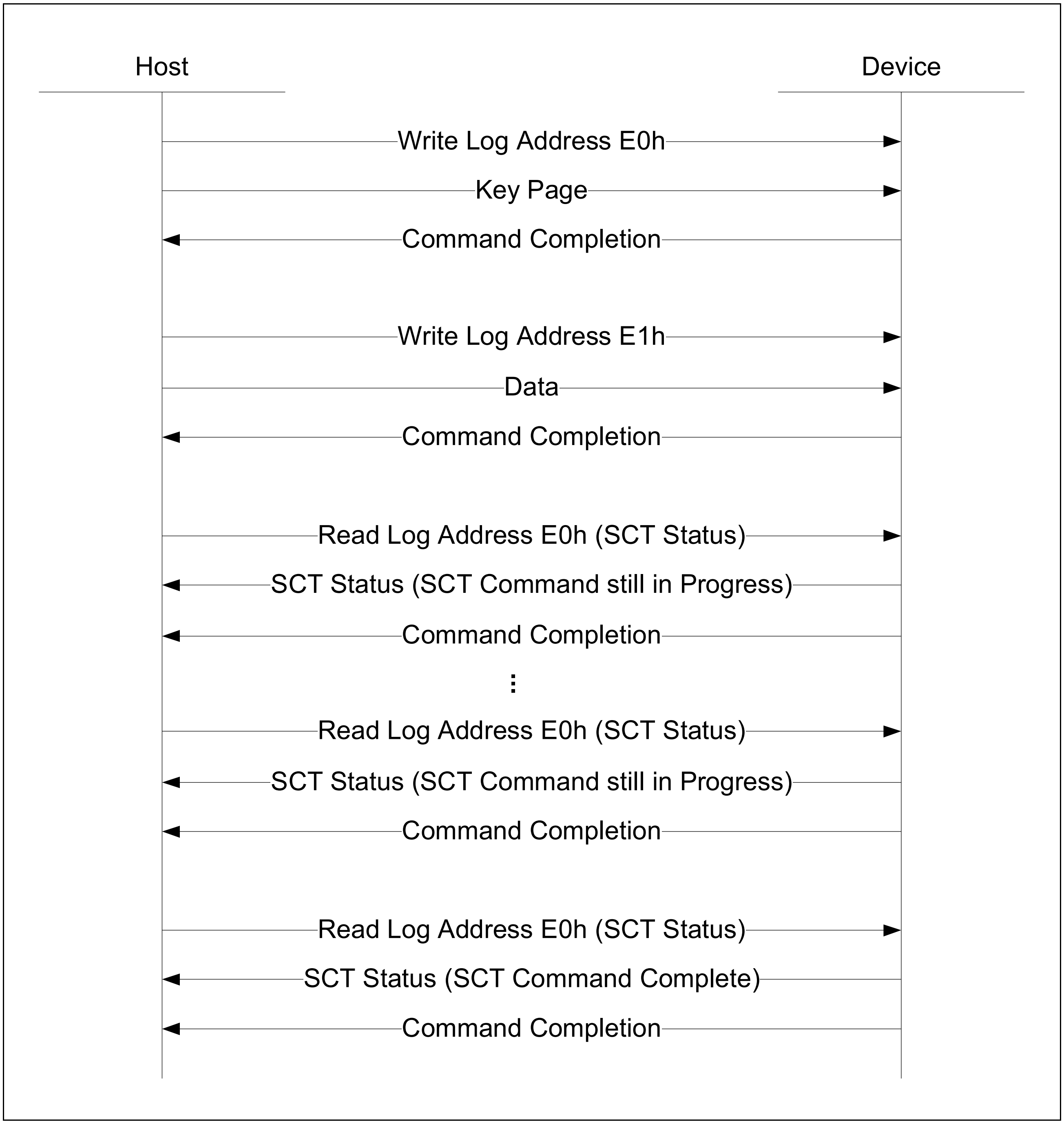

Figure B.7 — Example sequence for writing data using an SCT command with background activity

Figure B.8 shows an example command sequence for issuing an SCT command that writes data in the background. In the example, the key page is first written. The host then checks the SCT Status. After checking the SCT Status, the host then transfers the data necessary for the device to process the SCT Command. The SCT Data is transferred in two separate write log commands. The first write log command returns a nonzero value for number of pages remaining. The second write log command returns zero for number of pages remaining. After the data is transferred, the SCT Command is processed in the background. During background processing, the host polls the device for progress by requesting SCT Status. After the SCT Command is complete, the device returns an SCT Status indicating the success or failure of the SCT Command.

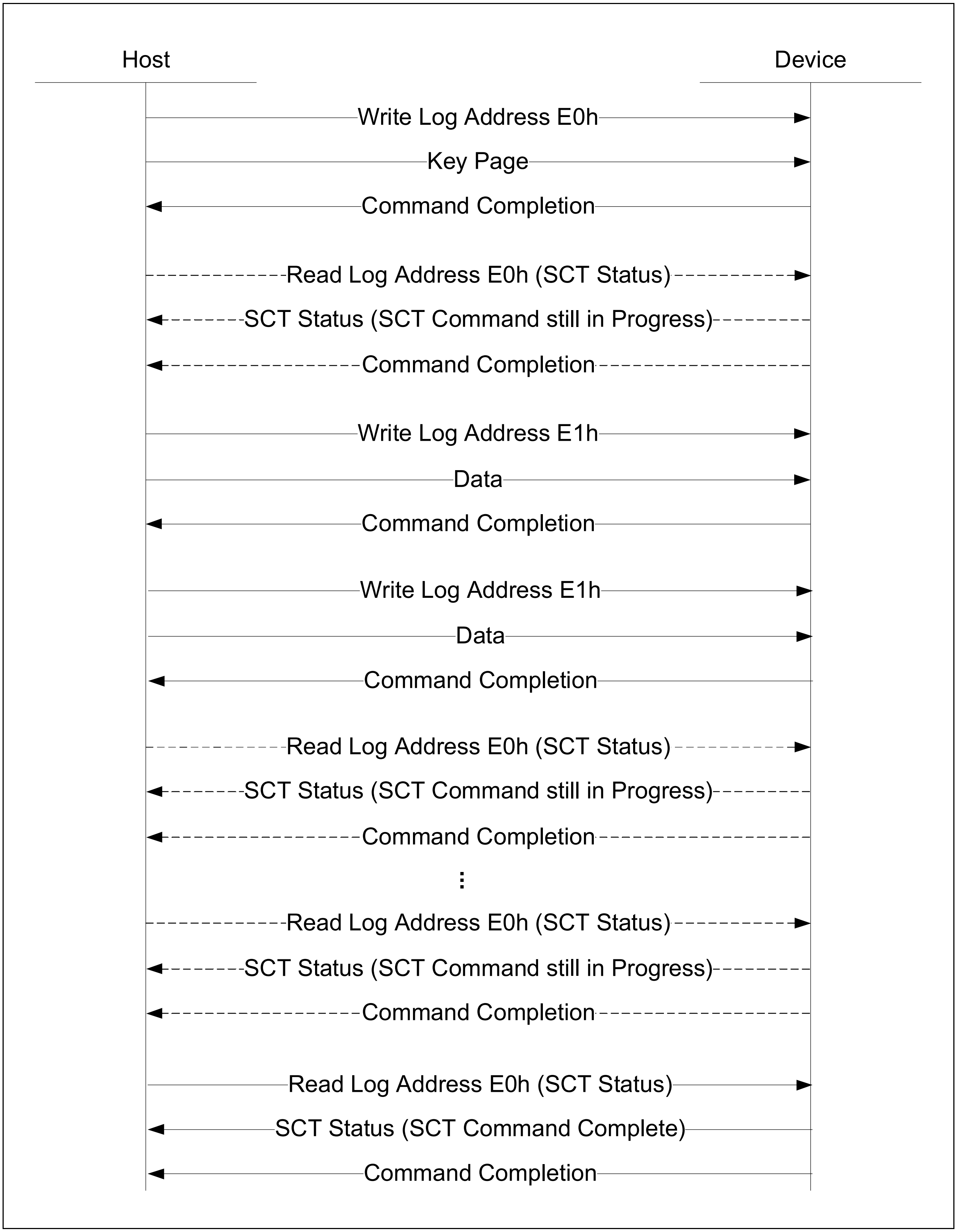

Figure B.8 — Example sequence for writing data using multiple write data transfers

Figure B.9 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.

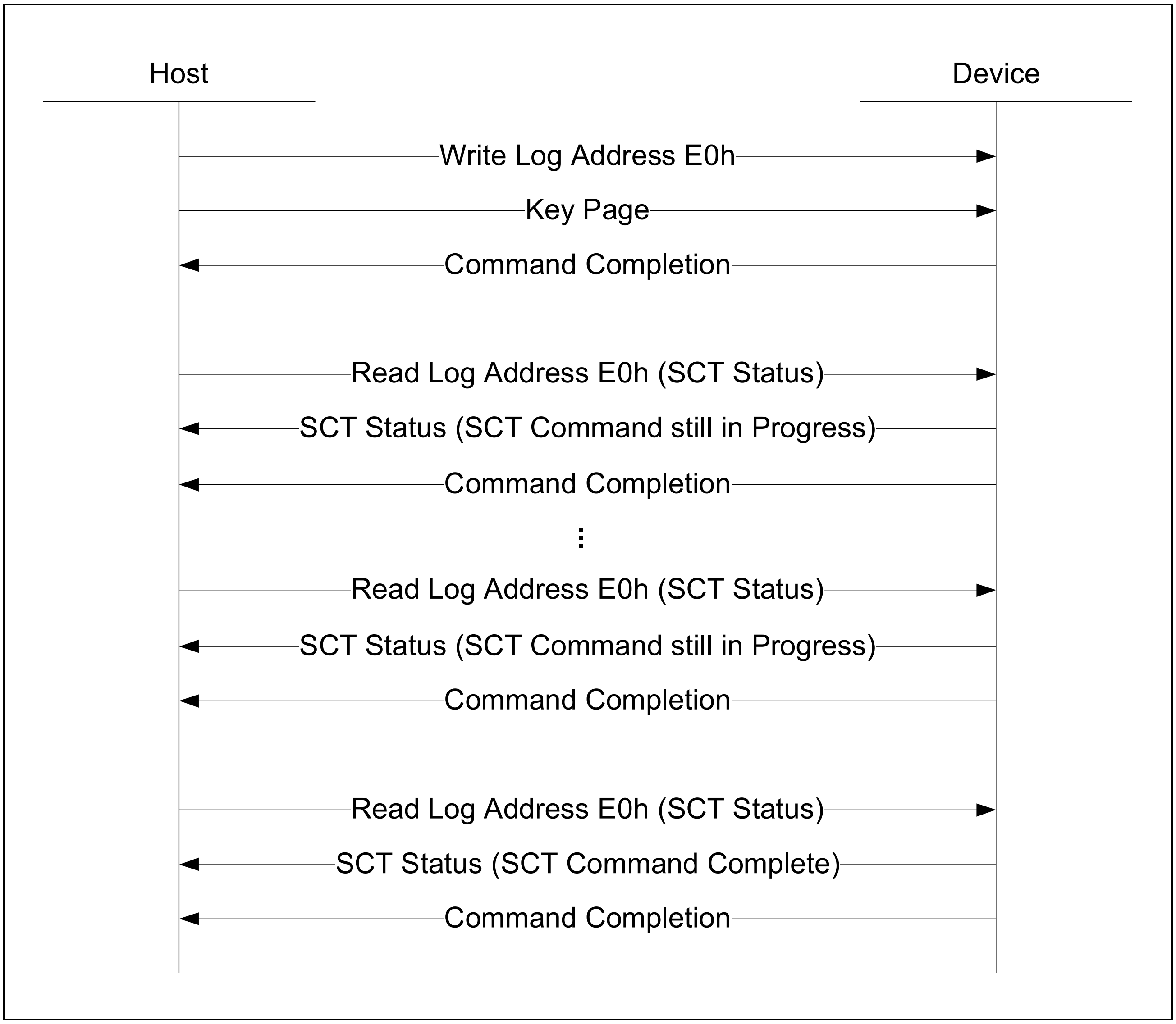

Figure B.9 — Example sequence for a Non-Data SCT command with background activity

B.3 Issuing an SCT Command to a Device

B.3.1 Step 1 – Build a Key Page

The host builds the key page in a host buffer for the appropriate action and parameters.

B.3.2 Step 2 – Issue the SCT command

The host issues the SCT command (see table B.1 or table B.2), and sends the key page to the device.

Table B.1 — SCT command using SMART WRITE LOG command

Field	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 6.2.11 3:0 Reserved
COMMAND	7:0 B0h

Table B.2 — SCT command using WRITE LOG EXT command

Field	Description
FEATURE	Reserved
COUNT	0001h (e.g., one page 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 6.2.11 3:0 Reserved
COMMAND	7:0 3Fh (e.g., WRITE LOG EXT) 57h (e.g., WRITE LOG DMA EXT)

If the SCT command returns command completion without error, then the device responds as shown in table 187. If the command is aborted, 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 Extended Status Code field (see table 188) for the error code (see table 189). If the command is 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 page read command, the data up to and including the page 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 the LBA field (23:8). If the LBA field (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 zero, then the host proceeds to Step 3.

B.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 190 and table 191). 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 190 and table 191). The transfer request is in the range of one data block up to the total number of data blocks not yet transferred. The number of data blocks remaining was reported in the NUMBER OF PAGES REMAINING field (see table 192) in the previous step. If the requested number of data blocks is larger than the value in the most recently reported NUMBER OF PAGES REMAINING field, the device reports an error. If the value is less than the value in the most recently reported NUMBER OF PAGES REMAINING field, the host may repeat Step 3 until all data blocks have been transferred.

For SCT commands that access the media, the device advances the data block pointer by the number of data blocks transferred, and returns the number of data blocks remaining to be transferred in the NUMBER OF PAGES

REMAINING field. If the NUMBER OF PAGES REMAINING field is cleared to zero, then the command is complete, and the host proceeds to Step 4. The host has complete control over the number of data blocks to transfer at a time. If the number of data block to be transferred is greater than or equal to FFFFh, the device sets the NUMBER OF PAGES REMAINING field to FFFFh. The value remains FFFFh until the number of data blocks remaining drops below FFFFh. The exact number to be transferred is reported by the SCT Status command. Upon receiving the final data block, 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.

B.3.4 Step 4 – Final Status/SCT Command Completion

The host reads the SCT status response (see table 196, table 197, and table 200) to determine how the command completed. If the command has not completed (i.e., by reporting FFFFh in table 200 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 final block of data has been transferred to the device.

Annex C
(informative)

Implementation Guidelines for 1 024- and 4 096-Byte Sector Sizes

C.1 Scope

This annex provides guidelines for implementing a media format that incorporates logical sector sizes greater than 512 bytes.

The information provided in this annex enables logical sector sizes that are a binary multiple greater than 512 bytes. This standard also specifies methods to report logical sector sizes that are not a binary multiple. Common logical sector sizes that are not binary multiples include 520-, 524-, 528-, and 532-byte logical sectors. Non-binary multiples are beyond the scope of this annex.

C.2 Overview

Figure C.1 shows major system components that are affected by a change in logical sector size.

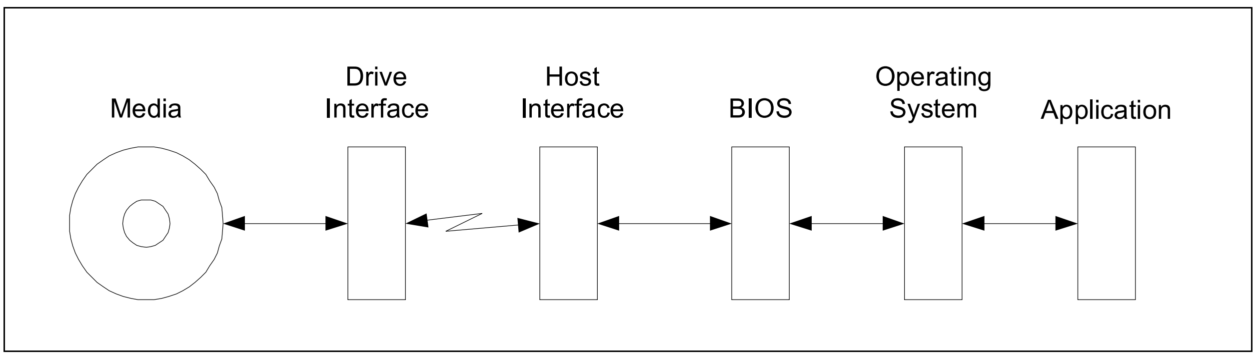

Figure C.1 — System Dependency Chain

The following methods may be used to expand the logical 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 C.2 illustrates these methods.

	Not Mapped	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, 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 C.1. The system dependency chain is evolving and may change to support logical sector sizes larger than 512 bytes.

Figure C.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 C.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 7.13), the Long Logical feature set (see 4.13), and Long Physical Sector feature set (see 4.14). Figure C.3 is an example of the capability specified in this standard.

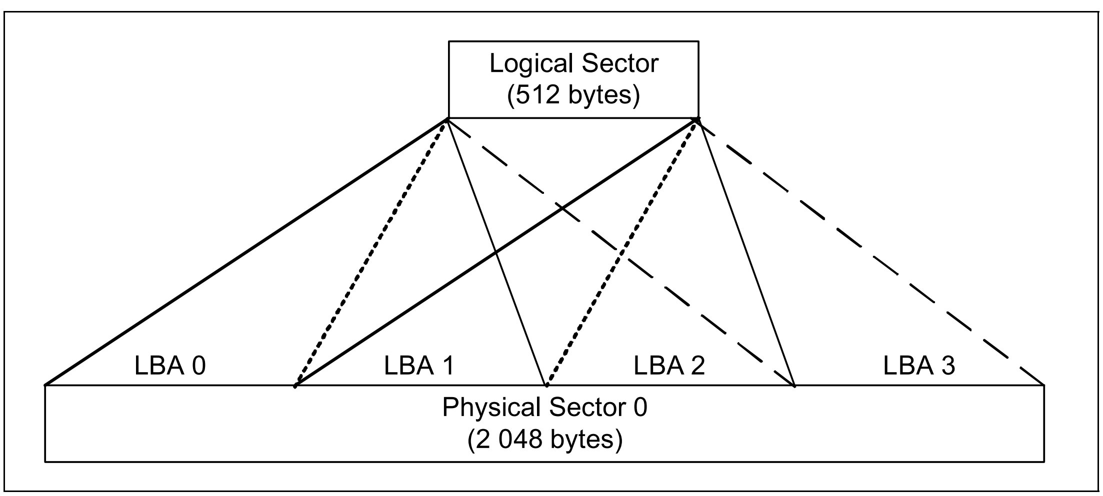

Figure C.3 — Logical Sector to Physical Mapping

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. If mis-alignment occurs, the drive is forced to perform a RMW operation (i.e., Read-Modify-Write) (see C.3.3) 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.

C.3 Implementation

C.3.1 4 096-Byte Physical Sector Size Implementation

Although the 4 096-byte physical sector size allows for greater format efficiencies, 4 096-byte physical sectors cause alignment issues.

The device indicates a 4 096-byte physical sector size to the host by:

a) returning:
   A) the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP SUPPORTED bit (see 9.10.4.3.1) set to one; and
   B) the LOGICAL TO PHYSICAL SECTOR RELATIONSHIP field (see 9.10.4.3.4) set to 3h;

   This indicates 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:
   A) the LOGICAL SECTOR SIZE SUPPORTED bit (see 9.10.4.3.2) set to one; and
   B) the LOGICAL SECTOR SIZE field (see 9.10.4.4) set to 0800h;

   This indicates 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.

C.3.2 Reporting Alignment (512-Byte LBA Only)

This standard defines the ability to report alignment using the LOGICAL SECTOR OFFSET field (see 9.10.4.3.5).

If the drive reports a 4 096-byte physical sector and a 512-byte logical sector, the LOGICAL SECTOR OFFSET field reports the alignment as follows. If the LOGICAL SECTOR OFFSET field is set to:

a) 0000h, then LBA 0 is aligned to the beginning for the first physical sector;
b) 0001h, then LBA 0 is offset from the start of the first physical sector by 512 bytes (i.e., 1 sector);
c) 0002h, then LBA 0 is offset from the start of the first physical sector by 1 024 bytes (i.e., 2 sectors);
d) 0003h, then LBA 0 is offset from the start of the first physical sector by 1 536 bytes (i.e., 3 sectors);
e) 0004h, then LBA 0 is offset from the start of the first physical sector by 2 048 bytes (i.e., 4 sectors);
f) 0005h, then LBA 0 is offset from the start of the first physical sector by 2 560 bytes (i.e., 5 sectors);
g) 0006h, then LBA 0 is offset from the start of the first physical sector by 3 072 bytes (i.e., 6 sectors); and
h) 0007h, 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 for the LOGICAL SECTOR OFFSET field is 0001h.

Windows® 7 reads this value and aligns partitions accordingly.

C.3.3 RMW operations (512-Byte LBA Only)

For devices with a logical sector size of 512 bytes, the drive may be forced to perform a RMW operation 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 6.2.6). 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 C.4 shows the issue.

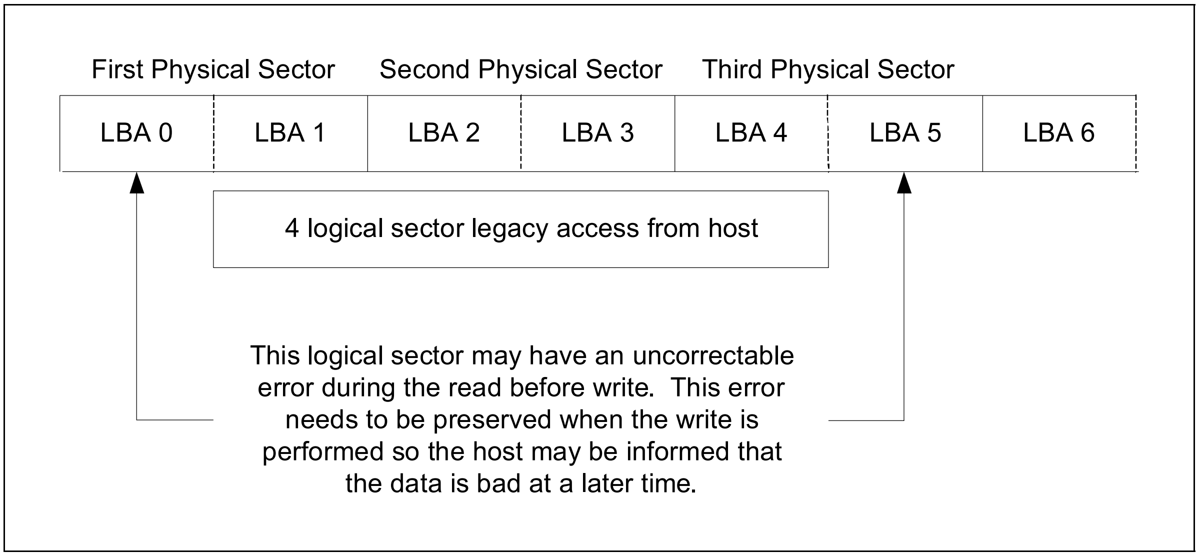

Figure C.4 — Uncorrectable Error Handling

C.4 Implementation Issues (512-Byte LBA Only)

C.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 C.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 logical sector numbers on the left hand side of Figure C.5 show typical and/or legacy locations for the various data structures on the media.

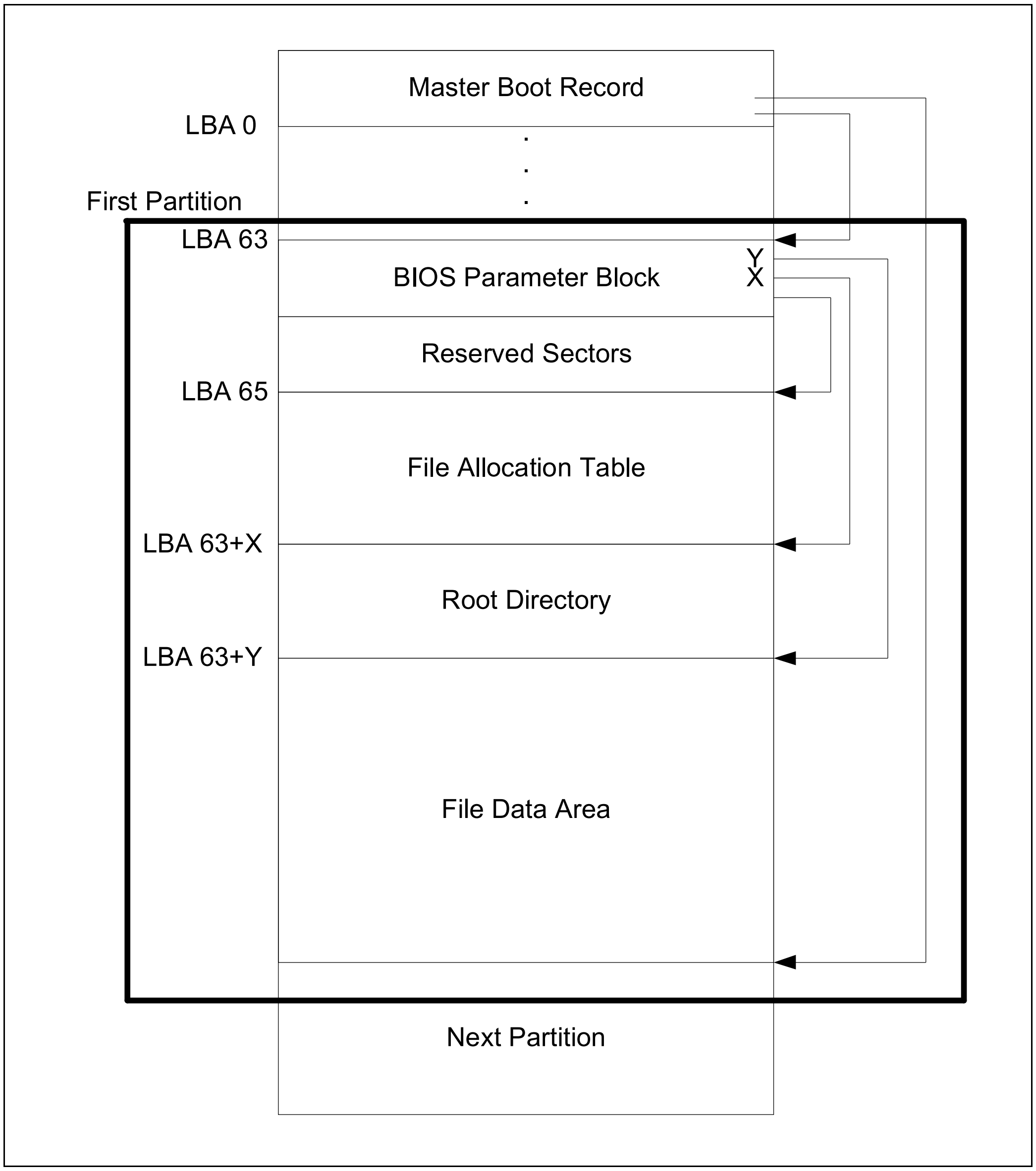

Figure C.5 — Typical HDD Layout Using A Master Boot Record

C.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 logical sector in the first partition varied). Once the logical sectors per track standardized on 63, the LBA value of the first logical 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 logical sectors.

As larger sectors occur, partition alignment becomes an important issue that affects applications that check if the first partition starts on logical sector 63 (e.g., on a 512-byte logical 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 logical sector device, the partitions should start on an even numbered logical sector and end on an odd numbered logical sector, and on a 4 096-byte logical 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 logical sector 63, but a change is required to implement larger sectors on the media.

C.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 logical 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 logical 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.

C.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. If 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.

C.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.

Annex D
(informative)

The DATA SET MANAGEMENT command with Trim

D.1 Overview

The purpose of a trim command is to allow the host to provide LBA/data usage information that allows the storage device to become more performant and to increase data integrity. The effect of any single trim may not be detectable by the host. The reason is that the device evaluates the sectors that are being trimmed to determine if trimming them is useful to the device. If the storage device chooses to leave the state of an LBA that has been trimmed by the host unchanged, then this is not an error. A good example is a trim that starts in the middle of one physical sector, spans a physical sector, and then completes in the middle of the adjacent physical sector. Trimming the fully spanned sector has value. The partial sectors maybe an overhead to the device and therefore may be ignored by the device. A trim that does this returns good status even though all the LBAs were not trimmed.

Trim enables the reporting of LBA's that are not in use by a filesystem to the storage device. The LBAs are specified as a list of ranges. The device evaluates the ranges and decides if there is value in trimming them. When an LBA is trimmed, it may no longer have storage resources associated with that LBA. The value proposition is that the media that has been made available by trimming may be used to support other LBAs. The two main uses are:

a) a second write to the same LBA; or
b) an initial write to an LBA that has never been written, or that has been previously trimmed.

The device does not need to write into the same location on the physical media each time an LBA is written.

The follow behaviors are specified by this standard for sectors that the device trims (see 7.5.3.3):

a) non-deterministic - the data in response to a read from a trimmed sector may change for each read until the sector is written by the host;
b) Deterministic Read After Trim (DRAT) - the data returned in response to a read of a trimmed sector does not change, but may be different than the data that was previously returned; and
c) Read Zeroes After Trim (RZAT) - the data returned in response to a read of the trimmed sector is zero.

If an LBA is trimmed, it does not return data from storage that has been associated with any other LBA. For both DRAT and non-deterministic storage devices, the data returned in response to a read command to an LBA that has been successfully trimmed:

a) may be the previously returned data for the specified LBA;
b) may be a pattern generated by the storage device; and
c) is not data previously written to a different LBA by the host.

Preventing the return of data that was previously written to any other LBA closes a security issue associated with read data that was written to a different LBA.

The DATA SET MANAGEMENT command uses the LBAs it receives as hints. This means that the command may or may not cause a trimmed LBA. If the host needs to force a range of LBAs to return a pattern of all zeros, the ZERO EXT command does this and has an option for forcing trimmed LBAs in the process.

Since trimming is performed based on the devices evaluation of each LBA specified in a Trim function, the host is unable to detect if a sector was trimmed (i.e., the non-deterministic, DRAT and RZAT behaviors, described earlier) based on command completion of a Trim function. This standard provides the LBA status log as a way to find LBAs that are in the trimmed state.

D.2 Trim interaction with volatile caches

This standard does not provide guidance regarding the interaction of DATA SET MANAGEMENT with a volatile caches. As a result, the following example scenarios characterize some of the interaction with volatile caches and surprise power removal.

Example 1, if the device receives:

1) a write of data pattern X to LBA 5;
2) a FLUSH EXT command;
3) a write of data pattern Y to LBA 5 where data is retained in the volatile cache;
4) a trim command for LBA 5;
5) a read of LBA 5 and the device returns pattern A (i.e., the device trimmed the logical block and returned an internal data pattern);
6) a power cycle; and
7) a read command requesting LBA 5,

then the device may return pattern X, pattern Y, pattern A, or a new pattern B.

The reason that example 1 has four possible returns is that there was no flush before the power was removed. If pattern Y was only contained in the cache, then it may be lost and the pattern X on the media is returned. If the trim property of the LBA was lost when power was removed, then pattern X is the only data available to return. If the trim property of the media was preserved prior to power removal, then pattern A is returned when power is reapplied. If pattern Y was written to the media by the device prior to power removal, then pattern Y may be returned. Finally, if the device supports non-deterministic trim, then a fourth unrelated pattern may be returned.

A device that supports non-deterministic behavior (see D.1) may return any data pattern that is not derived from data currently or previously associated with a different LBA. In example 1, a read command requesting LBA may also return a totally unrelated pattern B.

A device that supports DRAT behavior (see D.1) may only return pattern X, pattern Y, or pattern A. The lack of a flush command prior to power being cycled allows the trim status of the drive to be lost. If this is the case, and pattern Y was still in the cache when power was cycled, then the only remaining data to return is pattern X, even if a previous read of LBA 5 returned pattern A. If pattern Y had been written to the media by the device, then a read of LBA 5 returns pattern Y.

A device that supports RZAT behavior (see D.1) may only return pattern X, pattern Y, or pattern A where pattern A is all zeroes. The lack of a flush command prior to power being cycled allows the trim status of LBA 5 to be lost. If pattern Y was committed to the non-volatile media, then the device may return pattern Y or zeroes (i.e., pattern A) in response to the first read of LBA 5 after power is reapplied. If pattern Y was still in the cache when power was removed, then after power is reapplied, the first read of LBA 5 may return pattern X or zeroes (i.e., pattern A).

Example 2, if the device receives:

1) a write of data pattern X to LBA 5;
2) a FLUSH EXT command;
3) a write of data pattern Y to LBA 5 where data is retained in the volatile cache;
4) a trim of LBA 5;
5) a read of LBA 5 returns pattern Y or pattern A (i.e., the device trimmed the logical block and returned an internal data pattern);
6) a FLUSH EXT command that reports good status;
7) a power cycle; and
8) a read command requesting LBA 5,

then the device returns pattern Y, pattern A, or a new pattern B.

The difference between example 1 and example 2 is that in example 2, a flush command was completed before power was removed. This forced the most recent write of LBA 5 to become non-volatile.

A device that supports non-deterministic behavior (see D.1) may return any data pattern that is not derived from data currently or previously associated with a different LBA. In example 2, a read command requesting LBA 5 may also return a totally unrelated pattern B.

A device that supports DRAT behavior (see D.1) may only return pattern Y or pattern A. The flush command prior to power being cycled preserves the trim status of the drive and the pattern that was returned in step 5.

A device that supports RZAT behavior (see D.1) may only return pattern Y or pattern A. For an RZAT device, if pattern A is returned, it is all zeroes. The flush command prior to power being cycled preserves the trim status of the drive and the pattern that was returned in step 5.

Example 3, if the device receives:

1) a write of data pattern X to LBA 5;
2) a FLUSH EXT command;
3) a write of data pattern Y to LBA 5, data is retained in the volatile cache;
4) a trim of LBA 5;
5) a read of LBA 5 and returns pattern A (i.e., the device trimmed the logical block and returned an internal data pattern);
6) a FLUSH EXT command and is able to report good status;
7) a read of LBA 5 and returns pattern A;
8) a power cycle; and
9) a read command requesting LBA 5,

then the device returns pattern A.

Example 3 describes a command sequence that always yields the same result for a device that supports DRAT or RZAT behavior device. If the device supports RZAT, behavior then pattern A is all zeros. If the device supports DRAT behavior, then pattern A may be anything as long as it remains the same pattern for subsequent reads, until a write to LBA 5 is processed. If the device supports DRAT behavior, then the data returned in pattern A is not derived from any data currently or previously associated with a different LBA (see 7.5.3.3).

If the device supports non-deterministic behavior (see D.1), then the device may always return a different pattern in response to a read of LBA 5, as long as the pattern was not derived from data that was previously written to an LBA other than LBA 5.

Annex E
(informative)

Using repurposing depopulation

If a device's condition is suboptimal for a host, repurposing depopulation (see 4.26.3) may be used to depopulate suboptimal storage elements from the device. If the host's requirements for the device's condition change, repurposing depopulation restoration (see 4.26.4) may be used to restore previously depopulated storage elements to the device configuration.

A device indicates a degraded condition of a physical element using the DSN feature set as described in 4.8 and 4.26.2.

The host may determine which storage elements have a physical element health (see 7.12.6.5.5) that is outside the manufacturer's specification limit using the GET PHYSICAL ELEMENT STATUS command (see 7.12).

If the host determines that a storage element that is outside manufacturer's specification limit should be depopulated, then the host may send a REMOVE ELEMENT AND TRUNCATE command (see 7.33) that specifies:

a) the element identifier of the storage element to be depopulated; and
b) the requested native max address, if any.

The REMOVE ELEMENT AND TRUNCATE command initiates repurposing depopulation. A successful repurposing depopulation removes a storage element and may result in a reduction in the number of LBA resources. The repurposing depopulation is not required to preserve logical block data. After a repurposing depopulation has completed, the host may initialize all logical block data.

A sequence of REMOVE ELEMENT AND TRUNCATE commands may be used to depopulate multiple storage elements. A device may have a limit on the number of storage elements that may be depopulated. If the device is requested to depopulate a storage element in excess of this limit, then the device may abort that command as described in 7.33.

If a storage element transitions outside manufacturer's specification limit while performing the actions specified in 4.26.3.2 as a result of repurposing depopulation for a different storage element, then the device notifies the host of that new storage element status change as described in 4.26.2.

The RESTORE ELEMENTS AND REBUILD command (see 7.35) restores previous storage element depopulations. The device indicates which storage elements, if any, are able to be processed by a RESTORE ELEMENTS AND REBUILD command using the RESTORATION ALLOWED bit in the GET PHYSICAL ELEMENT STATUS command (see 7.12).

The RESTORE ELEMENTS AND REBUILD command initiates repurposing depopulation restoration. A successful repurposing depopulation restoration restores at least one storage element and may result in an increase in the number of LBA resources. The repurposing depopulation restoration is not required to preserve logical block data. After a repurposing depopulation restoration has completed, the host may initialize all logical block data.

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