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INTERNATIONAL STANDARD

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Information technology – AT Attachment – Part 102: ATA/ATAPI Command Set - 2 (ACS-2)

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Part 102: ATA/ATAPI Command Set - 2 (ACS-2)

FOREWORD

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International Standard ISO/IEC 17760-102 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

The list of all currently available parts of the ISO/IEC 17760 series, under the general title *Information technology – AT Attachment*, can be found on the IEC web site.

This International Standard has been approved by vote of the member bodies, and the voting results may be obtained from the address given on the second title page.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2, except as indicated in 3.3.

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INTRODUCTION

This International Standard standard encompasses the following:

Clause 1 describes the scope.

Clause 2 provides normative references for the entire standard.

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

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

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

Clause 6 describes Normal and Error Output fields.

Clause 7 describes commands.

Clause 8 describes the SCT Command Transport.

Clause 9 describes command normal and error outputs.

Normative Annex A describes logs.

Informative Annex B provides command summaries.

Informative Annex C describes considerations for using devices with non-512-byte sectors.

Informative Annex D provides a tutorial on how to use SCT.

Informative Annex E provides implementation guidelines for 1 024/4 096 byte sectors.

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ATA document relationships

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). Figure 1 shows the relationship of this standard to the other standards and related projects in the ATA and SCSI families of standards and specifications.

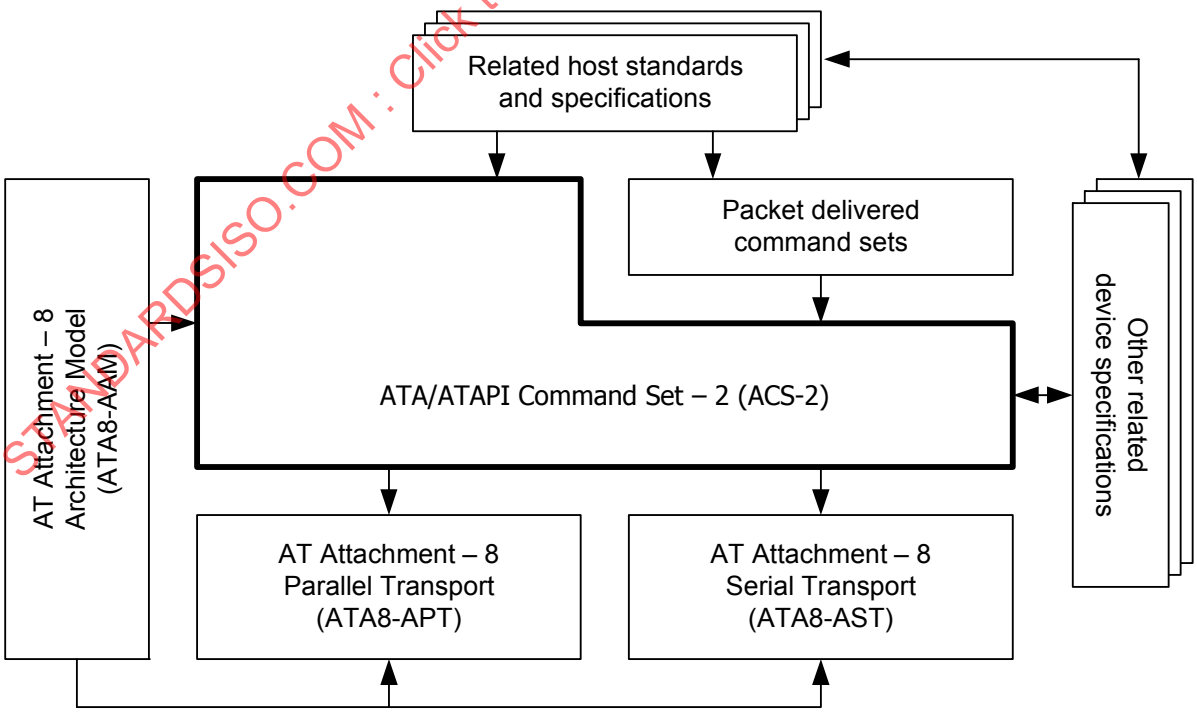

Figure 1 — ATA document relationships

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INFORMATION TECHNOLOGY – AT Attachment –

Part 102: ATA/ATAPI Command Set - 2 (ACS-2)

1 Scope

This part of ISO/IEC 17760-102 specifies the command set host systems use to access storage devices. It provides a common command set for systems manufacturers, system integrators, software suppliers, and suppliers of intelligent storage devices.

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

2 Normative references

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

ISO/IEC 646, *Information technology – ISO 7-bit coded character set for information interchange*[1]

ISO/IEC 14776-323, *SCSI Block Commands - 3 (SBC-3)*

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

ANSI INCITS 451-2008[R2013], *AT Attachment-8 – ATA/ATAPI Architecture Model (ATA8-AAM)*

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

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

ANSI INCITS BSR 513, *SCSI Primary Commands - 4 (SPC-4)* (planned as ISO/IEC 14776-454)

Serial ATA revision 2.6 (SATA 2.6) (see http://www.sata-io.org)

CompactFlash Association Specification, *Revision 5.0* (see http://www.compactflash.org)

CFast™, a CompactFlash™ Association Specification, *Rev 1.0* (see http://www.compactflash.org)[2]

IETF RFC 3280, *Internet X.509 Public Key Infrastructure: Certificate and Certificate Revocation List (CRL) Profile* (see http://www.ietf.org)

IETF RFC 3281, *An Internet Attribute Certificate: Profile for Authorization* (see http://www.ietf.org)

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1. ANSI INCITS 4-1986 (R2002), *Information Systems – Coded Character Sets – 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII)*

2. CFast and CompactFlash are trademarks of the Compact Flash Association.

3 Terms, definitions, abbreviations, and conventions

3.1 Terms and definitions

For the purposes of this document the following terms and definitions apply.

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

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

3.1.3
acoustics
measurement of airborne noise emitted by information technology and telecommunications equipment

Note 1 to entry: See ISO 7779:1999(E).

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

3.1.5
application
software that is dependent on the services of an operating system

3.1.6
application client
object in the host that is the source of commands and device management functions

Note 1 to entry: See ATA8-AAM.

3.1.7
ASCII character
byte containing a 7-bit ASCII pattern in bits (6:0) with bit 7 cleared to zero

Note 1 to entry: See ISO/IEC 646.

3.1.8
ATA device
AT Attachment device
device implementing the General feature set

Note 1 to entry: See 4.2.

3.1.9
ATA string
set of ASCII characters (see 3.1.7) in the format specified in 3.3.10

3.1.10
ATAPI device
AT Attachment Packet Interface device
device implementing the PACKET feature set

Note 1 to entry: See 4.3.

3.1.11
Audio-Video
AV
Audio-Video application data that is related to video images and/or audio

Note 1 to entry: See 4.24.

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3.1.12
Background Activities
activities initiated by a command that occur after command completion has been reported

3.1.13
basic input/output system
BIOS
initial application client that is run when power is applied

Note 1 to entry: The primary function of BIOS is to initialize various components (e.g. storage devices).

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

3.1.15
byte
sequence of eight contiguous bits considered as a unit

Note 1 to entry: See 3.3.9.

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

3.1.17
CFA device
device implementing the CFA feature set

Note 1 to entry: CFA devices may implement the ATA8-APT transport or the ATA8-AST transport (see 3.1.19).

Note 2 to entry: See 4.6.

3.1.18
CFA-APT device
CFA device that implements the ATA8-APT transport and not the ATA8-AST transport

3.1.19
CFast™ Device
CF form factor device that conforms to the SATA device requirements in this standard, implements the ATA8-AST transport and does not implement the ATA8-APT transport

Note 1 to entry: CFast™ devices may support the CompactFlash™ feature set.

3.1.20
check condition
indicates an error or exception condition has occurred for an ATAPI device

3.1.21
circular buffer
buffer that is filled starting at the first byte continuing to the last byte and then wraps to store data in the first byte of the buffer again

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

3.1.23
command acceptance
positive acknowledgement of a command being received by a device

Note 1 to entry: See the appropriate transport standard for a definition of positive acknowledgement.

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3.1.24
command completion
completion by the device of the action requested by the command or the termination of the command with an error, the setting of the appropriate bits in the Error field, and the setting of the appropriate bits in the Status field

3.1.25
command packet
data structure transmitted to the device during the processing of a PACKET command

Note 1 to entry: A command packet includes the command and command parameters.

3.1.26
COMRESET
commanded hardware reset in the Serial ATA transport

Note 1 to entry: See SATA 2.6.

3.1.27
Data Set
set of LBA Ranges used by the device as a single group

3.1.28
DCO Set
command which changes the device configuration

Note 1 to entry: The following commands are DCO Set commands: DEVICE CONFIGURATION SET command (see 7.10.6) and DEVICE CONFIGURATION SET DMA command (see 7.10.7).

Note 2 to entry: See 4.7.

3.1.29
device
data storage peripheral

EXAMPLE a disk drive.

Note 1 to entry: See 3.1.8 and 3.1.10.

3.1.30
DMA data transfer
direct memory access data transfer
means of data transfer between device and host memory without application client intervention

3.1.31
DRQ data block
Data Request 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

3.1.32
DWord
sequence of four contiguous bytes considered as a unit

Note 1 to entry: See 3.3.9.

3.1.33
FIS
Frame Information Structure for the serial ATA interface

Note 1 to entry: See ATA8-AST.

3.1.34
free fall
vendor specific condition of acceleration

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3.1.35
hardware reset
routine performed by a device after a hardware reset event as defined in ATA8-AAM

3.1.36
HPA Locked
condition of a device in the H2, HL1-HL6 or HEL1-HEL6 state

Note 1 to entry: See 4.11.6.

3.1.37
HPA Unlocked
condition of a device in the H0, H1, H3, HS1-HS6, or HES1-HES6 state

Note 1 to entry: HPA Unlocked states are those in which the password may or may not be set.

Note 2 to entry: See 4.11.6.

3.1.38
host
object that originates commands and device management functions

Note 1 to entry: See ATA8-AAM.

3.1.39
host adapter
implementation of the host transport, link, and physical layers

3.1.40
host interface
service delivery subsystem

Note 1 to entry: See ATA8-AAM.

3.1.41
Idle mode
power condition specified by the PM1: Idle state

3.1.42
Invalid LBA
LBA that is greater than or equal to the largest value reported in IDENTIFY DEVICE data words 60..61 (see 7.17.7.22), IDENTIFY DEVICE data words 100..103 (see 7.17.7.53), or IDENTIFY DEVICE data words 230..233 (see 7.17.7.89)

3.1.43
Invalid LBA Range
range of LBAs that contains one or more invalid LBAs

3.1.44
least significant bit
LSB
<binary code> bit or bit position with the smallest numerical weighting in a group of bits that, when taken as a whole, represent a numerical value

EXAMPLE - In the number 0001b, the bit that is set to one.

3.1.45
logical block address
LBA
value used to reference a logical sector

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3.1.46
logical sector
logical block
sector
set of logical words accessed and referenced as a unit

Note 1 to entry: Logical sectors are referenced by LBA (see 3.1.45).

Note 2 to entry: See IDENTIFY DEVICE data words 118:117 (see 7.17.7.61).

3.1.47
log
named sequence of one or more log pages

Note 1 to entry: See Annex A.

3.1.48
log address
numeric value that a log command uses to identify a specific log

3.1.49
log command
SMART READ LOG command (see 7.54.7), SMART WRITE LOG command (see 7.54.9), or GPL feature set (see 4.10) command

3.1.50
log page
512-byte block of data associated with a log

Note 1 to entry: See Annex A.

3.1.51
Master Password Capability
Security Level
indication of whether the Master password may be used to unlock the device

3.1.52
Media
material on which user data is stored

3.1.53
Media Access Command
command that causes the device to access non-volatile media

3.1.54
most significant bit
MSB
<binary code> bit or bit position with the largest numerical weighting in a group of bits that, when taken as a whole, represent a numerical value

EXAMPLE - In the number 1000b, the bit that is set to one.

3.1.55
native max address
highest LBA that a device accepts as reported by DEVICE CONFIGURATION IDENTIFY data as reduced by the DEVICE CONFIGURATION SET command

Note 1 to entry: The native max address is the highest LBA that is accepted by a device using the SET MAX ADDRESS command (see 7.50.2). If the 48-bit Address feature set is supported, the native max address is the highest value accepted by a device using the SET MAX ADDRESS EXT command (see 7.51).

3.1.56
Non-Volatile cache
cache that retains data through all reset events (e.g. power-on reset)

Note 1 to entry: Non-volatile cache is a subset of the non-volatile media.

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3.1.57
Non-Volatile Media
physical storage media that retains data written to it through all reset events (e.g., power-on reset)

3.1.58
NV Cache Pinned Set
set of logical blocks specified by the application client for which all user data accesses associated with those logical blocks are written to or read from the non-volatile cache

3.1.59
NV Cache Set
set of logical blocks represented in the device's entire NV Cache

3.1.60
NV Cache Set Data
data structure representing the standard format of transmitting logical blocks in the form of a list of LBA Range Entries

3.1.61
NV Cache Unpinned Set
set of logical blocks that are represented in the NV Cache Set but not represented in the NV Cache Pinned Set

Note 1 to entry: See 4.15.1.

3.1.62
organizationally unique identifier
OUI
numeric identifier that is assigned by the IEEE such that no assigned identifiers are identical

Note 1 to entry: OUI is equivalent to company_id or IEEE company_id.

Note 2 to entry: The numeric identifier is called an OUI when it is assigned by the IEEE.

Note 3 to entry: The IEEE maintains a tutorial describing the OUI at http://standards.ieee.org/regauth/oui/.

3.1.63
partition
range of LBAs specified by an application client

3.1.64
Password Attempt Counter Exceeded
contents of IDENTIFY DEVICE, word 128, bit 4 (see 7.17.7.66)

3.1.65
PATA device
Parallel ATA device
device implementing the parallel ATA transport

Note 1 to entry: See ATA8-APT.

3.1.66
physical sector
one or more contiguous logical sectors that are read from or written to the device media in a single operation

3.1.67
PIO data transfer
programmed input/output data transfer
data transfers performed using PIO commands and protocol

3.1.68
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 4.8.

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3.1.69
power cycle
interval from when power is removed from a host or device until the subsequent power-on event

Note 1 to entry: See ATA8-AAM.

3.1.70
power-on reset
host specific routine performed by the host or the routine performed by a device after detecting a power-on event

Note 1 to entry: See ATA8-AAM.

3.1.71
Queued Command
NCQ command that has reported command acceptance but not command completion

3.1.72
QWord
sequence of eight contiguous bytes considered as a unit

Note 1 to entry: See 3.3.9.

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

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

3.1.74
read stream command
command that causes the device to transfer data from the device to the host

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

3.1.75
SATA device
Serial ATA device
device implementing the serial ATA transport

Note 1 to entry: See ATA8-AST.

3.1.76
SCT Command
command that writes to the SCT command/status log

Note 1 to entry: See clause 8.

3.1.77
SCT Status
command that reads from the SCT command/status log

Note 1 to entry: See clause 8.

3.1.78
Serial ATAPI device
device implementing the serial ATA transport (see ATA8-AST) and the PACKET feature set

3.1.79
signature
unique set of values placed in the return parameters used to distinguish device types (e.g., General, ATAPI device, Port Multiplier)

Note 1 to entry: See table 217.

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3.1.80
signed
value that is encoded using two's compliment

3.1.81
Sleep mode
power condition specified by the PM3: Sleep state

3.1.82
software reset
routine performed by a device after a software reset event as defined in ATA8-AAM

Note 1 to entry: The software reset routine includes the actions defined in ATA8-AAM, this standard, and the applicable transport standards.

3.1.83
spin-down
process of bringing a rotating media device's media to a stop

3.1.84
spin-up
process of bringing a rotating media device's media to operational speed

3.1.85
Standby mode
power condition specified by the PM2: Standby state

3.1.86
Stream
set of operating parameters specified by a host using the CONFIGURE STREAM command (see 7.8) to be used for subsequent READ STREAM commands and WRITE STREAM commands

3.1.87
transport
mechanism used to communicate with a device

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

3.1.88
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

3.1.89
unrecoverable error
when the device sets either the Error bit or the Device Fault bit to one in the Status field at command completion

3.1.90
user data
data that is transferred between the application client and the device using read commands and write commands

3.1.91
user data area
area of the device's media that stores user data and is addressable by the host from LBA 0 to DEVICE CONFIGURATION IDENTIFY data words 3..6

3.1.92
Volatile Cache
cache that does not retain data through power cycles

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3.1.93
vendor specific
bits, bytes, fields, and code values that are reserved for vendor specific purposes, also levels of functionality whose definition is left to the vendor

Note 1 to entry: Vendor specific bits, bytes, fields, and code values are not described in this standard, and implementations may vary among vendors.

3.1.94
word
sequence of two contiguous bytes considered as a unit

Note 1 to entry: See 3.3.9.

3.1.95
write command
command that causes the device to transfer data from the host to the device

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

3.1.96
write stream command
command that causes the device to transfer data from the host to the device

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

3.1.97
world wide name
WWN
64-bit worldwide unique name based upon a company's IEEE OUI

Note 1 to entry: The WWN is reported in IDENTIFY DEVICE data words 108..111 (see 7.17.7.58) and IDENTIFY PACKET DEVICE data words 108..111 (see 7.18.6.44).

3.2 Symbols and abbreviations

3.2.1 Abbreviations

Abbreviations used in this standard:

Abbreviation	Meaning
ACS	ATA/ATAPI Command Set
APM	Advanced Power Management
ASC	Additional Sense Code
ASCII	American Standard Code for Information Interchange
ASCQ	Additional Sense Code Qualifier
ASR	Asynchronous Signal Recovery
ATA	AT Attachment
ATAPI	AT Attachment with Packet Interface
ATA/ATAPI-5	AT Attachment with Packet Interface Extension - 5 (see Bibliography)
ATA/ATAPI-6	AT Attachment with Packet Interface Extension - 6 (see Bibliography)
ATA/ATAPI-7	AT Attachment with Packet Interface Extension - 7 (see Bibliography)
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)

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Abbreviation	Meaning
AV	Audio/Visual
BIOS	Basic I/O System
CDB	Command Descriptor Block (see SPC-4)
CFA	Compact Flash Association
CFast	Compact Flash ATA Serial Transport
CRC	Cyclic Redundancy Check
DCO	Device Configuration Overlay
DDT	Method to Disable Data Transfer after Error Technical Report (see Bibliography)
DMA	Direct Memory Access
DRQ	Data ReQuest
EPC	Extended Power Conditions
EXT	Command used the extended (48-bit LBA) format parameters
FIS	Frame Information Structure
FUA	Forced Unit Access
GPL	General Purpose Logging
HBA	Host Bus Adapter
HBA-2	Host Bus Adapter - 2 (see Bibliography)
HPA	Host Protected Area
INCITS	InterNational Committee for Information Technology Standards (see www.incits.org)
ISO	Organization for International Standards
LBA	Logical Block Address
LLS	Long Logical Sector
LPS	Long Physical Sector
LSB	Least Significant Bit
MSB	Most Significant Bit
NCQ	Native Command Queueing
NV	Non-volatile
OUI	Organizationally Unique Identifier
PARTIES	Protected Area Run Time Interface Extensions (see Bibliography)
PATA	Parallel ATA
PIO	Programmed Input/Output
PUIS	Power-Up In Standby
RMW	Read-Modify-Write
SATA	Serial ATA
SATA-IO	Serial ATA International Organization (see www.sata-io.org)
SCT	SMART Command Transport
SMART	Self-Monitoring Analysis and Reporting Technology
SPC-4	SCSI Primary Commands - 4 (see clause 2)
SSP	Software Settings Preservation
T10	INCTIS Technical Committee T10
T13	INCTIS Technical Committee T13
TCG	Trusted Computing Group (see www.trustedcomputinggroup.org)
TLC	Time Limited Commands (see Bibliography)

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Abbreviation	Meaning
VS	Vendor Specific
WWN	World Wide Name

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
®	registered trademark
™	registered trademark

3.2.4 Mathematical operators

Mathematical operators used in this standard:

Mathematical Operator	Meaning
+	added to
–	subtracted from
×	multiplied by
/	divided by
<	less than
≤	less than or equal to
>	greater than
≥	greater than or equal to

3.3 Conventions

3.3.1 Overview

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

The names of abbreviations, commands, fields, and acronyms used as signal names are in all uppercase (e.g., IDENTIFY DEVICE). Fields containing only one bit are usually referred to as the “name” bit instead of the “name” field. (See 3.3.6 for the naming convention used for naming bits.)

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

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

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3.3.2 Precedence

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

3.3.3 Lists

3.3.3.1 Lists overview

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

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

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

3.3.3.2 Unordered lists

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

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

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.

3.3.3.3 Ordered lists

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

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

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.

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3.3.4 Keywords

3.3.4.1
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.

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

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

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

3.3.4.5
obsolete
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.

3.3.4.6
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.

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

3.3.4.8
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 in accordance with a future extension to this standard. The recipient shall not check reserved bits, bytes, words, or fields.

Note 3 to entry: Receipt of reserved code values in defined fields shall be considered a command parameter error and reported by returning command aborted.

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3.3.4.9
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.

3.3.4.10
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.

3.3.4.11
should
keyword indicating flexibility of choice with a strongly preferred alternative

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

3.3.5 Numbering

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

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

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

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

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

Table 1 — Numbering conventions

ISO/IEC	US	This standard
0,6	0.6	0.6
3,141 592 65	3.14159265	3.141 592 65
1 000	1,000	1 000
1 323 462,95	1,323,462.95	1 323 462.95

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

3.3.6 Bit conventions

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

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3.3.7 Number range convention

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

3.3.8 State diagram conventions

All state diagrams use the notation shown in Figure 2.

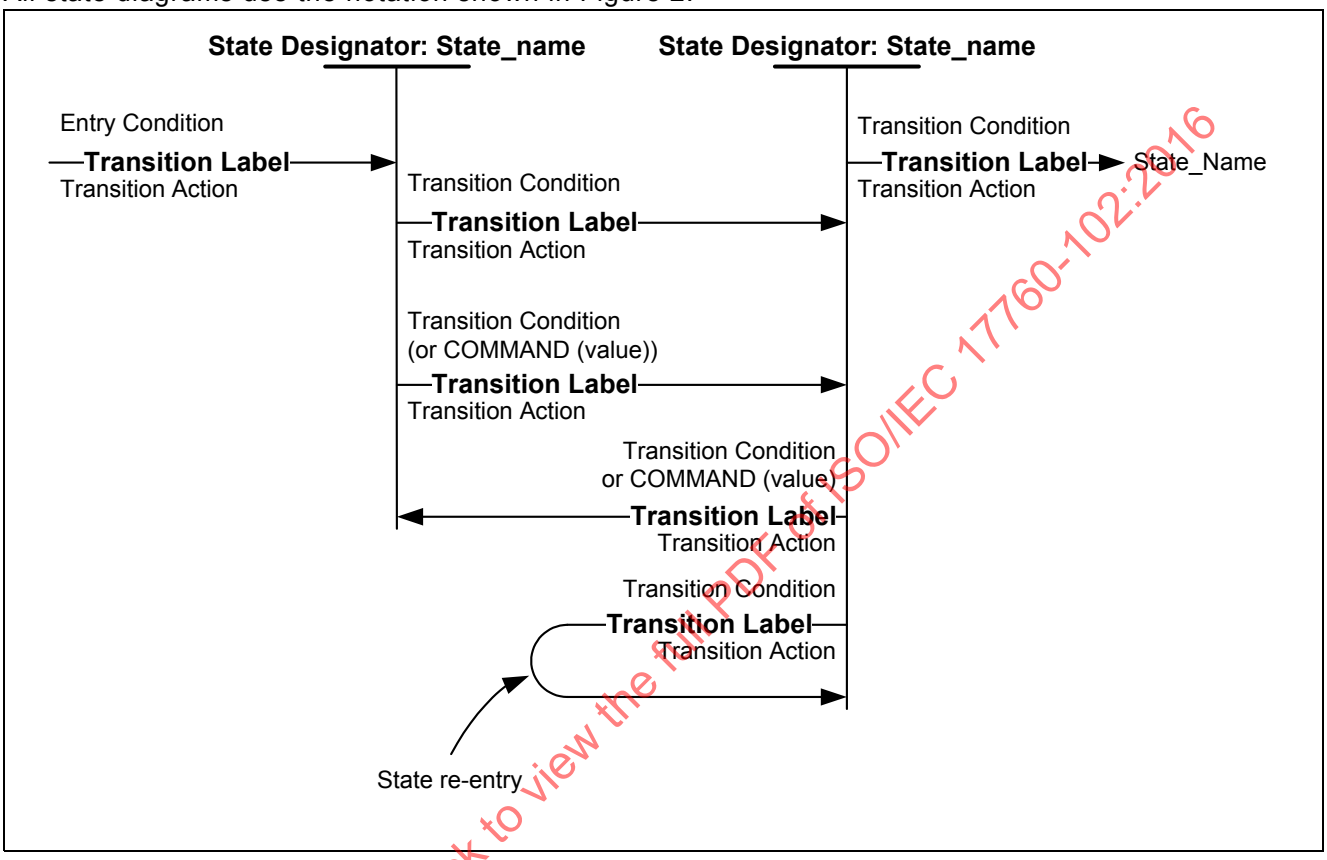

Figure 2 — State diagram convention

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

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

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

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

All transitions shall be instantaneous.

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

EXAMPLE 1 - SET MAX ADDRESS (volatile) means the device successfully processes a volatile SET MAX ADDRESS command (i.e., a SET MAX ADDRESS with the V_V field set to zero).

EXAMPLE 2 - SET MAX ADDRESS (non-volatile) means the device successfully processes a non-volatile SET MAX ADDRESS command (i.e., a SET MAX ADDRESS with the V_V field set to one).

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

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

3.3.9 Byte, word, DWord, and QWord Relationships

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

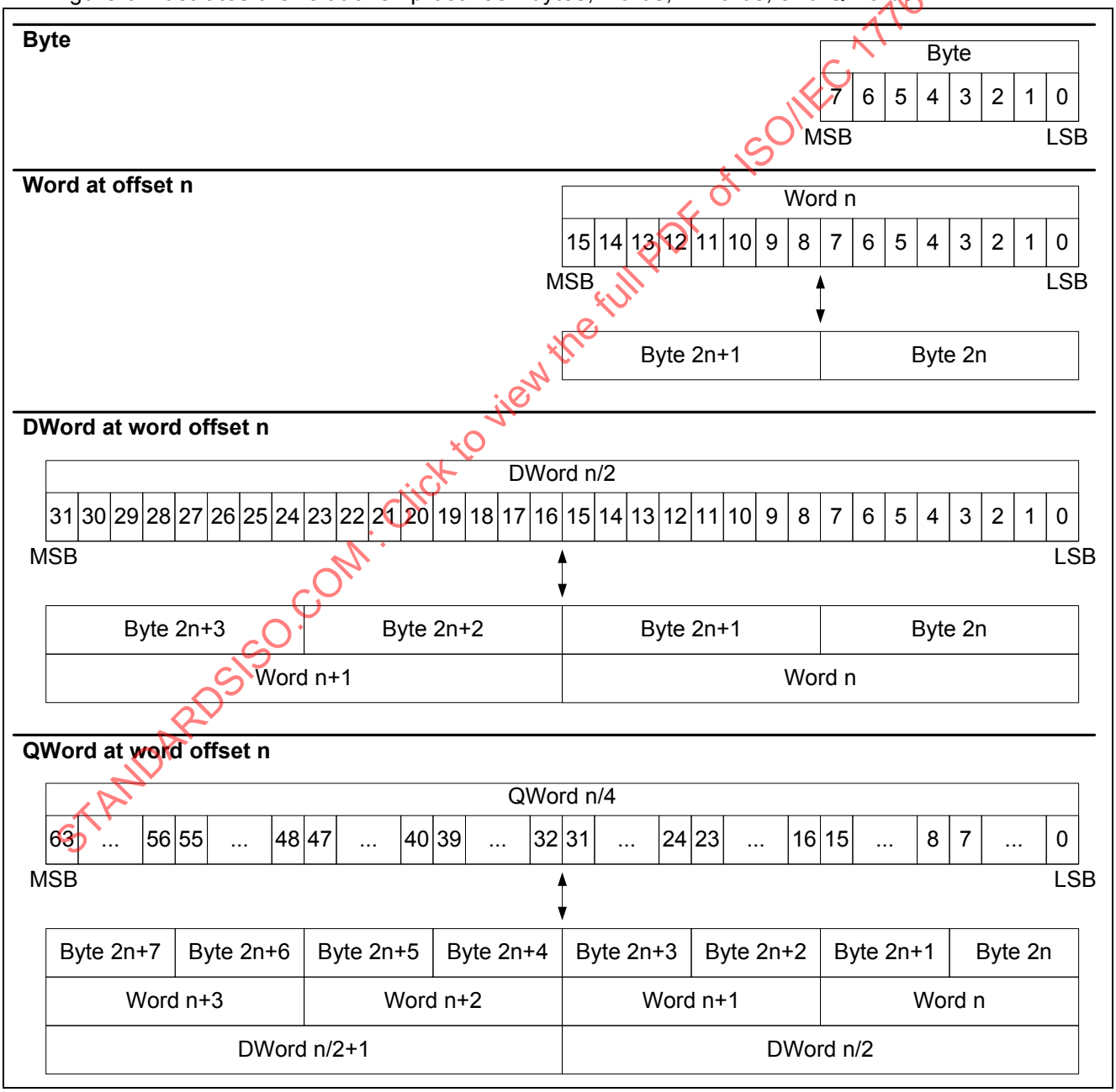

Figure 3 — Byte, word, DWord and QWord relationships

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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 197) 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 50) 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 WRITE SAME command words 2..5 (see table 199) contains 0000_0504_0302_0100h), then:

a) byte 4 contains 00h;
b) byte 5 contains 01h;
c) byte 6 contains 02h;
d) byte 7 contains 03h;
e) byte 8 contains 04h;
f) byte 9 contains 05h;
g) byte 10 contains 00h; and
h) byte 11 contains 00h.

Exceptions to this convention include:

a) each field containing an ATA string (e.g., the IDENTIFY DEVICE data and IDENTIFY PACKET DEVICE data Serial number, Firmware revision, and Model number fields) is considered to be an array of bytes, not a multi-byte value, and is handled as described in 3.3.10;
b) the IDENTIFY DEVICE data and IDENTIFY PACKET DEVICE data World Wide Name field consists of four word fields rather than one QWord field and is handled as described in 7.17.7.58;
c) the CFA TRANSLATE SECTOR data LBA and logical sector write cycles count fields (see table 25);
d) the command packet in the PACKET command (see 7.23) is formatted as defined by the applicable command standard); and
e) parameter data in the TRUSTED RECEIVE command (see 7.58), TRUSTED RECEIVE DMA command (see 7.59), TRUSTED SEND command (see 7.60), and TRUSTED SEND DMA command (see 7.61) is formatted as defined in those sections or in the standard defining the security protocol.

3.3.10 ATA string convention

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

The following fields in IDENTIFY DEVICE data (see 7.17.7) and IDENTIFY PACKET DEVICE data (see 7.18.6) contain ATA strings:

a) Serial number (words 10..19) (see 7.17.7.10);
b) Firmware revision (words 23..26) (see 7.17.7.13);
c) Model number (words 27..46) (see 7.17.7.14); and
d) Current media serial number (words 176..205) (see 7.17.7.74).

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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

If the Firmware revision field (i.e., words 23..26) contains the string “abcdefg ”, including one padding space character at the end, then the word and byte representations for the field are shown in table 3.

Table 3 — ATA firmware revision example

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

3.3.11 Offset Convention

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

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4 Feature set definitions

4.1 Overview

Table 4 lists the feature sets in alphabetical order and shows whether a feature set is mandatory, optional, prohibited, or not defined for ATA devices and ATAPI devices.

Table 4 — Feature Set Summary

Feature Set	ATA Devices	ATAPI Devices
48-Bit Address feature set (see 4.4)	O	P
Advanced Power Management (APM) feature set (see 4.5)	O	O
CompactFlash Association (CFA) feature set (see 4.6)	O	P
Device Configuration Overlay (DCO) feature set (see 4.7)	O	O
Extended Power Conditions (EPC) feature set (see 4.8)	O	P
Free-fall Control feature set (see 4.9)	O	P
General feature set (see 4.2)	M	P
General Purpose Logging (GPL) feature set (see 4.10)	O	O
Host Protected Area (HPA) feature set (see 4.11)	O	O
Long Logical Sector (LLS) feature set (see 4.12)	O	P
Long Physical Sector (LPS) feature set (see 4.13)	O	P
Native Command Queuing (NCQ) feature set (see 4.14)	O	P
NV Cache feature set (see 4.15)	O	P
NV Cache Power Management feature set (see 4.16)	O	P
PACKET feature set (see 4.3)	P	M
Power Management feature set (see 4.17)	M	O
Power-Up In Standby (PUIS) feature set (see 4.18)	O	O
Sanitize Device feature set (see 4.19)	O	P
Security feature set (see 4.20)	O	O
Self-Monitoring, Analysis, and Reporting Technology (SMART) feature set (see 4.21)	O	P
Sense Data Reporting feature set (see 4.22)	O	P
Software Settings Preservation (SSP) feature set (see 4.23)	O	P
Streaming feature set (see 4.24)	O	P
Trusted Computing feature set (see 4.25)	O	P
Write-Read-Verify feature set (see 4.26)	O	P
Key: M – Mandatory, O – Optional, P – Prohibited, N – Not defined		

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4.2 General feature set

The following General feature set commands are mandatory:

a) EXECUTE DEVICE DIAGNOSTIC (see 7.14);
b) IDENTIFY DEVICE (see 7.17); and
c) SET FEATURES (see 7.49).

The following General feature set commands are optional:

a) DOWNLOAD MICROCODE (see 7.13);
b) DOWNLOAD MICROCODE DMA (see 7.13)
c) NOP (see 7.22);
d) FLUSH CACHE (see 7.15);
e) READ BUFFER (see 7.24);

f) READ BUFFER DMA (see 7.25);
g) READ DMA (see 7.26);
h) READ MULTIPLE (see 7.31);
i) READ SECTOR(S) (see 7.35);
j) READ VERIFY SECTOR(S) (see 7.39);
k) SET MULTIPLE MODE (see 7.52);
l) WRITE BUFFER (see 7.62);
m) WRITE BUFFER DMA (see 7.63);
n) WRITE DMA (see 7.64);
o) WRITE MULTIPLE (see 7.70);
p) WRITE SECTOR(S) (see 7.73); and
q) WRITE UNCORRECTABLE EXT (see 7.77).

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

4.3 The PACKET feature set

4.3.1 Overview

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

The content of command packets delivered during processing of the PACKET command are defined in the standard indicated by IDENTIFY PACKET DEVICE data word 0 bits (12:8) (see 7.18.6.2) and are not described in this standard.

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

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

a) DEVICE RESET (see 7.11);
b) EXECUTE DEVICE DIAGNOSTIC (see 7.14);
c) IDENTIFY DEVICE (see 7.17);
d) IDENTIFY PACKET DEVICE (see 7.18);
e) NOP (see 7.22);
f) PACKET (see 7.23);
g) READ SECTOR(S) (see 7.35); and
h) SET FEATURES (see 7.49).

For ATAPI devices, the IDENTIFY DEVICE command (see 7.17) and the READ SECTOR(S) command (see 7.35) are command aborted and return the ATAPI device signature (see table 217).

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

a) FLUSH CACHE (see 7.15);
b) READ LOG DMA EXT (see 7.30);
c) READ LOG EXT (see 7.29);
d) WRITE LOG DMA EXT (see 7.69); and
e) WRITE LOG EXT (see 7.68).

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

4.3.2 Identification of PACKET feature set devices

The IDENTIFY PACKET DEVICE command is used by the host to get identifying parameter information for a device implementing the PACKET feature set (see 7.17.5 and 7.18).

4.3.3 Signature for ATAPI devices

ATAPI devices return a signature in the Normal Outputs that differentiate them from other device types (see table 217).

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4.3.4 The PACKET command

The PACKET command allows a host to send a command to the device via a command packet. The command packet contains the command and command parameters that the device is to process (see clause).

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

4.4 48-bit Address feature set

The 48-bit Address feature set allows devices:

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

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

c) FLUSH CACHE EXT (see 7.16);
d) READ DMA EXT (see 7.27);
e) READ MULTIPLE EXT (see 7.32);
f) READ SECTOR(S) EXT (see 7.36);
g) READ VERIFY SECTOR(S) EXT (see 7.40);
h) WRITE DMA EXT (see 7.65);
i) WRITE DMA FUA EXT (see 7.66);
j) WRITE MULTIPLE EXT (see 7.71);
k) WRITE MULTIPLE FUA EXT (see 7.72); and
l) WRITE SECTOR(S) EXT (see 7.74).

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

Devices that implement the 48-bit feature set shall indicate support of the 48-bit Address feature set in IDENTIFY DEVICE data word 83 bit 10 (see 7.17.7.40).

4.5 Advanced Power Management (APM) feature set

The Advanced Power Management feature set is an optional feature set that allows the host to select a power management level in a device. The power management level is specified using a scale from the lowest power consumption setting of 01h to the highest power consumption of FEh (i.e., maximum performance level), see table 120. Device performance may increase with increasing power management levels. Device power consumption may increase as the power management setting numerically increases. A device may implement one APM method for two or more contiguous power management levels (e.g., a device may implement one APM method from level 80h to A0h and a higher performance, higher power consumption method from level A1h to FEh). APM levels 80h and greater do not permit a device with rotating media to spin down as a result of an APM method.

The APM feature set uses the following subcommands:

a) a SET FEATURES subcommand to enable APM (see 7.49.6); and
b) an optional SET FEATURES subcommand to disable APM.

APM is independent of the Standby timer (see 4.17.3). If both APM and the Standby timer are set, then the device shall go to the Standby state when the timer expires or the device's APM algorithm indicates that the Standby state should be entered.

The device shall indicate:

a) feature set support in IDENTIFY DEVICE data word 83 bit 3 (see 7.17.7.40) and IDENTIFY PACKET DEVICE data word 83 bit 3 (see 7.18.6.34);
b) feature set enabled in IDENTIFY DEVICE data word 86 bit 3 (see 7.17.7.41) and IDENTIFY PACKET DEVICE data word 86 bit 3 (see 7.18.6.35); and

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c) APM level in IDENTIFY DEVICE data word 91 (see 7.17.7.45) and IDENTIFY PACKET DEVICE data word 91 (see 7.18.6.39).

The NV Cache Power management feature set may change the operation of the APM feature set (see 7.21.11).

4.6 CompactFlash Association (CFA) feature set

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

a) CFA ERASE SECTORS (see 7.2);
a) CFA REQUEST EXTENDED ERROR CODE (see 7.3);
b) CFA TRANSLATE SECTOR (see 7.4);
c) CFA WRITE MULTIPLE WITHOUT ERASE (see 7.5);
d) CFA WRITE SECTORS WITHOUT ERASE (see 7.6); and
e) SET FEATURES Enable/Disable 8-bit PIO data transfer (see 7.49.3).

Devices reporting the value 848Ah in IDENTIFY DEVICE data word 0 (see 7.17.7.2) or devices having IDENTIFY DEVICE data word 83 bit 2 (see 7.18.6.34) set to one shall support the CFA feature set. If the CFA feature set is implemented, then all CFA commands and the SET FEATIURES Enable/Disable 8-bit PIO data transfer subcommand shall be implemented.

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

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

4.7 Device Configuration Overlay (DCO) feature set

The DCO feature set allows an application client to reduce the capability of the device by modifying the capacity, commands, modes, and feature sets that a device indicates as supported in the IDENTIFY DEVICE data or IDENTIFY PACKET DEVICE data.

Commands unique to the DCO feature set use a single command code and are differentiated from one another by the value placed in the Feature field.

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

a) DEVICE CONFIGURATION FREEZE LOCK (see 7.10.2);
b) DEVICE CONFIGURATION IDENTIFY (see 7.10.3);
c) DEVICE CONFIGURATION RESTORE (see 7.10.5); and
d) DEVICE CONFIGURATION SET (see 7.10.6).

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

a) DEVICE CONFIGURATION IDENTIFY DMA (see 7.10.4); and
b) DEVICE CONFIGURATION SET DMA (see 7.10.7).

The DCO feature set may affect commands (e.g., IDENTIFY DEVICE data and IDENTIFY PACKET DEVICE data). Certain bits in these words that indicate that a command, mode, capacity, or feature set is supported and enabled may be cleared by a DCO Set command. For a particular command, mode, capacity, or feature set, when a bit is changed from one to zero requesting that the device shall not indicate support for the feature, the device shall not provide the feature.

The DCO Set commands may be used to reduce the maximum capacity of the device. Since a Host Protected Area may be lost if the capacity of the device is reduced, when a Host Protected Area is set a DCO Set command shall cause the device to return command aborted. The LBA value returned by a READ NATIVE MAX ADDRESS command or READ NATIVE MAX ADDRESS EXT command is modified by the DCO Set commands modifying the maximum capacity of the device.

After processing of a power-on reset or hardware reset, a device shall not change the settings made by a DCO Set command.

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DEVICE CONFIGURATION IDENTIFY data indicates the selectable commands, modes, capacity, and feature sets that may be disabled in the device. After the processing of a DCO Set command the fields associated with the disabled commands, modes, capacity, and feature sets are modified in the IDENTIFY DEVICE data or IDENTIFY PACKET DEVICE data. DEVICE CONFIGURATION IDENTIFY data or DEVICE CONFIGURATION IDENTIFY DMA data is not changed by the DCO Set command or DEVICE CONFIGURATION RESTORE command.

A DEVICE CONFIGURATION RESTORE command enables all capabilities that have been disabled by the DCO Set commands and returns the IDENTIFY DEVICE data or IDENTIFY PACKET DEVICE data to that indicated by the DEVICE CONFIGURATION IDENTIFY data and DEVICE CONFIGURATION IDENTIFY DMA data. If the value returned in IDENTIFY DEVICE data words 100..103 is less than the native max address for a device (i.e., a host protected area has been established), then the device shall return command aborted for a DEVICE CONFIGURATION RESTORE command.

If a device has completed a DCO Set command without error, then a device shall be in the DCO Reduced_config state after processing a power-on reset. If a device has not completed a DCO Set command (see figure 4) without error, then a device shall be in the DCO Factory_config state after processing a power cycle.

After completing a DEVICE CONFIGURATION FREEZE LOCK command without error, a device shall abort the following commands: DCO Set, DEVICE CONFIGURATION IDENTIFY, DEVICE CONFIGURATION IDENTIFY DMA, and DEVICE CONFIGURATION RESTORE until after completing the subsequent power-on reset. If a device is in the DCO_locked state, then processing a hardware reset or software reset does not cause the device to change state.

If the DEVICE CONFIGURATION IDENTIFY DMA command is supported, then all references to the DEVICE CONFIGURATION IDENTIFY command in figure 4 also apply to the DEVICE CONFIGURATION IDENTIFY DMA command. If the DEVICE CONFIGURATION SET DMA command is supported, then all references to the DCO SET command in figure 4 also apply to the DEVICE CONFIGURATION SET DMA command.

See figure 4 for a description of the Device Configuration Overlay state machine.

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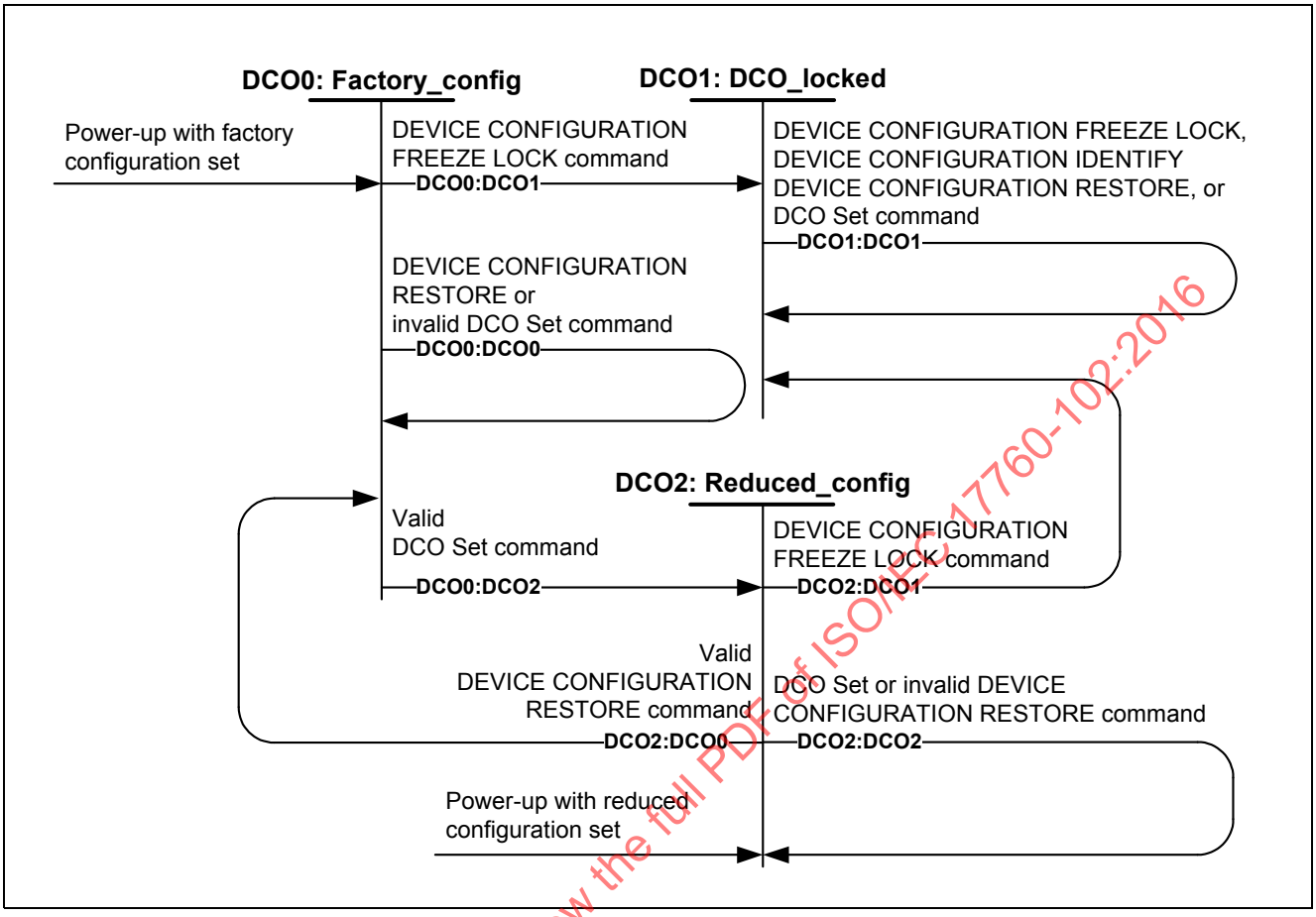

Figure 4 — Device Configuration Overlay state diagram

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

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

Transition DCO0:DCO0: When a DEVICE CONFIGURATION RESTORE command is received, the device shall return command aborted and transition to the DCO0: Factory_config state. If the device returns command aborted for a DCO Set command, then the device shall transition to the DCO0: Factory_config state. A device shall return command aborted if the DCO Set command requests that a device remove support for:

a) the HPA feature set (see 4.11) if a HPA has been established;
b) a Multiword or Ultra DMA mode if that mode or a higher numbered mode is currently selected;
c) the PUIS feature set (see 4.18) if the PUIS feature set has been enabled by a jumper;
d) the Security feature set (see 4.20) if the Security feature set has been enabled;
e) the SMART feature set (see 4.21) if the DCO Set data word 7 bits (2:1) are not cleared to zero; or
f) the SMART feature set (see 4.21) if the SMART feature set is enabled.

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

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

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This transition is made even if the configuration described by the DCO Set command is the same as the factory configuration.

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

Transition DCO1:DCO1: When one of the following commands is received: DEVICE CONFIGURATION FREEZE LOCK, DEVICE CONFIGURATION IDENTIFY, DEVICE CONFIGURATION IDENTIFY DMA, DCO Set, or DEVICE CONFIGURATION RESTORE, the device shall return command aborted and shall remain in the DCO1 state.

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

When in this state, the device shall support all commands, modes, feature sets, and the capacity specified by the DCO Set command that caused this state to be entered.

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

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

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

4.8 Extended Power Conditions (EPC) feature set

4.8.1 Overview

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

a) defining power conditions within the PM1:Idle power management state (i.e., Idle_a, Idle_b, and Idle_c);
b) defining power conditions within the PM2:Standby power management state (i.e., Standby_y and Standby_z);
c) enabling and initializing any of the power condition timers to specify that the device wait for a period of inactivity before transitioning to a specified power condition; and
d) allowing the host to determine the power condition settings of the device.

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

a) the SET FEATURES Extended Power Conditions subcommand (see 7.49.18);
b) the Power Conditions log (see clause A.8);
c) additional status values returned by the CHECK POWER MODE command (see 7.7);
d) IDENTIFY DEVICE data fields; and
e) DCO controls.

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

4.8.2 Power conditions

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

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

The Standby timer is controlled using:

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

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

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

4.8.3 Power condition timers

The device shall have manufacturer specified power-on default settings for the power condition timers. Power condition timers are changeable with the SET FEATURES Extended Power Conditions subcommand (see 7.49.18). Configured settings for the timers shall be readable in the Power Conditions log (see A.8).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1) if the unload feature was selected, then:
   A) the device shall protect itself (see 7.20.2.2); and
   B) if volatile write cache is enabled, then the device shall retain data in the write cache and resume writing the cached data onto the media after receiving a software reset, a hardware reset, or any new command except IDLE IMMEDIATE command with unload feature;
2) the device shall transition to the PM1:Idle state; and
3) the device shall enter the Idle_a power condition.

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

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

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

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

The Extended Power Conditions feature set and the Advanced Power Management feature set are mutually exclusive. All EPC subcommands, except Enable the EPC feature set (see 7.49.18.6), shall return command aborted if the EPC feature set is disabled.

If the device processes a SET FEATURES Enable APM subcommand without error and IDENTIFY DEVICE data word 120 bit 7 (see 7.17.7.41) is set to one, then the device shall disable the EPC feature set.

If the NV Cache Power Management feature is enabled, then the expiration of an EPC timer shall not cause the device to transition to a lower power state until the NV Cache power mode timer (see 4.17.4) expires.

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

4.9 Free-fall Control feature set

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

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

a) SET FEATURES subcommand to Enable the Free-fall Control feature set (see 7.49.14); and

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b) SET FEATURES subcommand to Disable the Free-fall Control feature set.

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

IDENTIFY DEVICE data word 120 bit 5 (see 7.17.7.41) or IDENTIFY PACKET DEVICE data word 120 bit 5 (see 7.18.6.35) indicates when the Free-fall Control feature set is enabled.

4.10 General Purpose Logging (GPL) feature set

The General Purpose Logging (GPL) feature set provides access to the logs in a device. These logs are associated with specific feature sets (e.g., SMART (see 4.21) and Streaming (see 4.24)). Support of the individual logs (see table A.2) is determined by support of the associated feature set. If the device supports a particular feature set, support for any associated log(s) is mandatory.

Support for the GPL feature set shall not be disabled by disabling SMART. If the feature set associated with a requested log is disabled, the device shall return command aborted.

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

a) READ LOG EXT (see 7.29); and
b) WRITE LOG EXT (see 7.68).

The following commands are optional:

a) READ LOG DMA EXT (see 7.30); and
b) WRITE LOG DMA EXT (see 7.69).

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

4.11 Host Protected Area (HPA) feature set

4.11.1 HPA overview

The Host Protected Area (HPA) feature set provides a method for an application client to reduce the number of logical sectors within the user data area. This method results in providing a data storage area on the device that may be used by that application client but may temporarily be inaccessible to other application clients. A device that implements the HPA feature set shall implement the following commands:

a) READ NATIVE MAX ADDRESS (see 7.33); and
b) SET MAX ADDRESS (see 7.50.2).

A device that implements the HPA feature set and supports the 48-bit Address feature set (see 4.4) shall implement the following additional commands:

a) READ NATIVE MAX ADDRESS EXT (see 7.34); and
b) SET MAX ADDRESS EXT (see 7.51).

Devices supporting this feature set shall set IDENTIFY DEVICE data word 82 bit 10 (see 7.18.6.34) to one.

NOTE The PARTIES standard specifies a method for managing the HPA.

4.11.2 HPA security extensions

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

If the HPA security extensions are implemented, the following commands shall be supported:

a) SET MAX FREEZE LOCK (see 7.50.3);
b) SET MAX LOCK (see 7.50.4);
c) SET MAX SET PASSWORD (see 7.50.5); and
d) SET MAX UNLOCK (see 7.50.7).

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If the HPA security extensions are implemented, the following commands are optional:

a) SET MAX SET PASSWORD DMA (see 7.50.6); and
b) SET MAX UNLOCK DMA (see 7.50.8).

Devices supporting these extensions shall set IDENTIFY DEVICE data word 82 bit 10 to one (see 7.17.7.40) or IDENTIFY PACKET DEVICE data word 82 bit 10 to one (see 7.18.6.34), and shall set IDENTIFY DEVICE data word 83 bit 8 to one (see 7.17.7.40) or IDENTIFY PACKET DEVICE data word 83 bit 8 to one (see 7.18.6.34).

Upon successful completion of a power-on reset:

a) the HPA security extensions are disabled;
b) there is no HPA password; and
c) IDENTIFY DEVICE data word 86 bit 8 (see 7.17.7.41) is cleared to zero or IDENTIFY PACKET DEVICE data word 86 bit 8 (see 7.18.6.35) is cleared to zero.

If the SET MAX SET PASSWORD DMA command is supported, then all requirements and behaviors for the SET MAX PASSWORD command also apply to the SET MAX SET PASSWORD DMA command. If the SET MAX UNLOCK DMA command is supported, then all requirements and behaviors for the SET MAX UNLOCK command also apply to the SET MAX UNLOCK DMA command.

If a SET MAX SET PASSWORD command is completed without error, then the HPA security extensions are enabled and IDENTIFY DEVICE data word 86 bit 8 (see 7.17.7.41) shall be set to one or IDENTIFY PACKET DEVICE data word 86 bit 8 (see 7.18.6.35) shall be set to one.

4.11.3 28-bit and 48-bit HPA commands interactions

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

The SET MAX ADDRESS command or the SET MAX ADDRESS EXT command allows the host to redefine the maximum LBA of the user data area. That is, when the SET MAX ADDRESS command or SET MAX ADDRESS EXT command is issued with a maximum LBA less than the native max address, the device reduces the user data area to the maximum specified by the command, providing a protected area above that maximum LBA. See 4.11.4 for a description of how to set IDENTIFY DEVICE data after issuing a SET MAX ADDRESS command or SET MAX ADDRESS EXT command.

Any read or write that attempts to access an LBA above the maximum LBA specified by the SET MAX ADDRESS command or SET MAX ADDRESS EXT command shall cause command completion with the ID Not Found bit set to one and the Error bit set to one, or command aborted.

The V_V bit (see 7.50.2.3.2 and 7.51.3.2) in the Count field allows the host to specify if the LBA field in the SET MAX ADDRESS command is preserved after a power-on reset or a hardware reset. After processing a power-on reset or hardware reset, the device sets the maximum LBA to the last non-volatile LBA setting regardless of subsequent volatile SET MAX ADDRESS command or SET MAX ADDRESS EXT command. If the SET MAX ADDRESS command or SET MAX ADDRESS EXT command is issued with a value that exceeds the native max address, then the device shall return command aborted.

Software reset shall not:

a) affect the HPA feature set settings in the device;
b) change the maximum accessible LBA for the device; or
c) change the HPA state of the device.

When the device is HPA Unlocked and has not processed a SET MAX FREEZE LOCK command, then multiple SET MAX SET PASSWORD commands may be processed. The device only keeps the password set by the last SET MAX SET PASSWORD command. Previously received passwords are overwritten by the new password. There is no limit to the number of times the password may be set.

Typical use of these commands is:

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EXAMPLE 1 - After a power-on reset or a hardware reset is processed:

1) BIOS receives control after the reset;
2) BIOS issues a READ NATIVE MAX ADDRESS command or READ NATIVE MAX ADDRESS EXT command to find the max capacity of the device;
3) BIOS issues a volatile SET MAX ADDRESS command or SET MAX ADDRESS EXT command to the values returned by READ NATIVE MAX ADDRESS command or READ NATIVE MAX ADDRESS EXT command;
4) BIOS reads configuration data from the highest area on the disk; and
5) BIOS restores the protected area by issuing a non-volatile SET MAX ADDRESS command or SET MAX ADDRESS EXT command using the original LBA.

EXAMPLE 2 - On save to disk:

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

NOTE HPA feature set commands are intended for use only by system BIOS or other low-level boot time processes. Using HPA feature set commands outside BIOS controlled boot or shutdown may result in damage to file systems on the device.

The SET MAX SET PASSWORD command allows the host to define the password to be used until the device processes a power-on reset or another SET MAX SET PASSWORD command. The password does not persist after a power-on reset has been processed but does persist after a hardware reset or a software reset has been processed. This password is not related to the password used for the Security feature set (see 4.20). When the password is set the device is HPA Unlocked.

The SET MAX LOCK command provides a method for the host to disable the SET MAX commands, except the SET MAX UNLOCK command, until after the device has processed the next power-on reset or command completion of a SET MAX UNLOCK command. When the SET MAX LOCK command is completed the device is HPA Locked.

The SET MAX UNLOCK command changes the device from HPA Locked to HPA Unlocked.

The SET MAX FREEZE LOCK command provides a method for the host to disable the SET MAX commands, including the SET MAX UNLOCK command, until after the device has processed the next power-on reset.

4.11.4 IDENTIFY DEVICE data

If the host issues a SET MAX ADDRESS command or SET MAX ADDRESS EXT command, then several IDENTIFY DEVICE data words may be affected. The following rules are used for setting IDENTIFY DEVICE data:

a) if the 48-bit Address feature set (see 4.4) is not supported, then words 60..61 (see 7.17.7.22) shall contain the total number of user addressable logical sectors, words 100..103 (see 7.17.7.53) shall be reserved, and word 69 bit 3 (see 7.17.7.30) shall be cleared to zero;
b) if the 48-bit Address feature set (see 4.4) is supported and the total number of user addressable logical sectors is less than or equal to 0FFF_FFFFh, then
   A) words 60..61 (see 7.17.7.22) and words 100..103 (see 7.17.7.53) shall contain the total number of user addressable logical sectors; and
   B) if word 69 bit 3 (see 7.17.7.30) is set to one, then words 230..233 (see 7.17.7.89) shall contain the total number of user addressable sectors;

   and

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c) if the 48-bit Address feature set is supported and the total number of user addressable logical sectors is greater than 0FFF_FFFFh, then words 60..61 (see 7.17.7.22) shall contain 0FFF_FFFFh and:
   A) if word 69 bit 3 (see 7.17.7.30) is cleared to zero, then words 100..103 (see 7.17.7.53) shall contain the total number of user addressable logical sectors; and
   B) If word 69 bit 3 (see 7.17.7.30) is set to one, then
      a) words 230..233 (see 7.17.7.89) shall contain the total number of user addressable sectors; and
      b) words 100.103 (see 7.17.7.53) shall contain a value
         A) less than or equal to the total number of user addressable sectors; and
         B) greater than 0000_0000_0FFF_FFFFh

NOTE IDENTIFY DEVICE data words 100..103 (see 7.17.7.53) may be limited to 0000_0000_FFFF_FFFFh and the full capacity reported in IDENTIFY DEVICE data words 230..233 (see 7.17.7.89)).

4.11.5 Determination of SET MAX security extension status

When the device is HPA Locked IDENTIFY DEVICE data word 86 bit 8 (see 7.17.7.41) shall be set to one or IDENTIFY PACKET DEVICE data word 86 bit 8 (see 7.18.6.35) shall be set to one.

4.11.6 HPA State Transition Diagrams

4.11.6.1 State Transition Figures

The HPA state transition diagrams are in five parts: figure 5, figure 6, figure 7, figure 8, and figure 9.

See 3.3.8 for conventions that use the COMMAND (value) notation in the state transition diagrams shown in this subclause.

In the state transition diagrams in this subclause:

a) if the SET MAX PASSWORD DMA command is supported, then all requirements and behaviors for the SET MAX PASSWORD command also apply to the SET MAX PASSWORD DMA command; and
b) if the SET MAX UNLOCK DMA command is supported, then all requirements and behaviors for the SET MAX UNLOCK command also apply to the SET MAX UNLOCK DMA command.
c) A First SET MAX ADDRESS (non-volatile) is the first SET MAX ADDRESS (non-volatile) processed by the device after a power cycle.
d) An additional SET MAX ADDRESS (non-volatile) is a SET MAX ADDRESS (non-volatile) that is processed by the device after a previous SET MAX ADDRESS (non-volatile)) has been successfully processed by the device with no intervening power a.

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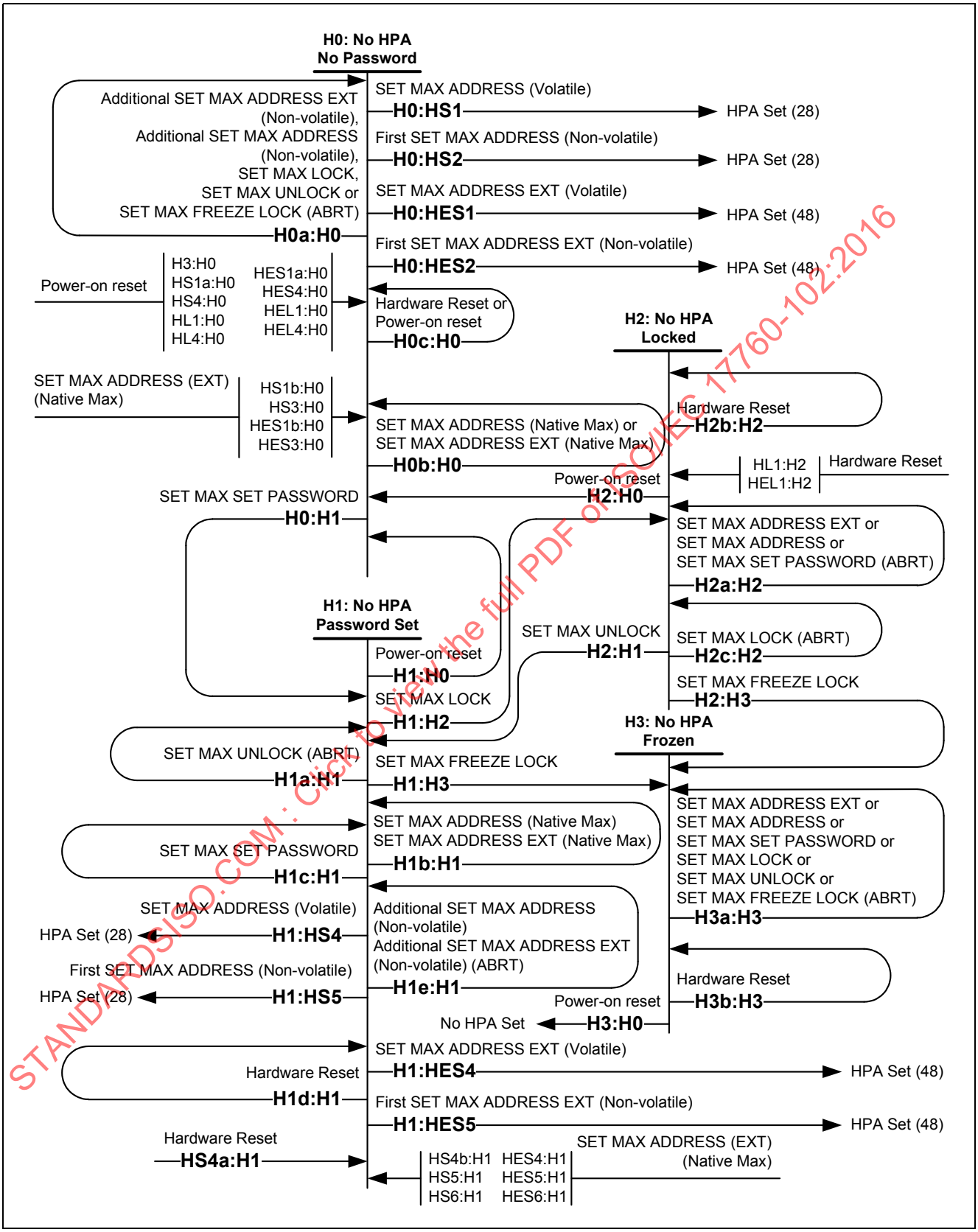

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Figure 5 — HPA Not Set

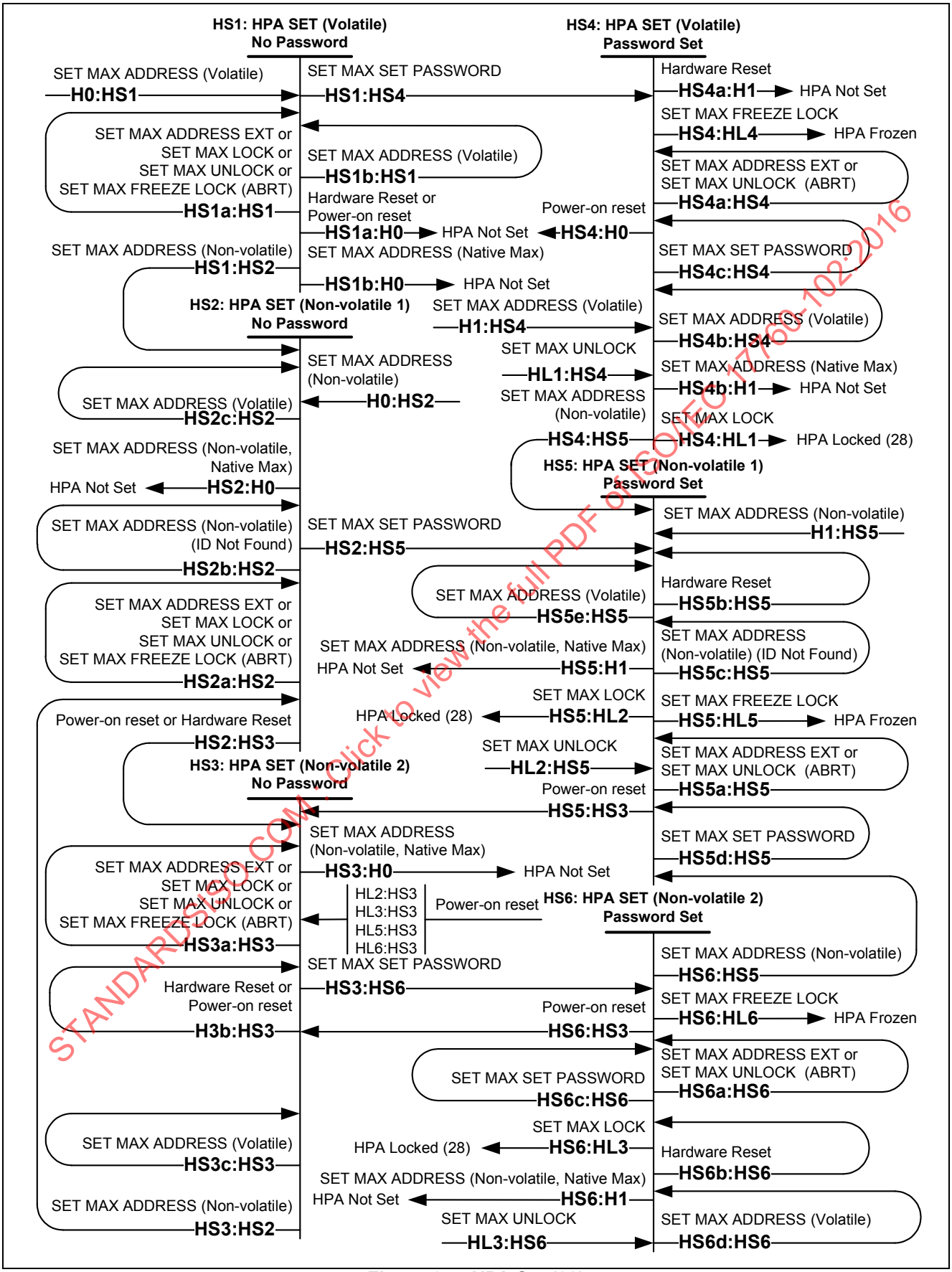

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Figure 6 — HPA Set (28)

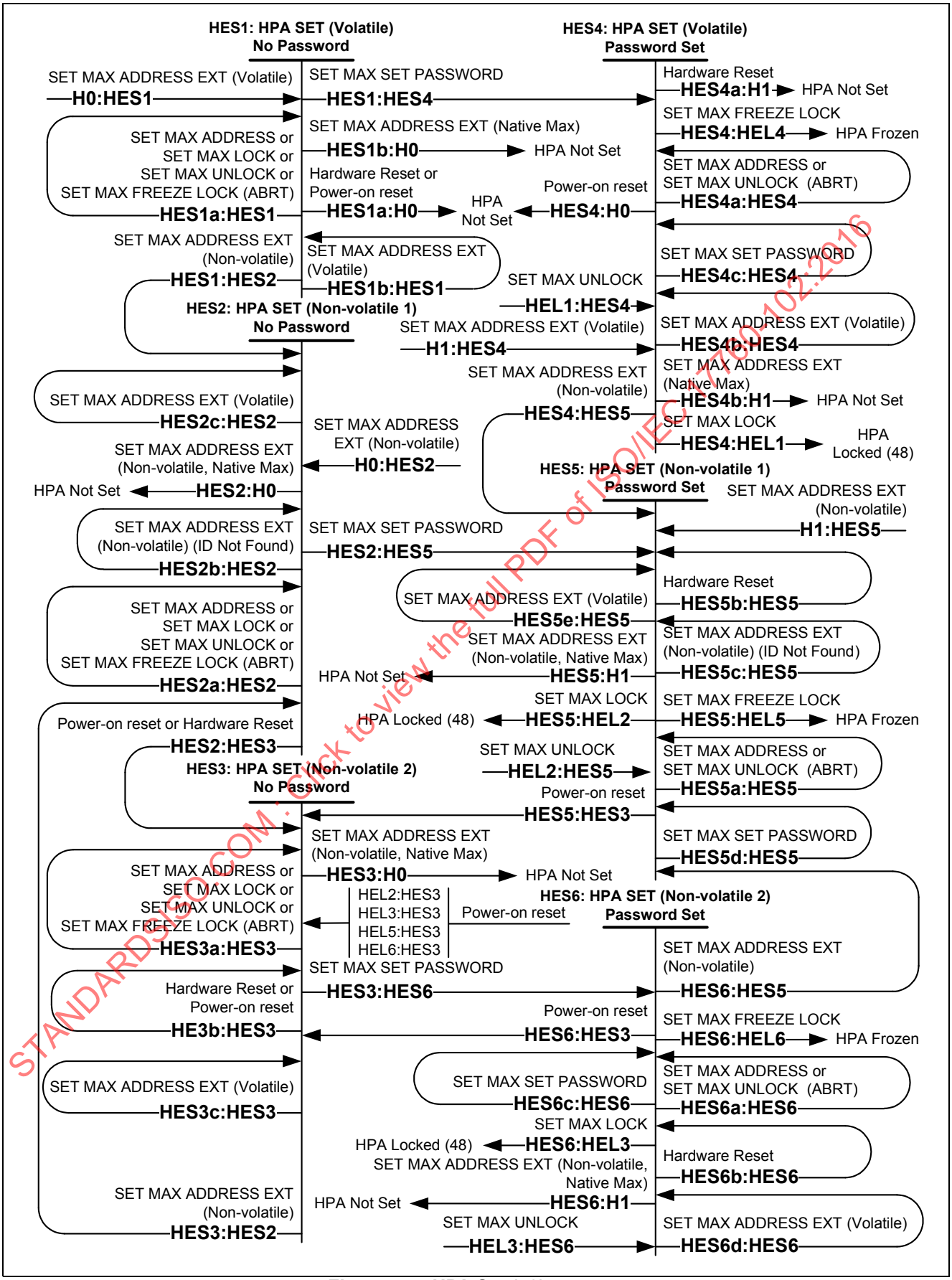

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Figure 7 — HPA Set (48)

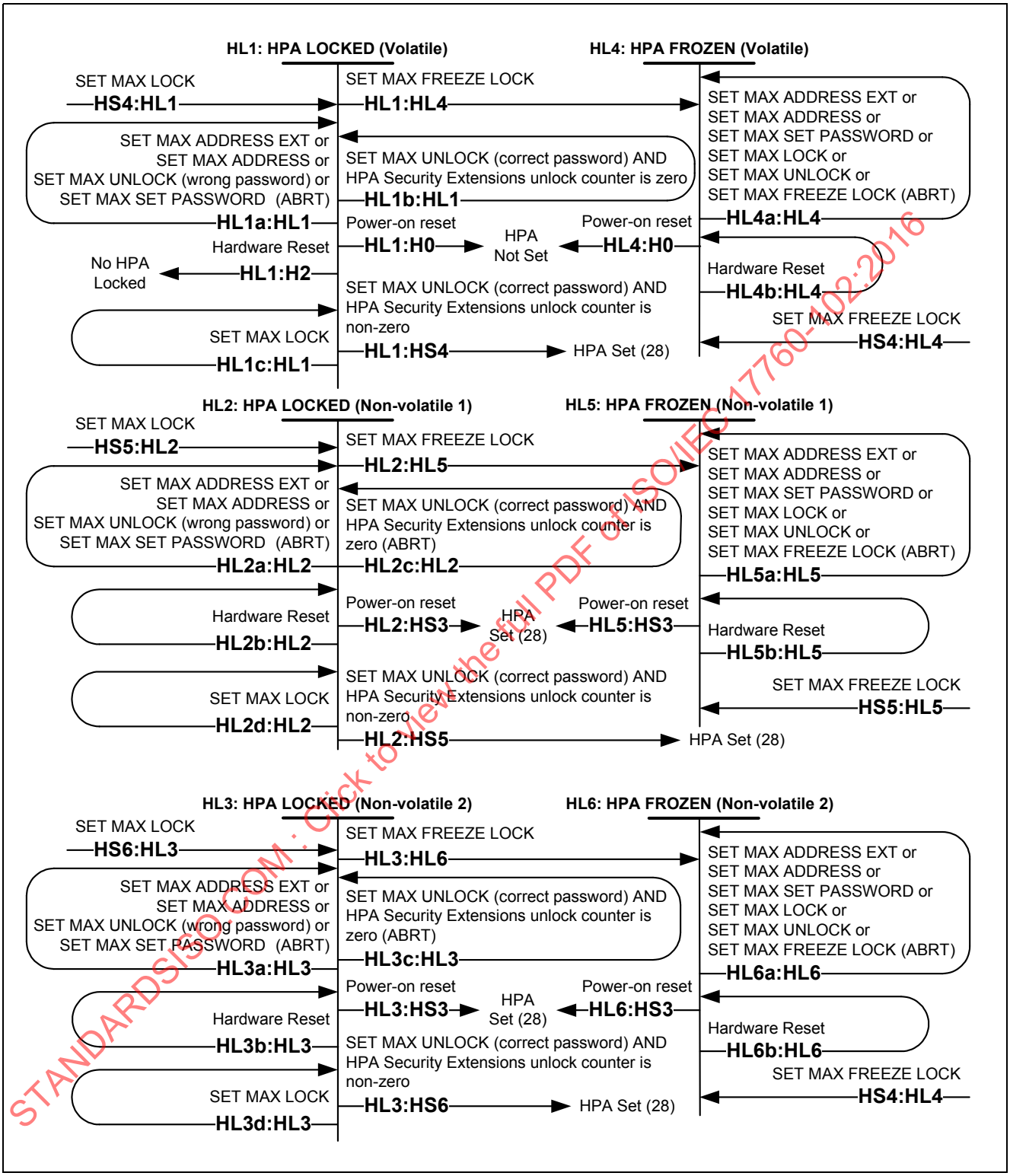

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Figure 8 — HPA Locked (28)

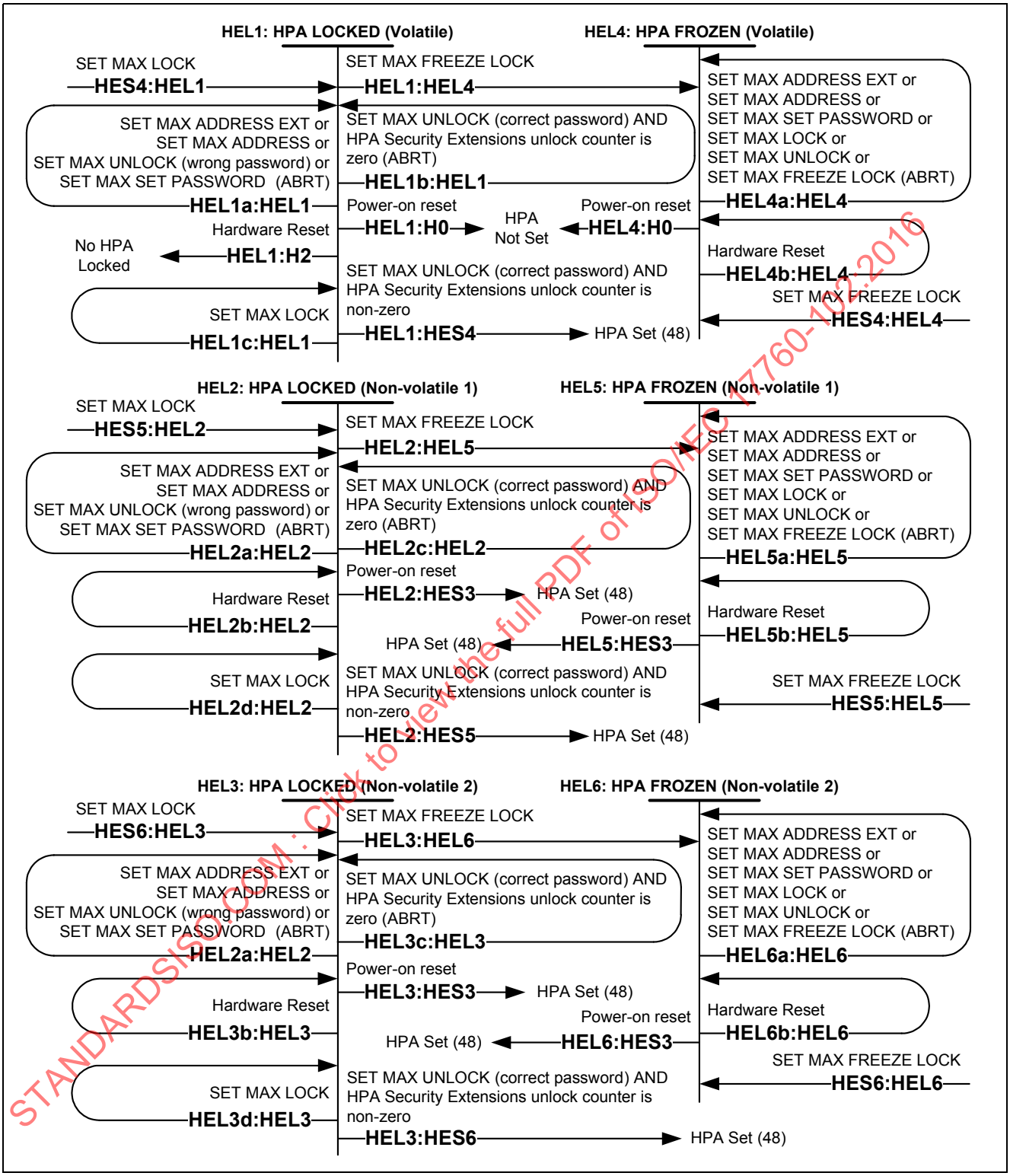

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Figure 9 — HPA Locked (48)

4.11.6.2 HPA Not Set

State H0: No HPA/No Password: This state shall be entered when the device is powered on and does not have a non-volatile max address set. In this state the device has not established the HPA and the password has not been set.

Transition H0:H1: If the device successfully processes a SET MAX SET PASSWORD () without error, then the device shall transition to the H1 state.

Transition H0:HS1: When the device successfully processes a SET MAX ADDRESS (Volatile) without error, the device shall process the command and transition to the HS1 state.

Transition H0:HS2: When the device successfully processes a First SET MAX ADDRESS (non-volatile) without error, the device shall process the command and transition to the HS2 state.

Transition H0:HES1: When the device successfully processes a SET MAX ADDRESS EXT (Volatile) without error, the device shall process the command and transition to the HES1 state.

Transition H0:HES2: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile) without error, the device shall process the command and transition to the HES2 state.

Transition H0a:H0: When the device processes a SET MAX LOCK (), SET MAX UNLOCK (), SET MAX FREEZE LOCK (), additional SET MAX ADDRESS EXT (non-volatile), or an additional SET MAX ADDRESS (non-volatile) without error, the device shall return command aborted and remain in the H0 state.

Transition H0b:H0: When the device successfully processes a SET MAX ADDRESS (Native Max) or SET MAX ADDRESS EXT (Native Max) without error, the device shall remain in the H0 state.

Transition H0c:H0: When the device successfully processes a hardware reset or a power-on reset, the device shall remain in the H0 state.

State H1: No HPA/Password Set: In this state the device has not established the HPA and the password has been set.

Transition H1:H0: When the device successfully processes a power-on reset, the device shall transition to the H0 state.

Transition H1:H2: When the device successfully processes a SET MAX LOCK (), the device shall transition to the H2 state.

Transition H1:H3: When the device successfully processes a SET MAX FREEZE LOCK () without error, the device shall transition to the H3 state.

Transition H1:HS4: When the device successfully processes a SET MAX ADDRESS (Volatile), the device shall transition to the HS4 state.

Transition H1:HES4: When the device successfully processes a SET MAX ADDRESS EXT (Volatile), the device shall transition to the HES4 state.

Transition H1:HES5: When the device successfully processes a First SET MAX ADDRESS EXT (Non-Volatile), the device shall transition to the HES5 state.

Transition H1a:H1: When the device successfully processes a SET MAX UNLOCK (), the device shall report command aborted and remain in the H1 state.

Transition H1b:H1: When the device successfully processes a SET MAX ADDRESS (Native Max) or SET MAX ADDRESS EXT (Native Max) without error, the device shall remain in the H1 state.

Transition H1c:H1: When the device successfully processes a SET MAX SET PASSWORD () without error, the device shall remain in the H1 state.

Transition H1d:H1: If the device processes a hardware reset, the device shall remain in the H1 state.

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Transition H1e:H1: When the device successfully processes an additional SET MAX ADDRESS EXT (Non-volatile) command or an additional SET MAX ADDRESS (Non-volatile) command, the device shall return command aborted and remain in the H1 state.

State H2: No HPA/Locked: In this state the device is HPA Locked and only the power-on reset transits the state to the H0 state.

Transition H2:H0: When the device successfully processes a power-on reset, the device shall transition to the H0 state.

Transition H2:H1: When the device successfully processes a SET MAX UNLOCK () with the correct password, the device shall transition to the H1 state.

Transition H2:H3: When the device successfully processes a SET MAX FREEZE LOCK () with the correct password, the device shall transition to the H3 state.

Transition H2a:H2: When the device successfully processes a SET MAX ADDRESS EXT (), SET MAX ADDRESS (), or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the H2 state.

Transition H2b:H2: If the device processes a hardware reset, then the device shall remain in the H2 state.

Transition H2c:H2: If the device successfully processes a SET MAX LOCK (), the device shall remain in the H2 state and the device may return command aborted.

State H3: No HPA FROZEN: In this state no HPA is established and the device is locked from all HPA commands. Only a power-on reset shall cause the device to change to another state.

Transition H3:H0: When the device successfully processes a power-on reset, the device shall transition to the H0 state.

Transition H3a:H3: When the device successfully processes a SET MAX ADDRESS EXT (), SET MAX ADDRESS (), SET MAX LOCK (), SET MAX UNLOCK (), SET MAX FREEZE LOCK () or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the H3 state.

Transition H3b:H3: When the device processes a hardware reset, the device shall remain in the H3 state.

4.11.6.3 28-bit HPA Set

State HS1: HPA SET (Volatile)/No Password: In this state the volatile 28-bit HPA is established and the password is not set.

Transition HS1:HS2: When the device successfully processes a SET MAX ADDRESS () without error in non-volatile state, the device shall transition to the HS2 state.

Transition HS1:HS4: When the device successfully processes a SET MAX SET PASSWORD () without error, the device shall transition to the HS4 state.

Transition HS1a:H0: When the device successfully processes a hardware reset or if device processes a power-on reset, the device shall transition to the H0 state.

Transition HS1b:H0: When the device successfully processes a SET MAX ADDRESS (Native Max) without error, the device shall transition to the H0 state.

Transition HS1a:HS1: When the device successfully processes a SET MAX ADDRESS EXT (), SET MAX LOCK (), SET MAX UNLOCK (), or SET MAX FREEZE LOCK (), the device shall return command aborted and remain in the HS1 state.

Transition HS1b:HS1: When the device successfully processes a SET MAX ADDRESS (Volatile), the device shall remain in the HS1 state.

State HS2: HPA SET (Non-Volatile 1)/No Password: In this state the non-volatile 28-bit HPA is established and the password is not set.

Transition HS2:H0: When the device successfully processes a SET MAX ADDRESS (Non-Volatile, Native Max), the device shall transition to the H0 state.

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Transition HS2:HS5: When the device successfully processes a SET MAX SET PASSWORD (), the device shall transition to the HS5 state.

Transition HS2a:HS2: When the device successfully processes a SET MAX ADDRESS EXT (), SET MAX LOCK (), SET MAX UNLOCK () or SET MAX FREEZE LOCK (), the device shall return command aborted and remain in the HS2 state.

Transition HS2b:HS2: When the device successfully processes a SET MAX ADDRESS (Non-Volatile), the device shall return ID Not Found and remain in the HS2 state.

Transition HS2c:HS2: When the device successfully processes a SET MAX ADDRESS (Volatile), the device shall remain in the HS2 state.

Transition HS2:HS3: When the device successfully processes a power-on reset or a hardware reset, the device shall make transition to the HS3 state.

State HS3: HPA SET (Non-Volatile 2)/No Password: In this state the non-volatile 28-bit HPA is established and the password is not set.

Transition HS3:H0: When the device successfully processes a SET MAX ADDRESS (Non-Volatile, Native Max), the device shall transition to the H0 state.

Transition HS3:HS2: When the device successfully processes a SET MAX ADDRESS (Non-Volatile) without error, the device shall transition to the HS2 state.

Transition HS3:HS6: When the device successfully processes a SET MAX SET PASSWORD () without error, the device shall transition to the HS6 state.

Transition HS3a:HS3: When the device successfully processes a SET MAX ADDRESS EXT (), SET MAX LOCK (), SET MAX UNLOCK () or SET MAX FREEZE LOCK (), the device shall return command aborted and remain in the HS3 state.

Transition HS3b:HS3: When the device successfully processes a hardware reset or when the device successfully processes a power-on reset, the device shall remain in the HS3 state.

Transition HS3c:HS3: When the device successfully processes a SET MAX ADDRESS (Volatile) without error, the device shall remain in the HS3 state.

State HS4: HPA SET (Volatile)/Password Set: In this state the volatile 28-bit HPA is established and the password is set.

Transition HS4:HL1: When the device successfully processes a SET MAX LOCK (), the device shall transition to the HL1 state.

Transition HS4:HL4: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HL4 state.

Transition HS4:H0: When the device successfully processes a power-on reset, the device shall transition to the H0 state.

Transition HS4:HS5: When the device successfully processes a SET MAX ADDRESS (Non-Volatile), the device shall process the command and transition to the HS5 state.

Transition HS4a:H1: When the device processes a hardware reset, the device shall transition to the H1 state.

Transition HS4b:H1: When the device successfully processes a SET MAX ADDRESS (Native Max) without error, the device shall transition to the H1 state.

Transition HS4a:HS4: When the device successfully processes a SET MAX ADDRESS EXT () or SET MAX UNLOCK (), the device shall return command aborted and remain in the HS4 state.

Transition HS4b:HS4: When the device successfully processes a SET MAX ADDRESS (Volatile), the device shall remain in the HS4 state.

Transition HS4c:HS4: When the device successfully processes a SET MAX SET PASSWORD (), the device shall remain in the HS4 state.

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State HS5: HPA SET (Non-Volatile 1)/Password Set: In this state the non-volatile 28-bit HPA is established and the password is set.

Transition HS5:H1: When the device successfully processes a SET MAX ADDRESS (Native Max), the device shall transition to the H1 state.

Transition HS5:HL2: When the device successfully processes a SET MAX LOCK (), the device shall transition to the HL2 state.

Transition HS5:HL5: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HL5 state.

Transition HS5:HS3: When the device successfully processes a power-on reset, the device shall transition to the HS3 state.

Transition HS5a:HS5: When the device successfully processes a SET MAX ADDRESS EXT () or SET MAX UNLOCK (), the device shall return command aborted and remain in the HS5 state.

Transition HS5b:HS5: When the device successfully processes a hardware reset, the device shall remain in the HS5 state.

Transition HS5c:HS5: When the device successfully processes a SET MAX ADDRESS (Non-Volatile), the device shall return command ID Not Found and remain in the HS5 state.

Transition HS5d:HS5: When the device successfully processes a SET MAX SET PASSWORD (), the device shall remain in the HS5 state.

Transition HS5e:HS5: When the device successfully processes a SET MAX ADDRESS (Volatile), the device shall remain in the HS5 state.

State HS6: HPA SET (Non-Volatile 2)/Password Set: In this state the non-volatile 28-bit HPA is established and the password is set.

Transition HS6:HS5: When the device successfully processes a SET MAX ADDRESS (Non-volatile), the device shall transition to the HS5 state.

Transition HS6:H1: When the device successfully processes a SET MAX ADDRESS (Non-volatile, Native Max), the device shall transition to the H1 state.

Transition HS6:HL3: When the device successfully processes a SET MAX LOCK (), the device shall transition to the HL3 state.

Transition HS6:HL6: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HL6 state.

Transition HS6:HS3: When the device successfully processes a power-on reset, the device shall transition to the HS3 state.

Transition HS6a:HS6: When the device successfully processes a SET MAX ADDRESS EXT () or SET MAX UNLOCK (), the device shall return command aborted and remain in the HS6 state.

Transition HS6b:HS6: When the device successfully processes a hardware reset, the device shall remain in the HS6 state.

Transition HS6c:HS6: When the device successfully processes a SET MAX SET PASSWORD (), the device shall remain in the HS6 state.

Transition HS6d:HS6: When the device successfully processes a SET MAX ADDRESS (Volatile), the device shall remain in the HS6 state.

4.11.6.4 48-Bit HPA Set

State HES1: HPA SET (Volatile)/No Password: In this state the volatile 48-bit HPA is established and the password is not set.

Transition HES1:HES2: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile), the device shall transition to the HES2 state.

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Transition HES1:HES4: When the device successfully processes a SET MAX SET PASSWORD (), the device shall transition to the HES4 state.

Transition HES1a:H0: When the device successfully processes a hardware reset or if the device successfully processes a power-on reset, the device shall transition to the H0 state.

Transition HES1b:H0: When the device successfully processes a SET MAX ADDRESS (Native Max), the device shall transition to the H0 state.

Transition HES1a:HES1: When the device successfully processes a SET MAX ADDRESS (), SET MAX LOCK (), SET MAX UNLOCK () or SET MAX FREEZE LOCK (), the device shall return command aborted and remain in the HES1 state.

Transition HES1b:HES1: When the device successfully processes a SET MAX ADDRESS EXT (Volatile), the device shall remain in the HES1 state.

State HES2: HPA SET (Non-Volatile 1)/No Password: In this state the non-volatile 48-bit HPA is established and the password is not set.

Transition HES2:H0: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile, Native Max), the device shall transition to the H0 state.

Transition HES2:HES3: When the device successfully processes a power-on reset or a hardware reset, the device shall transition to the HES3 state.

Transition HES2:HES5: When the device successfully processes a SET MAX SET PASSWORD (), the device shall transition to the HES5 state.

Transition HES2a:HES2: When the device successfully processes a SET MAX ADDRESS (), SET MAX LOCK (), SET MAX UNLOCK () or SET MAX FREEZE LOCK (), the device shall return command aborted and remain in the HES2 state.

Transition HES2b:HES2: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile), the device shall return ID Not Found and remain in the HES2 state.

Transition HES2c:HES2: When the device successfully processes a SET MAX ADDRESS EXT (Volatile), the device shall remain in the HES2 state.

State HES3: HPA SET (Non-Volatile 2)/No Password: In this state the non-volatile 48-bit HPA is established and the password is not set.

Transition HES3:H0: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile, Native Max), the device shall transition to the H0 state.

Transition HES3:HES2: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile), the device shall transition to the HES2 state.

Transition HES3:HES6: When the device successfully processes a SET MAX SET PASSWORD (), the device shall transition to the HES6 state.

Transition HES3a:HES3: When the device successfully processes a SET MAX ADDRESS EXT (), SET MAX LOCK (), SET MAX UNLOCK () or SET MAX FREEZE LOCK (), the device shall return command aborted and remain in the HES3 state.

Transition HES3b:HES3: When the device successfully processes a hardware reset or when the device successfully processes a power-on reset, the device shall remain in the HES3 state.

Transition HES3c:HES3: When the device processes a SET MAX ADDRESS EXT (Volatile) without error, the device shall remain in the HES3 state.

State HES4: HPA SET (Volatile)/Password Set: In this state the volatile 48-bit HPA is established and the password is set.

Transition HES4:H0: When the device successfully processes a power-on reset, the device shall transition to the H0 state.

Transition HES4:HES5: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile), the device shall transition to the HES5 state.

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Transition HES4:HEL1: When the device successfully processes a SET MAX LOCK (), the device shall transition to the HEL1 state.

Transition HES4a:H1: When the device processes a hardware reset, the device shall transition to the H1 state.

Transition HES4b:H1: When the device successfully processes a SET MAX ADDRESS (Native Max), the device shall transition to the H1 state.

Transition HES4:HEL4: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HEL4 state.

Transition HES4a:HES4: When the device successfully processes a SET MAX ADDRESS () or SET MAX UNLOCK (), the device shall return command aborted and remain in the HES4 state.

Transition HES4b:HES4: When the device successfully processes a SET MAX ADDRESS EXT (Volatile), the device shall remain in the HES4 state.

Transition HES4c:HES4: When the device successfully processes a SET MAX SET PASSWORD (), the device shall remain in the HES4 state.

State HES5: HPA SET (Non-Volatile 1)/Password Set: In this state the non-volatile 48-bit HPA is established and the password is set.

Transition HES5:H1: When the device successfully processes a SET MAX ADDRESS EXT (Non-volatile, Native Max), the device shall transition to the H1 state.

Transition HES5:HEL2: When the device successfully processes a SET MAX LOCK (), the device shall transition to the HEL2 state.

Transition HES5:HES3: When the device successfully processes a power-on reset, the device shall transition to the HES3 state.

Transition HES5:HEL5: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HEL5 state.

Transition HES5a:HES5: When the device successfully processes a SET MAX ADDRESS () or SET MAX UNLOCK (), the device shall return command aborted and remain in the HES5 state.

Transition HES5b:HES5: When the device successfully processes a hardware reset, the device shall remain in the HES5 state.

Transition HES5c:HES5: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile), the device shall return ID Not Found and remain in the HES5 state.

Transition HES5d:HES5: When the device successfully processes a SET MAX SET PASSWORD (), the device shall remain in the HES5 state.

Transition HES5e:HES5: When the device successfully processes a SET MAX ADDRESS EXT (Volatile), the device shall remain in the HES5 state.

State HES6: HPA SET (Non-Volatile 2)/Password Set: In this state the non-volatile 48-bit HPA is established and the password is set.

Transition HES6:HES5: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile), the device shall transition to the HES5 state.

Transition HES6:H1: When the device successfully processes a SET MAX ADDRESS EXT (Non-Volatile, Native Max), the device shall transition to the H1 state.

Transition HES6:HEL3: When the device successfully processes a SET MAX LOCK (), the device shall transition to the HEL3 state.

Transition HES6:HES3: When the device successfully processes a power-on reset, the device shall transition to the HES3 state.

Transition HES6:HEL6: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HEL6 state.

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Transition HES6a:HES6: When the device successfully processes a SET MAX ADDRESS () or SET MAX UNLOCK (), the device shall return command aborted and remain in the HES6 state.

Transition HES6b:HES6: When the device successfully processes a hardware reset, the device shall remain in the HES6 state.

Transition HES6c:HES6: When the device successfully processes a SET MAX SET PASSWORD (), the device shall remain in the HES6 state.

Transition HES6d:HES6: When the device successfully processes a SET MAX ADDRESS EXT (Volatile), the device shall remain in the HES6 state.

4.11.6.5 28-Bit HPA Locked

State HL1: HPA LOCKED (Volatile): In this state the volatile 28-bit HPA is established, and the device is locked from HPA commands, except SET MAX UNLOCK (), with a proper password or SET MAX FREEZE LOCK ().

Transition HL1:H0: When the device successfully processes a power-on reset, the device shall transition to the H0 state.

Transition HL1:HL4: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HL4 state.

Transition HL1:HS4: When the device successfully processes a SET MAX UNLOCK (correct password), and the HPA Security Extensions unlock counter is non-zero, the device shall transition to the HS4 state.

Transition HL1:H2: When the device successfully processes a hardware reset, the device shall transition to the H2 state.

Transition HL1a:HL1: When the device successfully processes a SET MAX ADDRESS EXT (), SET MAX ADDRESS (), SET MAX UNLOCK (wrong password) or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the HL1 state.

Transition HL1b:HL1: When the device successfully processes a SET MAX UNLOCK (correct password) and the HPA Security Extensions unlock counter is zero, the device shall return command aborted and remain in the HL1 state.

Transition HL1c:HL1: If the device successfully processes a SET MAX LOCK (), the device shall remain in the HL1 state and the device may return command aborted.

State HL2: HPA LOCKED (Non-volatile 1): In this state the non-volatile 28-bit HPA is established, and the device is locked from HPA commands except SET MAX UNLOCK () with a proper password or SET MAX FREEZE LOCK ().

Transition HL2:HL5: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HL5 state.

Transition HL2:HS3: When the device successfully processes a power-on reset, the device shall transition to the HS3 state.

Transition HL2:HS5: When the device successfully processes a SET MAX UNLOCK (correct password) and the HPA Security Extensions unlock counter is non-zero, the device shall transition to the HS5 state.

Transition HL2a:HL2: When the device successfully processes a SET MAX ADDRESS EXT (), SET MAX ADDRESS (), SET MAX UNLOCK (wrong password) or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the HL2 state.

Transition HL2b:HL2: When the device successfully processes a hardware reset, the device shall remain in the HL2 state.

Transition HL2c:HL2: When the device successfully processes a SET MAX UNLOCK (correct password) and the HPA Security Extensions unlock counter is zero, the device shall return command aborted and remain in the HL2 state.

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Transition HL2d:HL2: If the device successfully processes a SET MAX LOCK (), the device shall remain in the HL2 state and the device may return command aborted.

State HL3: HPA LOCKED (Non-volatile 2): In this state a non-volatile 28-bit HPA is established, and the device is locked from HPA commands except a SET MAX UNLOCK () with a proper password or a SET MAX FREEZE LOCK ().

Transition HL3:HL6: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HL6 state.

Transition HL3:HS3: When the device successfully processes a power-on reset, the device shall transition to the HS3 state.

Transition HL3:HS6: When the device successfully processes a SET MAX UNLOCK () without error with the correct password and the HPA Security Extensions unlock counter is non-zero, the device shall transition to the HS6 state.

Transition HL3a:HL3: When the device successfully processes a SET MAX ADDRESS EXT (), SET MAX ADDRESS (), SET MAX UNLOCK (wrong password) or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the HL3 state. If a SET MAX UNLOCK (wrong password) is successfully processes the HPA Security Extensions unlock counter shall be decremented by one.

Transition HL3b:HL3: When the device successfully processes a hardware reset, the device shall remain in the HL3 state.

Transition HL3c:HL3: When the device successfully processes a SET MAX UNLOCK (correct password) and the HPA Security Extensions unlock counter is zero, the device shall return command aborted and remain in the HL3 state.

Transition HL3d:HL3: If the device successfully processes a SET MAX LOCK (), the device shall remain in the HL3 state and the device may return command aborted.

State HL4: HPA FROZEN (Volatile): In this state a volatile 28-bit HPA is established and the device is locked from all HPA commands.

Transition HL4:H0: When the device successfully processes a power-on reset, the device shall transition to the H0 state.

Transition HL4a:HL4: When the device successfully processes a SET MAX ADDRESS EXT (), SET MAX ADDRESS (), SET MAX LOCK (), SET MAX UNLOCK (), SET MAX FREEZE LOCK () or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the HL4 state.

Transition HL4b:HL4: When the device processes a hardware reset, the device shall remain in the HL4 state.

State HL5: HPA FROZEN (Non-Volatile 1): In this state the non-volatile 28-bit HPA is established and the device is locked from all HPA commands.

Transition HL5a:HL5: When the device successfully processes a SET MAX ADDRESS EXT (), SET MAX ADDRESS (), SET MAX LOCK (), SET MAX UNLOCK (), SET MAX FREEZE LOCK () or SET MAX SET PASSWORD (), the device shall return command aborted and HL5 in the same state.

Transition HL5b:HL5: When the device successfully processes a hardware reset, the device shall remain in the HL5 state.

Transition HL5:HS3: When the device successfully processes a power-on reset, the device shall transition to the HS3 state.

State HL6: HPA FROZEN (Non-Volatile 2): In this state the non-volatile 28-bit HPA is established and the device is locked from all HPA commands.

Transition HL6:HS3: When the device successfully processes a power-on reset, the device shall transition to the HS3 state.

Transition HL6a:HL6: When the device successfully processes a SET MAX ADDRESS EXT (), SET MAX ADDRESS (), SET MAX LOCK (), SET MAX UNLOCK (), SET MAX FREEZE LOCK

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() or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the HL6 state.

Transition HL6b:HL6: When the device successfully processes a hardware reset, the device shall remain in the HL6 state.

4.11.6.6 48-Bit HPA Locked

State HEL1: HPA LOCKED (Volatile): In this state a volatile 48-bit HPA is established, and the device is locked from HPA commands, except a SET MAX UNLOCK (), with a proper password or a SET MAX FREEZE LOCK ().

Transition HEL1:H0: When the device processes a power-on reset, the device shall transition to the H0 state.

Transition HEL1:H2: When the device successfully processes a hardware reset, the device shall transition to the H2 state.

Transition HEL1:HEL4: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HEL4 state.

Transition HEL1:HES4: When the device successfully processes a SET MAX UNLOCK (correct password) and the HPA Security Extensions unlock counter is non-zero, the device shall transition to the HES4 state.

Transition HEL1a:HEL1: When the device successfully processes a SET MAX ADDRESS (), SET MAX ADDRESS EXT (), SET MAX UNLOCK (wrong password) or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the HEL1 state.

Transition HEL1b:HEL1: When the device successfully processes a SET MAX UNLOCK (correct password) and the HPA Security Extensions unlock counter is zero, the device shall return command aborted and remain in the HEL1 state.

Transition HEL1c:HEL1: If the device successfully processes a SET MAX LOCK (), the device shall remain in the HEL1 state and the device may return command aborted.

State HEL2: HPA LOCKED (Non-volatile 1): In this state a non-volatile 48-bit HPA is established, and the device is locked from HPA commands, except a SET MAX UNLOCK (), with a proper password or a SET MAX FREEZE LOCK ().

Transition HES5:HEL2: When the device successfully processes a SET MAX LOCK (), the device shall transition to the HEL2 state.

Transition HEL2:HEL5: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HEL5 state.

Transition HEL2:HES3: When the device successfully processes a power-on reset, the device shall transition to the HES3 state.

Transition HEL2:HES5: When the device successfully processes a SET MAX UNLOCK (correct password) and the HPA Security Extensions unlock counter is non-zero, the device shall transition to the HES5 state.

Transition HEL2a:HEL2: When the device successfully processes a SET MAX ADDRESS (), SET MAX ADDRESS EXT (), SET MAX UNLOCK (wrong password) or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the HEL2 state.

Transition HEL2b:HEL2: When the device successfully processes a hardware reset, the device shall remain in the HEL2 state.

Transition HEL2c:HEL2: When the device successfully processes a SET MAX UNLOCK (correct password) and the HPA Security Extensions unlock counter is zero, the device shall return command aborted and remain in the HEL2 state.

Transition HEL2d:HEL2: If the device successfully processes a SET MAX LOCK (), the device shall remain in the HEL2 state and the device may return command aborted.

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State HEL3: HPA LOCKED (Non-volatile 2): In this state a non-volatile 48-bit HPA is established, and the device is locked from HPA commands, except a SET MAX UNLOCK (), with a proper password or a SET MAX FREEZE LOCK ().

Transition HEL3:HEL6: When the device successfully processes a SET MAX FREEZE LOCK (), the device shall transition to the HEL6 state.

Transition HEL3:HES3: When the device successfully processes a power-on reset, the device shall transition to the HES3 state.

Transition HEL3:HES6: When the device successfully processes a SET MAX UNLOCK () with the correct password and the HPA Security Extensions unlock counter is non-zero, the device shall transition to the HES6 state.

Transition HEL3a:HEL3: When the device successfully processes a SET MAX ADDRESS (), SET MAX ADDRESS EXT (), SET MAX UNLOCK (wrong password) or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the HEL3 state. If a SET MAX UNLOCK (wrong password) is received the HPA Security Extensions unlock counter shall be decremented by one.

Transition HEL3b:HEL3: When the device successfully processes a hardware reset, the device shall remain in the HEL3 state.

Transition HEL3c:HEL3: When the device successfully processes a SET MAX UNLOCK (correct password) and the HPA Security Extensions unlock counter is zero, the device shall return command aborted and remain in the HEL3 state.

Transition HEL3d:HEL3: If the device successfully processes a SET MAX LOCK (), the device shall remain in the HEL3 state and the device may return command aborted.

State HEL4: HPA FROZEN (Volatile): In this state the volatile 48-bit HPA is established and the device is locked from all HPA commands.

Transition HEL4:H0: When the device successfully processes a power-on reset, the device shall transition to the H0 state.

Transition HEL4a:HEL4: When the device successfully processes a SET MAX ADDRESS (), SET MAX ADDRESS EXT (), SET MAX LOCK (), SET MAX UNLOCK (), SET MAX FREEZE LOCK () or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the HEL4 state.

Transition HEL4b:HEL4: When the device successfully processes a hardware reset, the device shall remain in the HEL4 state.

HEL5: HPA FROZEN (Non-Volatile 1): In this state the non-volatile 48-bit HPA is established, and the device is locked from all HPA commands.

Transition HEL5a:HEL5: When the device successfully processes a SET MAX ADDRESS (), SET MAX ADDRESS EXT (), SET MAX LOCK (), SET MAX UNLOCK (), SET MAX FREEZE LOCK () or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the HEL5 state.

Transition HEL5b:HEL5: When the device successfully processes a hardware reset, the device shall remain in the HEL5 state.

Transition HEL5:HES3: When the device successfully processes a power-on reset, the device shall transition to the HES3 state.

State HEL6: HPA FROZEN (Non-Volatile 2): In this state a non-volatile 48-bit HPA is established, and the device is locked from all HPA commands.

Transition HEL6:HES3: When the device successfully processes a power-on reset, the device shall transition to the HES3 state.

Transition HEL6a:HEL6: When the device successfully processes a SET MAX ADDRESS (), SET MAX ADDRESS EXT (), SET MAX LOCK (), SET MAX UNLOCK (), SET MAX FREEZE LOCK () or SET MAX SET PASSWORD (), the device shall return command aborted and remain in the HEL6 state.

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Transition HEL6b:HEL6: When the device successfully processes a hardware reset, the device shall remain in the HEL6 state.

4.12 Long Logical Sector (LLS) feature set

The Long Logical Sector (LLS) feature set provides a method for a device to indicate that it has more than 256 words per logical sector (e.g., sectors with 520 bytes or 528 bytes). Devices with logical sectors longer than 256 words shall set IDENTIFY DEVICE data word 106 bit 12 to 1 (see 7.17.7.56). The logical sector size is described by IDENTIFY DEVICE data words 117..118 (see 7.17.7.61).

Table 5 describes the command behavior of ATA devices that support the LLS feature set. Data transfer commands transfer either the long logical sector length or 256 words depending on the command (e.g., the READ DMA EXT command and the WRITE DMA EXT command transfer data in long logical sectors while the READ LOG EXT command and the WRITE LOG EXT command transfer 256 word blocks of data, regardless of the logical sector length). Configuration 2 in figure 10 shows a diagram of a device formatted with long logical sectors.

The Long Physical Sector (LPS) feature set (see 4.13) and the LLS feature set are not mutually exclusive. Configuration 4 in figure 10 illustrates a device implementing both the LPS and LLS feature sets.

Table 5 — Block Size By Command (part 1 of 2)

Command	Words transferred per block
ADD LBA(S) TO NV CACHE PINNED SET	256
CFA TRANSLATE SECTOR	256
CFA WRITE MULTIPLE WITHOUT ERASE	IDENTIFY DEVICE data words (118:117)
CFA WRITE SECTORS WITHOUT ERASE	IDENTIFY DEVICE data words (118:117)
DATA SET MANAGEMENT	256
DEVICE CONFIGURATION IDENTIFY	256
DEVICE CONFIGURATION IDENTIFY DMA	256
DEVICE CONFIGURATION SET	256
DEVICE CONFIGURATION SET DMA	256
DOWNLOAD MICROCODE	256
DOWNLOAD MICROCODE DMA	256
IDENTIFY DEVICE	256
IDENTIFY PACKET DEVICE	256
QUERY NV CACHE MISSES	256
QUERY NV CACHE PINNED SET	256
REMOVE LBA(S) FROM NV CACHE PINNED SET	256
READ BUFFER	256
READ BUFFER DMA	256
READ DMA	IDENTIFY DEVICE data words (118:117)
READ DMA EXT	IDENTIFY DEVICE data words (118:117)
READ FPDMA QUEUED	IDENTIFY DEVICE data words (118:117)
READ LOG EXT	256
READ LOG DMA EXT	256
READ MULTIPLE	IDENTIFY DEVICE data words (118:117)
READ MULTIPLE EXT	IDENTIFY DEVICE data words (118:117)
READ SECTOR(S)	IDENTIFY DEVICE data words (118:117)
READ SECTOR(S) EXT	IDENTIFY DEVICE data words (118:117)
READ STREAM DMA EXT	IDENTIFY DEVICE data words (118:117)

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Table 5 — Block Size By Command (part 2 of 2)

Command	Words transferred per block
READ STREAM EXT	IDENTIFY DEVICE data words (118:117)
READ VERIFY SECTOR(S)	IDENTIFY DEVICE data words (118:117)
SECURITY DISABLE PASSWORD	256
SECURITY ERASE UNIT	256
SECURITY SET PASSWORD	256
SECURITY UNLOCK	256
SET MAX SET PASSWORD	256
SET MAX SET PASSWORD DMA	256
SET MAX UNLOCK	256
SET MAX UNLOCK DMA	256
SMART READ DATA	256
SMART READ LOG	256
SMART WRITE LOG	256
TRUSTED RECEIVE	256
TRUSTED RECEIVE DMA	256
TRUSTED SEND	256
TRUSTED SEND DMA	256
WRITE BUFFER	256
WRITE BUFFER DMA	256
WRITE DMA	IDENTIFY DEVICE data words (118:117)
WRITE DMA EXT	IDENTIFY DEVICE data words (118:117)
WRITE DMA FUA EXT	IDENTIFY DEVICE data words (118:117)
WRITE FPDMA QUEUED	IDENTIFY DEVICE data words (118:117)
WRITE LOG EXT	256
WRITE LOG DMA EXT	256
WRITE MULTIPLE	IDENTIFY DEVICE data words (118:117)
WRITE MULTIPLE EXT	IDENTIFY DEVICE data words (118:117)
WRITE MULTIPLE FUA EXT	IDENTIFY DEVICE data words (118:117)
WRITE SECTOR(S)	IDENTIFY DEVICE data words (118:117)
WRITE SECTOR(S) EXT	IDENTIFY DEVICE data words (118:117)
WRITE STREAM DMA EXT	IDENTIFY DEVICE data words (118:117)
WRITE STREAM EXT	IDENTIFY DEVICE data words (118:117)

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4.13 Long Physical Sector (LPS) feature set

The Long Physical Sector (LPS) feature set allows a device to indicate that there are multiple logical sectors per physical sector as shown in figure 10.

Long Physical Sector Alignment Error Reporting Control (see 7.49.17) and the LPS Mis-alignment log (see A.11) are optional for devices implementing the LPS feature set.

1) Conventional logical sector example: 512 bytes per LBA

512 Bytes	512 Bytes	512 Bytes	512 Bytes	512 Bytes	512 Bytes	512 Bytes	
LBA 0	LBA 1	LBA 2	LBA 3	LBA 4	LBA 5	LBA 6	...

2) Long logical sector example: 524 bytes per LBA

524 Bytes	524 Bytes	524 Bytes	524 Bytes	524 Bytes	524 Bytes	524 Bytes	
LBA 0	LBA 1	LBA 2	LBA 3	LBA 4	LBA 5	LBA 6	...

3) Long physical sector example: 512 bytes per LBA, 1 024 bytes per physical sector

512 Bytes	512 Bytes	512 Bytes	512 Bytes	512 Bytes	512 Bytes	512 Bytes	
LBA 0	LBA 1	LBA 2	LBA 3	LBA 4	LBA 5	LBA 6	...
Physical Sector 0		Physical Sector 1		Physical Sector 2		...	

4) Long logical and Long physical sector example: 524 bytes per LBA, 1 048 bytes per physical sector

524 Bytes	524 Bytes	524 Bytes	524 Bytes	524 Bytes	524 Bytes	524 Bytes	
LBA 0	LBA 1	LBA 2	LBA 3	LBA 4	LBA 5	LBA 6	...
Physical Sector 0		Physical Sector 1		Physical Sector 2		...	

Figure 10 — LLS and LPS Example

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

EXAMPLE 1 - In Figure 11 there are 2 logical sectors within one physical sector, and the first logical sector is in the first half. The offset is: 0, and the value in IDENTIFY DEVICE data word 209 is 4000h.

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

Figure 11 — Alignment 0

EXAMPLE 2 - In Figure 12 there are 2 logical sectors within one physical sector, and the first logical sector is in the second half. The offset is: 1, and the value in word 209 is 4001h.

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

Figure 12 — Alignment 1

EXAMPLE 3 - In Figure 13 there are 4 logical sectors within one physical sector, and the first logical sector is in the second half. The offset is: 3, and the value in word 209 is 4003h.

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

Figure 13 — Alignment 3

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4.14 Native Command Queuing (NCQ) feature set

4.14.1 Overview

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

a) READ FPDMA QUEUED (see 7.28); and
b) WRITE FPDMA QUEUED (see 7.67).

Devices that report support for the NCQ feature set shall also report support for the GPL feature set (see 4.10), the General Purpose Log Directory log and the NCQ Command Error log.

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

All the commands in the NCQ feature set shall include a NCQ Tag. If the value of the NCQ Tag exceeds the value returned in IDENTIFY DEVICE data word 75 (see 7.17.7.33), then the device shall return command aborted for the new command and for all NCQ commands that are in the queue. If the device receives an NCQ command with a NCQ Tag value that is identical to the NCQ Tag value for another NCQ command in the queue, then the device shall return command aborted for the new command and for all the NCQ commands that are in the queue.

NOTE 1 The NCQ Tag identifies return information (i.e., error status, data transfer and command completion).

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

NOTE 2 The NCQ feature set uses 48-bit addresses and is intentionally not included in the 48-bit address feature set.

4.14.2 Priority

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

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

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

4.14.3 Unload

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

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

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

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

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

such that if the unload process completes successfully, then:

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

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

4.14.4 Command Phases

4.14.4.1 Command Acceptance

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

4.14.4.2 Data transmission

Data transfer should occur after acceptance of the command.

4.14.4.3 Command completion

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

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

4.15 NV Cache feature set

4.15.1 Overview

The NV Cache is managed as two distinct areas, the NV Cache Pinned Set and the NV Cache Unpinned Set. Each LBA stored in the NV Cache Set has an attribute called the pinned attribute that determines if the device may remove the sector from the NV Cache. The pinned attribute also indicates whether the LBA belongs to the NV Cache Pinned Set or the NV Cache Unpinned Set.

The host manages the NV Cache Pinned Set (i.e., the set of logical blocks that the host requires the device to keep in the NV Cache). The remaining NV Cache Set is the NV Cache Unpinned Set.

The NV Cache Pinned Set and the NV Cache Unpinned Set are mutually exclusive. NV Cache Unpinned Set is managed by the device and logical blocks represented in the NV Cache Unpinned Set may be added or removed from the NV Cache Set at any time.

See 7.21.1 for a list of the optional and mandatory commands in this feature set.

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4.15.2 Pinning

Adding or Removing an LBA from the NV Cache Pinned Set is accomplished by setting or clearing the pinned attribute on a mapped logical sector. If a device's NV Cache Unpinned Set is too full to satisfy an Add request, then the device shall remove some or all of the NV Cache Unpinned Set in order to complete the Add request.

When an LBA is pinned, the logical sector that is placed into the NV Cache may come from one of two sources:

a) the device's media; or
b) the host in the form of a write command.

The source of the logical sector is determined by the Populate Immediately (PI) bit in the ADD LBA(S) TO NV CACHE PINNED SET command. See 7.21.3.3.2 for the definition of the PI bit.

EXAMPLE 1 - A host may pin an LBA:
a) for subsequent read operations; and
b) that is about to be written.

EXAMPLE 2 - When the application client requires logical sectors to be accessed frequently (e.g., for preloading frequent randomly accessed operation system files or preloading boot files in preparation for a system reboot), the host may add the logical blocks to the pinned set with the ADD LBA(S) TO NV CACHE PINNED SET command.

EXAMPLE 3 - An application client that is going to write logical sectors (e.g., writing of the hibernate file in preparation for system hibernation), may add the logical sectors to the pinned set first with the PI bit cleared to zero.

4.15.3 NV Cache Management

4.15.3.1 Overview

The NV Cache management refers to the use of ATA commands to query or take action on the contents of the NV Cache Pinned Set. This is accomplished by transmitting lists of logical sectors that are used in NV Cache management actions. Some NV Cache management actions take lists of logical blocks as inputs and some NV Cache management actions give lists of logical blocks as outputs.

4.15.3.2 LBA Range Entry

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

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

EXAMPLE 2 - If only LBA 20 was represented in an LBA Range Entry, then the range value is one (i.e., 0000_0000_0014_0001h).

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

4.15.3.3 NV Cache Remaining for Pinned logical blocks

If the NV Cache runs out of space for pinned logical sectors, then the number of the remaining available spaces (i.e., Logical Blocks Remaining) shall be returned to the host during the completion of NV Cache Commands.

Logical Blocks Remaining is a six byte number that always represents the number of logical blocks in the total NV Cache size minus the number of logical blocks in the NV Cache Pinned Set.

4.15.4 Rotating media state after power-on event

If the NV Cache power mode is set in a device, then the device should not spin up its rotating media, if any, after after a power-on event until the device receives a command that requires media access.

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4.16 NV Cache Power Management feature set

The NV Cache Power Management feature set permits a host to modify the behavior of a device in a manner that allows the device to improve response times to read and write commands while reducing the device's power consumption.

Commands unique to the NV Cache Power Management feature set use a single command code and are differentiated from one another by the value placed in the Feature field.

See 7.21.2 for a list of the optional and mandatory commands in this feature set.

If the NV Cache power mode is set and the device contains rotating media, then the device carries out an aggressive policy to remove power from its rotational media and process all reads and writes from the device's NV Cache. If a device is not capable of satisfying a read or write from its NV Cache it shall service the read or write request through other means.

The only aspect of the NV Cache feature that affects the Power Management feature set (see 4.17) is the NV Cache power mode input. The purpose of the NV Cache power mode input is to enable and disable the aggressive spinning down of the device's rotating media while it is in the PM0:Active state. However, the Power Management state diagram does not reflect the state of the rotating media (e.g., spin-up or spin-down) and the NV Cache power mode does not affect any Power Management state transitions. The effects are as follows:

a) when the device is powered up, it should satisfy requests from NV Cache regardless of its current NV Cache power mode setting so that BIOSes are not required to be NV Cache sensitive;
b) when the NV Cache power mode is disabled, and the device is in PM0:Active state (see 4.17), the device shall spin up its rotating media;
c) when the NV Cache power a is enabled, and the device is in PM0:Active state, the device shall use its aggressive policy to reduce power to any rotating media. The only requirement for this policy is that, when the device is spun up, it remains spun up for at least the amount of time specified in the SET NV CACHE POWER MODE command; and
d) a Device Configuration Overlay command that disables the NV Cache power mode support in the device causes the NV Cache power mode to be disabled.

4.17 Power Management feature set

4.17.1 Overview

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

The Power Management feature set allows an application client to modify the behavior of a device in a manner that reduces the power required to operate. The Power Management feature set provides a set of commands and a timer that enable a device to implement low power consumption modes. An ATA device that implements the Power Management feature set shall implement the following (see also 4.5 and 4.18):

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

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

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

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4.17.2 Power management commands

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

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

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

The SLEEP command moves a device to Sleep mode. The device's interface becomes inactive after the device reports command completion for the SLEEP command. A device only transitions from Sleep mode after processing a hardware reset, a software reset, or a DEVICE RESET command.

4.17.3 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, then the standby timer is reinitialized and started from the previously specified time period.

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

See 7.21.11 for interactions with the NV Cache feature set.

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4.17.4 Power modes

Figure 14 shows the set of state transitions that shall be implemented.

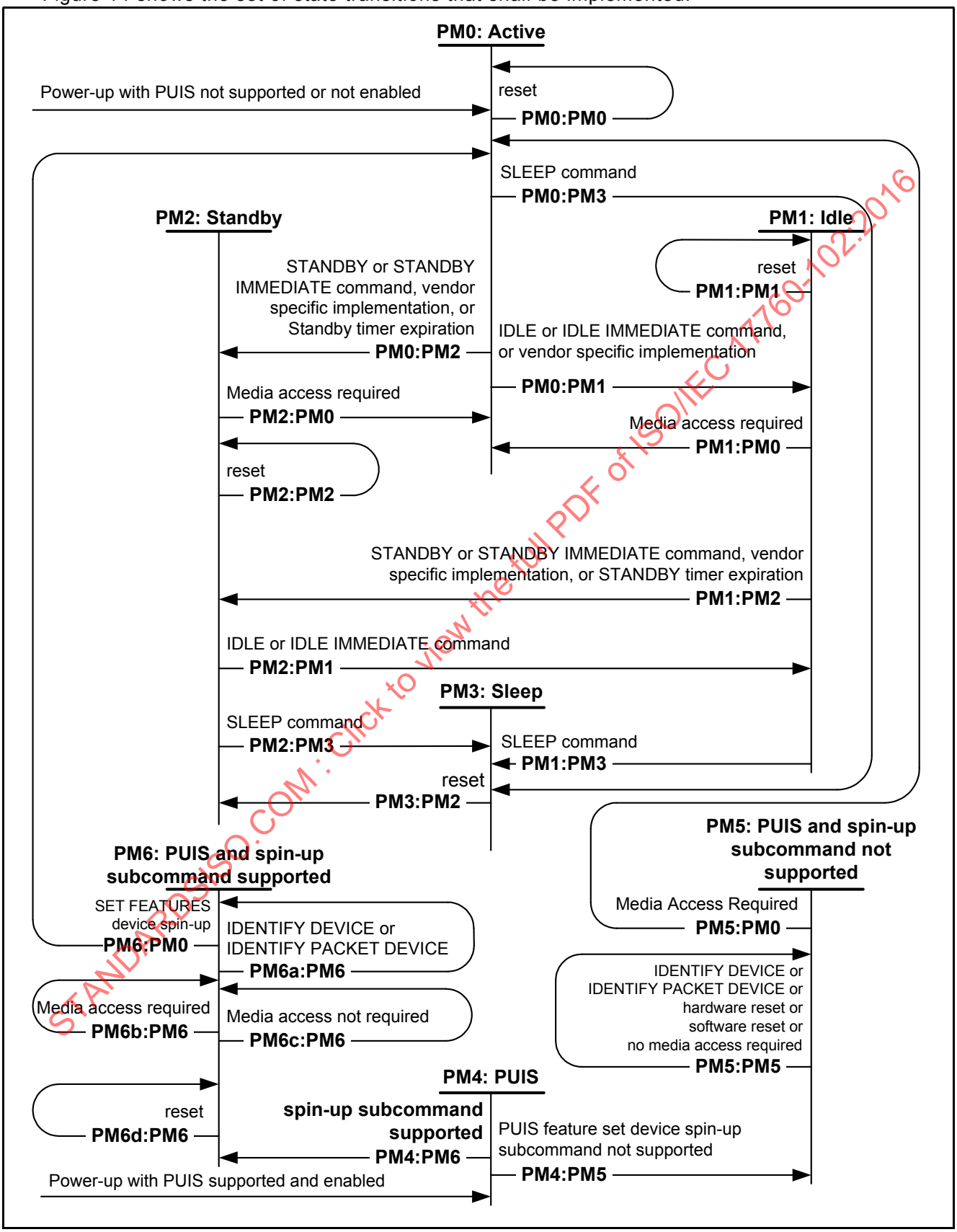

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Figure 14 — Power management state diagram

PM0: Active: This state shall be entered when the device receives a media access command while in Idle mode or Standby mode. This state shall also be entered after processing a power-on reset if the Power-Up In Standby feature is not supported or is not enabled (see 4.18).

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 state. Power consumption is greatest in this state.

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

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

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

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

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

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

Transition PM1:PM0: If a media access is required, then the device shall transition to the PM0: Active state.

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

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

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

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

PM2: Standby: This state shall be entered when:

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

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

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

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

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

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

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

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

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

PM4: PUIS: This state shall be entered after processing a power-on reset if the PUIS feature set (see 4.18) is supported and is enabled.

Transition PM4:PM5: A device shall transition to the PM5: PUIS and spin-up subcommand not supported state if the device does not implement the PUIS feature set device spin-up command (see 7.49.8).

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

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

In this state, the device is capable of responding to commands but the device may take longer (e.g., 30 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 receives a media access command, then the device shall transition to the PM0: Active state.

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

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

In this state, the device is capable of responding to commands but the device may take longer (e.g., 30 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 device spin-up subcommand.

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

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

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

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

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4.18 Power-Up In Standby (PUIS) feature set

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

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

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

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

A device may implement a SET FEATURES subcommand (see 7.49.8) that notifies the device to spin-up to the Active state when the device has powered-up into Standby. If the device implements this SET FEATURES subcommand and power-up into Standby is enabled, the device shall remain in the PM4: PUIS state until the SET FEATURES subcommand is received. If the device implements this SET FEATURES subcommand, the fact that the feature is implemented is reported in the IDENTIFY DEVICE data or IDENTIFY PACKET DEVICE data.

If the device:

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

then the device shall respond to the IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command without spinning up the media. If the device is unable to return a complete response without accessing the media, then the device shall set IDENITFY DEVICE data word 0 bit 2 (see 7.17.7.2) to one to indicate that the response is incomplete. At a minimum, IDENITFY DEVICE data word 0 and IDENITFY DEVICE data word 2 (see 7.17.7.4) shall be correctly reported. Those fields that are not provided shall be filled with zeros. Once a device is able to return all data for an IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command, the device shall return all data for those commands until after processing the next power-on reset.

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

4.19 Sanitize Device feature set

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

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

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

a) SANITIZE STATUS EXT (see 7.42.6); and
b) SANITIZE FREEZE LOCK EXT (see 7.42.5).

At least one of the following commands shall be implemented:

a) CRYPTO SCRAMBLE EXT (see 7.42.3);

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b) BLOCK ERASE EXT (see 7.42.2); or
c) OVERWRITE EXT (see 7.42.4).

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

Sanitize Device operations shall not affect non-user data areas (e.g., logs (see Annex A), and Device SMART data structure (see table 152)).

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

a) return an a if physical sectors that are available to be allocated for user data (e.g. allocated physical sectors or unallocated physical sectors allowed by vendor-specific means to be usable for user data) were not successfully sanitized; or
b) set the Sanitize Operation Complete Without Error bit if:
   A) all physical sectors that are available to be allocated for user data have been successfully sanitized; and
   B) any physical areas that were not successfully sanitized were removed from use.

To perform a Sanitize Device operation the host issues:

a) CRYPTO SCRAMBLE EXT command (see 7.42.3);
b) BLOCK ERASE EXT command (see 7.42.2); or
c) OVERWRITE EXT command (see 7.42.4),

followed by a SANITIZE STATUS EXT command (see 7.42.6) to check for completion.

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

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

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

An accepted CRYPTO SCRAMBLE EXT command, BLOCK ERASE EXT command, or OVERWRITE EXT command shall transition the device into the Sanitize Operation state. The device shall remain in this state until the device has completed the Sanitize Device operation (see figure 15).

The SANITIZE FREEZE LOCK EXT command (see 7.42.5) shall cause the device to transition to the Sanitize Frozen state and shall cause any subsequent CRYPTO SCRAMBLE EXT command, BLOCK ERASE EXT command, or OVERWRITE EXT command to be aborted. If the device processes a power-on reset or a hardware reset, then the device shall transition from the Sanitize Frozen state to the Sanitize Idle state.

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

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

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

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

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

Figure 15 describes the operation of the Sanitize Device feature set.

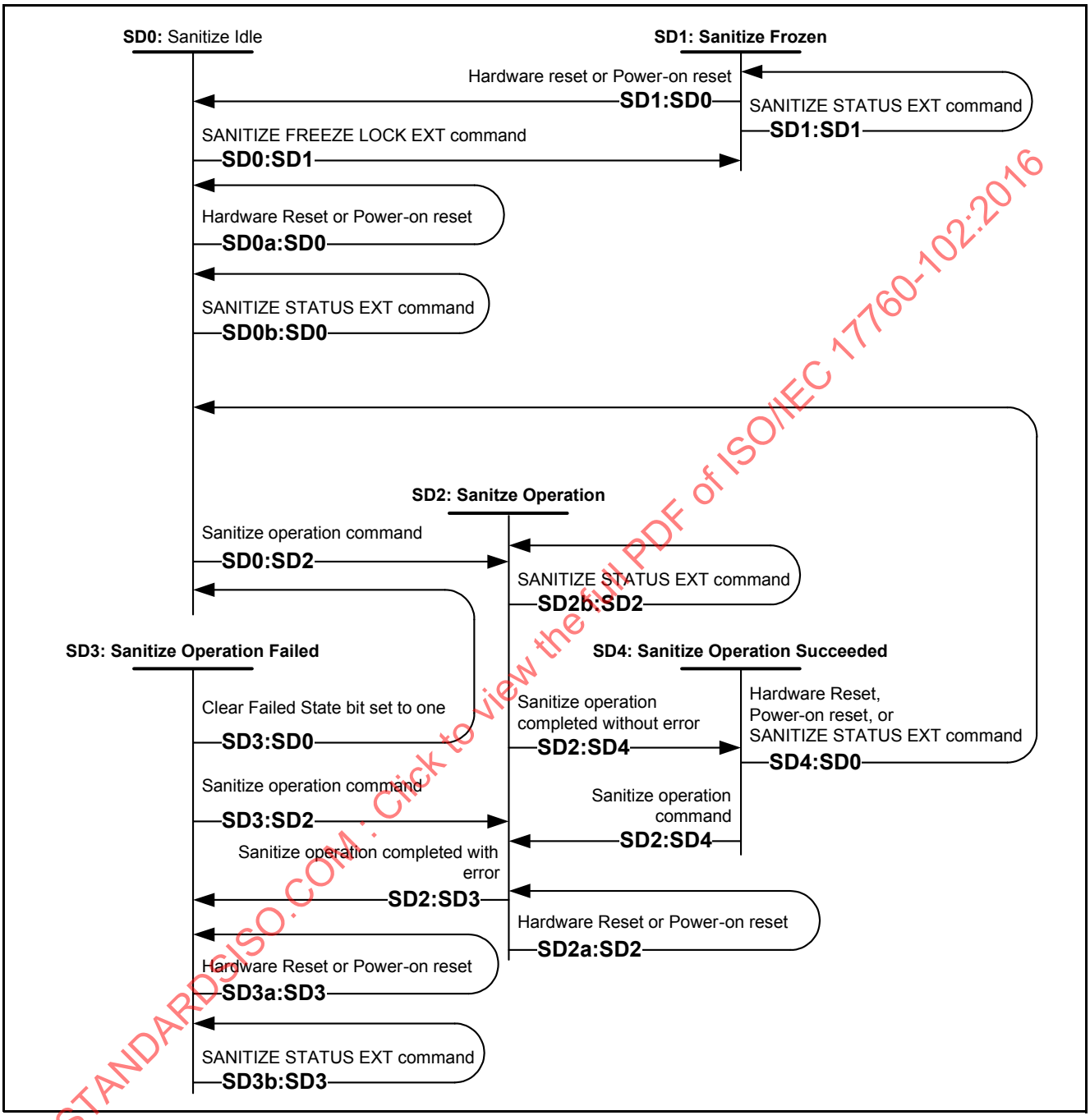

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Figure 15 — Sanitize Device state machine

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

Transition SD0a:SD0: If the device is:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

then the device shall transition to the Sanitize Idle state.

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

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

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

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

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

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

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

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

4.20 Security feature set

4.20.1 Overview

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

The Master Password Identifier feature (see 4.20.11) is an optional enhancement to the Security feature set.

4.20.2 Passwords

4.20.2.1 Overview

The system has two types of passwords:

a) User; and
b) Master.

4.20.2.2 User Password

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

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

4.20.2.3 Master Password

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

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

4.20.3 Master Password Capability

A device with security enabled has two ways of using the Master password. This capability has values of High or Maximum. The capability value is set when the User password is set (see 7.47).

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

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

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4.20.4 Frozen Mode

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

4.20.5 Commands

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

a) SECURITY SET PASSWORD (see 7.47);
b) SECURITY UNLOCK (see 7.48);
c) SECURITY ERASE PREPARE (see 7.44);
d) SECURITY ERASE UNIT (see 7.45);
e) SECURITY FREEZE LOCK (see 7.46); and
f) SECURITY DISABLE PASSWORD (see 7.43).

4.20.6 IDENTIFY DEVICE data

Support of the Security feature set is indicated in IDENTIFY DEVICE data words 82 and 128 (see 7.17.7.40 and 7.17.7.66) and IDENTIFY PACKET DEVICE data words 82 and 128 (see 7.18.6.34 and 7.18.6.51).

Security information in IDENTIFY DEVICE data words 82, 89 and 90 (see table 50) and IDENTIFY PACKET DEVICE data words 82, 89 and 90 (see table 61) is fixed until the next power-on reset and shall not change unless the DEVICE CONFIGURATION OVERLAY command removes support for the Security feature set.

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

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

4.20.7 Security initial setting

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

4.20.8 Password Rules

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

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

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

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

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

4.20.9 Password attempt counter

The device shall have a password attempt counter. The counter shall be decremented while in SEC4 state (see figure 16), whenever the SECURITY UNLOCK command fails because of an invalid User password or Master password.

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

a) not decrement the counter;

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b) set the Password Attempt Counter Exceeded bit (i.e., bit 4 of word 128 in the IDENTIFY DEVICE data) to one; and
c) return command aborted for all SECURITY UNLOCK commands and SECURITY ERASE UNIT commands until after the device processes a power-on reset or hardware reset.

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

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

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4.20.10 Security states

Figure 16 describes security states and state transitions, table 6 is a summary of the security states, and table 7 describes the effect of security on commands. When the power is off, the security characteristics are as in table 6, but are not reportable.

Table 6 — Summary of Security States and Security Characteristics

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

[a] IDENTIFY DEVICE data word 85 bit 1 (see 7.17.7.41)
[b] IDENTIFY DEVICE data word 128 bit 2 (see 7.17.7.66)
[c] IDENTIFY DEVICE data word 128 bit 3 (see 7.17.7.66)
[d] IDENTIFY DEVICE data word 128 bit 4 (see 7.17.7.66)

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Table 7 — Security Command Actions (part 1 of 3)

Command	Locked [a]	Unlocked or Disabled [b]	Frozen [c]
ADD LBA(S) TO NV CACHE PINNED SET	Command aborted	Executable	Executable
BLOCK ERASE EXT	Command aborted	Executable	Executable
CFA ERASE SECTORS	Command aborted	Executable	Executable
CFA REQUEST EXTENDED ERROR CODE	Executable	Executable	Executable
CFA TRANSLATE SECTOR	Executable	Executable	Executable
CFA WRITE MULTIPLE WITHOUT ERASE	Command aborted	Executable	Executable
CFA WRITE SECTORS WITHOUT ERASE	Command aborted	Executable	Executable
CHECK POWER MODE	Executable	Executable	Executable
CONFIGURE STREAM	Command aborted	Executable	Executable
CRYPTO SCRAMBLE EXT	Command aborted	Executable	Executable
DATA SET MANAGEMENT	Command aborted	Executable	Executable
DEVICE CONFIGURATION	Command aborted	Executable	Executable
DEVICE RESET	Executable	Executable	Executable
DOWNLOAD MICROCODE	Vendor Specific	Vendor Specific	Vendor Specific
DOWNLOAD MICROCODE DMA	Vendor Specific	Vendor Specific	Vendor Specific
EXECUTE DEVICE DIAGNOSTIC	Executable	Executable	Executable
FLUSH CACHE	Command aborted	Executable	Executable
FLUSH CACHE EXT	Command aborted	Executable	Executable
FLUSH NV CACHE	Command aborted	Executable	Executable
IDENTIFY DEVICE	Executable	Executable	Executable
IDENTIFY PACKET DEVICE	Executable	Executable	Executable
IDLE	Executable	Executable	Executable
IDLE IMMEDIATE	Executable	Executable	Executable
MEDIA EJECT	Command aborted	Executable	Executable
MEDIA LOCK	Command aborted	Executable	Executable
MEDIA UNLOCK	Command aborted	Executable	Executable
NOP	Executable	Executable	Executable
OVERWRITE EXT	Command aborted	Executable	Executable
PACKET	Command aborted	Executable	Executable
QUERY NV CACHE MISSES	Command aborted	Executable	Executable
QUERY NV CACHE PINNED SET	Command aborted	Executable	Executable
READ BUFFER	Executable	Executable	Executable
READ BUFFER DMA	Executable	Executable	Executable
READ DMA	Command aborted	Executable	Executable
READ DMA EXT	Command aborted	Executable	Executable

NOTE – All commands not listed in this table are not addressed by the Security feature set.

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

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Table 7 — Security Command Actions (part 2 of 3)

Command	Locked [a]	Unlocked or Disabled [b]	Frozen [c]
READ FPDMA QUEUED	Command aborted	Executable	Executable
READ LOG DMA EXT	Executable	Executable	Executable
READ LOG EXT	Executable	Executable	Executable
READ MULTIPLE	Command aborted	Executable	Executable
READ MULTIPLE EXT	Command aborted	Executable	Executable
READ NATIVE MAX ADDRESS	Executable	Executable	Executable
READ NATIVE MAX ADDRESS EXT	Executable	Executable	Executable
READ SECTOR(S)	Command aborted	Executable	Executable
READ SECTOR(S) EXT	Command aborted	Executable	Executable
READ STREAM DMA EXT	Command aborted	Executable	Executable
READ STREAM EXT	Command aborted	Executable	Executable
READ VERIFY SECTOR(S)	Command aborted	Executable	Executable
READ VERIFY SECTOR(S) EXT	Command aborted	Executable	Executable
REMOVE LBA(S) FROM NV CACHE PINNED SET	Command aborted	Executable	Executable
REQUEST SENSE DATA EXT	Executable	Executable	Executable
RETURN FROM NV CACHE POWER MODE	Command aborted	Executable	Executable
SANITIZE FREEZE LOCK EXT	Command aborted	Executable	Executable
SANITIZE STATUS EXT	Command aborted	Executable	Executable
SCT WRITE SAME	Command aborted	Executable	Executable
SCT ERROR RECOVERY CONTROL	Command aborted	Executable	Executable
SCT FEATURE CONTROL	Command aborted	Executable	Executable
SCT DATA TABLES	Command aborted	Executable	Executable
SCT READ STATUS	Executable	Executable	Executable
SECURITY DISABLE PASSWORD	Command aborted	Executable	Command aborted
SECURITY ERASE PREPARE	Executable	Executable	Command aborted
SECURITY ERASE UNIT	Executable	Executable	Command aborted
SECURITY FREEZE LOCK	Command aborted	Executable	Executable
SECURITY SET PASSWORD	Command aborted	Executable	Command aborted
SECURITY UNLOCK	Executable	Executable	Command aborted
SERVICE	Command aborted	Executable	Executable
SET FEATURES	Executable	Executable	Executable
SET MAX ADDRESS	Command aborted	Executable	Executable
SET MAX ADDRESS EXT	Command aborted	Executable	Executable
SET MAX SET PASSWORD	Command aborted	Executable	Executable
SET MAX SET PASSWORD DMA	Command aborted	Executable	Executable
SET MAX LOCK	Command aborted	Executable	Executable
SET MAX FREEZE LOCK	Command aborted	Executable	Executable

NOTE – All commands not listed in this table are not addressed by the Security feature set.

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

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Table 7 — Security Command Actions (part 3 of 3)

Command	Locked [a]	Unlocked or Disabled [b]	Frozen [c]
SET MAX UNLOCK	Command aborted	Executable	Executable
SET MAX UNLOCK DMA	Command aborted	Executable	Executable
SET MULTIPLE MODE	Executable	Executable	Executable
SET NV CACHE POWER MODE	Command aborted	Executable	Executable
SLEEP	Executable	Executable	Executable
SMART DISABLE OPERATIONS	Executable	Executable	Executable
SMART ENABLE/DISABLE AUTOSAVE	Executable	Executable	Executable
SMART ENABLE OPERATIONS	Executable	Executable	Executable
SMART EXECUTE OFF-LINE IMMEDIATE	Executable	Executable	Executable
SMART READ DATA	Executable	Executable	Executable
SMART READ LOG	Executable	Executable	Executable
SMART RETURN STATUS	Executable	Executable	Executable
SMART WRITE LOG	Executable	Executable	Executable
STANDBY	Executable	Executable	Executable
STANDBY IMMEDIATE	Executable	Executable	Executable
TRUSTED NON-DATA	Command aborted	Executable	Executable
TRUSTED RECEIVE	Command aborted	Executable	Executable
TRUSTED RECEIVE DMA	Command aborted	Executable	Executable
TRUSTED SEND	Command aborted	Executable	Executable
TRUSTED SEND DMA	Command aborted	Executable	Executable
WRITE BUFFER	Executable	Executable	Executable
WRITE BUFFER DMA	Executable	Executable	Executable
WRITE DMA	Command aborted	Executable	Executable
WRITE DMA EXT	Command aborted	Executable	Executable
WRITE DMA FUA EXT	Command aborted	Executable	Executable
WRITE FPDMA QUEUED	Command aborted	Executable	Executable
WRITE LOG DMA EXT	Command aborted	Executable	Executable
WRITE LOG EXT	Command aborted	Executable	Executable
WRITE MULTIPLE	Command aborted	Executable	Executable
WRITE MULTIPLE EXT	Command aborted	Executable	Executable
WRITE MULTIPLE FUA EXT	Command aborted	Executable	Executable
WRITE SECTOR(S)	Command aborted	Executable	Executable
WRITE SECTOR(S) EXT	Command aborted	Executable	Executable
WRITE STREAM DMA EXT	Command aborted	Executable	Executable
WRITE STREAM EXT	Command aborted	Executable	Executable
WRITE UNCORRECTABLE EXT	Command aborted	Executable	Executable

NOTE – All commands not listed in this table are not addressed by the Security feature set.

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

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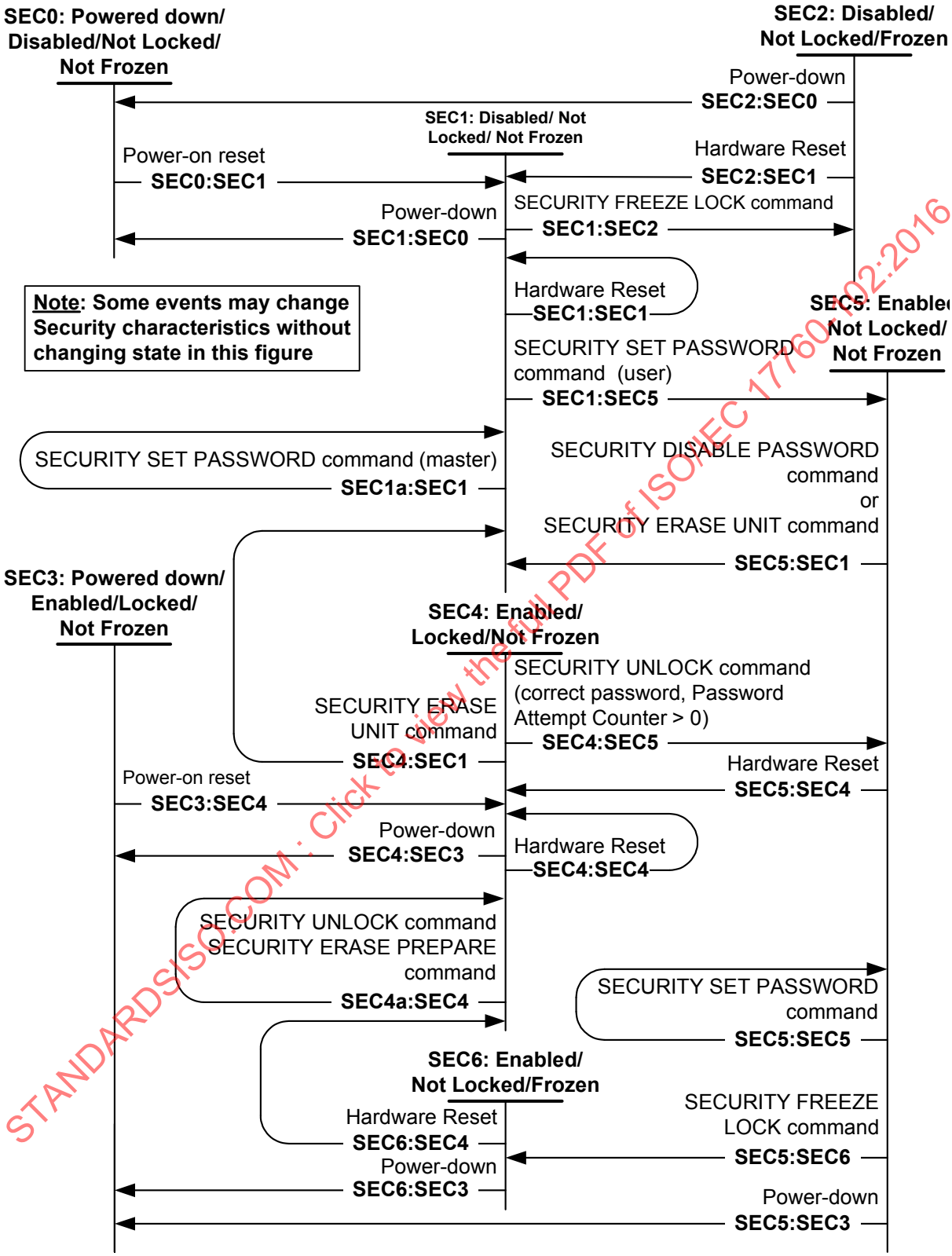

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Figure 16 — Security state diagram

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

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

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

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

In this state, the device shall respond to all commands as specified in the Disabled column of table 7. With the exception of the SECURITY commands, processing of these commands shall not cause a transition from state SEC1.

The device shall report IDENTIFY DEVICE command and IDENTIFY PACKET DEVICE command data words as described in table 8.

Table 8 — IDENTIFY settings for Security state SEC1

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

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

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

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

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

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

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

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

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

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In this state, the device shall respond to all commands as specified in the Frozen column of table 7. Processing of any of these commands shall not cause a transition from state SEC2.

The device shall report IDENTIFY DEVICE data words and IDENTIFY PACKET DEVICE data words as described in table 9.

Table 9 — IDENTIFY settings for Security state SEC2

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

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

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

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

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

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

In this state, the device shall respond to all commands as specified in the Locked column of table 7. With the exception of the SECURITY commands, processing of these commands shall not cause a transition from state SEC4.

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

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The device shall report IDENTIFY DEVICE data words and the IDENTIFY PACKET DEVICE data words as described in table 10.

Table 10 — IDENTIFY settings for Security state SEC4

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

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

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

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

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

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

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

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

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

In this state, the device shall respond to all commands as specified in the Unlocked column of table 7. With the exception of the SECURITY commands, processing of these commands shall not cause a transition from state SEC5.

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

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Table 11 — IDENTIFY settings for Security state SEC5

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

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

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

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

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

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

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

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

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

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

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

In this state, the device shall respond to all commands as specified in the Frozen column of table 7. With the exception of the SECURITY commands, processing of these commands shall not cause a transition from state SEC6.

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

Table 12 — IDENTIFY settings for Security state SEC6

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

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

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

4.20.11 Master Password Identifier feature

4.20.11.1 Overview

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

4.20.11.2 Example use case

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

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

4.20.11.3 Requirements

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

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

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

If the device supports the Security feature set, then:

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

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

4.21.1 Overview

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

4.21.2 Device SMART data structure

SMART feature set capability and status information for the device are stored in the device SMART data structure. The off-line data collection capability and status data stored in the SMART data structure may be useful to the host if the SMART EXECUTE OFF-LINE IMMEDIATE command is implemented (see 7.54.5).

4.21.3 Background data collection

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

4.21.4 Off-line/Captive mode data collection

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

4.21.5 Threshold exceeded condition

This condition occurs when the device's SMART reliability status indicates an impending degrading or fault condition (see 7.54.8).

4.21.6 SMART feature set commands

These commands use a single command code and are differentiated from one another by the value placed in the Feature field (see 7.54).

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

a) SMART DISABLE OPERATIONS (see 7.54.2);
b) SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE (see 7.54.3);
c) SMART ENABLE OPERATIONS (see 7.54.4); and
d) SMART RETURN STATUS (see 7.54.8).

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

a) SMART EXECUTE OFF-LINE IMMEDIATE (see 7.54.5);
b) SMART READ DATA (see 7.54.6);
c) SMART READ LOG (see 7.54.7); and
d) SMART WRITE LOG (see 7.54.9).

4.21.7 SMART operation with power management modes

When the SMART feature set is enabled a device should save the device accumulated SMART data upon receipt of an IDLE IMMEDIATE command, STANDBY IMMEDIATE command, or SLEEP command or upon return to an Active state or Idle state from a Standby state (see 7.54.6).

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 state to the Standby state or upon return to an Active state or Idle state from a Standby state.

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

4.21.8 SMART device error log reporting

Logging of reported errors is an optional SMART feature. If error logging is supported by a device, it is indicated in byte 370 of the SMART READ DATA command response (see table 152) and IDENTIFY DEVICE DATA word 84 bit 0 (see 7.17.7.40). If error logging is supported, the device shall provide information on the last five errors that the device reported as described in the SMART READ LOG command (see 7.54.7). The device may also provide additional vendor specific information on these reported errors.

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

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

4.22 Sense Data Reporting feature set

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

The REQUEST SENSE DATA EXT command (see 7.41) and the SET FEATURES subcommand Enable/Disable the Sense Data Reporting feature set (see 7.49.16) are mandatory for this feature set.

This feature is enabled by issuing a SET FEATURES subcommand Enable/Disable the Sense Data Reporting feature set (see 7.49.16), to the device. The host may disable this capability by issuing a SET FEATURES subcommand Enable/Disable the Sense Data Reporting feature set (see 7.49.16), to the device.

If the Sense Data Reporting feature set has been enabled (see 7.49.16), then the device notifies the host of additional information by setting the Sense Data Available bit in the Status field to one. The Error field shall comply with the requirements in clause 6. The host retrieves this additional information by issuing a REQUEST SENSE DATA EXT command to the device. The device may set the Sense Data Available bit to one in the Status field and clear the Error bit to zero in the Status field to indicate that the command was successfully processed and there is additional information about the command (e.g., a correctable error occurred).

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

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

The sense data shall be cleared after:

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

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

4.23 Software Settings Preservation (SSP) feature set

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

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The software settings that shall be preserved across COMRESET are listed in table 13. The device is only required to preserve the indicated software setting if it supports the particular feature/command with which the setting is associated.

Table 13 — Preserved Feature Sets and Settings

Capability	Preserved Setting
INITIALIZE DEVICE PARAMETERS	Obsolete
Security Mode	Preserve the Current Security State as defined in the security state transition diagram (see 4.20.10)
Standby Timer	Preserve the setting for the Standby timer (see 4.17.3)
Read/Write Stream Error Logs	Preserve the contents of these logs (see A.13 and A.18)
Password Attempt Counter	Preserve the value of the Password Attempt Counter (see 4.20.9)
SET MAX ADDRESS (EXT)	Current maximum LBA (see 7.50.2 and 7.51)
Write Cache enable/disable	Enabled or disabled (see 7.49.4)
Transfer Mode	Preserve the PIO, DMA and UDMA transfer mode settings (see 7.49.5)
Advanced Power Mode	Enabled or disabled (see 7.49.6)
Read look-ahead	Enabled or disabled (see 7.49.12)
Release Interrupt	Obsolete
Service Interrupt	Obsolete
Reverting to Power-On Defaults	Enabled or disabled (see 7.49.13)
Multiple Mode	Preserve the block size from the last set multiple mode (see 7.52)
SANITIZE FREEZE LOCK EXT	The Sanitize Frozen state established by the SANITIZE FREEZE LOCK EXT command (see 4.19)
Write-Read-Verify	Preserve the settings of the Write-Read-Verify feature set

4.24 Streaming feature set

4.24.1 Streaming feature set overview

The Streaming feature set allows a host to request delivery of data within an allotted time, placing a priority on the time to transfer the data rather than the integrity of the data. While processing commands in the Streaming feature set, devices may process background tasks if the specified command processing time limits for the commands are met. The Streaming feature set only defines commands that use 48-bit addressing.

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

a) CONFIGURE STREAM (see 7.8);
b) READ STREAM EXT (see 7.38);
c) WRITE STREAM EXT (see 7.76);
d) READ STREAM DMA EXT (see 7.37); and
e) WRITE STREAM DMA EXT (see 7.75).

SET FEATURES Set Maximum Host Interface Sector Times (see 7.49.11) is an optional feature of the Streaming feature set.

Support of the Streaming feature set is indicated in IDENTIFY DEVICE data word 84 bit 4 (see 7.17.7.40).

4.24.2 Streaming commands

4.24.2.1 Streaming command overview

The CONFIGURE STREAM command (see 7.8) is used by a host to define the properties of a stream to assist the device in configuring its caching for best performance. The Stream Identifier (Stream ID) in the CONFIGURE STREAM command is used by the host to specify the number of the stream to which the operating parameters in the command apply. Up to a total of

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eight streams may be configured. The Stream ID may be used by the device to configure its resources to support the streaming requirements of the AV content.

A host may use both read stream commands and write stream commands to access any stream.

The CONFIGURE STREAM command Default Command Completion Time Limit (Default CCTL) (see 7.8.3.4) provides a method for a host to set the time limit for a device to process read stream commands and write stream commands. If the host does not use a CONFIGURE STREAM command to set Default CCTL, the host may specify the time limit for command processing with the Command Completion Time Limit (CCTL) in each read stream command or write stream command, where the time limit is effective for that command only (see 7.37.3.2). Each stream may be configured with different command completion time limits.

The read stream commands and write stream commands may access all the user data on a device. These commands may be interspersed with commands not in the Streaming feature set, but, if commands not in the Streaming feature set are interspersed with read stream commands and write stream commands, there may be an impact on performance due to the unknown time required to complete the commands not in the Streaming feature set.

The host should send read stream commands and write stream commands specifying a transfer length that is a multiple of the Stream Minimum Request Size indicated in IDENTIFY DEVICE data word 95 (see 7.17.7.49).

4.24.2.2 Flush bit

The Flush bit (Flush) in the write stream commands (see 7.75.3.3) specifies that the device flushes all volatile cache data for the specified stream to the media before command completion. If a host requests flushes at times other than the end of each Allocation Unit (see 7.8.3.5), streaming performance may be degraded. The SET FEATURES command to enable and disable caching (see 7.49.4) may affect caching for commands in the Streaming feature set.

4.24.2.3 Not Sequential bit

The Not Sequential bit (NS) in the read stream commands (see 7.37.3.4) specifies that the next READ STREAM command with the same Stream ID may not start with the next LBA following the last LBA of the previous read stream command.

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

4.24.2.4 Read Continuous bit

The Read Continuous bit (RC) in the read stream commands (see 7.37.3.3) specifies that the device shall transfer the requested amount of data to the host within the time specified by Default CCTL or CCTL even if an error occurs. The data sent to the host by the device in an error condition is vendor specific.

4.24.2.5 Write Continuous bit

The Write Continuous bit (WC) in the write stream commands (see 7.75.3.2) specifies that the device shall transfer the requested amount of data from the host within the time specified by Default CCTL or CCTL even if an error occurs. If the device is unable to resolve an error within the time specified by Default CCTL or CCTL, the erroneous section on the media may be unchanged or may contain undefined data. A future read of this area may not report an error, even though the data is erroneous.

4.24.2.6 Streaming Logs

A device implementing the Streaming feature set shall implement the Read Stream Error Log (see A.13) and the Write Stream Error Log (see A.18). These logs are accessed by a host via the READ LOG EXT command (see 7.29).

4.25 Trusted Computing feature set

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

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

a) TRUSTED NON-DATA (see 7.57);
b) TRUSTED SEND (see 7.60);
c) TRUSTED SEND DMA (see 7.61);
d) TRUSTED RECEIVE (see 7.58); and
e) TRUSTED RECEIVE DMA (see 7.59).

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

IDENTIFY DEVICE data word 48 bit 0 (see 7.17.7.16) indicates whether or not this feature set is supported.

The DEVICE CONFIGURATION OVERLAY SET command provides a mechanism to remove support for this feature set.

The data streams and subsequent actions resulting from these commands are defined by the security protocol identified in the command parameters. The definition of Security Protocols, other than Security Protocol 00h, are outside the scope of this standard (see table 163 and table 169).

4.26 Write-Read-Verify feature set

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

To enable or disable the feature of Write/Read/Verify, the host may issue a SET FEATURES command (see 7.49.10).

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

These commands are affected by this feature:

a) WRITE DMA (see 7.64);
b) WRITE DMA EXT (see 7.65);
c) WRITE DMA FUA EXT (see 7.66);
d) WRITE FPDMA QUEUED (see 7.67);
e) WRITE MULTIPLE (see 7.70);
f) WRITE MULTIPLE EXT (see 7.71);
g) WRITE MULTIPLE FUA EXT (see 7.72);
h) WRITE SECTOR(S) (see 7.73); and
i) WRITE SECTOR(S) EXT (see 7.74).

See 7.49.10 for a description of device behavior when this feature set is supported and enabled.

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

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

If:

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

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

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

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

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

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5 ATA protocols

ATA Protocols are described in the transport standards (e.g., ATA8-APT and ATA8-AST). The protocols listed here shall be implemented by all transports that use commands defined by 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) PACKET command Protocol;
f) DMA Queued Command Protocol;
g) Execute Device Diagnostic Command Protocol; and
h) Device Reset Command Protocol.

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6 Normal and Error Output field descriptions

6.1 Overview

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

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

6.2 Status field

6.2.1 Overview

The Status field is one byte, is conveyed as an output from the device to the host, and is defined in table 14.

Table 14 — Status field

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

6.2.2 Alignment Error

The Alignment Error bit shall be set to one if:

a) IDENTIFY DEVICE data word 106 bit 13 (see 7.17.7.56) is set to one;
b) IDENTIFY DEVICE data word 69 bit 13 (see 7.17.7.30) is set to one;
c) IDENTIFY DEVICE data word 49 bits (1:0) (see 7.17.7.17) are 01b or 10b; and
d) the device successfully processes a write command where:
   A) the first byte of data transfer does not begin at the first byte of a physical sector (see IDENTIFY DEVICE data word 209 bits (13:0) (see 7.17.7.76)); or
   B) the last byte of data transfer does not end at the last byte of a physical sector (see IDENTIFY DEVICE data word 209 bits (13:0)).

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

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6.2.3 Busy bit

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

6.2.4 Check Condition bit

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

6.2.5 Data Request bit

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

6.2.6 Deferred Write Error bit

The Deferred Write Error bit shall be set to one if an error was detected in a deferred write to the media for a previous WRITE STREAM DMA EXT command (see 7.75) or WRITE STREAM EXT command (see 7.76). If the Deferred Write Error bit is set to one, then the location of the deferred error is only reported in the Write Stream Error Log (see A.18).

6.2.7 Device Fault bit

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

6.2.8 Device Ready bit

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

6.2.9 Error bit

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

6.2.10 Sense Data Available

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

a) IDENTIFY DEVICE data word 119 bit 6 (see 7.17.7.40) is set to one;
b) IDENTIFY DEVICE data word 120 bit 6 (see 7.17.7.41) is set to one; and
c) the device has sense data to report after processing any command.

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

Bit 1 of the Status field is obsolete if:

a) IDENTIFY DEVICE data word 119 bit 6 (see 7.17.7.40) is cleared to zero; or
b) IDENTIFY DEVICE data word 120 bit 6 (see 7.17.7.41) is cleared to zero.

6.2.11 Stream Error bit

The Stream Error bit shall be set to one if an error occurred during the processing of a command in the Streaming feature set (see 4.24) and either the Read Continuous (RC) bit is set to one in a READ STREAM command (see 7.37.3.3) or the Write Continuous (WC) bit is set to one in a WRITE STREAM command (see 7.75.3.2). When the Stream Error bit is set to one, the value returned in the LBA bits (47:0) contains the address of the first logical sector in error, and the Count field contains the number of consecutive logical sectors that may contain errors. If the RC bit is set to one in a READ STREAM command or the WC bit is set to one in a WRITE STREAM command, and the Interface CRC bit, the Uncorrectable Error bit, the ID Not Found bit, the Abort bit, or the Command Completion Time Out bit is set to one in the Error field (see 6.3), then:

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

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c) the error information (e.g., bits set in the Error field) shall be saved in the appropriate Read Stream Error Log (see A.13) or Write Stream Error log (see A.18).

6.2.12 Transport Dependent (TD)

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

6.3 Error field

6.3.1 Overview

The Error field is one byte, is conveyed as an output from the device to the host, and is defined in table 15.

Table 15 — Error field

Bit	Description
7:4	Sense Key (see 6.3.12)
7	Interface CRC (see 6.3.10)
6	Uncorrectable Error (see 6.3.13)
5	Obsolete
4	ID Not Found (see 6.3.6)
3	Obsolete
2	Abort (see 6.3.2)
1	End of Media (see 6.3.5)
0	Illegal Length Indicator (see 6.3.7) or Command Completion Time Out (see 6.3.4) or Media Error (see 6.3.11) or Attempted Partial Range Removal (see 6.3.3) or Insufficient NV Cache space (see 6.3.9) or Insufficient LBA Range Entries Remaining (see 6.3.8)

6.3.2 Abort bit

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

The Abort bit is set to one when the device does not set the ID Not Found bit to one when a a user addressable address was not found or the host request an address outside of the range of user addressable addresses (see 4.11.4 and 6.3.6).

6.3.3 Attempted Partial Range Removal bit

The Attempted Partial Range Removal bit shall be set to one if the REMOVE LBA(S) FROM NV CACHE PINNED SET command (see 7.21.9) attempted to unpin part of a previously defined NV Cache command range.

6.3.4 Command Completion Time Out bit

The Command Completion Time Out bit shall be set to one if a Command Completion Time Out error has occurred (see 4.24).

6.3.5 End of Media bit

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

6.3.6 ID Not Found bit

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

a) a user-addressable address was not found; or

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b) an address outside of the range of user-addressable addresses is requested, and the Abort bit is not set to one (see 4.11.4 and 6.3.2).

6.3.7 Illegal Length Indicator bit

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

6.3.8 Insufficient LBA Range Entries Remaining bit

The Insufficient LBA Range Entries Remaining bit shall be set to one if the device has run out of space to store LBA ranges for ADD LBA(S) TO NV CACHE PINNED SET command (see 7.21.3).

6.3.9 Insufficient NV Cache Space bit

The Insufficient NV Cache Space bit shall be set to one if there is not enough NV Cache to satisfy the ADD LBA(S) TO NV CACHE PINNED SET command (see 7.21.3).

6.3.10 Interface CRC bit

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

6.3.11 Media Error bit

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

6.3.12 Sense Key field

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

6.3.13 Uncorrectable Error bit

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

6.4 Interrupt Reason field

6.4.1 Overview

The Interrupt Reason field is one byte, is conveyed as an output from the device to the host for commands in the PACKET feature set and NCQ feature set, and is defined in table 16.

Table 16 — Interrupt Reason field

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

6.4.2 Command/Data bit

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

6.4.3 Input/Output (I/O) bit

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

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6.5 Count field

6.5.1 Overview

The Count field is one byte, is conveyed as an output from the device to the host, and is defined in table 17.

Table 17 — Count field

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

6.5.2 NCQ Tag field

The NCQ Tag field shall contain the NCQ Tag value for an NCQ command. An NCQ Tag value may be any value that does not exceed the value in word 75 in the IDENTIFY DEVICE data (see 7.17.7.33).

6.6 SActive field

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

6.7 SATA Status

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

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7 Command descriptions

7.1 Command description introduction

7.1.1 Overview

ATA commands are delivered using the following fields:

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

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

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

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

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

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 8 bits in length; and
b) the LBA field is 28-bits in length.

If a command uses 48-bit formatting, then:

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

EXAMPLE – A feature set subclause reads:

Feature Set

This 28-bit command is for all ATA devices.

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7.1.4 Inputs

The Inputs subclause contains a table showing the inputs for the command. An example command structure is shown in table 18.

Table 18 — Example Command Structure

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

7.1.5 Normal Outputs

Table 19 shows an example Normal Output. A command with Normal Outputs does not return an error. Therefore, the Error field in the Normal Outputs is reserved in every command. The Count field and LBA field may be reserved. In some commands these fields have return parameters on successful command completion. The Status field shows the Device Fault bit and the Error bit. Bit 7, bit 6, and bit 3 are marked Transport Dependent in many of the Normal Outputs.

Table 19 — Example Normal Output

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

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7.1.6 Error Outputs

Table 20 shows the Error field, Count field, LBA field, and Status field. An Error Output occurs when a bit in the Status field (e.g., the Error bit, the Device Fault bit, or the Stream Error bit) is set to one, indicating that an error occurred. If the Error bit is set to one, the Error field indicates the type of Error that occurred.

Table 20 — Example Error Output

Name	Description
Error	**Bit Description** 7 Interface CRC – See 6.3.10 6 Uncorrectable Error – See 6.3.13 5 Obsolete 4 ID Not Found – See 6.3.6 3 Obsolete 2 Abort – See 6.3.2 1 Obsolete 0 Obsolete
Count	Reserved
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12. 2:1 N/A 0 Error – See 6.2.9

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7.1.7 Input From the Device to the Host Data Structure

Some commands (e.g., IDENTIFY DEVICE command or DEVICE CONFIGURATION IDENTIFY command) return a data structure to the host. This data structure is referred to as an input data structure and is documented in a subclause following the Error Outputs subclause for each command that defines an input data structure.

7.1.8 Output From the Host to the Device Data Structure

Some commands, (e.g., DEVICE CONFIGURATION SET command or SECURITY SET PASSWORD command) accept a data structure from the host. This data structure is referred to as an Output Data Structure and is documented in a subclause following the Error Outputs subclause for each command that defines an output data structure.

7.1.9 Unsupported commands

The host should not issue commands that are indicated as not supported. If the device receives an unsupported command, then the device shall respond with command aborted as described in table 231.

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7.2 CFA ERASE SECTORS - C0h, Non-Data

7.2.1 Feature Set

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

7.2.2 Description

The CFA ERASE SECTORS command causes the device to pre-erase and condition from 1 to 256 logical sectors as specified in the Count field. This command should be issued in advance of a CFA WRITE SECTORS WITHOUT ERASE command or a CFA WRITE MULTIPLE WITHOUT ERASE command to increase the processing speed of the write operation.

7.2.3 Inputs

See table 21 for the CFA ERASE SECTORS command inputs.

Table 21 — CFA ERASE SECTORS command inputs

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

7.2.4 Normal Outputs

See table 210.

7.2.5 Error Outputs

See table 232.

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

7.3.1 Feature Set

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

7.3.2 Description

The CFA REQUEST EXTENDED ERROR CODE command returns the extended error code from a previously processed command that identifies the cause of an error condition in more detail than is available with Status field and Error field values. If the previous command completed with an error, then the CFA REQUEST EXTENDED ERROR CODE command shall return an extended error code (see table 23). If the previous command completed without an error, then the CFA REQUEST EXTENDED ERROR CODE command shall return the No error detected Extended error code (see table 23).

7.3.3 Inputs

See table 22 for the CFA REQUEST EXTENDED ERROR CODE command inputs.

Table 22 — CFA REQUEST EXTENDED ERROR CODE command inputs

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

7.3.4 Normal Outputs

See table 211.

Table 23 — Extended error codes (part 1 of 2)

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

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Table 23 — Extended error codes (part 2 of 2)

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

7.3.5 Error Outputs

See table 234.

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

7.4.1 Feature Set

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

7.4.2 Description

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

7.4.3 Inputs

See table 24 for the CFA TRANSLATE SECTOR command inputs.

Table 24 — CFA TRANSLATE SECTOR command inputs

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

7.4.4 Normal Outputs

See table 214.

7.4.5 Input From the Device to the Host Data Structure

512 bytes of data are transferred to the host (see table 25).

Table 25 — CFA TRANSLATE SECTOR data

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

7.4.6 Error Outputs

See table 234.

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

7.5.1 Feature Set

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

7.5.2 Description

The CFA WRITE MULTIPLE WITHOUT ERASE command is the same as the WRITE MULTIPLE command (see 7.70) except that the logical sectors are written without an implied erase operation. The logical sectors should be pre-erased by a preceding CFA ERASE SECTORS command.

If bit 8 of IDENTIFY DEVICE data word 59 (see 7.17.7.21) is cleared to zero, and a CFA WRITE MULTIPLE WITHOUT ERASE command is received by the device, and no successful SET MULTIPLE MODE command has been processed by the device, then the device shall return command aborted. A successful SET MULTIPLE MODE command should precede this command.

7.5.3 Inputs

See table 26 for the CFA WRITE MULTIPLE WITHOUT ERASE command inputs.

Table 26 — CFA WRITE MULTIPLE WITHOUT ERASE command inputs

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

7.5.4 Normal Outputs

See table 214.

7.5.5 Error Outputs

An unrecoverable error encountered during processing of this command results in command completion with the device returning the LBA of the logical sector where the first unrecovered error occurred. The amount of data transferred is indeterminate. See table 233.

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

7.6.1 Feature Set

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

7.6.2 Description

The CFA WRITE SECTORS WITHOUT ERASE command is the same as the WRITE SECTOR(S) command (see 7.73) except that the logical sectors are written without an implied erase operation. The logical sectors should be pre-erased by a preceding CFA ERASE SECTORS command. If the sector is not pre-erased with the CFA ERASE SECTORS command, then a normal write sector operation occurs.

7.6.3 Inputs

See table 27 for the CFA WRITE SECTORS WITHOUT ERASE command inputs.

Table 27 — CFA WRITE SECTORS WITHOUT ERASE command inputs

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

7.6.4 Normal Outputs

See table 214.

7.6.5 Error Outputs

An unrecoverable error encountered during processing of this command results in command completion with the device returning the LBA of the logical sector where the first unrecovered error occurred. The amount of data transferred is indeterminate. See table 233.

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7.7 CHECK POWER MODE - E5h, Non-Data

7.7.1 Feature Set

This 28-bit command is for ATA devices that implement the Power Management feature set (see 4.17). This command is mandatory for ATAPI devices when the Power Management feature set is not implemented in the command set transmitted via the PACKET command.

7.7.2 Description

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

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

7.7.3 Inputs

See table 28 for the CHECK POWER MODE command inputs.

Table 28 — CHECK POWER MODE command inputs

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

7.7.4 Normal Outputs

See table 215.

7.7.5 Error Outputs

See table 234.

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7.8 CONFIGURE STREAM - 51h, Non-Data

7.8.1 Feature Set

This 48-bit command is for devices that implement the Streaming feature set (see 4.24).

7.8.2 Description

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

7.8.3 Inputs

7.8.3.1 Overview

See table 29 for the CONFIGURE STREAM command inputs.

Table 29 — CONFIGURE STREAM command inputs

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

7.8.3.2 Add/Remove Stream (A/R)

If A/R is set to one (i.e., the application client is adding a stream), then the device shall set the operating parameters for the stream as specified by this command. If the Stream ID was specified by a previous CONFIGURE STREAM command, and the current CONFIGURE STREAM command completes without error, then the operating parameters specified by the current CONFIGURE STREAM command shall replace the operating parameters specified by the previous CONFIGURE STREAM command for the stream.

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

7.8.3.3 Stream Identifier (Stream ID)

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

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7.8.3.4 Default Command Completion Time Limit (Default CCTL)

The Default CCTL field indicates the time in which the device shall report command a for a read stream command or a write stream command for this stream with the CCTL field cleared to zero (see 7.37.3.2) according to the following formula:

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

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

7.8.3.5 Allocation Unit

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

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

7.8.4 Normal Outputs

See table 216.

7.8.5 Error Outputs

The Abort bit shall be set to one if any of the following are true:

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

If the Abort bit is set to one, then the last parameters specified for the Stream ID shall remain in effect. See table 240 for the definition of Error Outputs.

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7.9 DATA SET MANAGEMENT - 06h, DMA

7.9.1 Feature Set

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

7.9.2 Description

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

7.9.3 Inputs

7.9.3.1 Overview

See table 30 for the DATA SET MANAGEMENT command inputs.

Table 30 — DATA SET MANAGEMENT command inputs

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

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7.9.3.2 Trim

If the Trim bit is set to one, then a trim operation is being requested on the LBAs addressed by the DATA SET MANAGEMENT command's output data (see 7.9.6). For a logical block that has been trimmed, if a subsequent write of that logical block has not successfully completed and the data from that logical block is read, then the data is returned as described in table 31.

Table 31 shows the interactions of IDENTIFY DEVICE data word 169 bit 0 (see 7.17.7.71), IDENTIFY DEVICE data word 69 bit 14 (see 7.17.7.30), and IDENTIFY DEVICE data word 69 bit 5 (see 7.17.7.30).

Table 31 — Trim related interactions

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

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

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

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

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

Trim shall not add or remove logical blocks from the NV Cache Pinned Set.

7.9.4 Normal Outputs

See table 223.

7.9.5 Error Outputs

If the Trim bit is set to one and:

a) the device detects an invalid LBA Range Entry; or
b) count is greater than IDENTIFY DEVICE data word 105 (see 7.17.7.55),

then the device shall return command aborted.

A device may trim one or more LBA Range Entries before it returns command aborted. See table 249.

7.9.6 Output From the Host to the Device Data Structure

DATA SET MANAGEMENT Request Data is a list of one or more LBA Range Entries (see 4.15.3.2). If the Trim bit is set to one, then LBA Range Entries may overlap and are not required to be sorted. See table 69.

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7.10 Device Configuration Overlay (DCO)

7.10.1 DCO Overview

Individual DCO feature set (see 4.7) commands are identified by the value placed in the Feature field (see table 32).

Table 32 — Device Configuration Overlay Feature field values

Value	Commands
00h..BFh	Reserved
C0h	DEVICE CONFIGURATION RESTORE (see 7.10.5)
C1h	DEVICE CONFIGURATION FREEZE LOCK (see 7.10.2)
C2h	DEVICE CONFIGURATION IDENTIFY (see 7.10.3)
C3h	DEVICE CONFIGURATION SET (see 7.10.6)
C4h	DEVICE CONFIGURATION IDENTIFY DMA (see 7.10.4)
C5h	DEVICE CONFIGURATION SET DMA (see 7.10.7)
C6h..FFh	Reserved

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

7.10.2.1 Feature Set

This 28-bit command is for devices implementing the DCO feature set (see 4.7).

7.10.2.2 Description

The DEVICE CONFIGURATION FREEZE LOCK command provides a method for the host to prevent accidental modification of a device's DCO settings. After a a has completed a DEVICE CONFIGURATION FREEZE LOCK command without error, the device shall return command aborted for all DEVICE CONFIGURATION SET commands, DEVICE CONFIGURATION FREEZE LOCK commands, DEVICE CONFIGURATION IDENTIFY commands, and DEVICE CONFIGURATION RESTORE commands until after the device processes a power-on reset. A device shall be in the factory_config state or the reduced_config state (see figure 4) after processing a power-on reset. A device shall not exit the DCO_Locked state as the result of processing a hardware reset or a software reset.

7.10.2.3 Inputs

See table 33 for the DEVICE CONFIGURATION FREEZE LOCK command inputs.

Table 33 — DEVICE CONFIGURATION FREEZE LOCK command inputs

Name	Description
Feature	C1h
Count	N/A
LBA	N/A
Device	**Bit Description** 7:5 N/A 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B1h

7.10.2.4 Normal Outputs

See table 212.

7.10.2.5 Error Outputs

The Abort bit shall be set to one if the device has completed a previous DEVICE CONFIGURATION FREEZE LOCK command without error since processing the most recent power-on reset. See table 235.

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

7.10.3.1 Feature Set

This 28-bit command is for devices implementing the DCO feature set (see 4.7).

7.10.3.2 Description

The DEVICE CONFIGURATION IDENTIFY command requires a device to return a 512-byte data structure. The content of this data structure indicates the selectable commands, modes, and feature sets that the device is capable of disabling or modifying through processing of a DEVICE CONFIGURATION SET command. If a DEVICE CONFIGURATION SET command reducing a device's capabilities has completed without error, then:

a) the response by a device to commands other than the DEVICE CONFIGURATION IDENTIFY command, shall reflect the reduced set of capabilities; and
b) the response by a device to a DEVICE CONFIGURATION IDENTIFY command shall reflect the entire set of selectable capabilities.

If the feature is not changeable, then the device may support the feature but the DEVICE CONFIGURATION SET command shall not affect support of the feature.

The format of the Device Configuration Overlay data structure is shown in table 35.

7.10.3.3 Inputs

See table 34 for the DEVICE CONFIGURATION IDENTIFY command inputs.

Table 34 — DEVICE CONFIGURATION IDENTIFY command inputs

Name	Description
Feature	C2h
Count	N/A
LBA	N/A
Device	**Bit Description** 7:5 N/A 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B1h

7.10.3.4 Normal Outputs

See table 212.

7.10.3.5 Error Outputs

A device shall return command aborted if the device has completed a DEVICE CONFIGURATION FREEZE LOCK command without error since processing the most recent power-on reset. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 236.

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

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7.10.3.6 Input From the Device to the Host Data Structure

7.10.3.6.1 Overview

Table 35 — Device Configuration Identify data structure (part 1 of 2)

Word	Description
0	Data structure revision
1	Multiword DMA modes supported 15:3 Reserved 2 1 = Reporting support for Multiword DMA mode 2 and below is changeable 1 1 = Reporting support for Multiword DMA mode 1 and below is changeable 0 1 = Reporting support for Multiword DMA mode 0 is changeable
2	Ultra DMA modes supported 15:7 Reserved 6 1 = Reporting support for Ultra DMA mode 6 and below is changeable 5 1 = Reporting support for Ultra DMA mode 5 and below is changeable 4 1 = Reporting support for Ultra DMA mode 4 and below is changeable 3 1 = Reporting support for Ultra DMA mode 3 and below is changeable 2 1 = Reporting support for Ultra DMA mode 2 and below is changeable 1 1 = Reporting support for Ultra DMA mode 1 and below is changeable 0 1 = Reporting support for Ultra DMA mode 0 is changeable
3..6	Maximum LBA (QWord) 63:48 Reserved 47:0 Maximum LBA
7	Command set/feature set supported part 1 15 Reserved 14 1 = Reporting support for the Write-Read-Verify feature set is changeable 13 1 = Reporting support for the SMART Conveyance self-test is changeable 12 1 = Reporting support for the SMART Selective self-test is changeable 11 1 = Reporting support for the Forced Unit Access is changeable 10 Reserved for TLC 9 1 = Reporting support for the Streaming feature set is changeable 8 1 = Reporting support for the 48-bit Addressing feature set is changeable 7 1 = Reporting support for the HPA feature set is changeable 6:5 Obsolete 4 1 = Reporting support for the PUIS feature set is changeable 3 1 = Reporting support for the Security feature set is changeable 2 1 = Reporting support for the SMART error log is changeable 1 1 = Reporting support for the SMART self-test is changeable 0 1 = Reporting support for the SMART feature set is changeable
NOTE – The phrase “is changeable” indicates that the feature may be disabled by the host using a DEVICE CONFIGURATION SET command (see 7.10.6).	

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Table 35 — Device Configuration Identify data structure (part 2 of 2)

Word	Description
8	Serial ATA Command set/feature set supported 15:5 Reserved for Serial ATA 4 1 = Reporting support for the SSP feature set is changeable 3 1 = Reporting support for asynchronous notification is changeable 2 1 = Reporting support for interface power management is changeable 1 1 = Reporting support for non-zero buffer offsets is changeable 0 1 = Reporting support for the NCQ feature set is changeable
9	Reserved for Serial ATA
10..20	Reserved
21	Command set/feature set supported part 2 15 1 = Reporting support for the NV Cache feature set is changeable 14 1 = Reporting support for the NV Cache Power Management feature set is changeable 13 1 = Reporting support for WRITE UNCORRECTABLE EXT is changeable 12 1 = Reporting of support for the Trusted Computing feature set is changeable 11 1 = Reporting support for the Free-fall Control feature set is changeable 10 1 = Reporting support for the DATA SET MANAGEMENT command is changeable 9 1 = Reporting support for Extended Power Conditions is changeable 8:0 Reserved
22	Command set/feature set supported part 3 15:0 Reserved
23..207	Reserved
208..254	Vendor Specific
255	Integrity word 15:8 Checksum 7:0 A5h
NOTE – The phrase “is changeable” indicates that the feature may be disabled by the host using a DEVICE CONFIGURATION SET command (see 7.10.6).	

7.10.3.6.2 Word 0: Data structure revision

Word 0 shall contain the value 0002h.

7.10.3.6.3 Word 1: Multiword DMA modes supported

Word 1 bits (2:0) contain the same information as contained in IDENTIFY DEVICE data word 63 (see 7.17.7.24) or IDENTIFY PACKET DEVICE data word 63 (see 7.18.6.18). Bits (15:3) of word 1 are reserved.

7.10.3.6.4 Word 2: Ultra DMA modes supported

Word 2 bits (6:0) contain the same information as contained in IDENTIFY DEVICE data word 88 (see 7.17.7.42) or IDENTIFY PACKET DEVICE data word 88 (see 7.18.6.36). Bits (15:7) of word 2 are reserved.

7.10.3.6.5 Words 3..6: Maximum LBA

Words 3..6 define the maximum LBA (i.e., the highest LBA accepted by the device in the factory default condition). If the device is in the:

a) DCO2:Reduced_config state or DCO1:DCO_locked state; and
b) has a reduced Maximum LBA,

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then the native max address is less than the Maximum LBA reported by DEVICE CONFIGURATION IDENITFY command.

7.10.3.6.6 Word 7: Command/features set supported part 1

If bit 0 of Word 7 is set to one, then support for the SMART feature set is changeable.

If bit 1 of Word 7 is set to one, then support for SMART self-test including the self-test log is changeable.

If bit 2 of Word 7 is set to one, then support for SMART error logging is changeable.

If bit 3 of Word 7 is set to one, then support for the Security feature set is changeable.

If bit 4 of Word 7 is set to one, then support for the PUIS feature set is changeable.

Bits 6:5 of Word 7 are obsolete.

If bit 7 of Word 7 is set to one, then support for the HPA feature set is changeable.

If bit 8 of Word 7 is set to one, then support for the 48-bit Addressing feature set is changeable.

If bit 9 of Word 7 is set to one, then support for the Streaming feature set is changeable.

Bit 10 of Word 7 is reserved for technical report TLC.

If bit 11 of Word 7 is set to one, then support for Force Unit Access commands is changeable.

If bit 12 of Word 7 is set to one, then support for SMART Selective self-test (see 7.54.6.10) is changeable.

If bit 13 of Word 7 is set to one, then support for SMART Conveyance self-test (see 7.54.6.10) is changeable.

If bit 14 of Word 7 is set to one, then support for the Write-Read-Verify feature set is changeable.

7.10.3.6.7 Word 8: Serial ATA Command set/feature set supported

Bits (15:5) Reserved for Serial ATA.

If bit 4 of Word 8 is set to one, then support for software settings preservation is changeable.

If bit 3 of Word 8 is set to one, then support for asynchronous notification by an ATAPI device is changeable. See SATA 2.6 for more information.

If bit 2 of Word 8 is set to one, then support for interface power management requests is changeable. See SATA 2.6 for more information.

If bit 1 of Word 8 is set to one, then support for non-zero buffer offsets for commands in the NCQ feature set is changeable.

If bit 0 of Word 8 is set to one, then support for the NCQ feature set is changeable.

7.10.3.6.8 Word 9: Reserved for Serial ATA

This word is reserved for Serial ATA.

7.10.3.6.9 Words 10..20: Reserved

7.10.3.6.10 Word 21: Command/features set supported part 2

If bit 15 of Word 21 is set to one, then support for the NV Cache feature set is changeable.

If bit 14 of Word 21 is set to one, then support for the NV Cache Power Management feature set is changeable.

If bit 13 of Word 21 is set to one, then support for the WRITE UNCORRECTABLE EXT command (see 7.77) is changeable.

If bit 12 of Word 21 is set to one, then support for the Trusted Computing feature set is changeable.

If bit 11 of Word 21 is set to one, then support for the Free-fall Control feature set is changeable.

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If bit 10 of Word 21 is set to one, then support for the DATA SET MANAGEMENT command (see 7.9) is changeable.

If bit 9 of Word 21 is set to one, then support for the Extended Power Conditions feature set is changeable.

Bits 8:0 of Word 21 are reserved.

7.10.3.6.11 Word 22: Command/features set supported part 3

Bits (15:0) are reserved.

7.10.3.6.12 Words 23..207: Reserved

7.10.3.6.13 Words 208..254: Vendor Specific

7.10.3.6.14 Word 255: Integrity word

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

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7.10.4 DEVICE CONFIGURATION IDENTIFY DMA - B1h/C4h, DMA

7.10.4.1 Feature Set

This 28-bit command is for devices implementing the DCO feature set (see 4.7).

7.10.4.2 Description

See 7.10.3.2.

7.10.4.3 Inputs

See table 36 for the DEVICE CONFIGURATION IDENTIFY DMA command inputs.

Table 36 — DEVICE CONFIGURATION IDENTIFY DMA command inputs.

Name	Description
Feature	C4h
Count	N/A
LBA	N/A
Device	**Bit Description** 7:5 N/A 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B1h

7.10.4.4 Normal Outputs

See 7.10.3.4.

7.10.4.5 Error Outputs

See 7.10.3.5.

7.10.4.6 Input From the Device to the Host Data Structure

See 7.10.3.6.

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7.10.5 DEVICE CONFIGURATION RESTORE - B1h/C0h, Non-Data

7.10.5.1 Feature Set

This 28-bit command is for devices implementing the DCO feature set (see 4.7).

7.10.5.2 Description

The DEVICE CONFIGURATION RESTORE command restores to their factory default settings, any setting previously changed by a DEVICE CONFIGURATION SET command (see 7.10.6). The results of this action are indicated by the data returned from the Input Data of a DEVICE CONFIGURATION IDENTIFY command (see 7.10.3).

If a DEVICE CONFIGURATION RESTORE command changes reporting of support for the Security feature set from not allowed to allowed, and the DEVICE CONFIGURATION IDENTIFY command indicates that reporting of that support is allowed, then he device shall:

a) set the Security feature set state to SEC1 (see figure 16);
b) set IDENTIFY DEVICE data to the values described in table 8; and
c) restore the saved Master password and Master Password Identifier,

otherwise, the Security state shall not change.

If a DEVICE CONFIGURATION RESTORE command changes reporting of support for the EPC feature set from not supported to supported, then the device shall:

a) set IDENTIFY DEVICE data word 119 bit 7 (see 7.17.7.40) to one;
b) change the Log Directory to indicate that the Power Conditions log is supported; and
c) initialize the Power Conditions log such that the Default, Saved and Current settings match for all power conditions.

7.10.5.3 Inputs

See table 37 for the DEVICE CONFIGURATION RESTORE command inputs.

Table 37 — DEVICE CONFIGURATION RESTORE command inputs.

Name	Description
Feature	C0h
Count	N/A
LBA	N/A
Device	**Bit Description** 7:5 N/A 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B1h

7.10.5.4 Normal Outputs

See table 212.

7.10.5.5 Error Outputs

The Abort bit shall be set to one if a HPA has been set by a non-volatile SET MAX ADDRESS command or SET MAX ADDRESS EXT command, or if DEVICE CONFIGURATION FREEZE LOCK command has been completed without error since a power-on reset has been processed. See table 235.

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

7.10.6.1 Feature Set

This 28-bit command is for devices implementing the DCO feature set (see 4.7).

7.10.6.2 Description

The DEVICE CONFIGURATION SET command reduces the set of optional commands, modes, or feature sets supported by a device as indicated by a DEVICE CONFIGURATION IDENTIFY command. The DEVICE CONFIGURATION SET command may modify the data returned by the IDENTIFY DEVICE command or IDENTIFY PACKET DEVICE command. When the IDENTIFY DEVICE data or the IDENTIFY PACKET DEVICE data is changed, the device shall respond in a manner consistent with the new data.

If a bit is set to one in the DEVICE CONFIGURATION SET data transmitted to the device (see table 39) that is not set in the data received from a DEVICE CONFIGURATION IDENTIFY command (see table 35), then no action is taken for that bit.

Modifying the maximum LBA of the device also modifies the LBA value returned by a READ NATIVE MAX ADDRESS command or READ NATIVE MAX ADDRESS EXT command.

The format of the DEVICE CONFIGURATION SET data transmitted by the device is described in table 39 (see 7.10.6.6) for the restrictions on changing these bits.

If the device is configured to not support a feature, then the device shall:

a) report that the feature is not supported;
b) as required, report that the feature is not enabled; and
c) not support the feature.

7.10.6.3 Inputs

See table 38 for the DEVICE CONFIGURATION SET command inputs.

Table 38 — DEVICE CONFIGURATION SET command inputs

Name	Description
Feature	C3h
Count	N/A
LBA	N/A
Device	**Bit Description** 7:5 N/A 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B1h

7.10.6.4 Normal Outputs

See table 212.

7.10.6.5 Error Outputs

The Abort bit shall be set to one and the data returned by the IDENTIFY DEVICE command and IDENTIFY PACKET DEVICE command shall not be changed as a result of the failed DEVICE CONFIGURATION SET command if:

a) a DEVICE CONFIGURATION SET command has already modified the original settings as reported by a DEVICE CONFIGURATION IDENTIFY command;
b) a DEVICE CONFIGURATION FREEZE LOCK command has completed without error;
c) any of the bit modification restrictions described in 7.10.6.2 are violated;

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d) an HPA has been established by the processing of a SET MAX ADDRESS command or SET MAX ADDRESS EXT command; or
e) an attempt was made to modify a mode or feature that shall not be modified with the device in its current state.

See table 253.

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7.10.6.6 Output From the Host to the Device Data Structure

7.10.6.6.1 Overview

Table 39 — Device Configuration Overlay (DCO) data structure (part 1 of 2)

Word	Description
0	Data structure revision
1	Multiword DMA modes supported 15:3 Reserved 2 1 = Reporting support for Multiword DMA mode 2 and below is allowed 1 1 = Reporting support for Multiword DMA mode 1 and below is allowed 0 1 = Reporting support for Multiword DMA mode 0 is allowed
2	Ultra DMA modes supported 15:7 Reserved 6 1 = Reporting support for Ultra DMA mode 6 and below is allowed 5 1 = Reporting support for Ultra DMA mode 5 and below is allowed 4 1 = Reporting support for Ultra DMA mode 4 and below is allowed 3 1 = Reporting support for Ultra DMA mode 3 and below is allowed 2 1 = Reporting support for Ultra DMA mode 2 and below is allowed 1 1 = Reporting support for Ultra DMA mode 1 and below is allowed 0 1 = Reporting support for Ultra DMA mode 0 is allowed
3..6	Maximum LBA (QWord) 63:48 Reserved 47:0 Maximum LBA
NOTE – The phrase “is allowed” specifies that the device may report that a feature is supported.	

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Table 39 — Device Configuration Overlay (DCO) data structure (part 2 of 2)

Word	Description
7	Command set/feature set supported part 1 15 Reserved 14 1 = Reporting support for the Write-Read-Verify feature set is allowed 13 1 = Reporting support for the SMART Conveyance self-test is allowed 12 1 = Reporting support for the SMART Selective self-test is allowed 11 1 = Reporting support for Forced Unit Access is allowed 10 Reserved for TLC 9 1 = Reporting support for the Streaming feature set is allowed 8 1 = Reporting support for the 48-bit Addressing feature set is allowed 7 1 = Reporting support for HPA feature set is allowed 6:5 Obsolete 4 1 = Reporting support for the PUIS feature set is allowed 3 1 = Reporting support for the Security feature set is allowed 2 1 = Reporting support for the SMART error log is allowed 1 1 = Reporting support for the SMART self-test is allowed 0 1 = Reporting support for the SMART feature set is allowed
8	Serial ATA Command set/feature set supported 15:5 Reserved for Serial ATA 4 1 = Reporting support for the SSP feature set is allowed 3 1 = Reporting support for asynchronous notification is allowed 2 1 = Reporting support for interface power management is allowed 1 1 = Reporting support for non-zero buffer offsets is allowed 0 1 = Reporting support for the NCQ feature set is allowed
9	Reserved for Serial ATA
10..20	Reserved
21	Command set/feature set supported part 2 15 Reporting support for the NV Cache feature set is allowed 14 Reporting support for the NV Cache Power Management feature set is allowed 13 1= Reporting support for the WRITE UNCORRECTABLE EXT command is allowed 12 1= reporting of support for the Trusted Computing feature set is allowed 11 1 = Reporting support for the Free-fall Control feature set is allowed 10 1 = Reporting support for the DATA SET MANAGEMENT command is allowed 9 1 = Reporting support for Extended Power Conditions is allowed 8:0 Reserved
22	Command set/feature set supported part 3 15:0 Reserved
23..207	Reserved
208..254	Vendor Specific
255	Integrity word 15:8 Checksum 7:0 A5h
NOTE – The phrase “is allowed” specifies that the device may report that a feature is supported.	

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7.10.6.6.2 Word 0: Data structure revision

Word 0 shall contain the value 0002h.

7.10.6.6.3 Word 1: Multiword DMA modes supported

Bits (15:3) of word 1 are reserved.

If Multiword DMA mode 2 is not currently selected and bit 2 of word 1 is cleared to zero, then the device shall:

a) disable support for Multiword DMA mode 2; and
b) clear IDENTIFY DEVICE data word 63 bit 2 (see 7.17.7.24) to zero or IDENTIFY PACKET DEVICE data word 63 bit 2 (see 7.18.6.18) to zero.

If Multiword DMA mode 2 is currently selected and bit 2 of word 1 is cleared to zero, then the device shall not clear IDENTIFY DEVICE data word 63 bit 2 (see 7.17.7.24) to zero or IDENTIFY PACKET DEVICE data word 63 bit 2 (see 7.18.6.18) to zero.

If Multiword DMA mode 1 is not currently selected and bit 1 of word 1 is cleared to zero, then the device shall:

a) disable support for Multiword DMA mode 1; and
b) clear IDENTIFY DEVICE data word 63 bit 1 (see 7.17.7.24) to zero or IDENTIFY PACKET DEVICE data word 63 bit 1 (see 7.18.6.18) to zero.

If Multiword DMA mode 2 is supported or Multiword DMA mode 1 or mode 2 is currently selected and bit 1 of word 1 is cleared to zero, then the device shall not clear IDENTIFY DEVICE data word 63 bit 1 (see 7.17.7.24) to zero or IDENTIFY PACKET DEVICE data word 63 bit 1 (see 7.18.6.18) to zero.

Bit 0 of word 1 shall be set to one.

7.10.6.6.4 Word 2: Ultra DMA modes supported

Bits (15:7) of word 2 are reserved.

If Ultra DMA mode 6 is not currently selected and bit 6 of word 2 is cleared to zero, then the device shall:

a) disable support for Ultra DMA mode 6; and
b) clear IDENTIFY DEVICE data word 88 bit 6 (see 7.17.7.42) to zero or IDENTIFY PACKET DEVICE data word 88 bit 6 (see 7.18.6.36) to zero.

If Ultra DMA mode 6 is currently selected, then the device shall not clear IDENTIFY DEVICE data word 88 bit 6 (see 7.17.7.42) to zero or IDENTIFY PACKET DEVICE data word 88 bit 6 (see 7.18.6.36) to zero.

If bit 5 of word 2 is cleared to zero and:

a) Ultra DMA mode 6 and mode 5 are not currently selected; and
b) Ultra DMA mode 6 is not supported,

then the device shall clear IDENTIFY DEVICE data word 88 bit 5 (see 7.17.7.42) to zero or IDENTIIFY PACKET DEVICE data word 88 bit 5 (see 7.18.6.36) to zero.

If bit 4 of word 2 is cleared to zero and:

a) Ultra DMA mode 6, mode 5 and mode 4 are not currently selected; and
b) Ultra DMA mode 6 and mode 5 are not supported,

then the device shall clear IDENTIFY DEVICE data word 88 bit 4 (see 7.17.7.42) to zero or IDENTIIFY PACKET DEVICE data word 88 bit 4 (see 7.18.6.36) to zero.

If bit 3 of word 2 is cleared to zero and:

a) Ultra DMA mode 6, mode 5, mode 4 and mode 3 are not currently selected; and
b) Ultra DMA mode 6, mode 5 and mode 4 are not supported,

then the device shall clear IDENTIFY DEVICE data word 88 bit 3 (see 7.17.7.42) to zero or IDENTIIFY PACKET DEVICE data word 88 bit 3 (see 7.18.6.36) to zero.

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If bit 2 of word 2 is cleared to zero and:

a) Ultra DMA mode 6, mode 5, mode 4, mode 3 and mode 2 are not currently selected; and
b) Ultra DMA mode 6, mode 5, mode 4 and mode 3 are not supported,

then the device shall clear IDENTIFY DEVICE data word 88 bit 2 (see 7.17.7.42) to zero or IDENTIIFY PACKET DEVICE data word 88 bit 2 (see 7.18.6.36) to zero.

If bit 1 of word 2 is cleared to zero and:

a) Ultra DMA mode 6, mode 5, mode 4, mode 3, mode 2 and mode 1 are not currently selected; and
b) Ultra DMA mode 6, mode 5, mode 4, mode 3 and mode 2 are not supported,

then the device shall clear IDENTIFY DEVICE data word 88 bit 1 (see 7.17.7.42) to zero or IDENTIIFY PACKET DEVICE data word 88 bit 1 (see 7.18.6.36) to zero.

If bit 0 of word 2 is cleared to zero and:

a) Ultra DMA mode 6, mode 5, mode 4, mode 3, mode 2, mode 1 and mode 0 are not currently selected; and
b) Ultra DMA mode 6, mode 5, mode 4, mode 3, mode 2 and mode 1 are not supported,

then the device shall clear IDENTIFY DEVICE data word 88 bit 0 (see 7.17.7.42) to zero or IDENTIIFY PACKET DEVICE data word 88 bit 0 (see 7.18.6.36) to zero.

7.10.6.6.5 Words 3..6: Maximum LBA

Words 3..6 define the Maximum LBA. This shall be the highest LBA accepted by the device after processing of the command. When Maximum LBA is changed, the content of IDENTIFY DEVICE data words 60..61 (see 7.17.7.22) and IDENTIFY DEVICE data words 100..103 (see 7.17.7.53) shall be changed as described in the SET MAX ADDRESS command and SET MAX ADDRESS EXT command descriptions to reflect the maximum LBA set with this command. If the device has established an HPA as the result of processing a SET MAX ADDRESS command or SET MAX ADDRESS EXT command with an LBA value less than that returned by a READ NATIVE MAX ADDRESS command or READ NATIVE MAX ADDRESS EXT command, then the device shall return command aborted for this command and not change any data in the HPA.

7.10.6.6.6 Word 7: Command/features set supported part 1

Bit 15 of word 7 is reserved.

If bit 14 of word 7 is cleared to zero, then the device shall:

a) disable support for the Write-Read-Verify feature set;
b) clear IDENTIFY DEVICE data word 119 bit 1 (see 7.17.7.40) to zero or IDENTIFY PACKET DEVICE data word 119 bit 1 (see 7.18.6.34) to zero; and
c) clear IDENTIFY DEVICE data word 120 bit 1 (see 7.17.7.41) to zero or IDENTIFY PACKET DEVICE data word 120 bit 1 (see 7.18.6.35) to zero.

If bit 13 of word 7 is cleared to zero, then the device shall:

a) disable support for the SMART Conveyance self-test;
b) return command aborted for subsequent SMART EXECUTE OFF-LINE IMMEDIATE commands with an Execute SMART Conveyance self-test routine subcommand; and
c) clear bit 5 to zero in the Offline Data Collection Capabilities field in the Device SMART data structure.

If bit 12 of word 7 is cleared to zero, then the device shall:

a) disable support for the SMART Selective self-test;
b) return command aborted for subsequent SMART EXECUTE OFF-LINE IMMEDIATE commands with an Execute SMART Selective self-test routine subcommand; and
c) clear bit 6 to zero in the Offline Data Collection Capabilities field in the Device SMART data structure.

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If bit 11 of word 7 is cleared to zero, then the device shall:

a) disable support for the WRITE DMA FUA EXT command and the WRITE MULTIPLE FUA EXT command; and
b) clear IDENTIFY DEVICE data word 84 bits (7:6) (see 7.17.7.40) to zero or IDENTIFY PACKET DEVICE data word 84 bits (7:6) (see 7.18.6.34) to zero.

Bit 10 of Word 7 is reserved for TLC.

If bit 9 of word 7 is cleared to zero, then the device shall:

a) disable support for the Streaming feature set;
b) clear IDENTIFY DEVICE data
   A) word 84 bit 4 to zero;
   B) word 84 bit 9 to zero; and
   C) word 84 bit 10 to zero;
c) clear IDENTIFY DEVICE data words 95..99 (see 7.17.7.49, 7.17.7.50, 7.17.7.51, and 7.17.7.52) to zero; and
d) clear IDENTIFY DEVICE data word 104 see 7.17.7.54 to zero.

If bit 8 of word 7 is cleared to zero, then the device shall:

a) disable support for the 48-bit Addressing feature set;
b) clear IDENTIFY DEVICE data word 83 bit 10 to zero; and
c) clear IDENTIFY DEVICE data words 100..103 to zero.

If bit 7 of word 7 is cleared to zero, and a HPA has not been established by use of a SET MAX ADDRESS command or SET MAX ADDRESS EXT command, then the device shall:

a) disable support for the HPA feature set;
b) clear:
   A) IDENTIFY DEVICE data:
      a) word 82 bit 10 to zero;
      b) word 83 bit 8 to zero;
      c) word 85 bit 10 to zero; and
      d) word 86 bit 8 to zero;

or

   B) IDENTIFY PACKET DEVICE data:
      a) word 82 bit 10 to zero;
      b) word 83 bit 8 to zero;
      c) word 85 bit 10 to zero; and
      d) word 86 bit 8 to zero;

If bit 7 of word 7 is cleared to zero, and an HPA has been established by use of a SET MAX ADDRESS command or SET MAX ADDRESS EXT command, then the device shall return command aborted for the DEVICE CONFIGURATION SET command.

Bits 6:5 of word 7 are obsolete.

If bit 4 of word 7 is cleared to zero, and the PUIS feature set has not been enabled by a jumper, then the device shall:

a) disable support for the Power-Up In Standby feature set;
b) clear IDENTIFY DEVICE data word 83 bits (6:5) (see 7.17.7.40) to zero or IDENTIFY PACKET DEVICE data word 83 bits (6:5) (see 7.18.6.34) to zero; and
c) clear IDENTIFY DEVICE data word 86 bits (6:5) (see 7.17.7.41) to zero or IDENTIFY PACKET DEVICE data word 86 bits (6:5) (see 7.18.6.35) to zero.

If bit 4 of word 7 is cleared to zero, and PUIS has been enabled by jumper, then the DEVICE CONFIGURATION SET command shall return command aborted and the IDENTIFY DEVICE data and IDENTIFY PACKET DEVICE data words shall remain unchanged.

If bit 3 of word 7 is cleared to zero, and security is disabled, then the device shall:

a) save any Master Password and Master Password Identifier;
b) disable support for the Security feature set;

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c) not change its Security state;
d) clear
   A) IDENTIFY DEVICE data
      a) word 82 bit 1 (see 7.17.7.40) to zero;
      b) word 85 bit 1 (see 7.17.7.41) to zero;
      c) word 90 (see 7.17.7.44) to zero;
      d) word 92 (see 7.17.7.46) to zero; and
      e) word 128 (see 7.17.7.66) to zero;

or

   B) IDENTIFY PACKET DEVICE data
      a) word 82 bit 1 (see 7.18.6.34) to zero;
      b) word 85 bit 1 (see 7.18.6.35) to zero;
      c) word 90 (see 7.18.6.38) to zero;
      d) word 92 (see 7.18.6.40) to zero; and
      e) word 128 (see 7.18.6.51) to zero.

If bit 3 of word 7 is cleared to zero, and security is enabled, then the device shall return command aborted for the DEVICE CONFIGURATION SET command.

If bit 2 of word 7 is cleared to zero, then the device shall:

a) disable support for SMART error logging;
b) clear IDENTIFY DEVICE data word 84 bit 0 (see 7.17.7.40) to zero; and
c) clear IDENTIFY DEVICE data word 87 bit 0 (see 7.17.7.41) to zero.

If bit 1 of word 7 is cleared to zero, then the device shall:

a) disable support for the SMART Off-line self-test, Short self test, and Extended self-test;
b) return command aborted for subsequent SMART EXECUTE OFF-LINE IMMEDIATE commands with an Execute SMART Off-line, Short, or Extended self-test routine subcommand;
c) clear Device SMART data structure Offline Data Collection Capabilities bit 4 (see 7.54.6.10) to zero;
d) clear Device SMART data structure Offline Data Collection Capabilities bit 3 (see 7.54.6.10) to zero;
e) clear IDENTIFY DEVICE data word 84 bit 1 (see 7.17.7.40) to zero; and
f) clear IDENTIFY DEVICE data word 87 bit 1 (see 7.17.7.41) to zero.

If bit 1 of word 7 is cleared to zero, bit 12 and bit 13 of word 7 are not supported, then the device may:

a) disable support for the SMART Conveyance self-test;
b) return command aborted for subsequent SMART EXECUTE OFF-LINE IMMEDIATE commands with an Execute SMART Conveyance self-test routine subcommand;
c) clear Device SMART data structure Offline Data Collection Capabilities bit 5 (see 7.54.6.10) to zero;
d) disable support for the SMART Selective self-test;
e) return command aborted subsequent SMART EXECUTE OFF-LINE IMMEDIATE commands with an Execute SMART Selective self-test routine subcommand; and
f) clear Device SMART data structure Offline Data Collection Capabilities bit 5 (see 7.54.6.10) to zero.

If bit 0 of word 7 is cleared to zero, and bits (2:1) of word 7 are cleared to zero, then the device shall:

a) disable support for the SMART feature set;
b) clear IDENTIFY DEVICE data word 82 bit 0 (see 7.17.7.40) to zero; and
c) clear IDENTIFY DEVICE data word 85 bit 0 (see 7.17.7.41) to zero.

If bit 0 of word 7 is cleared to zero, and bits (2:1) of word 7 are not both cleared to zero, then the device shall return command aborted for the DEVICE CONFIGURATION SET command.

7.10.6.6.7 Word 8: Serial ATA Command set/feature set supported

This word enables configuration of command sets and feature sets.

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Bits (15:5) of word 8 are reserved for Serial ATA. If bit 4 of word 8 is cleared to zero, then the device shall:

a) disable support for the SSP feature set;
b) clear
   A) IDENTIFY DEVICE data:
      a) word 78 bit 6 (see 7.17.7.36) to zero; and
      b) word 79 bit 6 (see 7.17.7.37) to zero;

or

   B) IDENTIFY PACKET DEVICE data:
      a) word 78 bit 6 (see 7.18.6.30) to zero; and
      b) word 79 bit 6 (see 7.18.6.31) to zero;
c) clear any software settings that would be cleared when the SSP feature set is disabled.

If bit 3 of word 8 is cleared to zero, then the device shall:

a) disable support for asynchronous notification (see the Serial ATA specification);
b) clear
   A) IDENTIFY DEVICE data:
      a) word 78 bit 5 (see 7.17.7.36) to zero; and
      b) word 79 bit 5 (see 7.17.7.37) to zero;

or

   B) IDENTIFY PACKET DEVICE data:
      a) word 78 bit 5 to (see 7.18.6.30) zero; and
      b) word 79 bit 5 (see 7.18.6.31) to zero.

If bit 2 of word 8 is cleared to zero, then the device shall:

a) disable support for interface power management requests (see the Serial ATA specification);
b) clear
   A) IDENTIFY DEVICE data:
      a) word 76 bit 9 (see 7.17.7.34) to zero;
      b) word 78 bit 3 (see 7.17.7.36) to zero; and
      c) word 79 bit 3 (see 7.17.7.37) to zero;

or

   B) IDENTIFY PACKET DEVICE data:
      a) word 76 bit 9 (see 7.18.6.28) to zero;
      b) word 78 bit 3 (see 7.18.6.30) to zero; and
      c) word 79 bit 3 (see 7.18.6.31) to zero.

If bit 1 of word 8 is cleared to zero, then the device shall:

a) disable support for non-zero buffer offsets for NCQ commands (also see the Serial ATA specification);
b) clear
   A) IDENTIFY DEVICE data:
      a) word 78 bit 1 (see 7.17.7.36) to zero;
      b) word 78 bit 4 (see 7.17.7.36) to zero;
      c) word 79 bit 1 (see 7.17.7.37) to zero; and
      d) word 79 bit 4 (see 7.17.7.37) to zero;

or

   B) IDENTIFY PACKET DEVICE data:
      a) word 78 bit 1 (see 7.18.6.30) to zero;
      b) word 78 bit 4 (see 7.18.6.30) to zero;
      c) word 79 bit 1 (see 7.18.6.31) to zero; and
      d) word 79 bit 4 (see 7.18.6.31) to zero.

If bit 0 of word 8 is cleared to zero, then the device shall:

a) disable support for the NCQ feature set;

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b) clear
   A) IDENTIFY DEVICE data:
      a) word 76 bit 8 (see 7.17.7.34) to zero;
      b) word 78 bit 1 (see 7.17.7.36) to zero;
      c) word 78 bit 2 (see 7.17.7.36) to zero;
      d) word 78 bit 4 (see 7.17.7.36) to zero;
      e) word 79 bit 1 (see 7.17.7.37) to zero;
      f) word 79 bit 2 (see 7.17.7.37) to zero; and
      g) word 79 bit 4 (see 7.17.7.37) to zero;

or

   B) IDENTIFY PACKET DEVICE data:
      a) word 76 bit 8 (see 7.18.6.28) to zero;
      b) word 78 bit 1 (see 7.18.6.30) to zero;
      c) word 78 bit 2 (see 7.18.6.30) to zero;
      d) word 78 bit 4 (see 7.18.6.30) to zero;
      e) word 79 bit 1 (see 7.18.6.31) to zero;
      f) word 79 bit 2 (see 7.18.6.31) to zero; and
      g) word 79 bit 4 (see 7.18.6.31) to zero;

7.10.6.6.8 Word 9: Reserved for Serial ATA

Word 9 is reserved for use by Serial ATA.

7.10.6.6.9 Words 10..20: Reserved

7.10.6.6.10 Word 21: Command/features set supported part 2

If bit 15 of word 21 is set to one, then the device may support the NV Cache feature set. If bit 15 of word 21 is cleared to zero, and bit 14 of word 21 is set to one, then the device shall return command aborted for the DEVICE CONFIGURATION SET command. If bit 15 of word 21 is cleared to zero, and there is pinned data or the NV Cache has not been flushed, then the device shall return command aborted for the DEVICE CONFIGURATION SET command.

If bit 15 and bit 14 of word 21 is set to one, then the device may support the NV Cache Power Management feature set.

If bit 13 of word 21 is set to one, then the device may support the WRITE UNCORRECTABLE EXT command.

If bit 12 of word 21 is cleared to zero and security is disabled, then the device shall:

a) disable support for the Trusted Computing feature set; and
b) clear bit 0 of word 48 in IDENTIFY DEVICE data or IDENTIFY PACKET DEVICE data to zero.

If bit 12 of word 21 is cleared to zero, and security is enabled, then the device shall return command aborted for the DEVICE CONFIGURATION SET command.

If bit 11 of word 21 is set to one, then the device may support the Free-fall Control feature set.

If bit 10 of word 21 is set to one, then the device may support the DATA SET MANAGEMENT command.

If bit 9 of word 21 is cleared to zero, then the device shall:

a) disable support for the Extended Power Conditions feature;
b) change the Log Directory to indicate that the Power Conditions log is not supported;
c) clear IDENTIFY DEVICE data word 119 bit 7 (see 7.17.7.40) to zero; and
d) clear IDENTIFY DEVICE data word 120 bit 7 (see 7.17.7.41) to zero.

Bits (8:0) of word 21 are reserved.

7.10.6.6.11 Word 22: Command/features set supported part 3

Bit (15:0) of word 22 are reserved.

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7.10.6.6.12 Words 23..207: Reserved

7.10.6.6.13 Words 208..254: Vendor Specific

7.10.6.6.14 Word 255: Integrity word

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

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7.10.7 DEVICE CONFIGURATION SET DMA - B1h/C5h, DMA

7.10.7.1 Feature Set

This 28-bit command is for devices implementing the DCO feature set (see 4.7).

7.10.7.2 Description

See 7.10.6.2.

7.10.7.3 Inputs

See table 40 for the DEVICE CONFIGURATION SET DMA command inputs.

Table 40 — DEVICE CONFIGURATION SET DMA command inputs

Name	Description
Feature	C5h
Count	N/A
LBA	N/A
Device	**Bit Description** 7:5 N/A 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B1h

7.10.7.4 Normal Outputs

See 7.10.6.4.

7.10.7.5 Error Outputs

See 7.10.6.5.

7.10.7.6 Output From the Host to the Device Data Structure

See 7.10.6.6.

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7.11 DEVICE RESET - 08h, Device Reset

7.11.1 Feature Set

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

7.11.2 Description

The DEVICE RESET command resets the device.

7.11.3 Inputs

See table 41 for the DEVICE RESET command inputs.

Table 41 — DEVICE RESET command inputs

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

7.11.4 Normal Outputs

See table 217.

7.11.5 Error Outputs

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

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

7.12.1 Feature Set

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

7.12.2 Description

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

All transfers shall be zero length or an integer multiple of 512-byte data blocks. The size of the data transfer is determined by the content of the LBA field and Count field, allowing transfer sizes from 0 bytes to 33 553 920 bytes. If a value of zero is in both fields, then the Non-Data transfer protocol shall be used.

The Feature field indicates the mode of the DOWNLOAD MICROCODE command as described in 7.12.3.

The optional Download with offsets and save microcode for immediate and future use (see 7.17.7.40) allows the application client to transfer microcode in two or more DOWNLOAD MICROCODE commands.

The download block count value in the Count field and LBA field shall specify how many 512-byte blocks of data are being transferred in one command.

The buffer offset is defined by the value in the LBA (23:8). The buffer offset is the starting location in the data relative to the last successful DOWNLOAD MICROCODE command received by the device with a buffer offset of zero. The buffer offset shall be between 0 and 65 535. The buffer offset value is the byte count divided by 512 (e.g., if a microcode file is to be transferred to the device in 32 768 byte segments the first command should be issued with buffer offset value of zero, the second command should be issued with a buffer offset of 64, the third command should be issued with a buffer offset value of 128 and so on until the complete microcode is transferred).

If the current buffer offset is not equal to the sum of the previous DOWNLOAD MICROCODE command buffer offset and the previous block count, then the device shall report command aborted for the DOWNLOAD MICROCODE command and discard all previously downloaded microcode. The first DOWNLOAD MICROCODE command shall have a buffer offset of zero.

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

The new microcode should become effective before the device reports command completion for the last data segment.

If the device receives a command other than DOWNLOAD MICROCODE command prior to the receipt of the last segment, then the device shall process the new command and may discard previously downloaded microcode.

During the processing of a power-on reset, a hardware reset, or a software reset prior to applying the new microcode, the device shall discard any received microcode segments.

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7.12.3 Inputs

See table 42 for the DOWNLOAD MICROCODE command inputs.

Table 42 — DOWNLOAD MICROCODE command inputs

Name	Description
Feature	**Sub command** / **Description** 00h Reserved 01h Obsolete 02h Reserved 03h Download with offsets and save microcode for immediate and future use. 04h-06h Reserved 07h Download and save microcode for immediate and future use. 08-FFh Reserved
Count	Block count (7:0)
LBA	**Bit** / **Description** 27:24 Reserved 23:8 Buffer offset (only used for Feature = 03h, otherwise this field shall be reserved) 7:0 Block count (15:8)
Device	**Bit** / **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 92h

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7.12.4 Normal Outputs

If IDENTIFY DEVICE data word 234 (see 7.17.7.90) or IDENTIFY DEVICE data word 235 (see 7.17.7.91) have 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	Description
00h	No indication of download microcode status.
01h	Indicates the ATA device is expecting more download microcode commands to follow.
02h	Indicates that the ATA device has applied the new microcode.
03h-FFh	Reserved

For additional returns see table 213.

7.12.5 Error Outputs

The device shall return command aborted if the device did not accept the microcode data. The device shall return command aborted if the subcommand code is not a supported value. See table 236.

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7.13 DOWNLOAD MICROCODE DMA - 93h, DMA

7.13.1 Feature Set

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

7.13.2 Description

See 7.12.2.

7.13.3 Inputs

See table 44 for the DOWNLOAD MICROCODE DMA command inputs.

Table 44 — DOWNLOAD MICROCODE DMA command inputs

Name	Description
Feature	See the Feature field in 7.12.3.
Count	See the Count field in 7.12.3.
LBA	See the LBA field in 7.12.3.
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 93h

7.13.4 Normal Outputs

See 7.12.4.

7.13.5 Error Outputs

See 7.12.5.

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7.14 EXECUTE DEVICE DIAGNOSTIC - 90h, Execute Device Diagnostic

7.14.1 Feature Set

This 28-bit command is for all devices (see 4.2 and 4.3).

7.14.2 Description

The EXECUTE DEVICE DIAGNOSTIC command shall cause the device to perform internal diagnostic tests.

NOTE There are transport and Host Adapter implications for this command (i.e., see ATA8-APT and HBA2).

If the host issues an EXECUTE DEVICE DIAGNOSTIC command while a device is in, or transitioning to, a power management state other than the PM3:Sleep state (see figure 14), then the device shall process the diagnostic sequence.

7.14.3 Inputs

See table 45 for the EXECUTE DEVICE DIAGNOSTIC command inputs.

Table 45 — EXECUTE DEVICE DIAGNOSTIC command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 90h

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7.14.4 Normal Outputs

The diagnostic code written into the Error field is an 8-bit code defined in table 46. See table 217.

Table 46 — Diagnostic codes

Code [a]	Description
When this code is in the Device 0 [c] Error field	
01h	Device 0 [c] passed, Device 1 [c] passed or not present
00h, 02h-7Fh	Device 0 [c] failed, Device 1 [c] passed or not present
81h	Device 0 [c] passed, Device 1 [c] failed
80h, 82h-FFh	Device 0 [c] failed, Device 1 [c] failed
When this code is in the Device 1 [c] Error field	
01h	Device 1 [c] passed [b]
00h, 02h-7Fh	Device 1 [c] failed [b]
80h-FFh	Reserved

[a] Codes other than 01h and 81h may indicate additional information about the failure(s).
[b] If Device 1 is not present, the host may see the information from Device 0 even though Device 1 is selected.
[c] See the appropriate transport standard for the definition of device 0 and device 1.

7.14.5 Error Outputs

This command shall complete without setting the Error bit to one (see 7.14.4).

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7.15 FLUSH CACHE - E7h, Non-Data

7.15.1 Feature Set

This 28-bit command is for ATA devices (see 4.2) and ATAPI devices (see 4.3).

7.15.2 Description

The FLUSH CACHE command requests the device to flush the volatile write cache. If there is data in the volatile write cache, that data shall be written to the non-volatile media. This command shall not indicate completion until the data is flushed to the non-volatile media or an error occurs. If the device supports more than 28 bits of addressing this command shall attempt to flush all the data in the volatile cache. If the volatile write cache is disabled or no volatile write cache is present, the device shall indicate command completion without error.

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

7.15.3 Inputs

See table 47 for the FLUSH CACHE command inputs.

Table 47 — FLUSH CACHE command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 E7h

7.15.4 Normal Outputs

See table 212.

7.15.5 Error Outputs

If an unrecoverable error occurs while the device is writing data to its media, then the device shall terminate processing the command and report the error, including the LBA of the first sector where an unrecoverable error occurred. Subsequent FLUSH CACHE commands continue the process of flushing the cache. See table 241.

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 7.16).

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7.16 FLUSH CACHE EXT - EAh, Non-Data

7.16.1 Feature Set

This 48-bit command is mandatory for devices implementing the 48-bit Address feature set (see 4.4).

7.16.2 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 This command may take longer than 30 s to complete.

7.16.3 Inputs

See table 47 for the FLUSH CACHE EXT command inputs.

Table 48 — FLUSH CACHE EXT command inputs

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

7.16.4 Normal Outputs

See table 223.

7.16.5 Error Outputs

If an unrecoverable error occurs while the device is writing data to its media, then the device shall terminate processing the command and report the error, including the LBA of the first sector where an unrecoverable error occurred. If a device receives a subsequent FLUSH CACHE EXT command, then the device shall continue the process of flushing its cache. See table 242.

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7.17 IDENTIFY DEVICE - ECh, PIO Data-In

7.17.1 Feature Set

This 28-bit command is mandatory for all devices (see 4.2 and 4.3).

7.17.2 Description

The IDENTIFY DEVICE command specifies that the device shall send a 512-byte block of data to the host. See 7.17.7 for a description of the return data.

Devices may read the non-volatile media in order to complete this command.

The IDENTIFY DEVICE data contains information regarding optional feature or command support. If the host issues a command that is indicated as not supported in the IDENTIFY DEVICE data, the device shall return command aborted for the command.

7.17.3 Inputs

See table 49 for the IDENTIFY DEVICE command inputs.

Table 49 — IDENTIFY DEVICE command inputs

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

7.17.4 Normal Outputs for ATA devices

See table 212.

7.17.5 Normal Outputs for ATAPI devices

In response to this command, ATAPI devices shall return command aborted and place the PACKET feature set signature in the appropriate fields (see table 217).

7.17.6 Error Outputs

ATA devices shall not report an error, except after a NCQ Feature Set command error and before the NCQ Command Error Log is read (see table 236).

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7.17.7 Input From the Device to the Host Data Structure

7.17.7.1 Overview

Table 50 specifies the format of the IDENTIFY DEVICE data.

Table 50 — IDENTIFY DEVICE data (part 1 of 19)

Word	OM	SP	FV	Description
0	M	B		General configuration (see 7.17.7.2)
			F	15 0 = ATA device
			X	14:8 Retired
			X	7:6 Obsolete
			X	5:3 Retired
			V	2 Response incomplete
			X	1 Retired
				0 Reserved
1			X	Obsolete
2	O	B	V	Specific configuration (see 7.17.7.4)
3			X	Obsolete
4..5			X	Retired
6			X	Obsolete
7..8		N		Reserved for the CompactFlash Association
9			X	Retired
10..19	M	B	F	Serial number (ATA string) (see 7.17.7.10)
20..21			X	Retired
22			X	Obsolete
23..26	M	B	F	Firmware revision (ATA string) (see 7.17.7.13)
27..46	M	B	F	Model number (ATA string) (see 7.17.7.14)
47	M			See 7.17.7.15
		B	F	15:8 80h
		B	F	7:0 00h = Reserved
				01h-FFh = Maximum number of logical sectors that shall be transferred per DRQ data block on READ/WRITE MULTIPLE commands

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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.

a/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

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Table 50 — IDENTIFY DEVICE data (part 2 of 19)

Word	O M	S P	F V		Description
48	O	B			Trusted Computing feature set options (see 7.17.7.16)
			F	15	Shall be cleared to zero
			F	14	Shall be set to one
				13:1	Reserved for the Trusted Computing Group
			F	0	1=Trusted Computing feature set is supported
49	M				Capabilities (see 7.17.7.17)
				15:14	Reserved for the IDENTIFY PACKET DEVICE command.
		B	F	13	1 = Standby timer values as specified in this standard are supported
					0 = Standby timer values shall be managed by the device
				12	Reserved for the IDENTIFY PACKET DEVICE command.
		P	F	11	1 = IORDY (see ATA8-APT) supported
					0 = IORDY (see ATA8-APT) may be supported
		P	F	10	1 = IORDY (see ATA8-APT) may be disabled
		B	F	9	Shall be set to one to indicate that LBA is supported.
		P	F	8	1 = DMA supported
			X	7:2	Reserved
				1:0	Current Long Physical Sector Alignment setting
50	M				Capabilities (see 7.17.7.17)
		B	F	15	Shall be cleared to zero
		B	F	14	Shall be set to one
				13:2	Reserved
			X	1	Obsolete
		B	F	0	Shall be set to one to indicate a vendor specific Standby timer value minimum
51..52			X		Obsolete

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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.

a/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

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Table 50 — IDENTIFY DEVICE data (part 3 of 19)

Word	OM	SP	FV	Description
53				See 7.17.7.19
	M	B	F	15:8 Free-fall Control Sensitivity
				00h = Vendor's recommended setting
				01h-FFh = Sensitivity level. A larger number is a more sensitive setting.
				7:3 Reserved
		B	F	2 1 = the fields reported in word 88 are valid
				0 = the fields reported in word 88 are not valid
		B	F	1 1 = the fields reported in words (70:64) are valid
				0 = the fields reported in words (70:64) are not valid
			X	0 Obsolete
54..58			X	Obsolete
59				See 7.17.7.21
	M			15 1 = The BLOCK ERASE EXT command is supported (see 7.42.2)
				14 1= The OVERWRITE EXT command is supported (see 7.42.4)
				13 1 = The CRYPTO SCRAMBLE EXT command is supported (see 7.42.3)
				12 1 = The Sanitize feature set is supported (see 4.19)
				11:9 Reserved
		B	V	8 1 = Multiple logical sector setting is valid
		B	V	7:0 Current setting for number of logical sectors that shall be transferred per DRQ data block on READ/WRITE Multiple commands
60..61	M	B	F	Total number of user addressable logical sectors for 28-bit commands (DWord) (see 7.17.7.22)
62			X	Obsolete

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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.

a/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

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Table 50 — IDENTIFY DEVICE data (part 4 of 19)

Word	OM	SP	FV	Description
63				See 7.17.7.24
	M			15:11 Reserved
		P	V	10 1 = Multiword DMA mode 2 is selected
				0 = Multiword DMA mode 2 is not selected
		P	V	9 1 = Multiword DMA mode 1 is selected
				0 = Multiword DMA mode 1 is not selected
		P	V	8 1 = Multiword DMA mode 0 is selected
				0 = Multiword DMA mode 0 is not selected
				7:3 Reserved
		P	F	2 1 = Multiword DMA mode 2 and below are supported
		P	F	1 1 = Multiword DMA mode 1 and below are supported
		P	F	0 1 = Multiword DMA mode 0 is supported
64				See 7.17.7.25
	M			15:8 Reserved
		P	F	7:0 PIO modes supported
65	M			Minimum Multiword DMA transfer cycle time per word (see 7.17.7.26)
		P	F	15:0 Cycle time in nanoseconds
66	M			Manufacturer's recommended Multiword DMA transfer cycle time (see 7.17.7.27)
		P	F	15:0 Cycle time in nanoseconds
67	M			Minimum PIO transfer cycle time without flow control (see 7.17.7.28)
		P	F	15:0 Cycle time in nanoseconds
68	M			Minimum PIO transfer cycle time with IORDY (see ATA8-APT) flow control (see 7.17.7.29)
		P	F	15:0 Cycle time in nanoseconds

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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.

a/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

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Table 50 — IDENTIFY DEVICE data (part 5 of 19)

Word	O M	S P	F V	Description
69				Additional Supported (see 7.17.7.30)
	O	S	F	15 1 = CFast Specification Support
	O	B	F	14 1 = Deterministic data in trimmed LBA range(s) is supported
	O	B	F	13 1 = Long Physical Sector Alignment Error Reporting Control is supported
	O	B	F	12 1 = DEVICE CONFIGURATION IDENTIFY DMA and DEVICE CONFIGURATION SET DMA are supported
	O	B	F	11 1 = READ BUFFER DMA is supported
	O	B	F	10 1 = WRITE BUFFER DMA is supported
	O	B	F	9 1 = SET MAX SET PASSWORD DMA and SET MAX UNLOCK DMA are supported
	O	B	F	8 1 = DOWNLOAD MICROCODE DMA is supported
				7 Reserved for IEEE 1667
	M	B	F	6 0 = Optional ATA device 28-bit commands supported
				5 1 = Trimmed LBA range(s) returning zeroed data is supported
				4 1 = Device Encrypts All User Data
				3 1 = Extended Number of User Addressable Sectors is supported
				2:0 Reserved
70				Reserved
71..74				Reserved for the IDENTIFY PACKET DEVICE command
75	O			Queue depth (see 7.17.7.33)
				15:5 Reserved
		B	F	4:0 Maximum queue depth – 1
76	O	S		Serial ATA Capabilities (see 7.17.7.34)
				15:13 Reserved for Serial ATA
				12 1 = Supports NCQ priority information
				11 1 = Supports Unload while NCQ commands are outstanding
			F	10 1 = Supports the SATA Phy Event Counters log
			F	9 1 = Supports receipt of host initiated power management requests
			F	8 1 = Supports the NCQ feature set
				7:3 Reserved for Serial ATA
			F	2 1 = Supports SATA Gen2 Signaling Speed (3.0Gb/s)
			F	1 1 = Supports SATA Gen1 Signaling Speed (1.5Gb/s)
			F	0 Shall be cleared to zero

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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.

a/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

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Table 50 — IDENTIFY DEVICE data (part 6 of 19)

Word	O M	S P	F V	Description
77		S		Reserved for Serial ATA
78	O	S		Serial ATA features supported (see 7.17.7.36)
				15:7 Reserved for Serial ATA
			F	6 1 = Device supports Software Settings Preservation
				5 Reserved for Serial ATA
			F	4 1 = Device supports in-order data delivery
			F	3 1 = Device supports initiating power management
			F	2 1 = Device supports DMA Setup auto-activation
			F	1 1 = Device supports non-zero buffer offsets
			F	0 Shall be cleared to zero
79	O	S		Serial ATA features enabled (see 7.17.7.37)
				15:7 Reserved for Serial ATA
			V	6 1 = Software Settings Preservation enabled
				5 Reserved for Serial ATA
			V	4 1 = In-order data delivery enabled
			V	3 1 = Device initiated power management enabled
			V	2 1 = DMA Setup auto-activation enabled
			V	1 1 = Non-zero buffer offsets enabled
			F	0 Shall be cleared to zero
80	M			Major version number (see 7.17.7.38)
				15:10 Reserved
				9 1 = supports ACS-2
		B	F	8 1 = supports ATA8-ACS
		B	F	7 1 = supports ATA/ATAPI-7
		B	F	6 1 = supports ATA/ATAPI-6
		B	F	5 1 = supports ATA/ATAPI-5
		B	F	4 Obsolete
			X	3 Obsolete
			X	2 Obsolete
			X	1 Obsolete
				0 Reserved
81	M	B	F	Minor version number (see 7.17.7.39)

Key:
F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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.

a/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

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Table 50 — IDENTIFY DEVICE data (part 7 of 19)

Word	O M	S P	F V		Description
82	M				Commands and feature sets supported (see 7.17.7.40)
			X	15	Obsolete
		B	F	14	1 = The NOP command is supported
		B	F	13	1 = The READ BUFFER command is supported
		B	F	12	1 = The WRITE BUFFER command is supported
			X	11	Obsolete
		B	F	10	1 = The HPA feature set is supported
		B	F	9	Shall be cleared to zero to indicate that the DEVICE RESET command is not supported
		B	F	8	1 = The SERVICE interrupt is supported
		B	F	7	1 = The release interrupt is supported
		B	F	6	1 = Read look-ahead is supported
		B	F	5	1 = The volatile write cache is supported
		B	F	4	Shall be cleared to zero to indicate that the PACKET feature set is not supported
		B	F	3	Shall be set to one to indicate that the mandatory Power Management feature set is supported
			X	2	Obsolete
		B	F	1	1 = The Security feature set is supported
		B	F	0	1 = The SMART feature set is supported

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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.

a/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

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Table 50 — IDENTIFY DEVICE data (part 8 of 19)

Word	O M	S P	F V		Description
83	M				Commands and feature sets supported (see 7.17.7.40)
			F	15	Shall be cleared to zero
			F	14	Shall be set to one
		B	F	13	1 = The FLUSH CACHE EXT command is supported
		B	F	12	Shall be set to one to indicate that the mandatory FLUSH CACHE command is supported
		B	F	11	1 = The DCO feature set is supported
		B	F	10	1 = The 48-bit Address feature set is supported
		B	F	9	Obsolete
		B	F	8	1 = The SET MAX security extension is supported
				7	Reserved for the Address Offset Reserved Area Boot Method
		B	F	6	1 = SET FEATURES subcommand is required to spin-up after power-up
		B	F	5	1 = The PUIS feature set is supported
			X	4	Obsolete
		B	F	3	1 = The APM feature set is supported
		N	F	2	1 = The CFA feature set is supported
			X	1	Obsolete
		B	F	0	1 = The DOWNLOAD MICROCODE command is supported

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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.

a/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

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Table 50 — IDENTIFY DEVICE data (part 9 of 19)

Word	O M	S P	F V		Description
84	M				Commands and feature sets supported (see 7.17.7.40)
			F	15	Shall be cleared to zero
			F	14	Shall be set to one
		B	F	13	1 = The IDLE IMMEDIATE command with UNLOAD feature is supported
				12	Reserved for TLC
				11	Reserved for TLC
			X	10:9	Obsolete
		B	F	8	1 = The 64-bit World wide name is supported
			X	7	Obsolete
		B	F	6	1 = The WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported
		B	F	5	1 = The GPL feature set is supported
		B	F	4	1 = The Streaming feature set is supported
		N	F	3	Obsolete
		B	F	2	1 = Media serial number is supported
		B	F	1	1 = The SMART self-test is supported
		B	F	0	1 = SMART error logging is supported

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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.

a/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

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Table 50 — IDENTIFY DEVICE data (part 10 of 19)

Word	O M	S P	F V		Description
85	M				Commands and feature sets supported or enabled (see 7.17.7.41)
			X	15	Obsolete
		B	F	14	1 = The NOP command is supported
		B	F	13	1 = The READ BUFFER command is supported
		B	F	12	1 = The WRITE BUFFER command is supported
			X	11	Obsolete
		B	V	10	1 = HPA feature set is supported
		B	F	9	Shall be cleared to zero to indicate that the DEVICE RESET command is not supported
		B	V	8	1 = The SERVICE interrupt is enabled
		B	V	7	1 = The release interrupt is enabled
		B	V	6	1 = Read look-ahead is enabled
		B	V	5	1 = The volatile write cache is enabled
		B	F	4	Shall be cleared to zero to indicate that the PACKET feature set is not supported
		B	F	3	Shall be set to one to indicate that the mandatory Power Management feature set is supported
			X	2	Obsolete
		B	V	1	1 = The Security feature set is enabled
		B	V	0	1 = The SMART feature set is enabled

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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.

a/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

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Table 50 — IDENTIFY DEVICE data (part 11 of 19)

Word	O M	S P	F V		Description
86	M				Commands and feature sets supported or enabled(see 7.17.7.41)
		B	F	15	1 = Words 119..120 are valid
				14	Reserved
		B	F	13	1 = FLUSH CACHE EXT command supported
		B	F	12	1 = FLUSH CACHE command supported
		B	F	11	1 = The DCO feature set is supported
		B	F	10	1 = The 48-bit Address features set is supported
		B	V	9	Obsolete
		B	V	8	1 = the SET MAX security extension is enabled by SET MAX SET PASSWORD
				7	Reserved for Address Offset Reserved Area Boot Method
		B	F	6	1 = SET FEATURES subcommand is required to spin-up after power-up
		B	V	5	1 = The PUIS feature set is enabled
			X	4	Obsolete
		B	V	3	1 = The APM feature set is enabled
		N	F	2	1 = The CFA feature set is supported
			X	1	Obsolete
		B	F	0	1 = The DOWNLOAD MICROCODE command is supported

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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.

a/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

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Table 50 — IDENTIFY DEVICE data (part 12 of 19)

Word	O M	S P	F V		Description
87	M				Commands and feature sets supported or enabled(see 7.17.7.41)
			F	15	Shall be cleared to zero
			F	14	Shall be set to one
		B	F	13	1 = The IDLE IMMEDIATE command with UNLOAD FEATURE is supported
				12	Reserved for TLC
				11	Reserved for TLC
			X	10:9	Obsolete
		B	F	8	1 = The 64-bit World wide name is supported
			X	7	Obsolete
		B	F	6	1 = The WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands are supported
		B	F	5	1 = The GPL feature set is supported
			X	4	Obsolete
		N	V	3	Obsolete
		B	V	2	1 = Media serial number is valid
		B	F	1	1 = SMART self-test supported
		B	F	0	1 = SMART error logging is supported

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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.

a/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

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Table 50 — IDENTIFY DEVICE data (part 13 of 19)

Word	O M	S P	F V	Description
88	O			Ultra DMA modes (see 7.17.7.42)
				15 Reserved
		P	V	14 1 = Ultra DMA mode 6 is selected
		P		0 = Ultra DMA mode 6 is not selected
		P	V	13 1 = Ultra DMA mode 5 is selected
		P		0 = Ultra DMA mode 5 is not selected
		P	V	12 1 = Ultra DMA mode 4 is selected
		P		0 = Ultra DMA mode 4 is not selected
		P	V	11 1 = Ultra DMA mode 3 is selected
		P		0 = Ultra DMA mode 3 is not selected
		P	V	10 1 = Ultra DMA mode 2 is selected
		P		0 = Ultra DMA mode 2 is not selected
		P	V	9 1 = Ultra DMA mode 1 is selected
		P		0 = Ultra DMA mode 1 is not selected
		P	V	8 1 = Ultra DMA mode 0 is selected
		P		0 = Ultra DMA mode 0 is not selected
				7 Reserved
		P	F	6 1 = Ultra DMA mode 6 and below are supported
		P	F	5 1 = Ultra DMA mode 5 and below are supported
		P	F	4 1 = Ultra DMA mode 4 and below are supported
		P	F	3 1 = Ultra DMA mode 3 and below are supported
		P	F	2 1 = Ultra DMA mode 2 and below are supported
		P	F	1 1 = Ultra DMA mode 1 and below are supported
		P	F	0 1 = Ultra DMA mode 0 is supported
89				See 7.17.7.43
				15:8 Reserved
	O	B	F	7:0 Time required for Normal Erase mode SECURITY ERASE UNIT command
90				See 7.17.7.44
				15:8 Reserved
	O	B	F	7:0 Time required for an Enhanced Erase mode SECURITY ERASE UNIT command
91	O	B	V	Current APM level value (see 7.17.7.45)
92	O	B	V	Master Password Identifier (see 7.17.7.46)

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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.

a/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

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Table 50 — IDENTIFY DEVICE data (part 14 of 19)

Word	OM	SP	FV	Description
93	M			Hardware reset result (see 7.17.7.47)
			F	15 Shall be cleared to zero.
			F	14 Shall be set to one.
		P	V	13 1 = device detected the CBLID- above V_{iHB} (see ATA8-APT)
				0 = device detected the CBLID- below V_{iL} (see ATA8-APT)
		P		12:8 Device 1 hardware reset result. Device 0 shall clear these bits to zero. Device 1 shall set these bits as follows:
				12 Reserved.
			V	11 0 = Device 1 did not assert PDIAG-.
				1 = Device 1 asserted PDIAG-.
			V	10:9 These bits indicate how Device 1 determined the device number:
				00 = Reserved.
				01 = a jumper was used.
				10 = the CSEL signal was used.
				11 = some other method was used or the method is unknown.
				8 Shall be set to one.
		P		7:0 Device 0 hardware reset result. Device 1 shall clear these bits to zero. Device 0 shall set these bits as follows:
				7 Reserved.
			F	6 0 = Device 0 does not respond when Device 1 is selected.
				1 = Device 0 responds when Device 1 is selected.
			V	5 0 = Device 0 did not detect the assertion of DASP-.
				1 = Device 0 detected the assertion of DASP-.
			V	4 0 = Device 0 did not detect the assertion of PDIAG-.
				1 = Device 0 detected the assertion of PDIAG-.
			V	3 0 = Device 0 failed diagnostics.
				1 = Device 0 passed diagnostics.
93 cont.			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.

Key:
F/V – Fixed/variable content
F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
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.

a/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

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Table 50 — IDENTIFY DEVICE data (part 15 of 19)

Word	OM	SP	FV	Description
94				Obsolete
95	O	B	F	Stream Minimum Request Size (see 7.17.7.49)
96	O	B	V	Streaming Transfer Time – DMA (see 7.17.7.50)
97	O	B	V	Streaming Access Latency – DMA and PIO (see 7.17.7.51)
98..99	O	B	F	Streaming Performance Granularity (DWord) (see 7.17.7.52)
100..103	O	B	V	Number of User Addressable Logical Sectors (QWord) (see 7.17.7.53)
104	O	B	V	Streaming Transfer Time – PIO (see 7.17.7.54)
105				Maximum number of 512-byte blocks per DATA SET MANAGEMENT command (see 7.9)
106	O			Physical sector size / logical sector size (see 7.17.7.56)
		B	F	15 Shall be cleared to zero
		B	F	14 Shall be set to one
		B	F	13 1 = Device has multiple logical sectors per physical sector.
		B	F	12 1 = Device Logical Sector longer than 256 Words
				11:4 Reserved
		B	F	3:0 2^X logical sectors per physical sector
107	O	B	F	Inter-seek delay for ISO 7779 standard acoustic testing (see 7.17.7.57)
108..111	M	B	F	World wide name (see 7.17.7.58)
112..115				Reserved
116				Reserved for TLC
117..118	O	B	F	Logical sector size (DWord) (see 7.17.7.61)

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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.

a/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

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Table 50 — IDENTIFY DEVICE data (part 16 of 19)

Word	OM	SP	FV	Description
119	M			Commands and feature sets supported (Continued from words 82..84) (see 7.17.7.40)
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
				13:8 Reserved
				7 1 = Extended Power Conditions feature set is supported
	O	B	F	6 1 = Sense Data Reporting feature set is supported
		B	F	5 1 = The Free-fall Control feature set is supported
		B	F	4 1 = Download Microcode mode 3 is supported
		B	F	3 1 = The READ LOG DMA EXT and WRITE LOG DMA EXT commands are supported
		B	F	2 1 = The WRITE UNCORRECTABLE EXT command is supported
		B	F	1 1 = The Write-Read-Verify feature set is supported
				0 Reserved for DDT
120	M			Commands and feature sets supported or enabled (Continued from words 85..87) (see 7.17.7.41)
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
				13:8 Reserved
				7 1 = Extended Power Conditions feature set is enabled
	O	B	V	6 1 = Sense Data Reporting feature set is enabled
		B	V	5 1 = The Free-fall Control feature set is enabled
		B	F	4 1 = Download Microcode mode 3 is supported
		B	F	3 1 = The READ LOG DMA EXT and WRITE LOG DMA EXT commands are supported
		B	F	2 1 = The WRITE UNCORRECTABLE EXT command is supported
		B	V	1 1 = The Write-Read-Verify feature set is enabled
				0 Reserved for DDT
121..126				Reserved for expanded supported and enabled settings
127			X	Obsolete

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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.

a/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

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Table 50 — IDENTIFY DEVICE data (part 17 of 19)

Word	O M	S P	F V	Description
128	O			Security status (see 7.17.7.66)
				15:9 Reserved
		B	V	8 Master Password Capability: 0 = High, 1 = Maximum
				7:6 Reserved
		B	F	5 1 = Enhanced security erase supported
		B	V	4 1 = Security count expired
		B	V	3 1 = Security frozen
		B	V	2 1 = Security locked
		B	V	1 1 = Security enabled
		B	F	0 1 = Security supported
129..159			X	Vendor specific
160	O	N		CFA power mode (see 7.17.7.68)
			F	15 Word 160 supported
				14 Reserved
			F	13 CFA power mode 1 is required for one or more commands implemented by the device
			V	12 CFA power mode 1 disabled
			F	11:0 Maximum current in milliamperes
161..167				Reserved for the CompactFlash Association
168				See 7.17.7.70
				15:4 Reserved
	O	B	F	3:0 Device Nominal Form Factor
169				DATA SET MANAGEMENT command is supported (see 7.17.7.71)
				15:1 Reserved
	O	B	F	0 1 = the Trim bit in the DATA SET MANAGEMENT command is supported
170..173	O	B	F	Additional Product Identifier (ATA String) (see 7.17.7.72)
174..175				Reserved
176..205	O	B	V	Current media serial number (ATA string) (see 7.17.7.74)

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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.

a/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

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Table 50 — IDENTIFY DEVICE data (part 18 of 19)

Word	O M	S P	F V	Description
206	O	B		SCT Command Transport(see 7.17.7.75)
			X	15:12 Vendor Specific
				11:6 Reserved
			F	5 The SCT Data Tables command is supported
			F	4 The SCT Feature Control command is supported
			F	3 The SCT Error Recovery Control command is supported
			F	2 The SCT Write Same command is supported
			F	1 Obsolete
			F	0 The SCT Command Transport is supported
207..208		N		Reserved
209	O		F	Alignment of logical blocks within a physical block (see 7.17.7.76)
				15 Shall be cleared to zero
				14 Shall be set to one
			B	13:0 Logical sector offset within the first physical sector where the first logical sector is placed
210..211	O	B	V	Write-Read-Verify Sector Count Mode 3 (DWord) (see 7.17.7.77)
212..213	O	B	F	Write-Read-Verify Sector Count Mode 2 (DWord) (see 7.17.7.78)
214	O	B		NV Cache Capabilities (see 7.17.7.79)
			F	15:12 NV Cache feature set version
			F	11:8 NV Cache Power Mode feature set version
				7:5 Reserved
			V	4 1 = NV Cache feature set enabled
				3:2 Reserved
			V	1 1 = NV Cache Power Mode feature set enabled
			F	0 1 = NV Cache Power Mode feature set supported
215..216	O	B	V	NV Cache Size in Logical Blocks (DWord) (see 7.17.7.80)
217	M	B	F	Nominal media rotation rate (see 7.17.7.81)
218				Reserved
219	O	B		NV Cache Options (see 7.17.7.83)
				15:8 Reserved
			F	7:0 Device Estimated Time to Spin Up in Seconds

Key:
F/V – Fixed/variable content
F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
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.

a/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
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Table 50 — IDENTIFY DEVICE data (part 19 of 19)

Word	OM	SP	FV	Description
220				See 7.17.7.84
	O	B		15:8 Reserved
			V	7:0 Write-Read-Verify feature set current mode
221				Reserved
222	M	B		Transport major version number (see 7.17.7.86) 0000h or FFFFh = device does not report version
			F	15:12 Transport Type 0h = Parallel 1h = Serial 2h-Fh = Reserved
				Parallel **Serial**
				11:6 Reserved Reserved
				5 Reserved SATA Rev 3.0
			F	4 Reserved SATA Rev 2.6
			F	3 Reserved SATA Rev 2.5
			F	2 Reserved SATA II: Extensions
			F	1 ATA/ATAPI-7 SATA 1.0a
			F	0 ATA8-APT ATA8-AST
223	M	B	F	Transport minor version number (see 7.17.7.87)
224..229		N		Reserved
230..233				Extended Number of User Addressable Sectors (QWord) (see 7.17.7.89)
234	O	B	F	Minimum number of 512-byte data blocks per Download Microcode mode 03h operation (see 7.17.7.90)
235	O	B	F	Maximum number of 512-byte data blocks per Download Microcode mode 03h operation (see 7.17.7.91)
236..254				Reserved
255	M		V	Integrity word (see 7.17.7.93)
		B		15:8 Checksum
		B		7:0 Checksum Validity Indicator

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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.

a/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
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7.17.7.2 Word 0: General configuration

If the device is an ATA device, then bit 15 shall be cleared to zero.

Bits (7:6) are obsolete.

If bit 2 of word 0 is set to one, then the content of the IDENTIFY DEVICE data is incomplete. This may occur if the device supports the Power-up in Standby feature set and required data is contained on the device media. The content of IDENTIFY DEVICE data word 0 and word 2 shall be valid.

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

7.17.7.3 Word 1: Obsolete

7.17.7.4 Word 2: Specific configuration

Word 2 shall be set as defined in table 51.

Table 51 — 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.

7.17.7.5 Word 3: Obsolete

7.17.7.6 Words 4..5: Retired

7.17.7.7 Word 6: Obsolete

7.17.7.8 Words 7..8: Reserved for assignment by the CompactFlash Association

7.17.7.9 Word 9: Retired

7.17.7.10 Words 10..19: Serial number

This field contains the serial number of the device. The contents of this field is an ATA string of twenty bytes in the format defined by 3.3.10. The device shall pad the string with spaces (i.e., 20h), if necessary, to ensure that the string is the proper length. The combination of Serial number (i.e., words 10..19) and Model number (i.e., words 27..46) shall be unique for a given manufacturer.

7.17.7.11 Words 20..21: Retired

7.17.7.12 Word 22: Obsolete

7.17.7.13 Words 23..26: Firmware revision

This field contains the firmware revision of the device. The contents of this field is an ATA string of eight bytes in the format defined by 3.3.10. The device shall pad the string with spaces (20h), if necessary, to ensure that the string is the proper length.

7.17.7.14 Words 27..46: Model number

This field contains the model number of the device. The contents of this field is an ATA string of forty bytes in the format defined by 3.3.10. The device shall pad the string with spaces (i.e., 20h), if necessary, to ensure that the string is the proper length. The combination of Serial

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number (i.e., words 10..19) and Model number (i.e., words 27..46) shall be unique for a given manufacturer.

7.17.7.15 Word 47

Bits (7:0) of this word define the maximum number of logical sectors per DRQ data block that the device supports for READ/WRITE MULTIPLE commands.

For SATA devices, bits (7:0) shall be set to 16 or less.

7.17.7.16 Word 48: Trusted Computing feature set options

If bit 0 of word 48 is set to one, then the Trusted Computing feature set is supported.

7.17.7.17 Words 49..50: Capabilities

Bits (15:14) of word 49 are reserved for use in IDENTIFY PACKET DEVICE data (see table 60).

If bit 13 of word 49 is set to one, then table 63 shall define the Standby timer values used by the device. If bit 13 of word 49 is cleared to zero, then the timer values used by the device shall be vendor specific.

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

For PATA devices, if bit 11 of word 49 is set to one, then the device supports the IORDY signal (see ATA8-APT). All PATA devices, except CFA-APT devices, shall set bit 11 of word 49 to one.

For SATA devices, bit 11 of word 49 shall be set to one.

For PATA devices, if bit 10 of word 49 is set to one, then the device supports the disabling of IORDY (see ATA8-APT) via the SET FEATURES command.

For SATA devices, bit 10 of word 49 shall be set to one.

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

If bit 8 of word 49 is set to one, then the device supports the DMA data transfer protocols. All devices, except CFA-APT devices, shall set this bit to one.

Bits (7:2) of word 49 are reserved.

If bit 13 of word 69 (see 7.17.7.30 and 7.49.17) is set to one, then if bits (1:0) of word 49 are:

a) set to 00b, then Long Physical Sector Alignment Error reporting is disabled;
b) set to 01b, then Long Physical Sector Alignment Error reporting is enabled;
c) set to 10b, then the device shall report command aborted when an Alignment Error occurs; and
d) set to 11b, then this value is reserved.

Bit 15 of word 50 shall be cleared to zero.

Bit 14 of word 50 shall be set to one.

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

Bit 1 of word 50 is obsolete.

If bit 0 of word 50 is set to one, then the device has a minimum Standby timer value that is vendor specific.

7.17.7.18 Words 51..52: Obsolete

7.17.7.19 Word 53

Bit 0 of word 53 is obsolete.

For PATA devices when bit 1 of word 53 is set to one, the values reported in words 64..70 are valid. If this bit is cleared to zero, the values reported in words 64..70 are not valid. All devices except CFA-APT devices shall support PIO mode 3 or above and shall set bit 1 of word 53 to one and support the fields contained in words 64..70.

For SATA devices, bit 1 of word 53 shall be set to one.

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

For SATA devices, bit 2 of word 53 shall be set to one.

7.17.7.20 Words 54..58: Obsolete

7.17.7.21 Word 59

If bit 15 of word 59 is set to one, then the device supports the Sanitize Device feature set BLOCK ERASE EXT command (see 7.42.2).

If bit 14 of word 59 is set to one, then the device supports the Sanitize Device feature set OVERWRITE EXT command (see 7.42.4).

If bit 13 of word 59 is set to one, then the device supports the Sanitize Device feature set CRYPTO SCRAMBLE EXT command (see 7.42.3).

If bit 12 of word 59 is set to one the device supports the Sanitize Device feature set.

If bit 8 of word 59 is set to one, then bits (7:0) indicate the number of logical sectors that shall be transferred per DRQ data block for a READ MULTIPLE command or a WRITE MULTIPLE command. This default setting of this field is the optimum value for the device or zero (see 7.52).

7.17.7.22 Words 60..61: Total number of user addressable logical sectors for 28-bit commands

This field contains a value that is one greater than the maximum user addressable LBA. The maximum value that shall be placed in this field is 0FFF_FFFFh. If this field contains 0FFF_FFFFh and the device has user addressable LBAs greater than or equal to 0FFF_FFFFh, then words 100..103 contain the total number of user addressable LBAs (see 4.11.4).

7.17.7.23 Word 62: Obsolete

7.17.7.24 Word 63

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

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

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

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

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

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

For PATA devices, if bit 2 of word 63 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 bit 0 of word 63 shall be set to one and bit 1 of word 63 shall be set to one.

For SATA devices, bit 2 of word 63 shall be set to one.

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For PATA devices, if bit 1 of word 63 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 bit 0 of word 63 shall be set to one.

For SATA devices, bit 1 of word 63 shall be set to one.

For PATA devices, if bit 0 of word 63 is set to one, then Multiword DMA mode 0 is supported.

For SATA devices, bit 0 of word 63 shall be set to one.

7.17.7.25 Word 64

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

Of these bits, bits (7:2) are reserved for future PIO modes. Bit 0, if set to one, indicates that the device supports PIO mode 3. All devices except CFA-APT devices shall support PIO mode 3 and shall set bit 0 to one. Bit 1, if set to one, indicates that the device supports PIO mode 4. See ATA8-APT for more information.

For SATA devices bits (1:0) shall be set to one.

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

For PATA devices word 65 is defined as the minimum Multiword DMA transfer cycle time per word. This field defines, in nanoseconds, the minimum cycle time that the device supports when performing Multiword DMA transfers on a per word basis.

For SATA devices word 65 shall be set to indicate 120 ns.

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

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

7.17.7.27 Word 66: Device recommended Multiword DMA transfer cycle time

For PATA devices:

a) word 66 contains the Multiword DMA transfer cycle time recommended by the device in nanoseconds (i.e., the minimum cycle time per word during a single logical sector host transfer while performing a multiple logical sector READ DMA or WRITE DMA command for any location on the media under nominal conditions);
b) if this field is supported, then bit 1 of word 53 shall be set to one;
c) any device that supports Multiword DMA mode 1 or above shall support this field;
d) the value in word 66 shall not be less than the value in word 65;
e) if bit 1 of word 53 is set to one because a device supports a field in words 64..70 other than this field, and the device does not support word 66, then the device shall return a value of zero in word 66; and
f) if a host runs at a faster cycle rate by operating at a cycle time of less than this value, then the device may negate DMARQ for flow control. The rate at which DMARQ is negated may result in reduced throughput despite the faster cycle rate. Transfer at this rate does not ensure that flow control is not used, but implies that higher performance may result (see ATA8-APT).

For SATA devices, word 66 shall be set to 78h to indicate 120 ns.

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

For PATA devices word 67 is defined as the minimum PIO transfer without IORDY (see ATA8-APT) flow control cycle time. This field defines, in nanoseconds, the minimum cycle time

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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 word 67 shall be set to indicate 120 ns.

If word 67 is supported, bit 1 of word 53 shall be set to one.

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

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

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

For PATA devices word 68 is defined as the minimum PIO transfer with IORDY (see ATA8-APT) flow control cycle time. This field defines, in nanoseconds, the minimum cycle time that the device supports while performing data transfers while utilizing IORDY (see ATA8-APT) flow control.

For SATA devices word 68 shall be set to indicate 120 ns.

If word 68 is supported, bit 1 of word 53 shall be set to one.

All devices except CFA-APT devices shall support PIO mode 3 and shall support this field, and the value in word 68 shall be the fastest defined PIO mode supported by the device. The maximum value reported in this field shall be 180 (i.e., PIO mode 3 or above).

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

7.17.7.30 Word 69: Additional Supported

Word 69 shall indicate features and command sets supported. If a defined bit is cleared to zero, the indicated features and command set is not supported. These features and command sets are enabled and there is no disable mechanism.

If bit 15 of word 69 is set to one, then the device supports the CFast specification.

If word 169 bit 0 is set to one and word 69 bit 14 is cleared to zero, then the Trim function of the DATA SET MANAGEMENT command (see 7.9.3.2) supports indeterminate read after trim behavior. If word 169 bit 0 is set to one and word 69 bit 14 is set to one, the Trim function of the DATA SET MANAGEMENT command supports deterministic read after trim behavior. If word 169 bit 0 is cleared to zero, then word 69 bit 14 is reserved.

If bit 13 of word 69 is set to one, then the device supports the SET FEATURES command with the Long Physical Sector Alignment Error Reporting Control subcommand (see 7.49.17).

If bit12 of word 69 is set to one, then the DEVICE CONFIGURATION IDENTIFY DMA command and DEVICE CONFIGURATION SET DMA command are supported.

If bit 11 of word 69 is set to one, then the READ BUFFER DMA command is supported.

If bit 10 of word 69 is set to one, then the WRITE BUFFER DMA command is supported.

If bit 9 of word 69 is set to one, then the SET MAX SET PASSWORD DMA command and SET MAX UNLOCK DMA command are supported.

If bit 8 of word 69 is set to one, then the DOWNLOAD MICROCODE DMA command is supported.

Bit 7 is reserved for IEEE 1667.

Bit 6 of word 69 shall be cleared to zero if the following commands are supported:

a) FLUSH CACHE;
b) READ DMA;
c) READ MULTIPLE;
d) READ SECTOR(S);

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e) READ VERIFY SECTOR(S);
f) SET MULTIPLE MODE;
g) WRITE DMA;
h) WRITE MULTIPLE; and
i) WRITE SECTOR(S).

Bit 6 of word 69 shall be set to one if any of the following commands are not supported:

a) FLUSH CACHE;
b) READ DMA;
c) READ MULTIPLE;
d) READ SECTOR(S);
e) READ VERIFY SECTOR(S);
f) SET MULTIPLE MODE;
g) WRITE DMA;
h) WRITE MULTIPLE; or
i) WRITE SECTOR(S).

If word 69 bit 14 is set to one and word 69 bit 5 is set to one, then a read operation after a Trim operation returns data from trimmed LBAs as all words cleared to zero. If word 69 bit 14 is set to one and word 69 bit 5 is cleared to zero, then a read operation after a Trim operation may have words set to any value. If word 69 bit 14 is cleared to zero, then word 69 bit 5 is reserved.

If word 69 bit 4 is set to one the device encrypts all user data. If word 69 bit 4 is cleared to zero the device may not encrypt all user data.

NOTE This standard does not provide a method to cryptographically authenticate the state of word 69 bit 4.

If word 69 bit 3 is set to one, then words 230..233 (see 7.17.7.89) are valid. If word 69 bit 3 is cleared to zero, then words 230..233 (see 7.17.7.89) are reserved.

Bits (2:0) of word 69 are reserved.

7.17.7.31 Word 70: Reserved

7.17.7.32 Words 71..74: Reserved for ATAPI

7.17.7.33 Word 75: Queue depth

Bits (4:0) of word 75 indicate the maximum queue depth supported by the device. The queue depth includes all commands for which command acceptance has occurred and command completion has not occurred. The value in this field shall be set to one less than the maximum queue depth (e.g., a value of zero in this field indicates a queue depth of one, and a value of 31 in this field indicates a queue depth of 32). If bit 6 of word 76 is cleared to zero indicating that the device does not support NCQ feature set commands, then the value in this field shall be zero. Support of this word is mandatory if the NCQ feature set is supported.

7.17.7.34 Word 76: Serial ATA Capabilities

Word 76 indicates the capabilities of a SATA device. A PATA device shall set word 76 to 0000h or FFFFh. If word 76 is set to 0000h or FFFFh, then the device does not claim compliance with the Serial ATA specification and words 76 through 79 are not valid and shall be ignored.

If word 76 is not set to 0000h or FFFFh, then the device claims compliance with the Serial ATA specification, and words 77 through 79 shall be valid.

Bits (15:13) of word 76 are reserved for Serial ATA.

If bit 12 of word 76 is set to one, then the device supports the Priority field in the READ FPDMA QUEUED command and WRITE FPDMA QUEUED command and optimization based on this information. This bit shall only be set to one if the device supports NCQ as shown in bit 8 of Word 76.

If bit 11 of word 76 is set to one, then the device supports moving the heads to a safe position upon reception of the IDLE IMMEDIATE command with the Unload Feature specified while

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NCQ commands are outstanding. This bit shall only be set to one if the device supports NCQ as shown in bit 8 of Word 76.

If bit 10 of word 76 is set to one, then the device supports the SATA Phy Event Counters log (see A.14).

If bit 9 of word 76 is set to one, then the device supports Partial and Slumber interface power management states when initiated by the host (see SATA 2.6).

If bit 8 of word 76 is set to one, then the device supports the NCQ feature set.

Bits (7:3) of word 76 are reserved for Serial ATA.

If bit 2 of word 76 is set to one, then the device supports the Gen2 signaling rate of 3.0 Gbit/s (see SATA 2.6).

If bit 1 of word 76 is set to one, then the device supports the Gen1 signaling rate of 1.5 Gbit/s (see SATA 2.6).

Bit 0 of word 76 shall be cleared to zero.

7.17.7.35 Word 77: Reserved for Serial ATA

Word 77 is reserved for Serial ATA.

7.17.7.36 Word 78: Serial ATA features supported

If Word 76 is not 0000h or FFFFh, Word 78 reports the optional features supported by the device. If this word is not supported the word shall be cleared to zero.

Bits (15:7) are reserved for Serial ATA.

If bit 6 is set to one, then the device supports the SSP feature set (see 4.23).

Bit 5 is reserved for Serial ATA.

If bit 4 is set to one the device supports guaranteed in-order data delivery when non-zero buffer offsets are used for commands in the NCQ feature set. See SATA 2.6 for more information.

If bit 3 is set to one the device supports device initiated power management requests. If bit 3 is cleared to zero the device does not support device initiated power management requests. A device may support reception of power management requests initiated by the host as described in the definition of bit 9 of Word 76 without supporting initiating such power management requests as indicated by this bit.

If bit 2 is set to one the device supports the use of the DMA Setup FIS Auto-Activate optimization. See SATA 2.6 for more information.

If bit 1 is set to one the device supports the use of non-zero buffer offsets for commands in the NCQ feature set. See SATA 2.6 for more information.

Bit 0 shall be cleared to zero.

7.17.7.37 Word 79: Serial ATA features enabled

If Word 76 is not 0000h or FFFFh, Word 79 reports which optional features supported by the device are enabled. This word shall be supported if Word 78 is supported and shall not be supported if Word 78 is not supported.

Bits (15:7) are reserved for Serial ATA.

If bit 6 is set to one, then the SSP feature set is enabled. If the device supports the SSP feature set, then this field shall be one after a power on reset has been processed. If the device does not support the SSP feature set, then this field shall be zero by default.

Bit 5 is reserved for Serial ATA.

If bit 4 is set to one, then device support for guaranteed in-order data delivery when non-zero buffer offsets are used for commands in the NCQ feature set is enabled. See SATA 2.6 for more information.

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If bit 3 is set to one, then device support for initiating power management requests to the host is enabled. When set to one the device may initiate power management transition requests. When cleared to zero the device shall not initiate interface power management requests to the host. This field shall be zero by default.

If bit 2 is set to one, then the device support for use of the DMA Setup FIS Auto-Activate optimization is enabled. See SATA 2.6 for more information.

If bit 1 is set to one, then device support for the use of non-zero buffer offsets for commands in the NCQ feature set is enabled. See SATA 2.6 for more information.

Bit 0 shall be cleared to zero.

7.17.7.38 Word 80: Major version number

If word 80 is not set to 0000h or FFFFh, then the device claims compliance with the major version(s) as indicated by bits (8:4) being set to one. Values other than 0000h and FFFFh are bit significant. A device may set more than one bit.

7.17.7.39 Word 81: Minor version number

Table 52 defines the value that shall be reported in word 81 to indicate the version of the standard that guided the implementation.

Table 52 — Minor version number (part 1 of 2)

Value	Minor Version
0000h	Minor version is not reported
0001h	Obsolete
0002h	Obsolete
0003h	Obsolete
0004h	Obsolete
0005h	Obsolete
0006h	Obsolete
0007h	Obsolete
0008h	Obsolete
0009h	Obsolete
000Ah	Obsolete
000Bh	Obsolete
000Ch	Obsolete
000Dh	Obsolete
000Eh	Obsolete
000Fh	Obsolete
0010h	Obsolete
0011h	Obsolete
0012h	Obsolete
0013h	ATA/ATAPI-5 T13 1321D version 3
0014h	Obsolete
0015h	ATA/ATAPI-5 T13 1321D version 1
0016h	ATA/ATAPI-5 published, ANSI INCITS 340-2000
0017h	Obsolete
0018h	ATA/ATAPI-6 T13 1410D version 0
0019h	ATA/ATAPI-6 T13 1410D version 3a
001Ah	ATA/ATAPI-7 T13 1532D version 1

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Table 52 — Minor version number (part 2 of 2)

Value	Minor Version
001Bh	ATA/ATAPI-6 T13 1410D version 2
001Ch	ATA/ATAPI-6 T13 1410D version 1
001Dh	ATA/ATAPI-7 published ANSI INCITS 397-2005.
001Eh	ATA/ATAPI-7 T13 1532D version 0
001Fh	Reserved
0020h	Reserved
0021h	ATA/ATAPI-7 T13 1532D version 4a
0022h	ATA/ATAPI-6 published, ANSI INCITS 361-2002
0023h..0026h	Reserved
0027h	ATA8-ACS version 3c
0028h	ATA8-ACS version 6
0029h	ATA8-ACS version 4
0030h	Reserved
0031h	ASC-2 Revision 2
0032h	Reserved
0033h	ATA8-ACS version 3e
0034h..0038h	Reserved
0039h	ATA8-ACS version 4c
0040h..0041h	Reserved
0042h	ATA8-ACS version 3f
0043h..0051h	Reserved
0052h	ATA8-ACS version 3b
0053h..0106h	Reserved
0107h	ATA8-ACS version 2d
0108h..010Fh	Reserved
0110h	ACS-2 Revision 3
0111h..FFFEh	Reserved
FFFFh	Minor version is not reported

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7.17.7.40 Words 82..84, 119: Commands and feature sets supported

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

Bit 15 of word 82 is obsolete.

If bit 14 of word 82 is set to one, then the NOP command (see 7.22) is supported.

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

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

Bit 11 of word 82 is obsolete.

If bit 10 of word 82 is set to one, then the HPA feature set is supported.

Bit 9 shall be cleared to zero to indicate that the DEVICE RESET command is not supported.

Bits 8:7 of word 82 are obsolete.

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

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

Bit 4 of word 82 shall be cleared to zero to indicate that this is not an ATAPI device.

If bit 3 of word 82 is set to one, then the Power Management feature set is supported.

Bit 2 of word 82 is obsolete.

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

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

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

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

If bit 11 of word 83 is set to one, then the DCO feature set is supported.

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

Bit 9 of word 83 is obsolete.

If bit 8 of word 83 is set to one, then the HPA Security Extensions (see 4.11.2) are supported.

Bit 7 of word 83 is reserved for Address Offset Reserved Area Boot Method.

If bit 6 of word 83 is set to one, then the device requires the SET FEATURES subcommand to spin-up after power-up if the PUIS feature set is enabled (see 7.49.8).

If bit 5 of word 83 is set to one, then the PUIS feature set is supported.

Bit 4 of word 83 is obsolete.

If bit 3 of word 83 is set to one, then the APM feature set is supported.

If bit 2 of word 83 is set to one, then the CFA feature set is supported.

Bit 1 of word 83 is obsolete.

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

If bit 13 of word 84 is set to one, then the IDLE IMMEDIATE command with unload feature is supported.

Bit 12 of word 84 is reserved for TLC.

Bit 11 of word 84 is reserved for TLC.

Bits (10:9) are obsolete.

Bit 8 of word 84 shall be set to one indicating the mandatory World Wide Name in words 108..111 is supported.

Bit 7 of word 84 is obsolete.

If bit 10 of word 83 is set to one, then bit 6 of word 84 shall be set to one to indicate that the WRITE DMA FUA EXT command and WRITE MULTIPLE FUA EXT command are supported. If bit 10 of word 83 is cleared to zero, then bit 6 of word 84 shall be cleared to zero.

If bit 5 of word 84 is set to one, then the GPL feature set is supported.

If bit 4 of word 84 is set to one, then the Streaming feature set is supported.

If bit 3 of word 84 is obsolete.

If bit 2 of word 84 is set to one, then the media serial number field in words 176..205 is supported.

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If bit 1 of word 84 is set to one, SMART self-test is supported. This bit is valid if bit 0 of word 82 is set to one indicating that the SMART feature set is supported.

If bit 0 of word 84 is set to one, SMART error logging is supported. This bit is valid if bit 0 of word 82 is set to one indicating that the SMART feature set is supported.

Bits (13:8) of word 119 are reserved.

If bit 7 of word 119 is set to one, then the Extended Power Conditions feature is supported (see 7.49.18).

If bit 6 of word 119 is set to one, then the Sense Data Reporting feature set is supported.

If bit 5 of word 119 is set to one, then the Free-fall Control feature set is supported.

If bit 4 of word 119 is set to one, then the DOWNLOAD MICROCODE command and DOWNLOAD MICROCODE DMA command requesting the offset transfer method is supported.

If bit 3 of word 119 is set to one, then the READ LOG DMA EXT command and WRITE LOG DMA EXT command are supported. This bit shall only be set to one if word 84 bit 5 is set to one.

If bit 2 of word 119 is set to one, then the WRITE UNCORRECTABLE EXT command is supported.

If bit 1 of word 119 is set to one, then the Write-Read-Verify feature set is supported.

Bit 0 of word 119 is reserved for DDT.

7.17.7.41 Words 85..87, 120: Commands and feature sets supported or enabled

Words 85..87 and 120 shall indicate features and command sets enabled. If a defined bit is cleared to zero, the indicated features and command set is not enabled. If a supported feature or feature set is supported and there is no defined method to disable the feature or feature set, then it is defined as supported and the bit shall be set to one. If bit 14 of word 87 is set to one and bit 15 of word 87 is cleared to zero, then the contents of words 85..87 contain valid information. If bit 14 of word 120 is set to one and bit 15 of word 120 is cleared to zero, then the contents of word 120 contain valid information. Otherwise, information is not valid in these words.

NOTE Some features do not have a method to be disabled. These features are marked as supported in this subclause for symmetry.

Bit 14 of word 85 is a copy of bit 14 of word 82.

Bit 13 of word 85 is a copy of bit 13 of word 82.

Bit 12 of word 85 is a copy of bit 12 of word 82.

Bit 10 of word 85 is a copy of bit 10 of word 82.

Bit 9 of word 85 shall be cleared to zero to indicate that the DEVICE RESET command is not supported.

Bits 8:7 of word 85 are obsolete.

If bit 6 of word 85 is set to one, then read look-ahead is enabled (see 7.49.12). If bit 6 of word 85 is cleared to zero, then read look-ahead is disabled. This bit is valid if bit 6 of word 82 is set to one indicating read look-ahead is supported.

If bit 5 of word 85 is set to one, then volatile write cache is enabled (see 7.49.4). If bit 5 of word 85 is cleared to zero, then volatile write cache is disabled. This bit is valid if bit 5 of word 82 is set to one indicating write cache is supported.

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.

If bit 1 of word 85 is set to one, then security has been enabled by setting a User password via the SECURITY SET PASSWORD command. If bit 1 of word 85 is cleared to zero, then there is no valid User password. If the Security feature set is not supported, then this bit shall be

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cleared to zero. This bit is valid if bit 1 of word 82 is set to one indicating Security feature set is supported.

If bit 0 of word 85 is set to one, then the SMART feature set is enabled (see 7.54.4). If bit 0 of word 85 is cleared to zero, then the SMART feature set is disabled (see 7.54.2). This bit is valid if bit 0 of word 82 is set to one indicating SMART feature set is supported.

If bit 15 of word 86 is set to one, then words 119 and 120 are valid.

Bit 14 of word 86 is reserved.

Bit 13 of word 86 is a copy of bit 13 of word 83.

Bit 12 of word 86 is a copy of bit 12 of word 83.

Bit 11 of word 86 is a copy of bit 11 of word 83.

Bit 10 of word 86 is a copy of bit 10 of word 83.

Bit 9 of word 86 is obsolete.

If bit 8 of word 86 is set to one, then the HPA Security Extensions are enabled (see 7.50.5). This bit is valid if bit 8 of word 83 is set to one indicating the HPA Security Extensions are supported.

Bit 7 of word 86 is reserved for Address Offset Reserved Area Boot Method.

Bit 6 of word 86 is a copy of bit 6 of word 83.

If bit 5 of word 86 is set to one, then the PUIS feature set is enabled (see 7.49.7). If bit 5 of word 86 is cleared to zero, then the PUIS feature set is disabled. This bit is valid if bit 5 of word 83 is set to one indicating PUIS feature set is supported.

If bit 3 of word 86 is set to one, then the APM feature set is enabled (see 7.49.6). If bit 3 of word 86 is cleared to zero, the APM feature set is disabled.

Bit 2 of word 86 is a copy of bit 2 of word 83.

Bit 1 of word 86 is obsolete.

Bit 0 of word 86 is a copy of bit 0 of word 83.

Bit 13 of word 87 is a copy of bit 13 of word 84.

Bit 12 of word 87 is reserved for TLC.

Bit 11 of word 87 is reserved for TLC.

Bit 8 of word 87 is a copy of word 84 bit 8.

Bit 7 of word 87 is obsolete.

Bit 6 of word 87 is a copy of bit 6 of word 84.

Bit 5 of word 87 is a copy of bit 5 of word 84.

If bit 3 of word 87 is obsolete.

If bit 2 of word 87 is set to one, then the media serial number field in words 176..205 is valid. This bit shall be cleared to zero if the media does not contain a valid serial number or if no media is present. This bit is valid if bit 2 of word 84 is set to one indicating Media serial number is supported.

Bit 1 of word 87 is a copy of bit 1 of word 84.

Bit 0 of word 87 is a copy of bit 0 of word 84.

Bits (13:8) of word 120 are reserved.

If bit 7 of word 120 is set to one, then the EPC feature set is enabled (see 7.49.18.6). If bit 7 of word 120 is cleared to zero, then the EPC feature set is disabled (see 7.49.18.7).

If bit 6 of word 120 is set to one, then the Sense Data Reporting feature set is enabled.

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If bit 5 of word 120 is set to one, then the Free-fall Control feature set is enabled. If bit 5 of word 120 is cleared to zero, then the Free-fall Control feature set is disabled.

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.

If bit 1 of word 120 is set to one, then the Write-Read-Verify feature set is enabled. If bit 1 of word 120 is cleared to zero, then the Write-Read-Verify feature set is disabled.

Bit 0 of word 120 is reserved for DDT.

7.17.7.42 Word 88: Ultra DMA modes

Word 88 identifies the Ultra DMA transfer modes supported by the device and indicates the mode that is currently selected. Only one DMA mode shall be selected at any given time. If an Ultra DMA mode is selected, then no Multiword DMA mode shall be selected. If a Multiword DMA mode is selected, then no Ultra DMA mode shall be selected. Support of this word is mandatory if any Ultra DMA mode is supported.

Bit 15 of word 88 is reserved.

If bit 14 of word 88 is set to one, then Ultra DMA mode 6 is selected. If this bit is cleared to zero, then Ultra DMA mode 6 is not selected. If bit 13 or bit 12 or bit 11 or bit 10 or bit 9 or bit 8 is set to one, then this bit shall be cleared to zero.

If bit 13 of word 88 is set to one, then Ultra DMA mode 5 is selected. If this bit is cleared to zero, then Ultra DMA mode 5 is not selected. If bit 14 or bit 12 or bit 11 or bit 10 or bit 9 or bit 8 is set to one, then this bit shall be cleared to zero.

If bit 12 of word 88 is set to one, then Ultra DMA mode 4 is selected. If this bit is cleared to zero, then Ultra DMA mode 4 is not selected. If bit 14 or bit 13 or bit 11 or bit 10 or bit 9 or bit 8 is set to one, then this bit shall be cleared to zero.

If bit 11 of word 88 is set to one, then Ultra DMA mode 3 is selected. If this bit is cleared to zero, then Ultra DMA mode 3 is not selected. If bit 14 or bit 13 or bit 12 or bit 10 or bit 9 or bit 8 is set to one, then this bit shall be cleared to zero.

If bit 10 of word 88 is set to one, then Ultra DMA mode 2 is selected. If this bit is cleared to zero, then Ultra DMA mode 2 is not selected. If bit 14 or bit 13 or bit 12 or bit 11 or bit 9 or bit 8 is set to one, then this bit shall be cleared to zero.

If bit 9 of word 88 is set to one, then Ultra DMA mode 1 is selected. If this bit is cleared to zero, then Ultra DMA mode 1 is not selected. If bit 14 or bit 13 or bit 12 or bit 11 or bit 10 or bit 8 is set to one, then this bit shall be cleared to zero.

If bit 8 of word 88 is set to one, then Ultra DMA mode 0 is selected. If this bit is cleared to zero, then Ultra DMA mode 0 is not selected. If bit 14 or bit 13 or bit 12 or bit 11 or bit 10 or bit 9 is set to one, then this bit shall be cleared to zero.

Bit 7 of word 88 is reserved.

For PATA devices when bit 6 of word 88 is set to one Ultra DMA modes 6 and below are supported. If this bit is cleared to zero, then Ultra DMA mode 6 is not supported. If Ultra DMA mode 6 is supported, then Ultra DMA modes 5, 4, 3, 2, 1 and 0 shall also be supported. If this bit is set to one, then bits (5:0) shall be set to one.

For SATA devices bit 6 of word 88 may be set to one.

For PATA devices when bit 5 of word 88 is set to one Ultra DMA modes 5 and below are supported. If this bit is cleared to zero, then Ultra DMA mode 5 is not supported. If Ultra DMA mode 5 is supported, then Ultra DMA modes 4, 3, 2, 1 and 0 shall also be supported. If this bit is set to one, then bits (4:0) shall be set to one.

For SATA devices bit 5 of word 88 shall be set to one.

For PATA devices when bit 4 of word 88 is set to one Ultra DMA modes 4 and below are supported. If this bit is cleared to zero, then Ultra DMA mode 4 is not supported. If Ultra DMA

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mode 4 is supported, then Ultra DMA modes 3, 2, 1 and 0 shall also be supported. If this bit is set to one, then bits (3:0) shall be set to one.

For SATA devices bit 4 of word 88 shall be set to one.

For PATA devices when bit 3 of word 88 is set to one Ultra DMA modes 3 and below are supported. If this bit is cleared to zero, then Ultra DMA mode 3 is not supported. If Ultra DMA mode 3 is supported, then Ultra DMA modes 2, 1 and 0 shall also be supported. If this bit is set to one, then bits (2:0) shall be set to one.

For SATA devices bit 3 of word 88 shall be set to one.

For PATA devices when bit 2 of word 88 is set to one Ultra DMA modes 2 and below are supported. If this bit is cleared to zero, then Ultra DMA mode 2 is not supported. If Ultra DMA mode 2 is supported, then Ultra DMA modes 1 and 0 shall also be supported. If this bit is set to one, bits (1:0) shall be set to one.

For SATA devices bit 2 of word 88 shall be set to one.

For PATA devices when bit 1 of word 88 is set to one Ultra DMA modes 1 and below are supported. If this bit is cleared to zero, then Ultra DMA mode 1 is not supported. If Ultra DMA mode 1 is supported, then Ultra DMA mode 0 shall also be supported. If this bit is set to one, bit 0 shall be set to one.

For SATA devices bit 1 of word 88 shall be set to one.

For PATA devices when bit 0 of word 88 is set to one Ultra DMA mode 0 is supported. If this bit is cleared to zero, then Ultra DMA is not supported.

For SATA devices bit 0 of word 88 shall be set to one.

7.17.7.43 Word 89

Word 89 specifies the estimated time required for the SECURITY ERASE UNIT command to complete its normal mode erasure as defined in table 53. Support of this word is mandatory if the Security feature set is supported. If the Security feature set is not supported, this word shall be cleared to zero.

Table 53 — Normal Erase Mode Time

Value	Time
0	Value not specified
1..254	(Value×2) minutes
255	>508 min

7.17.7.44 Word 90

Word 90 specifies the estimated time required for the SECURITY ERASE UNIT command to complete its enhanced mode erasure as defined in table 54. Support of this word is mandatory if support of the Security feature set is supported. If the Security feature set is not supported, this word shall be cleared to zero.

Table 54 — Enhanced Erase Mode Time

Value	Time
0	Value not specified
1..254	(Value×2) minutes
255	>508 min

7.17.7.45 Word 91: Current advanced power management level value

Bits (7:0) of word 91 contain the current APM level setting (see table 120). Support of this word is mandatory if the APM feature set is supported. This word is valid if bit 3 of word 83 and bit 3 of word 86 are set to one indicating the APM feature set is supported.

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7.17.7.46 Word 92: Master Password Identifier

If the Security feature set is not supported (i.e., bit 1 of word 82 is cleared to zero) or the Master Password Identifier feature is not supported, then word 92 shall contain 0000h or FFFFh.

If the Security feature set and the Master Password Identifier feature are supported, then word 92 contains the value of the Master Password Identifier set when the Master Password was last changed.

7.17.7.47 Word 93: Hardware reset results

For PATA devices, when bit 14 of word 93 is set to one and bit 15 of word 93 is cleared to zero the content of word 93 contains valid information. During processing of a hardware reset, Device 0 shall set bits (12:8) of this word to zero and shall set bits (7:0) of this word to show the result of the hardware reset. During processing of a hardware reset, Device 1 shall clear bits (7:0) of this word to zero and shall set bits (12:8) of the word to show the result of the hardware reset. The contents of bits (12:0) of this word shall change only during the processing of a hardware reset.

Bit 13 shall be set or cleared by the selected device to indicate whether the device detected the CBLID- signal (see ATA8-APT) above V_{IH} or the CBLID- signal below V_{IL} at any time during the processing of each IDENTIFY DEVICE command after receiving the command from the host but before returning data to the host. This test may be repeated by the device during command processing (see ATA8-APT).

For SATA devices, word 93 shall be set to the value 0000h.

7.17.7.48 Word 94: Obsolete

7.17.7.49 Word 95: Stream Minimum Request Size

Word 95 contains the number of logical sectors that provides optimum performance in a streaming environment. This number shall be a power of two, with a minimum of eight logical sectors. The starting LBA value for each streaming command should be evenly divisible by this request size. This word is valid if bit 4 of word 84 is set to one, indicating that the Streaming feature set is supported. If the Streaming feature set is not supported by the device, then the content of word 95 shall be zero.

7.17.7.50 Word 96: Streaming Transfer Time – DMA

Word 96 defines the Streaming Transfer Time for DMA mode. The worst-case sustainable transfer time per logical sector for the device is calculated as follows:

$$\text{Worst Case Sustainable Transfer Time} = \frac{x \times y}{65\,536}$$

Where:

x = Streaming Performance Granularity (see 7.17.7.52); and
y = Streaming Transfer Time for DMA mode.

The content of word 96 may be affected by the host issuing a Set Maximum Host Interface Sector Times (see 7.49.11). As a result, the host should issue an IDENTIFY DEVICE command after issuing a SET FEATURES command that may affect this word. If the Streaming feature set is not supported by the device, then the content of word 96 shall be zero.

This word is valid if bit 4 of word 84 is set to one indicating that the Streaming feature set is supported.

7.17.7.51 Word 97: Streaming Access Latency – DMA and PIO

Word 97 defines the Streaming Access Latency for DMA and PIO mode. The worst-case access latency of the device for a streaming command is calculated as follows:

$$\text{Worst Case Access Latency} = \frac{x \times y}{256}$$

Where:

x = Streaming Performance Granularity (see 7.17.7.52); and
y = Streaming Access Latency for DMA and PIO mode.

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The host should issue an IDENTIFY DEVICE command after issuing a SET FEATURES command that may affect this word. If the Streaming feature set is not supported by the device, then the content of word 97 shall be zero.

This word is valid if bit 4 of word 84 is set to one indicating that the Streaming feature set is supported.

7.17.7.52 Words 98..99: Streaming Performance Granularity

These words define the fixed unit of time that is used in IDENTIFY DEVICE data word 96, word 97 and word 104, SET FEATURES subcommand Set Maximum Host Interface Sector Times (see 7.49.11), and in the Command Completion Time Limit that is passed in streaming commands. The unit of time for this parameter shall be in microseconds (e.g., a value of 10 000 indicates 10 ms). If yy was returned by the ATA device as the Streaming Performance Granularity, then:

a) the Command Completion Time Limit in the Feature field for a streaming command shall be yy microseconds;
b) the Streaming Transfer Time shall be:
   A) ((word 96) × (yy / 65 536)) microseconds; or
   B) ((word 104) × (yy / 65 536)) microseconds;
c) the Streaming Access Latency shall be ((word 97) × (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 ((word 104 × S / 65 536) + (word 97 / 256)) × yy microseconds; or
   B) for DMA ((word 96 × S / 65 536) + (word 97 / 256)) × yy microseconds.

The value of the Streaming Performance Granularity is vendor specific and fixed for a device.

This word is valid if bit 4 of word 84 is set to one indicating that the Streaming feature set is supported.

7.17.7.53 Words 100..103: Number of User Addressable Logical Sectors

Words 100..103 contain a value that is one greater than the maximum LBA in the user data area when the 48-bit Addressing feature set is supported. The maximum value that shall be placed in this field is 0000_FFFF_FFFF_FFFFh. Support of these words is mandatory if the 48-bit Address feature set is supported.

7.17.7.54 Word 104: Streaming Transfer Time – PIO

Word 104 defines the Streaming Transfer Time for PIO mode. The worst-case sustainable transfer time per logical sector for the device is calculated as follows:

$$\text{Worst Case Sustainable Transfer Time} = \frac{x \times y}{65\,536}$$

Where:

x = Streaming Performance Granularity (see 7.17.7.52); and
y = Streaming Transfer Time for PIO mode.

The content of word 104 may be affected by the host issuing a Set Maximum Host Interface Sector Times (see 7.49.11). As a result, the host should issue an IDENTIFY DEVICE command after issuing a SET FEATURES command that may affect this word. If the Streaming feature set is not supported by the device, then the content of word 104 shall be zero.

This word is valid if bit 4 of word 84 is set to one indicating that the Streaming feature set is supported.

7.17.7.55 Word 105: Maximum number of 512-byte blocks of LBA Range Entries per DATA SET MANAGEMENT command

Word 105 contains the maximum number of 512-byte blocks of LBA Range Entries per DATA SET MANAGEMENT command that the ATA device shall accept. A value of 0000_0000h indicates that the maximum number of 512-byte blocks of LBA Range Entries is not specified.

If bit 0 of word 169 (see 7.17.7.71) is cleared to zero, then word 105 is reserved.

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7.17.7.56 Word 106: Physical sector size / logical sector size

If bit 14 of word 106 is set to one and bit 15 of word 106 is cleared to zero, then the contents of word 106 contain valid information. Otherwise, information is not valid in this word.

If bit 13 of word 106 is set to one, then the device has more than one logical sector per physical sector and bits (3:0) of word 106 are valid. See 7.17.7.76 for information on the alignment of logical sectors within a physical sector.

If bit 12 of word 106 is set to one, then the device has been formatted with a logical sector size larger than 256 words and words 117..118 (see 7.17.7.61) are valid. If bit 12 of word 106 is cleared to zero, then words 117..118 are invalid and the logical sector size is 256 words.

Bits (11:4) of word 106 are reserved.

Bits (3:0) of word 106 indicate the size of the device physical sectors in power of two logical sectors.

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.

7.17.7.57 Word 107: Inter-seek delay for ISO 7779 standard acoustic testing

Word 107 is the manufacturer's recommended time delay between seeks in microseconds during ISO 7779 standard acoustic testing (i.e., ISO 7779 value t_D (see ISO 7779:1999 (E))).

7.17.7.58 Words 108..111: World wide name

Words 108..111 contain a mandatory World Wide Name (WWN) in the NAA IEEE Registered identifier format.

Word 108 bits (15:12) shall contain 5h.

Word 108 bits (11:0) and word 109 bits (15:4) shall contain the OUI (i.e., company ID) for the device manufacturer assigned by the IEEE.

Word 109 bits (3:0), word 110, and word 111 shall contain a value assigned by the vendor that is unique for the device in the OUI domain.

The IDENTIFY DEVICE data World Wide Name field is shown by word number in table 55.

Table 55 — IDENTIFY DEVICE data World Wide Name field (word-based view)

	Bit number within each word															
Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
108	NAA (5h)				bit 23 (MSB)			IEEE OUI								bit 12
109	bit 11										(LSB) bit 0		bit 35 (MSB)			bit 32
110	bit 31							Unique ID								bit 16
111	bit 15															(LSB) bit 0

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The World Wide Name field is shown by byte number in table 56.

Table 56 — IDENTIFY DEVICE data World Wide Name field (byte-based view)

Word	Offset	Bit number within each byte							
		7	6	5	4	3	2	1	0
108	216	bit 19			IEEE OUI				bit 12
	217	NAA (5h)				bit 23 (MSB)			bit 20
109	218	bit 3			(LSB) bit 0	bit 35 (MSB)		UNIQUE ID	bit 32
	219	bit 11			IEEE OUI				bit 4
110	220	bit 23							bit 16
	221	bit 31							bit 24
111	222	bit 7			UNIQUE ID				(LSB) bit 0
	223	bit 15							bit 8

7.17.7.59 Words 112..115: Reserved for a 128-bit world wide name

7.17.7.60 Word 116: Reserved for TLC

7.17.7.61 Words 117..118: Logical sector size

Words 117..118 indicate the size of device logical sectors in words. The value of logical sector size shall be greater than or equal to 256. The value of logical sector size shall be valid when bit 12 of word 106 is set to one. All logical sectors on a device shall be this length. When bit 12 of word 106 is cleared to zero words 117..118 shall be cleared to zero.

7.17.7.62 Word 119: See 7.17.7.40

7.17.7.63 Word 120: See 7.17.7.41

7.17.7.64 Words 121..126: Reserved for expanded supported and enabled settings

7.17.7.65 Word 127: Obsolete

7.17.7.66 Word 128: Security status

Support of this word is mandatory if the Security feature set is supported. If the Security feature set is not supported, this word shall be cleared to zero.

Bit 8 of word 128 indicates the Master Password Capability. If security is enabled and the Master Password Capability is high, bit 8 shall be cleared to zero. If security is enabled and the Master Password Capability is maximum, bit 8 shall be set to one. When security is disabled, bit 8 shall be cleared to zero.

Bit 5 of word 128 set to one indicates that the enhanced mode of the SECURITY ERASE UNIT command is supported.

Bit 4 of word 128 (i.e., Password Attempt Counter Exceeded bit) set to one indicates that the password attempt counter has decremented to zero.

Bit 3 of word 128 set to one indicates that security is frozen.

Bit 2 of word 128 set to one indicates that security is locked.

Bit 1 of word 128 set to one indicates that security is enabled. This is a copy of word 85, bit 1.

Bit 0 of word 128 set to one indicates that the Security feature set is supported. This is a copy of word 82, bit 1.

7.17.7.67 Words 129..159: Vendor specific

7.17.7.68 Word 160: CFA power mode

Word 160 indicates the presence and status of a CFA feature set device that supports CFA Power Mode 1. Support of this word is mandatory if CFA Power Mode 1 is supported.

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If bit 13 of word 160 is set to one, then the device is in CFA Power Mode 1 to perform one or more commands implemented by the device.

If bit 12 of word 160 is set to one, then the device is in CFA Power Mode 0 (see 7.49.9).

Bits (11:0) indicate the maximum average RMS current in milliamperes required during 3.3 V or 5 V device operation in CFA Power Mode 1.

7.17.7.69 Words 161..167: Reserved for assignment by the CompactFlash Association

7.17.7.70 Word 168: Device Nominal Form Factor

Bits (3:0) of Word 168 indicate the nominal form factor of the device and is defined in table 57.

Table 57 — Device Nominal Form Factor

Value	Description
0h	Nominal form factor not reported
1h	5.25 inch nominal form factor
2h	3.5 inch nominal form factor
3h	2.5 inch nominal form factor
4h	1.8 inch nominal form factor
5h	Less than 1.8 inch nominal form factor
6h..Fh	Reserved

7.17.7.71 Word 169: DATA SET MANAGEMENT is supported

Word 169 bits 15:1 are reserved.

If bit 0 of word 169 is set to one, then the device supports the Trim bit of the DATA SET MANAGEMENT command. See 7.17.7.30 and 7.9.3.2 for reporting Trim methods.

If bit 0 of word 169 is cleared to zero, then the Trim bit in the DATA SET MANAGEMENT command is not supported and:

a) word 105 is reserved;
b) bit 5 of word 69 is reserved; and
c) bit 14 of word 69 is reserved.

7.17.7.72 Words 170..173: Additional Product Identifier

This field contains the Additional Product Identifier. The contents of this field is an ATA string of eight bytes in the format defined by 3.3.10. The device shall pad the string with spaces (i.e., 20h), if necessary, to ensure that the string is the proper length. If the Additional Product Identifier is not present, then this field is reserved.

7.17.7.73 Words 174..175: Reserved

7.17.7.74 Words 176..205: Current media serial number

Words 176..205 contain the current media serial number. Media serial numbers shall be an ATA string of 60 bytes in the format defined by 3.3.10. The first 40 bytes shall indicate the media serial number and the remaining 20 bytes shall indicate the media manufacturer.

7.17.7.75 Word 206: SCT Command Transport

Bits (15:12) indicate support for vendor specific action codes.

Bits (11:6) of word 206 are reserved.

If bit 5 of word 206 is set to one, then the device supports SCT Data Tables (see 8.3.5).

If bit 4 of word 206 is set to one, then the device supports SCT Feature Control (see 8.3.4).

If bit 3 of word 206 is set to one, then the device supports SCT Error Recovery Control (see 8.3.3).

If bit 2 of word 206 is set to one, then the device supports SCT Write Same (see 8.3.2).

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Bit 1 of word 206 is obsolete.

If bit 0 of word 206 is set to one, then the device supports the SCT Command Transport including SCT Read Status (see clause 8).

7.17.7.76 Word 209: Alignment of logical blocks within a physical block

Word 209 shall report the location of logical sector zero within the first physical sector of the media. See Annex E for more information. This word is valid if bit 13 of word 106 is set to one.

Bit 15 of word 209 shall be cleared to zero.

Bit 14 of word 209 shall be set to one.

Bits 13:0 of word 209 indicate the Logical sector offset within the first physical sector where the first logical sector is placed.

7.17.7.77 Words 210..211: Write-Read-Verify Sector Count Mode 3

Words 210..211 shall indicate the number of logical sectors to be verified after every spin-up, when Write-Read-Verify feature set mode 3 is selected (i.e., word 220 bits 7:0 are 03h). This field is valid when word 120 bit 1 is set to one and word 220 bits 7:0 are 03h.

7.17.7.78 Words 212..213: Write-Read-Verify Sector Count Mode 2

Words 212..213 shall indicate the number of logical sectors to be verified after every spin-up, when Write-Read-Verify feature set mode 2 is selected (i.e., word 220 bits 7:0 are 02h). These words are valid when word 119 bit 1 is set to one.

7.17.7.79 Word 214: NV Cache Capabilities

Both the NV Cache Power Mode feature set version (word 214 bits (11:8)) and the NV Cache feature set version (word 214 bits (15:12)) shall be set to zero.

If bit 4 of word 214 is set to one, the NV Cache feature set is enabled.

If bit 1 of word 214 is set to one, the NV Cache Power Management feature is enabled. This capability is enabled by issuing a SET NV CACHE POWER MODE command and disabled by issuing a RETURN FROM NV CACHE POWER MODE command.

If bit 0 of word 214 is set to one, the NV Cache Power Management feature set is supported.

7.17.7.80 Words 215..216: NV Cache Size in Logical Blocks

Words 215..216 indicate the maximum number of logical sectors that the device's NV Cache Set contains for the host to pin (see 4.17.2). This field is valid if word 214 bit 0 or bit 4 is set to one indicating NV Cache feature set is supported.

7.17.7.81 Word 217: Nominal media rotation rate

Word 217 indicates the nominal media rotation rate of the device and is defined in table 58.

Table 58 — 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

7.17.7.82 Word 218: Reserved

7.17.7.83 Word 219: NV Cache Options

Word 219 bits (7:0) contains the device's estimate of the amount of time in seconds it takes for the device to satisfy a read or write request from its rotational media when the read or write

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request is received while the rotational media is not spinning. This field is valid if bit 4 of word 214 is set to one.

7.17.7.84 Word 220

Word 220 contains the current mode of the Write-Read-Verify feature set, as set by the SET FEATURES Enable/Disable Write-Read-Verify subcommand. See 7.49.10 for more information on setting Write-Read-Verify mode.

Bits (15:8) of word 220 are reserved.

Bits (7:0) of word 220 indicate the current mode of the Write-Read-Verify feature set.

7.17.7.85 Word 221: Reserved

7.17.7.86 Word 222: Transport major version number

If word 222 is not set to FFFFh or 0000h, then the device claims compliance with one or more of the ATA transport standard major versions as indicated by bits (11:0). Bits (15:12) indicate the transport type. Values other than 0000h and FFFFh are bit significant. A device may set more than one bit to one.

7.17.7.87 Word 223: Transport minor version number

Table 59 defines the value that shall be reported in word 223 to indicate the version of the standard that guided the implementation.

Table 59 — Transport minor version number

Value	Minor Version
0000h	Minor version not reported
a	Reserved
0021h	ATA8-AST T13 Project D1697 Version 0b
0022h..0050h	Reserved
0051h	ATA-AST T13 Project D1697 Version 1
0052h..FFFEh	Reserved
FFFFh	Minor version not reported

7.17.7.88 Words 224..229: Reserved

7.17.7.89 Words 230..233: Extended Number of User Addressable Sectors

If word 69 bit 3 (see 7.17.7.30) is set to one, then words 230..233 contain a value that is one greater than the maximum LBA in user accessible space. The maximum value that shall be placed in this field is 0000_FFFF_FFFF_FFFFh.

7.17.7.90 Word 234: Minimum number of 512-byte data blocks per Download Microcode mode 03h operation

Word 234 contains the minimum number of 512-byte data blocks per Download Microcode mode 3 operation that the ATA device accepts when using the offset transfer method (see 7.12). This word is valid if bit 0 of word 83, bit 0 of word 86, and bit 4 of word 120 are set to one (i.e., the DOWNLOAD MICROCODE command and DOWNLOAD MICROCODE DMA command using the offset transfer method is supported). The values 0000h and FFFFh indicate no minimum is specified (i.e., that there is no minimum number of 512-byte data blocks).

7.17.7.91 Word 235: Maximum number of 512-byte data blocks per Download Microcode mode 03h operation

Word 234 contains the maximum number of 512-byte data blocks per Download Microcode mode 3 operation that the ATA device shall accept when using the offset transfer method (see 7.12). This word is valid if bit 0 of word 83, bit 0 of word 86, and bit 4 of word 120 are set to one (i.e., the DOWNLOAD MICROCODE command and the DOWNLOAD MICROCODE DMA command using the offset transfer method is supported). The values 0000h and FFFFh

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indicate no maximum is specified (i.e., that there is no maximum number of 512-byte data blocks)

7.17.7.92 Words 236..254: Reserved

7.17.7.93 Word 255: Integrity word

If bits (7:0) of this word contain the Checksum Validity Indicator A5h, then bits (15:8) contain the data structure checksum. The data structure checksum is the two's complement of the sum of all bytes in words 0..254 and the byte consisting of bits (7:0) in word 255. Each byte shall be added with unsigned arithmetic, and overflow shall be ignored. The sum of all 512 bytes is zero when the checksum is correct.

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7.18 IDENTIFY PACKET DEVICE - A1h, PIO Data-In

7.18.1 Feature Set

This 28-bit command is mandatory for devices implementing the PACKET feature set (see 4.3).

7.18.2 Description

The IDENTIFY PACKET DEVICE command enables the host to receive parameter information from a device that implements the PACKET feature set. See table 61 for a description of the return data.

Devices may read the non-volatile media in order to complete this command.

The IDENTIFY PACKET DEVICE data contains information regarding feature or command support. If the host issues a command that is indicated as not supported in the IDENTIFY PACKET DEVICE data, the device shall return command aborted for the command.

7.18.3 Inputs

See table 60 for the IDENTIFY PACKET DEVICE command inputs.

Table 60 — IDENTIFY PACKET DEVICE command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 A1h

7.18.4 Normal Outputs

See table 212.

7.18.5 Error Outputs

The device shall return command aborted if the device does not implement this command, otherwise, the device shall not report an error. See table 236. The device may return command completion with the Error bit set to one if an Interface CRC error has occurred.

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

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7.18.6 Input From the Device to the Host Data Structure

7.18.6.1 Overview

Table 61 specifies the format of IDENTIFY PACKET DEVICE data.

Table 61 — IDENTIFY PACKET DEVICE data (part 1 of 11)

Word	O/M	S/P	F/V	Description
0	M	B		General configuration
			F	15:14 10b = ATAPI device
			F	11b = Reserved
				13 Reserved
			F	12:8 Indicates command set used by the device
			X	7 Obsolete
			F	6:5 00b = Device shall set DRQ to one within 3 ms of receiving PACKET command.
				01b = Obsolete.
				10b = Device shall set DRQ to one within 50 µs of receiving PACKET command.
				11b = Reserved
				4:3 Reserved
			V	2 Incomplete response
			F	1:0 00b = 12 byte command packet
				01b = 16 byte command packet
				1xb = Reserved
1				Reserved
2		B	V	Specific configuration
3..9				Reserved
10..19	M	B	F	Serial number (ATA String)
20..22				Reserved
23..26	M	B	F	Firmware revision (ATA String)
27..46	M	B	F	Model number (ATA String)
47..48				Reserved

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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

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Table 61 — IDENTIFY PACKET DEVICE data (part 2 of 11)

Word	O M	S P	F V	Description
49	M			Capabilities
			X	15:12 Obsolete
		P	F	11 1 = IORDY supported
		P	F	10 1 = IORDY may be disabled
			F	9 Shall be set to one.
		P	F	8 1 = DMA supported. Devices that require the DMADIR bit in the PACKET command shall clear this bit to 0
			X	7:0 Vendor specific
50	O			Capabilities
			F	15 Shall be cleared to zero.
			F	14 Shall be set to one.
				13:2 Reserved
			X	1 Obsolete
		B	F	0 Shall be set to one to indicate a device specific Standby timer value minimum.
51..52			X	Obsolete
53	M			15:3 Reserved
		B	F	2 1 = the fields reported in word 88 are valid
		B	F	1 1 = the fields reported in words 64..70 are valid
			X	0 Obsolete
54..61				Reserved

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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

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Table 61 — IDENTIFY PACKET DEVICE data (part 3 of 11)

Word	O M	S P	F V	Description
62	M			DMADIR (see 7.18.6.17)
		S	F	15 1 = DMADIR bit in the PACKET command is required for DMA transfers 0 = DMADIR bit in PACKET command is not required for DMA transfers.
				14:11 Reserved
		P	F	10 1 = DMA is supported
		P	F	9 1 = Multiword DMA mode 2 is supported
		P	F	8 1 = Multiword DMA mode 1 is supported
		P	F	7 1 = Multiword DMA mode 0 is supported
		P	F	6 1 = Ultra DMA mode 6 and below are supported
		P	F	5 1 = Ultra DMA mode 5 and below are supported
		P	F	4 1 = Ultra DMA mode 4 and below are supported
		P	F	3 1 = Ultra DMA mode 3 and below are supported
		P	F	2 1 = Ultra DMA mode 2 and below are supported
		P	F	1 1 = Ultra DMA mode 1 and below are supported
		P	F	0 1 = Ultra DMA mode 0 is supported
63	M			15:11 Reserved
		P	V	10 1 = Multiword DMA mode 2 is selected
		P	V	9 1 = Multiword DMA mode 1 is selected
		P	V	8 1 = Multiword DMA mode 0 is selected
				7:3 Reserved
		P	F	2 1 = Multiword DMA mode 2 and below are supported.
		P	F	1 1 = Multiword DMA mode 1 and below are supported.
		P	F	0 1 = Multiword DMA mode 0 is supported Multiword DMA mode selected.
64	M			15:8 Reserved
		P	F	7:0 PIO transfer modes supported
65	M			Minimum Multiword DMA transfer cycle time per word
		P	F	15:0 Cycle time in nanoseconds
66	M			Manufacturer's recommended Multiword DMA transfer cycle time
		P	F	15:0 Cycle time in nanoseconds
67	M			Minimum PIO transfer cycle time without flow control
		P	F	15:0 Cycle time in nanoseconds
68	M			Minimum PIO transfer cycle time with IORDY (see ATA8-APT) flow control
		P	F	15:0 Cycle time in nanoseconds

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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

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Table 61 — IDENTIFY PACKET DEVICE data (part 4 of 11)

Word	O M	S P	F V	Description
69..70				Reserved
71..72			X	Obsolete
73..74				Reserved
75			X	Obsolete
76	O	S		Serial ATA Capabilities
				15:11 Reserved for Serial ATA
			F	10 1 = The SATA Phy Event Counters log is supported
			F	9 1 = Receipt of host initiated power management requests are supported
				8:3 Reserved for Serial ATA
			F	2 1 = The SATA Gen2 Signaling Speed (3.0Gb/s) is supported
			F	1 1 = The SATA Gen1 Signaling Speed (1.5Gb/s) is supported
			F	0 Shall be cleared to zero
77				Reserved for Serial ATA
78	O	S		Serial ATA features supported
				15:7 Reserved for Serial ATA
			F	6 1 = The SSP feature set is supported
				5 1 = Asynchronous notification supported
			F	4 Reserved for Serial ATA
			F	3 1 = Device initiated power management is supported
			F	2:1 Reserved for Serial ATA
			F	0 Shall be cleared to zero
79	O	S		Serial ATA features enabled
				15:7 Reserved for Serial ATA
			V	6 1 = The SSP feature set is enabled
				5 1 = Asynchronous notification enabled
			V	4 Reserved for Serial ATA
			V	3 1 = Device initiated power management is enabled
			V	2:1 Reserved for Serial ATA
			F	0 Shall be cleared to zero

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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

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Table 61 — IDENTIFY PACKET DEVICE data (part 5 of 11)

Word	O/M	S/P	F/V	Description
80	M	B		Major version number 0000h or FFFFh = device does not report version
				15:9 Reserved
			F	8 1 = ATA8-ACS is supported
			F	7 1 = ATA/ATAPI-7 is supported
			F	6 1 = ATA/ATAPI-6 is supported
			F	5 1 = ATA/ATAPI-5 is supported
			F	4 Obsolete
			X	3 Obsolete
			X	2 Obsolete
			X	1 Obsolete
				0 Reserved
81	M	B	F	Minor version number
82	M	B		Commands and feature sets supported
			X	15 Obsolete
			F	14 Shall be set to one to indicate that the NOP command is supported
			F	13 Shall be cleared to zero to indicate that the READ BUFFER command is not supported
			F	12 Shall be cleared to zero to indicate that the WRITE BUFFER command is not supported
			X	11 Obsolete
			F	10 Shall be cleared to zero to indicate that the HPA set is not supported
			F	9 Shall be set to one to indicate that the DEVICE RESET command is supported
			X	8 Obsolete
			X	7 Obsolete
			F	6 1 = Read look-ahead supported
			F	5 1 = The volatile write cache is supported
			F	4 Shall be set to one indicating the PACKET feature set is supported.
			F	3 1 = The Power Management feature set supported
			X	2 Obsolete
			F	1 1 = The Security feature set is supported
			F	0 Shall be cleared to zero to indicate that the SMART feature set is not supported

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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

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Table 61 — IDENTIFY PACKET DEVICE data (part 6 of 11)

Word	O M	S P	F V	Description
83	M	B		Commands and feature sets supported
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
				13 Reserved
			F	12 1 = The FLUSH CACHE command is supported
			F	11 1 = The DCO feature set is supported
				10 Reserved
			F	9 Obsolete
			F	8 1 = The SET MAX security extension is supported
				7 Reserved for Address Offset Reserved Area Boot Method
			F	6 1 = The SET FEATURES subcommand is required to spin-up after power-up
			F	5 1 = The PUIS feature set is supported
			X	4 Obsolete
			F	3 1 = The APM feature set is supported
				2:1 Reserved
			F	0 Shall be cleared to zero to indicate that the DOWNLOAD MICROCODE command is not supported
84	M	B		Commands and feature sets supported
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
				13:9 Reserved
			F	8 shall be set to one to indicate that the mandator WWN is supported
				7:6 Reserved
			F	5 1 = The GPL feature set is supported
				4:0 Reserved

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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

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Table 61 — IDENTIFY PACKET DEVICE data (part 7 of 11)

Word	O M	S P	F V		Description
85	M	B			Commands and feature sets supported or enabled
			X	15	Obsolete
			F	14	Shall be set to one to indicate that the NOP command is supported
			F	13	Shall be cleared to zero to indicate that the READ BUFFER command is not supported
			F	12	Shall be cleared to zero to indicate that the WRITE BUFFER command is not supported
			X	11	Obsolete
			V	10	Shall be cleared to zero to indicate that the HPA feature set is not supported
			F	9	Shall be set to one to indicate that the DEVICE RESET command is supported
			X	8	Obsolete
			X	7	Obsolete
			V	6	1 = Read look-ahead is enabled
			V	5	1 = The volatile write cache is enabled
			F	4	Shall be set to one indicating the PACKET feature set is supported.
			F	3	1 = Power Management feature set is enabled
			X	2	Obsolete
			V	1	1 = The Security feature set is enabled
			F	0	Shall be cleared to zero to indicate that the SMART feature set is not supported

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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

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Table 61 — IDENTIFY PACKET DEVICE data (part 8 of 11)

Word	O M	S P	F V	Description
86	M	B		Commands and feature sets supported or enabled
				15:13 Reserved
			V	12 1 = The FLUSH CACHE command is supported
			F	11 1 = The DCO feature set is supported
				10 Reserved
			V	9 Obsolete
			V	8 1 = SET MAX security extension enabled by a SET MAX SET PASSWORD
				7 Reserved for Address Offset Reserved Area Boot Method
			F	6 1 = SET FEATURES subcommand required to spin-up after power-up
			V	5 1 = The PUIS feature set is enabled
			X	4 Obsolete
			V	3 1 = The APM feature set is enabled
				2:1 Reserved
			F	0 Shall be cleared to zero to indicate that the DOWNLOAD MICROCODE command is not supported
87	M			Commands and feature sets supported or enabled
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
				13:9 Reserved
			F	8 Shall be set to one to indicate that the mandator WWN is supported
				7:6 Reserved
			F	5 This bit is a copy of word 84 bit 5
				4:0 Reserved

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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

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Table 61 — IDENTIFY PACKET DEVICE data (part 9 of 11)

Word	O M	S P	F V	Description
88	M	B		Ultra DMA modes
				15 Reserved
			V	14 1 = Ultra DMA mode 6 is selected
			V	13 1 = Ultra DMA mode 5 is selected
			V	12 1 = Ultra DMA mode 4 is selected
			V	11 1 = Ultra DMA mode 3 is selected
			V	10 1 = Ultra DMA mode 2 is selected
			V	9 1 = Ultra DMA mode 1 is selected
			V	8 1 = Ultra DMA mode 0 is selected
				7 Reserved
			F	6 1 = Ultra DMA mode 6 and below are supported.
			F	5 1 = Ultra DMA mode 5 and below are supported.
			F	4 1 = Ultra DMA mode 4 and below are supported.
			F	3 1 = Ultra DMA mode 3 and below are supported.
			F	2 1 = Ultra DMA mode 2 and below are supported.
			F	1 1 = Ultra DMA mode 1 and below are supported.
			F	0 1 = Ultra DMA mode 0 is supported.
89	O	B	F	Time required for Normal Erase mode SECURITY ERASE UNIT command
90	O	B	F	Time required for an Enhanced Erase mode SECURITY ERASE UNIT command
91	O	B	V	Current APM level value (see 7.18.6.39)
92	O	B	V	Master Password Identifier
93	M	B		Hardware reset result. The contents of bits (12:0) of this word shall change only during the processing of a hardware reset.
			F	15 Shall be cleared to zero.
			F	14 Shall be set to one.
			V	13 1 = device detected CBLID- (see ATA8-APT) above V_{iH} 0 = device detected CBLID- (see ATA8-APT) below V_{iL}
				12:8 Device 1 hardware reset result. Device 0 shall clear these bits to zero. Device 1 shall set these bits as follows:
				12 Reserved.
			V	11 0 = Device 1 did not assert PDIAG-.
				1 = Device 1 asserted PDIAG-.
			V	10:9 These bits indicate how Device 1 determined the device number:

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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

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Table 61 — IDENTIFY PACKET DEVICE data (part 10 of 11)

Word	O M	S P	F V	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.
			F	8 Shall be set to one.
				7:0 Device 0 hardware reset result. Device 1 shall clear these bits to zero. Device 0 shall set these bits as follows:
				7 Reserved.
			F	6 0 = Device 0 does not respond when Device 1 is selected.
				1 = Device 0 responds when Device 1 is selected.
			V	5 0 = Device 0 did not detect the assertion of DASP-.
				1 = Device 0 detected the assertion of DASP-.
			V	4 0 = Device 0 did not detect the assertion of PDIAG-.
				1 = Device 0 detected the assertion of PDIAG-.
			V	3 0 = Device 0 failed diagnostics.
				1 = Device 0 passed diagnostics.
			V	2:1 These bits indicate how Device 0 determined the device number:
				00b = Reserved.
				01b = a jumper was used.
				10b = the CSEL signal was used.
				11b = some other method was used or the method is unknown.
			F	0 Shall be set to one.
94				Obsolete
95..107				Reserved
108..111	M	B	F	World wide name
112..115				Reserved for world wide name extension to 128 bits
116..118				Reserved
119				Commands and feature sets supported 15:0 Reserved
120				Commands and feature sets supported or enabled 15:0 Reserved
121..125				Reserved
125	M	B	F	ATAPI byte count = 0 behavior

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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

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Table 61 — IDENTIFY PACKET DEVICE data (part 11 of 11)

Word	O M	S P	F V	Description
126..127			X	Obsolete
128	O			Security status
				15:9 Reserved
			V	8 Master Password Capability: 0 = High, 1 = Maximum
				7:6 Reserved
			F	5 1 = The enhanced security erase mode is supported
			V	4 1 = The Security count is expired
			V	3 1 = Security is frozen
			V	2 1 = Security is locked
			V	1 1 = Security is enabled
			F	0 1 = Security is supported
129..159			X	Vendor specific
160..175		N		Reserved for assignment by the CompactFlash Association
176..221				Reserved
222	M	B		Transport Major version number. 0000h or FFFFh = device does not report version
			F	15:12 Transport Type 0h = Parallel 1h = Serial 2h-Fh = Reserved
				Parallel **Serial**
				11:5 Reserved Reserved
			F	4 Reserved SATA Rev 2.6
			F	3 Reserved SATA Rev 2.5
			F	2 Reserved SATA II: Extensions
			F	1 ATA/ATAPI-7 SATA 1.0a
			F	0 ATA8-APT ATA8-AST
223	M	B	F	Transport Minor version number
224..254				Reserved
255	O		V	Integrity word
		B		15:8 Checksum
		B		7:0 Checksum Validity Indicator

Key:

F/V – Fixed/variable content
- F – The content of the field is fixed and does not change. The DCO command may change the value of a fixed field.
- 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

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7.18.6.2 Word 0: General configuration

Bits (15:14) of word 0 indicate the type of device. Bit 15 shall be set to one and bit 14 shall be cleared to zero to indicate the device is an ATAPI device.

Bits (12:8) of word 0 indicate the command set used by the device. This value follows the peripheral device type as defined in SPC-4 (e.g., 05h indicates a CD/DVD device).

Bit 7 of word 0 is Obsolete.

For PATA devices, bits (6:5) of word 0 indicate the DRQ response time when a PACKET command is received. A value of 00b indicates that the maximum time for a device to set DRQ to one after receiving a PACKET command is 3 ms. The value 01b is obsolete. A value of 10b indicates that the maximum time for a device to set DRQ to one after receiving a PACKET command is 50 µs. The value 11b is reserved.

If bit 2 of word 0 is set to one, then the content of the IDENTIFY PACKET DEVICE data is incomplete. This may occur if the device supports the PUIS feature set and required data is contained on the device media. The content of IDENTIFY DEVICE data word 0 and word 2 shall be valid.

Bits (1:0) of word 0 indicate the packet size the device supports. A value of 00b indicates that a 12-byte packet is supported and a value of 01b indicates a 16 byte packet. The values 10b and 11b are reserved.

7.18.6.3 Word 1: Reserved

7.18.6.4 Word 2: Specific configuration

Word 2 shall have the same content described for IDENTIFY DEVICE data word 2 (see 7.17.7.4).

7.18.6.5 Words 3..9: Reserved

7.18.6.6 Words 10..19: Serial number

If the ATAPI device does not report the serial number, then the content shall be 0000h in each word. Otherwise, the content shall be as described for IDENTIFY DEVICE data words 10..19 (see 7.17.7).

7.18.6.7 Words 20..22: Reserved

7.18.6.8 Words 23..26: Firmware revision

Words 23..26 shall have the content described for IDENTIFY DEVICE data words 23..26 (see 7.17.7.13).

7.18.6.9 Words 27..46: Model number

Words 27..46 shall have the content described for IDENTIFY DEVICE data words 27..46 (see 7.17.7.14).

7.18.6.10 Words 47..48: Reserved

7.18.6.11 Word 49: Capabilities

Bits (15:12) of word 49 are obsolete.

Bit 11 of word 49 indicates whether a device supports IORDY (see ATA8-APT). If this bit is set to one, then the device supports IORDY (see ATA8-APT) operation. If this bit is cleared to zero, the device may support IORDY (see ATA8-APT). If a device supports PIO mode 3 or higher, then this bit shall be set to one. For SATA devices, this bit shall be set to one.

Bit 10 of word 49 indicates a device's ability to enable or disable the use of IORDY (see ATA8-APT). If this bit is set to one, then the device supports the disabling of IORDY (see ATA8-APT). Disabling and enabling of IORDY (see ATA8-APT) is accomplished using the SET FEATURES command. For SATA devices, this bit shall be set to one.

Bit 9 of word 49 shall be set to one.

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Bit 8 of word 49 indicates that DMA is supported. Devices that require the DMADIR bit in the PACKET command shall clear this bit to 0.

7.18.6.12 Word 50: Capabilities

Word 50 shall have the content described for IDENTIFY DEVICE data word 50 (see 7.17.7.17). Support of this word is mandatory if the STANDBY command is supported.

7.18.6.13 Word 51: Obsolete

7.18.6.14 Word 52: Obsolete

7.18.6.15 Word 53

Word 53 bits (2:0) shall have the content described for IDENTIFY DEVICE data word 53 bits (2:0). Bits (15:3) are reserved.

7.18.6.16 Words 54..61: Reserved

7.18.6.17 Word 62: DMADIR

ATAPI devices may require use of the DMADIR bit to indicate transfer direction for PACKET commands using the DMA data transfer protocol. Word 62 indicates if such support is required.

If word 62 bit 15 is set to one, then the DMADIR bit in the PACKET command is required by the device for PACKET commands using the DMA data transfer protocol and:

a) word 63 bits (2:0);
b) word 49 bit 15;
c) word 49 bit 8; and
d) word 88 bits (6:0),

shall be cleared to zero.

If word 62 bit 15 is cleared to zero, then:

a) the DMADIR bit in the PACKET command is not required; and
b) word 62 shall be cleared to zero.

Bits (14:11) of word 62 are reserved.

If word 62 bit 15 is set to one and word 62 bit:

a) 10 is set to one, then DMA is supported;
b) 10 is cleared to zero, then DMA is not supported;
c) 9 is set to one, then Multiword DMA mode 2 is supported;
d) 9 is cleared to zero, then Multiword DMA mode 2 is not supported;
e) 8 is set to one, then Multiword DMA mode 1 is supported;
f) 8 is cleared to zero, then Multiword DMA mode 1 is not supported;
g) 7 is set to one, then Multiword DMA mode 0 is supported;
h) 7 is cleared to zero, then Multiword DMA mode 0 is not supported;
i) 6 is set to one, then Ultra DMA mode 6 and below are supported;
j) 6 is cleared to zero, then Ultra DMA mode 6 and below are not supported;
k) 5 is set to one, then Ultra DMA mode 5 and below are supported;
l) 5 is cleared to zero, then Ultra DMA mode 5 and below are not supported;
m) 4 is set to one, then Ultra DMA mode 4 and below are supported;
n) 4 is cleared to zero, then Ultra DMA mode 4 and below are not supported;
o) 3 is set to one, then Ultra DMA mode 3 and below are supported;
p) 3 is cleared to zero, then Ultra DMA mode 3 and below are not supported;
q) 2 is set to one, then Ultra DMA mode 2 and below are supported;
r) 2 is cleared to zero, then Ultra DMA mode 2 and below are not supported;
s) 1 is set to one, then Ultra DMA mode 1 and below are supported;
t) 1 is cleared to zero, then Ultra DMA mode 1 and below are not supported;
u) 0 is set to one, then Ultra DMA mode 0 is supported; and
v) 0 is cleared to zero, then Ultra DMA mode 0 is not supported.

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7.18.6.18 Word 63: Multiword DMA transfer

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

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

Bits (10:8) of word 63 shall have the content described for IDENTIFY DEVICE data word 63 (see 7.17.7.24).

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

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

For SATA devices:

a) if bit 15 of IDENTIFY PACKET DEVICE data word 62 (see 7.18.6.17) is set to one, then bit 2 of IDENTIFY PACKET DEVICE data word 63 shall be cleared to zero; and
b) if bit 15 of IDENTIFY PACKET DEVICE data word 62 is cleared to zero, then bit 2 of IDENTIFY PACKET DEVICE data word 63 shall be set to one.

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

For SATA devices:

a) if bit 15 of IDENTIFY PACKET DEVICE data word 62 (see 7.18.6.17) is set to one, then bit 1 of IDENTIFY PACKET DEVICE data word 63 shall be cleared to zero; and
b) if bit 15 of IDENTIFY PACKET DEVICE data word 62 is cleared to zero, then bit 2 of IDENTIFY PACKET DEVICE data word 63 shall be set to one.

If bit 0 of word 63 is set to one, then Multiword DMA mode 0 is supported.

For SATA devices:

a) if bit 15 of IDENTIFY PACKET DEVICE data word 62 (see 7.18.6.17) is set to one, then bit 0 of IDENTIFY PACKET DEVICE data word 63 shall be cleared to zero; and
b) if bit 15 of IDENTIFY PACKET DEVICE data word 62 is cleared to zero, then bit 0 of IDENTIFY PACKET DEVICE data word 63 shall be set to one.

7.18.6.19 Word 64: PIO transfer modes supported

Word 64 shall have the content described for IDENTIFY DEVICE data word 64 (see 7.17.7.25).

7.18.6.20 Word 65: Minimum multiword DMA transfer cycle time per word

Word 65 shall have the content described for IDENTIFY DEVICE data word 65 (see 7.17.7.26).

7.18.6.21 Word 66: Device recommended multiword DMA transfer cycle time

Word 66 shall have the content described for IDENTIFY DEVICE data word 66 (see 7.17.7.27).

7.18.6.22 Word 67: Minimum PIO transfer cycle time without flow control

Word 67 shall have the content described for IDENTIFY DEVICE data word 67 (see 7.17.7.28).

7.18.6.23 Word 68: Minimum PIO transfer cycle time with IORDY

Word 68 shall have the content described for IDENTIFY DEVICE data word 68 (see 7.17.7.29).

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7.18.6.24 Words 69..70: Reserved

7.18.6.25 Words 71..72: Obsolete

7.18.6.26 Words 73..74: Reserved

7.18.6.27 Word 75: Obsolete

7.18.6.28 Word 76: Serial ATA Capabilities

Bits (15:11) of word 76 are reserved for SATA.

bits (10:9) of word 76 shall have the content described for IDENTIFY DEVICE data word 76 bits (10:9) (see 7.17.7.34).

Bits (8:3) of word 76 are reserved for SATA.

Bits (2:0) of word 76 shall have the content described for IDENTIFY DEVICE data word 76 bits (2:0) (see 7.17.7.34).

7.18.6.29 Word 77: Reserved for Serial ATA

7.18.6.30 Word 78: Serial ATA features supported

Bits 15:7 of word 78 are reserved for Serial ATA.

Bit 6 of word 78 shall have the content described for IDENTIFY DEVICE data word 78 bit 6 (see 7.17.7.36).

If bit 5 of word 78 is set to one, then the device shall support initiating notification events. If bit 5 of word 78 is cleared to zero, then the device shall not support initiating notification events (See SATA 3.0).

Bit 4 is reserved for Serial ATA.

Bit 3 or word 78 shall have the content described for IDENTIFY DEVICE data word 78 bit 3 (see 7.17.7.36).

Bits 2:1 of word 78 are reserved for Serial ATA.

Bit 0 of word 78 shall be cleared to zero.

7.18.6.31 Word 79: Serial ATA features enabled

Bits 15:7 of word 79 are reserved for Serial ATA.

Bit 6 of word 79 shall have the content described for IDENTIFY DEVICE data word 79 bit 6 (see 7.17.7.37).

If bit 5 of word 79 is set to one, then the device shall support initiating notification events. If bit 5 of word 79 is cleared to zero, then the device shall not support initiating notification events (see SATA 3.0).

Bit 4 of word 79 is reserved for Serial ATA.

Bit 3 of word 79 shall have the content described for IDENTIFY DEVICE data word 79 bit 3 (see 7.17.7.37).

Bits 2:1 of word 79 are reserved for Serial ATA.

Bit 0 of word 79 shall be cleared to zero.

7.18.6.32 Word 80: Major version number

Word 80 shall have the content described for IDENTIFY DEVICE data word 80 (see 7.17.7.38).

7.18.6.33 Word 81: Minor version number

Word 81 shall have the content described for IDENTIFY DEVICE data word 81 (see 7.17.7.39).

7.18.6.34 Words 82..84, 119: Commands and feature sets supported

Words 82..84 and 119 shall have the content described for IDENTIFY DEVICE data words 82..84 and 119 (see 7.17.7.40) except as specified in table 61.

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7.18.6.35 Words 85..87, 120: Commands and feature sets supported or enabled

Words 85..87 and 120 shall have the content described for IDENTIFY DEVICE data words 85..87 and 120 (see 7.17.7.41) except as specified in table 61.

7.18.6.36 Word 88:Ultra DMA modes

Word 88 bits (15:7) shall have the content described for IDENTIFY DEVICE data word 88 (see 7.17.7.42). If word 62 bit 15 is cleared to zero then word 88 bits (6:0) shall be the content described for IDENTIFY DEVICE data word 88 (see 7.17.7.42). If word 62 bit 15 is set to one then:

a) word 88 bit 6 may be set to one; and
b) word 88 bits (5:0) shall be cleared to zero.

7.18.6.37 Word 89: Time required for Normal Erase mode SECURITY ERASE UNIT command

Word 89 shall have the content described for IDENTIFY DEVICE data word 89 (see 7.17.7.43).

7.18.6.38 Word 90: Time required for an Enhanced Erase mode SECURITY ERASE UNIT command

Word 90 shall have the content described for IDENTIFY DEVICE data word 90 (see 7.17.7.44).

7.18.6.39 Word 91: Current APM level value

Word 91 shall have the content described for IDENTIFY DEVICE data word 91 (see 7.17.7.45)

7.18.6.40 Word 92: Master Password Identifier

Word 92 shall have the content described for IDENTIFY DEVICE data word 92 (see 7.17.7.46).

7.18.6.41 Word 93: Hardware reset results

Word 93 shall have the content described for IDENTIFY DEVICE data word 93 (see 7.17.7.47).

7.18.6.42 Word 94: Current automatic acoustic management value

Word 94 shall have the content described for IDENTIFY DEVICE data word 94 (see 7.17.7.48).

7.18.6.43 Word 95..107: Reserved

7.18.6.44 Words 108..111: World wide name

Words 108..111 shall have the content described for IDENTIFY DEVICE data words 108..111 (see 7.17.7.58).

7.18.6.45 Words 112..115: Reserved for a 128-bit world wide name

7.18.6.46 Words 116..118: Reserved

7.18.6.47 Words 119..120: See words 82..84 and words 85..87

7.18.6.48 Words 121..124: Reserved

7.18.6.49 Word 125 ATAPI byte count = 0 behavior

If the contents of word 125 are 0000h and the value of the Byte Count Limit is zero, then the device shall return command aborted.

If the contents of word 125 are non-zero and the value of the Byte Count Limit is zero, then the device shall use the contents of word 125 as the actual byte count limit for the current command and shall not abort.

The device may be reconfigured to report a new value. However, after the device is reconfigured, the content of word 125 reported shall not change until after the next power-on reset or hardware reset.

7.18.6.50 Word 126..127: Obsolete

7.18.6.51 Word 128: Security status

Word 128 shall have the content described for IDENTIFY DEVICE data word 128 (see 7.17.7.66).

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7.18.6.52 Words 129..159: Reserved

7.18.6.53 Words 160..167: Reserved for assignment by the CompactFlash Association

7.18.6.54 Words 168..221: Reserved

7.18.6.55 Word 222: Transport major version number

Word 222 shall have the content described for IDENTIFY DEVICE data word 222 (see 7.17.7.86).

7.18.6.56 Word 223: Transport minor version number

Word 223 shall have the content described for IDENTIFY DEVICE data word 223 (see 7.17.7.87).

7.18.6.57 Words 224..254: Reserved

7.18.6.58 Word 255: Integrity word

Word 255 shall have the content described for IDENTIFY DEVICE data word 255 (see 7.17.7.93).

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7.19 IDLE - E3h, Non-Data

7.19.1 Feature Set

This 28-bit command is for devices implementing the Power Management feature set (see 4.17).

7.19.2 Description

The IDLE command places the device in the Idle mode and sets the Standby timer. Command completion may occur even though the device has not fully transitioned into the Idle mode.

If the host sets the Count field to 00h, then the device shall disable its Standby timer (see 4.17). If the host sets the Count field to a value > 00h, then table 63 defines the Standby timer value.

See 4.8.4 for interactions with the EPC feature set.

7.19.3 Inputs

See table 62 for the IDLE command inputs.

Table 62 — IDLE command inputs

Name	Description
Feature	Reserved
Count	This value shall determine the time period programmed into the Standby timer. Table 63 defines these values
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 E3h

Table 63 — Standby timer periods

Count field	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.	

7.19.4 Normal Outputs

See table 212.

7.19.5 Error Outputs

See table 235.

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7.20 IDLE IMMEDIATE - E1h, Non-Data

7.20.1 Feature Set

This 28-bit command is for devices implementing the Power Management feature set (see 4.17).

7.20.2 Description

7.20.2.1 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 4.8.4 for interactions with the EPC feature set.

7.20.2.2 Unload feature

The unload feature of the IDLE IMMEDIATE command causes a device that has movable read/write heads to move them to a safe position.

Upon receiving an IDLE IMMEDIATE command with the unload feature, a device shall:

a) stop read look-ahead if that operation is in process;
b) stop writing cached data to the media if that operation is in process;
c) the device shall retract the head(s) onto the ramp if the device implements unloading its head(s) onto a ramp;
d) the device shall park its head(s) in the landing zone if the device implements parking its head(s) in a landing zone on the media; and
e) transition to the Idle mode.

The device shall retain any data in any write cache and resume writing the cached data onto the media after receiving a software reset, a hardware reset, or any new command except IDLE IMMEDIATE command with unload feature.

A device shall report command completion after the head(s) have been unloaded or parked.

7.20.3 Inputs (Default Function)

See table 64 for the IDLE IMMEDIATE command inputs.

Table 64 — IDLE IMMEDIATE command inputs

Name	Description
Feature	N/A except when the unload feature is requested, see 7.20.4
Count	N/A except when the unload feature is requested, see 7.20.4
LBA	N/A except when the unload feature is requested, see 7.20.4
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 E1h

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7.20.4 Inputs (Unload Feature)

See table 65 for the IDLE IMMEDIATE with Unload command inputs.

Table 65 — IDLE IMMEDIATE with Unload command inputs

Name	Description
Feature	44h
Count	00h
LBA	055_4E4Ch
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 E1h

7.20.5 Normal Outputs (default)

See table 212.

7.20.6 Normal Outputs (unload feature)

See table 218.

7.20.7 Error Outputs

See table 235.

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7.21 Non-Volatile Cache

7.21.1 NV Cache Overview

The NV Cache feature set modifies the NV Cache Pinned Set of a device allowing the device to improve response times to read and write commands while reducing the device's power consumption.

The NV Cache feature set provides a set of commands that allow control of a device's management of the contents of its NV Cache.

Commands unique to the NV Cache feature set use a single command code and are differentiated from one another by the value placed in the Feature field. A device that implements the NV Cache Commands feature set shall implement the following commands:

A) ADD LBA(S) TO NV CACHE PINNED SET;
B) REMOVE LBA(S) FROM NV CACHE PINNED SET;
C) QUERY NV CACHE PINNED SET;
D) QUERY NV CACHE MISSES;
e) FLUSH NV CACHE; and
f) NV CACHE ENABLE/DISABLE.

Individual NV Cache Commands are identified by the value placed in the Feature field as shown in table 66.

Table 66 — NV Cache Commands

Value	Command Name
0000h-000Fh	Reserved for the NV Cache Power Management feature set
0010h	ADD LBA(S) TO NV CACHE PINNED SET
0011h	REMOVE LBA(S) FROM NV CACHE PINNED SET
0012h	QUERY NV CACHE PINNED SET
0013h	QUERY NV CACHE MISSES
0014h	FLUSH NV CACHE
0015h	NV CACHE ENABLE
0016h	NV CACHE DISABLE
0017h..002Fh	Reserved for the NV Cache feature set
0030h..00CFh	Reserved
00D0h..00EFh	Vendor Specific
00F0h..FFFFh	Reserved

7.21.2 NV Cache Power Management Overview

The NV Cache Power Management feature set modifies the behavior of a device allowing the device to improve response times to read and write commands while reducing the device's power consumption.

Commands unique to the NV Cache Power Management feature set use a single command code and are differentiated from one another by the value placed in the Feature field. A device that implements the NV Cache Power Management feature set shall implement the following commands:

a) SET NV CACHE POWER MODE; and
B) RETURN FROM NV CACHE POWER MODE.

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Individual NV Cache Power Management commands are identified by the value placed in the Feature field as shown in table 67.

Table 67 — NV Cache Power Management Commands

Value	Command Name
0000h	SET NV CACHE POWER MODE
0001h	RETURN FROM NV CACHE POWER MODE
0002h..000Fh	Reserved for the NV Cache Power Management feature set
0010h..002Fh	Reserved for the NV Cache feature set
0030h..00CFh	Reserved
00D0h..00EFh	Vendor Specific
00F0h..FFFFh	Reserved

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7.21.3 ADD LBA(S) TO NV CACHE PINNED SET - B6h/10h, DMA

7.21.3.1 Feature set

This 48-bit command is for devices implementing the NV Cache feature set (see 4.15).

7.21.3.2 Description

The ADD LBA(S) TO NV CACHE PINNED SET command adds the logical blocks specified in the NV Cache Set Data to the NV Cache Pinned Set.

If the PI bit is set to one, then the ADD LBA(S) TO NV CACHE PINNED SET command shall not complete until the device has transferred all of the logical sector data into the NV Cache Pinned Set. If the PI bit is cleared to zero, then the command shall complete before the device has transferred any of the logical sectors into the NV Cache Pinned Set and the logical sector data shall be transferred into the NV Cache Pinned Set on subsequent Write operations. If a Read operation occurs to an LBA marked with the PI bit cleared to zero before the logical sector data is received, then this data shall be sourced from the valid data located outside of the NV Cache Pinned Set and may require a disk spin up.

If an LBA Range Entry (see 7.21.3.6) specified in the NV Cache Set Data does exist but is beyond the range of user addressable logical blocks, the device shall add the logical blocks to the NV Cache Pinned Set, but continue to fail all reads and writes to the LBA as before.

The response to this command shall be the number of logical sectors that may be added to the NV Cache's pinned set.

7.21.3.3 Inputs

7.21.3.3.1 Overview

See table 68 for the ADD LBA(S) TO NV CACHE PINNED SET command inputs.

Table 68 — ADD LBA(S) TO NV CACHE PINNED SET command inputs

Name	Description
Feature	0010h
Count	Number of 512-byte data blocks to be transferred. 0000h specifies that 65 536 blocks shall be transferred
LBA	**Bit Description** 47:1 Reserved 0 Populate Immediately (PI) – See 7.21.3.3.2
Device	**Bit Description** 7:5 N/A 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B6h

7.21.3.3.2 Populate Immediately

If the PI (Populate Immediately) bit is set to one, then the device shall add the logical blocks specified in the Pin Request Data (see table 69) to the device's NV Pinned Cache Set and populated with the specified data from the rotating media before command completion.

If PI is cleared to zero, then the logical blocks specified in the Pin Request Data shall be added to the device's NV Pinned Cache Set and:

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a) the LBA in the pinned set shall be populated with data from a subsequent write operation; and
b) the LBA in the pinned set may be populated with data from a subsequent read operation.

7.21.3.4 Normal Outputs

See table 225.

7.21.3.5 Error Outputs

If this command fails, none of the requested logical blocks are added to the NV Cache Pinned Set. See table 262 for more information.

7.21.3.6 Output From the Host to the Device Data Structure

Pin Request Data is a list of individual LBA ranges. Each entry in the Pin Request Data is called a LBA Range Entry (see 4.15.3.2). If the range length is zero, then the LBA Range Entry is not valid. The range entries shall be non-overlapping and shall be sorted with the LBA values in ascending order.

Table 69 — LBA Range Entries

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

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7.21.4 FLUSH NV CACHE - B6h/14h, Non-Data

7.21.4.1 Feature set

This 48-bit command is for devices implementing the NV Cache feature set (see 4.15).

7.21.4.2 Description

The FLUSH NV CACHE command, requests the device to provide at least as many logical blocks as are specified in LBA (31:0) for use by the NV Cache Pinned Set. If necessary the device flushes logical blocks from the NV Cache Unpinned Set to provide the capacity requested. The device may spin-up to complete this command. The logical blocks shall remain available until the next reset or NV Cache feature set command is processed by the device.

7.21.4.3 Inputs

See table 70 for the ADD LBA(S) TO NV CACHE PINNED SET command inputs.

Table 70 — ADD LBA(S) TO NV CACHE PINNED SET command inputs

Name	Description
Feature	0014h
Count	Reserved
LBA	**Bit** **Description** 47:32 Reserved 31:0 Minimum number of logical blocks to flush
Device	**Bit** **Description** 7:5 N/A 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B6h

7.21.4.4 Normal Outputs

The number of unflushed logical blocks is the number of logical blocks that have yet to be flushed from the NV Cache Unpinned Set to satisfy the Minimum Number of logical blocks to flush or the number of logical blocks to empty from the NV Cache Unpinned Set, whichever is less. See table 226.

7.21.4.5 Error Outputs

See table 264.

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7.21.5 NV CACHE DISABLE - B6h/16h, Non-Data

7.21.5.1 Feature set

This 48-bit command is for devices implementing the NV Cache feature set (see 4.15).

7.21.5.2 Description

The NV CACHE DISABLE command shall cause the device to perform the following actions:

a) flush all non-volatile cached data (i.e., pinned and unpinned data) to other non-volatile media;
b) erase the pinned logical sectors list;
c) disable the NV Cache Power Management feature set; and
d) no longer read user data from or write user data to the non-volatile cache.

Once the device has reported successful command completion, the device shall return command aborted for all commands in the NV Cache feature set except for NV CACHE ENABLE command (see 7.21.6).

This setting is non-volatile.

7.21.5.3 Inputs

See table 71 for the NV CACHE DISABLE command inputs.

Table 71 — NV CACHE DISABLE command inputs

Name	Description
Feature	0016h
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7:5 N/A 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B6h

7.21.5.4 Normal Outputs

See table 223.

7.21.5.5 Error Outputs

See table 264.

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7.21.6 NV CACHE ENABLE - B6h/15h, Non-Data

7.21.6.1 Feature set

This 48-bit command is for devices implementing the NV Cache feature set (see 4.15).

7.21.6.2 Description

The NV CACHE ENABLE command allows the device to read data from or write data to the non-volatile cache.

This setting is non-volatile.

7.21.6.3 Inputs

See table 72 for the NV CACHE ENABLE command inputs.

Table 72 — NV CACHE ENABLE command inputs

Name	Description
Feature	0015h
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7:5 N/A 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B6h

7.21.6.4 Normal Outputs

See table 223.

7.21.6.5 Error Outputs

See table 264.

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7.21.7 QUERY NV CACHE MISSES - B6h/13h, DMA

7.21.7.1 Feature set

This 48-bit command is for devices implementing the NV Cache feature set (see 4.15).

7.21.7.2 Description

The QUERY NV CACHE MISSES command requests the device to report Cache Miss Data (see table 74) in LBA Ranges in a single 512-byte block. The first 64 cache misses are returned as LBA Ranges and shall be listed in accessed order. If the device does not have as many LBA ranges as are requested in the transfer, the unused LBA ranges shall be filled with zeroes.

Any of the following conditions shall cause the Cache Miss Data to be cleared:

a) the device processes a power-on reset;
b) the devices completes a QUERY NV CACHE MISSES command; or
c) the device completes a STANDBY IMMEDIATE command.

7.21.7.3 Inputs

See table 73 for the QUERY NV CACHE MISSES command inputs.

Table 73 — QUERY NV CACHE MISSES command inputs

Name	Description
Feature	0013h
Count	0001h
LBA	Reserved
Device	**Bit** **Description** 7:5 N/A 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B6h

7.21.7.4 Normal Outputs

See table 225.

7.21.7.5 Error Outputs

See table 265.

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7.21.7.6 Input From the Device to the Host Data Structure

Cache Miss Data is a list of individual LBA ranges. Each entry in Cache Miss Data is called a LBA Range Entry (see 4.15.3.2) and is represented by 8 bytes. If the range length is zero, then the LBA Range Entry is not valid.

Table 74 — Cache Miss Data

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

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7.21.8 QUERY NV CACHE PINNED SET - B6h/12h, DMA

7.21.8.1 Feature set

This 48-bit command is for devices implementing the NV Cache feature set (see 4.15).

7.21.8.2 Description

The QUERY NV CACHE PINNED SET command requests the device to send the LBA Ranges currently in the NV Cache Pinned Set in one or more 512-byte blocks equal to the number in Block Count. If a device does not have as many LBA Ranges as are requested in the transfer, the unused LBA Range Entries shall be filled with zero.

7.21.8.3 Inputs

See table 75 for the QUERY NV CACHE PINNED SET command inputs.

Table 75 — QUERY NV CACHE PINNED SET command inputs

Name	Description
Feature	0012h
Count	Number of 512-byte data blocks to be transferred. 0000h specifies that 65 536 blocks shall be transferred.
LBA	Starting 512-byte data block. The first 512-byte data block is numbered zero.
Device	**Bit Description** 7:5 N/A 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B6h

7.21.8.4 Normal Outputs

See table 225.

7.21.8.5 Error Outputs

See table 265.

7.21.8.6 Input From the Device to the Host Data Structure

Pin Set Data is a list of individual LBA ranges. Each entry in Pin Set Data is called a LBA Range Entry (see 4.15.3.2) and is represented by eight bytes. The LBA Range Entries shall be sent in ascending numerical order by LBA value.

Table 76 — Pin Set Data

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

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7.21.9 REMOVE LBA(S) FROM NV CACHE PINNED SET - B6h/11h, DMA/Non-Data

7.21.9.1 Feature set

This 48-bit command is for devices implementing the NV Cache feature set (see 4.15).

7.21.9.2 Description

The REMOVE LBA(S) FROM NV CACHE PINNED SET command removes the logical blocks specified in the NV Cache Set Data from the NV Cache's pinned set. This command may not remove the logical blocks from the NV Cache.

If the NV Cache Set Data specifies an LBA not in the NV Cache Pinned Set, the LBA shall be ignored without causing an error.

The response to this command shall be the number of additional logical blocks that the host may add to the NV Cache's pinned working set as specified in the Count and LBA fields.

7.21.9.3 Inputs

7.21.9.3.1 Overview

See table 77 for the QUERY NV CACHE PINNED SET command inputs.

Table 77 — QUERY NV CACHE PINNED SET command inputs

Name	Description
Feature	0011h
Count	Number of 512-byte data blocks to be transferred. 0000h specifies that 65 536 blocks shall be transferred.
LBA	**Bit** **Description** 47:1 Reserved 0 Unpin All (UA) – See 7.21.9.3.2
Device	**Bit** **Description** 7:5 N/A 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B6h

7.21.9.3.2 Unpin All

If the UA (Unpin All) bit is set to one, then the device shall:

a) ignore the value in the Count field;
b) unmap all logical blocks in the NV Cache Pinned Set; and
c) use the Non-Data protocol.

7.21.9.4 Normal Outputs

See table 225.

7.21.9.5 Error Outputs

If a device completes this command with an error, then none of the requested logical blocks are removed from the NV Cache Pinned Set. See table 263.

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7.21.9.6 Output From the Host to the Device Data Structure

Remove Pin Data is a list of individual LBA ranges. Each entry in Remove Pin Data is called a LBA Range Entry (see 4.15.3.2) and is represented by eight bytes. If the range length is zero, then the LBA Range Entry is not valid. The range entries shall be non-overlapping and sorted with the LBA Values in ascending order.

Table 78 — Remove Pin Data

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

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7.21.10 RETURN FROM NV CACHE POWER MODE - B6h/01h, Non-Data

7.21.10.1 Feature set

This 48-bit command is for devices implementing the NV Cache Power Management feature set (see 4.16).

7.21.10.2 Description

The RETURN FROM NV CACHE POWER MODE command shall cause the device to disable the NV Cache power mode and clear IDENTIFY DEVICE data word 214 bit 1 (see 7.17.7.79). Upon completion of this command the device shall disable the NV Cache power mode timer (see 4.17.4).

This command shall not enable or disable the non-volatile cache or the NV Cache feature set.

7.21.10.3 Inputs

See table 79 for the QUERY NV CACHE PINNED SET command inputs.

Table 79 — QUERY NV CACHE PINNED SET command inputs

Name	Description
Feature	0001h
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7:5 N/A 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B6h

7.21.10.4 Normal Outputs

See table 212.

7.21.10.5 Error Outputs

See table 238.

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7.21.11 SET NV CACHE POWER MODE - B6h/00h, Non-Data

7.21.11.1 Feature set

This 48-bit command is for devices implementing the NV Cache Power Management feature set (see 4.16).

7.21.11.2 Description

The SET NV CACHE POWER MODE command shall cause the device to set the NV Cache power mode timer and set IDENTIFY DEVICE data word 214 bit 1 to one (see 7.17.7.79). The device should minimize power consumption and use the NV Cache to complete read and write requests whenever possible.

When the device spins-up its rotating media, the rotating media shall remain spun-up for at least as many seconds as the value in the Count field.

If the Standby timer or the Standby_y timer or the Standby_z timer (see 4.8) expires before the NV Cache power mode timer (see 4.17.4), the device shall not transition to Standby mode until the NV Cache power mode timer expires. APM shall not cause the device to transition to a lower power state until the NV Cache power mode timer expires.

7.21.11.3 Inputs

7.21.11.3.1 Overview

See table 80 for the QUERY NV CACHE PINNED SET command inputs.

Table 80 — QUERY NV CACHE PINNED SET command inputs

Name	Description
Feature	0000h
Count	Minimum High-Power Time – See 7.21.11.3.2
LBA	Reserved
Device	**Bit Description** 7:5 N/A 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B6h

7.21.11.3.2 Minimum High-Power Time

Minimum High-Power Time contains the minimum value, in seconds, that the device shall stay in the Active state or Idle state (see 4.17.4) when the device needs to enter the high power state to access its media while NV CACHE power mode is set. The high power state may include any Power Management state in which the media is spun up and available.

The maximum amount of time the device shall keep the media spun up is vendor specific.

7.21.11.4 Normal Outputs

See table 212.

7.21.11.5 Error Outputs

See table 238.

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7.22 NOP - 00h, Non-Data

7.22.1 Feature Set

This 28-bit command is for ATA devices (see 4.2) and ATAPI devices (see 4.3).

7.22.2 Description

The NOP command shall complete with an error.

7.22.3 Inputs

See table 81 for the NOP command inputs.

Table 81 — NOP command inputs

Name	Description
Feature	Subcommand Code (see table 82).
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 00h

Table 82 — NOP Subcommand Code

Subcommand Code	Description	Action
00h	NOP	Return command aborted.
01h..FFh	Obsolete	

7.22.4 Normal Outputs

When processed by a device, this command always fails with an error (see table 82).

The Count and LBA fields retain the values that were present when the NOP command was accepted.

7.22.5 Error Outputs

See table 254.

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7.23 PACKET - A0h, Packet

7.23.1 Feature Set

This 28-bit command is for devices implementing the PACKET feature set (see 4.3).

7.23.2 Description

The PACKET command transfers a SCSI CDB (see SPC-4) via a command packet. If the native form of the encapsulated command is shorter than the packet size reported in IDENTIFY PACKET DEVICE data word 0 bits (1:0) (see 7.18.6.2), then the encapsulated command shall begin at byte 0 of the packet. Packet bytes beyond the end of the encapsulated command are reserved.

7.23.3 Inputs

See table 83 for the PACKET command inputs.

Table 83 — PACKET command inputs

Name	Description
Feature	**Bit Description** 7:3 Reserved 2 DMADIR – See 7.23.4. 1 Obsolete 0 DMA – This bit is set to one to inform the device that the data transfer (i.e., not the command packet transfer) associated with this command is via Multiword DMA or Ultra DMA mode.
Count	**Bit Description** 7:3 Obsolete 2:0 N/A
LBA	**Bit Description** 27:24 Reserved 23:8 Byte Count Limit – See 7.23.5. 7:0 Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 A0h

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7.23.4 DMADIR

The DMADIR bit indicates the direction of the DMA data transfer for the PACKET command and is used only for ATAPI devices that require direction indication from the host. If IDENTIFY PACKET DEVICE data word 62 bit 15 (see 7.18.6.17) is set to one, then the device requires the use of the DMADIR bit for DMA data transfer for PACKET commands.

If the device requires the DMADIR bit to be set to one for a DMA data transfer for a PACKET command (i.e., bit 0, the DMA bit, is set to one), then this bit indicates the direction of data transfer (i.e., 0 = transfer to the device, and 1 = transfer to the host). If the device requires the DMADIR bit to be set for a DMA data transfer for a PACKET command, but the current operation is a PIO data transfer (i.e., bit 0, the DMA bit, is cleared to zero), then this bit is ignored.

Since the data transfer direction is set by the host as the command is constructed, the DMADIR bit should not conflict with the data transfer direction of the command. If a conflict between the command transfer direction and the DMADIR bit occurs, the device should return with an ABORTED command, and the sense key set to ILLEGAL REQUEST.

If the device does not require the DMADIR bit to be set for a DMA data transfer for a PACKET command, then this bit should be cleared to zero.

A device that does not support the DMADIR feature may return command aborted for a command if the DMADIR bit is set to one.

7.23.5 Byte Count Limit

The Byte Count Limit is the maximum byte count that is to be transferred in any single DRQ data block for PIO transfers. The Byte Count Limit does not apply to the command packet transfer. If the PACKET command does not transfer data, the Byte Count Limit is ignored.

NOTE The amount of data transferred by this command is specified in the CDB (see SBC-3).

If the PACKET command results in a data transfer, then:

a) the host should not set the Byte Count Limit to zero (see 7.18.6.49);
b) if the total requested data transfer length is greater than the Byte Count Limit, then the value set into the Byte Count Limit shall be even;
c) if the total requested data transfer length is equal to or less than the Byte Count Limit, then the value set into the Byte Count Limit may be odd; and
d) the value FFFFh shall be interpreted by the device as though the value were FFFEh.

7.23.6 Normal Outputs

7.23.6.1 Awaiting command

When the device is ready to accept the command packet from the host the return structure shall be set according to table 219. The Input/Output bit shall be cleared to zero, and the Command/Data bit shall be set to one. The Byte Count Limit shall reflect the value set by the host when the command was issued.

7.23.6.2 Data transmission

Data transfer shall occur after the receipt of the command packet. See table 219 for the return structure when the device is ready to transfer data requested by a data transfer command. Input/Output is ignored, and Command/Data shall be set to zero.

If the transfer is to be in PIO mode, then the byte count of the data to be transferred for this DRQ data block shall be:

a) not equal to zero;
b) less than or equal to the byte count limit value received from the host;
c) less than or equal to FFFEh; and
d) even if this is not the last transfer of a command.

If this is the last transfer for a command in PIO mode, then the byte count for the DRQ data block may be odd. If the byte count for the DRQ data block is odd, then the last byte

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transferred shall be a pad byte (i.e., to make the total number of bytes transferred be even). The value of the pad byte is undefined.

7.23.6.3 Successful command completion

When the device has command completion without error, the device returns the data structure found in table 219. Input/Output shall be set to one, Command/Data shall be set to one. Byte Count is reserved at command completion.

7.23.7 Error Outputs

The device shall not terminate the PACKET command with an error before the last byte of the command packet has been written. See table 255.

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7.24 READ BUFFER - E4h, PIO Data-In

7.24.1 Feature Set

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

7.24.2 Description

The READ BUFFER command enables the host to read a 512-byte block of data.

The READ BUFFER command and WRITE BUFFER command shall be synchronized such that sequential WRITE BUFFER command and READ BUFFER command access the same data.

The command prior to a READ BUFFER command should be a WRITE BUFFER command. If the READ BUFFER command is not preceded by a WRITE BUFFER command, the data returned by READ BUFFER command may be indeterminate.

7.24.3 Inputs

See table 84 for the READ BUFFER command inputs.

Table 84 — READ BUFFER command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 E4h

7.24.4 Normal Outputs

See table 212.

7.24.5 Error Outputs

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 236.

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

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7.25 READ BUFFER DMA - E9h, DMA

7.25.1 Feature Set

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

7.25.2 Description

See 7.24.2.

7.25.3 Inputs

See table 85 for the READ BUFFER DMA command inputs.

Table 85 — READ BUFFER DMA command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 E9h

7.25.4 Normal Outputs

See 7.24.4.

7.25.5 Error Outputs

See 7.24.5.

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7.26 READ DMA - C8h, DMA

7.26.1 Feature Set

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

7.26.2 Description

The READ DMA command allows the host to read data using the DMA data transfer protocol.

7.26.3 Inputs

See table 86 for the READ DMA command inputs.

Table 86 — READ DMA command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred.
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 C8h

7.26.4 Normal Outputs

See table 212.

7.26.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred. The validity of the data transferred is indeterminate. See table 245.

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7.27 READ DMA EXT - 25h, DMA

7.27.1 Feature Set

This 48-bit command is for devices implementing the 48-bit Address feature set (see 4.4).

7.27.2 Description

The READ DMA EXT command allows the host to read data using the DMA data transfer protocol.

7.27.3 Inputs

See table 87 for the READ DMA EXT command inputs.

Table 87 — READ DMA EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred.
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 25h

7.27.4 Normal Outputs

See table 223.

7.27.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred. The validity of the data transferred is indeterminate. See table 243.

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7.28 READ FPDMA QUEUED - 60h, DMA Queued

7.28.1 Feature Set

This 48-bit command is for devices implementing the NCQ feature set (see 4.14).

7.28.2 Description

The READ FPDMA QUEUED command requests data to be transferred from the device to the host.

7.28.3 Inputs

7.28.3.1 Overview

See table 88 for the READ FPDMA QUEUED command inputs.

Table 88 — READ FPDMA QUEUED command inputs

Name	Description
Feature	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred.
Count	**Bit Description** 15 PRIO – See 7.28.3.2. 14:8 Reserved 7:3 NCQ Tag – See 6.5.2. 2:0 N/A
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7 FUA – See 7.28.3.3. 6 Shall be set to one. 5 Reserved 4 Shall be set to zero. 3:0 Reserved
Command	7:0 60h

7.28.3.2 Priority (PRIO)

The Priority (PRIO) value shall be assigned by the host based on the priority of the command issued. If PRIO is set to one, then the command shall be high priority. If PRIO is cleared to zero, then the command shall be normal priority. The device shall make a best effort to complete high priority requests in a more timely fashion than normal priority requests.

7.28.3.3 Forced Unit Access (FUA)

When the FUA bit is set to one the device shall retrieve the data from the non-volatile media regardless of whether the device holds the requested information in its volatile cache. If the device holds a modified copy of the requested data as a result of having volatile cached writes, the modified data shall be written to the non-volatile media before being retrieved from the non-volatile media as part of this operation. When the FUA bit is cleared to zero the data shall be retrieved either from the device's non-volatile media or cache.

7.28.4 Command Acceptance Outputs

See table 227.

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7.28.5 Normal Outputs

See table 228.

7.28.6 Error Outputs

This return indicates that the command was aborted due to LBA out of range, a duplicate tag number, an invalid tag number, or an Interface CRC error, see table 266 for more information.

Errors that occur during the processing of this command are reported by returning a transport dependent indicator with additional information available in the NCQ Command Error log. The validity of the data transferred is indeterminate. See table 268.

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7.29 READ LOG EXT - 2Fh, PIO Data-In

7.29.1 Feature Set

This 48-bit command is for devices implementing the GPL feature set (see 4.10).

7.29.2 Description

The READ LOG EXT command returns the specified log to the host. See table A.2 for the list of logs.

7.29.3 Inputs

7.29.3.1 Overview

All the logs in this standard reserve the Feature field unless otherwise specified. See table 89 for the READ LOG EXT command inputs.

Table 89 — READ LOG EXT command inputs

Name	Description
Feature	Log Specific
Count	Block Count – See 7.29.3.2.
LBA	**Bit Description** 47:40 Reserved 39:32 Page # (15:8) – See 7.29.3.4. 31:16 Reserved 15:8 Page # (7:0) – See 7.29.3.4. 7:0 Log Address – See 7.29.3.3.
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 2Fh

7.29.3.2 Block Count

Specifies the number of 512-byte blocks of data to be read from the specified log. The log transferred by the device shall start at the block of data in the specified log at the specified offset, regardless of the block count requested. A value of zero is illegal and shall result in command aborted.

7.29.3.3 Log Address

Specifies the log to be read as described in table A.2. A device may support a subset of the available logs. Support for individual logs is determined by support for the associated feature set. Support of the associated log(s) is mandatory for devices implementing the associated feature.

7.29.3.4 Page

Specifies the first log page to be read from the specified log address. The first page number shall be zero.

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7.29.4 Normal Outputs

See table 223.

7.29.5 Error Outputs

A device shall return command aborted if:

a) the feature set associated with the log specified in the LBA field (7:0) is not supported or not enabled;
b) the values in other fields are invalid (e.g., the Count field is cleared to zero); or
c) the value in the Page # field plus the value in the Count field is larger than the log size reported in the General Purpose Log Directory.

A device may return command aborted if an Interface CRC error has occurred. The validity of the data transferred is indeterminate.

See table 244.

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

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7.30 READ LOG DMA EXT - 47h, DMA

7.30.1 Feature Set

This 48-bit command is for devices implementing the General Purpose Logging feature set (see 4.10).

7.30.2 Description

See 7.29.2.

7.30.3 Inputs

All the logs in this standard reserve the Feature field unless otherwise specified. See table 90 for the READ LOG DMA EXT command inputs.

Table 90 — READ LOG DMA EXT command inputs

Name	Description
Feature	Log Specific
Count	Block Count – See 7.29.3.2.
LBA	**Bit Description** 47:40 Reserved 39:32 Page # (15:8) – See 7.29.3.4. 31:16 Reserved 15:8 Page # (7:0) – See 7.29.3.4. 7:0 Log Address – See 7.29.3.3.
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 47h

7.30.4 Normal Outputs

See 7.29.4.

7.30.5 Error Outputs

See 7.29.5.

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7.31 READ MULTIPLE - C4h, PIO Data-In

7.31.1 Feature Set

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

7.31.2 Description

The READ MULTIPLE command reads the number of logical sectors specified in the Count field.

The number of logical sectors per DRQ data block is defined by the content of IDENTIFY DEVICE data word 59 (see 7.17.7.21). The device shall interrupt (See ATA8-APT and ATA8-AST) for each DRQ data block transferred.

If the number of requested logical sectors is not evenly divisible by the DRQ data block count (see 7.52), as many full DRQ data blocks as possible are transferred, followed by a final, partial DRQ data block transfer.

Device errors encountered during READ MULTIPLE commands are returned at the beginning of the DRQ data block or partial DRQ data block transfer.

If a READ MULTIPLE command is received by the device and:

a) IDENTIFY DEVICE data word 59 bit 8 (see 7.17.7.21) is cleared to zero; or
b) IDENTIFY DEVICE data word 59 bit 8 (see 7.17.7.21) is set to one and IDENTIFY DEVICE data word 59 bits 7:0 are set to zero,

then the device shall return command aborted. A successful SET MULTIPLE MODE command should precede a READ MULTIPLE command.

7.31.3 Inputs

See table 91 for the READ MULTIPLE command inputs.

Table 91 — READ MULTIPLE command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred.
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 C4h

7.31.4 Normal Outputs

See table 212.

7.31.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred. The validity of the data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 245.

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

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7.32 READ MULTIPLE EXT - 29h, PIO Data-In

7.32.1 Feature Set

This 48-bit command is for all devices implementing the 48-bit Address feature set (see 4.4).

7.32.2 Description

The READ MULTIPLE EXT command reads the number of logical sectors specified in the Count field.

The number of logical sectors per DRQ data block is defined by the content of IDENTIFY DEVICE data word 59 (see 7.17.7.21). The device shall interrupt for each DRQ data block transferred.

If the number of requested logical sectors is not evenly divisible by the DRQ data block count (see 7.52), as many full DRQ data blocks as possible are transferred, followed by a final, partial DRQ data block transfer.

Device errors encountered during READ MULTIPLE EXT commands are returned at the beginning of the DRQ data block or partial DRQ data block transfer.

If IDENTIFY DEVICE data word 59 bit 8 (see 7.17.7.21) is cleared to zero, and a READ MULTIPLE EXT command is received by the device, and no successful SET MULTIPLE MODE command has been processed by the device, the device shall return command aborted. A successful SET MULTIPLE MODE command should precede a READ MULTIPLE EXT command.

7.32.3 Inputs

See table 92 for the READ MULTIPLE EXT command inputs.

Table 92 — READ MULTIPLE EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred.
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 29h

7.32.4 Normal Outputs

See table 223.

7.32.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred. The validity of the data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 257.

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

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7.33 READ NATIVE MAX ADDRESS - F8h, Non-Data

7.33.1 Feature Set

This 28-bit command is for devices implementing the HPA feature set (see 4.11).

7.33.2 Description

The READ NATIVE MAX ADDRESS command returns the maximum LBA that is valid when using the SET MAX ADDRESS command.

If the native max address of a device is equal to or less than 268 435 454, a READ NATIVE MAX ADDRESS command shall return the native max address. If the native max address is greater than 268 435 454, a READ NATIVE MAX ADDRESS command shall cause the device to return a maximum value of 268 435 454.

7.33.3 Inputs

See table 93 for the READ NATIVE MAX ADDRESS command inputs.

Table 93 — READ NATIVE MAX ADDRESS command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 F8h

7.33.4 Normal Outputs

See table 220. LBA contains the native max address.

7.33.5 Error Outputs

See table 238.

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7.34 READ NATIVE MAX ADDRESS EXT - 27h, Non-Data

7.34.1 Feature Set

This 48-bit command is for devices implementing both the HPA feature set (see 4.11) and the 48-bit Address feature set (see 4.4).

7.34.2 Description

The READ NATIVE MAX ADDRESS EXT commands returns the maximum LBA that is valid when using the SET MAX ADDRESS EXT command.

7.34.3 Inputs

See table 94 for the READ NATIVE MAX ADDRESS EXT command inputs.

Table 94 — READ NATIVE MAX ADDRESS EXT command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 Shall be set to one. 5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 27h

7.34.4 Normal Outputs

See table 224. LBA contains the native max address.

7.34.5 Error Outputs

See table 258.

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

7.35.1 Feature Set

This 28-bit command is for ATA devices (see 4.2) and ATAPI devices (see 4.3).

7.35.2 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.

7.35.3 Inputs

See table 95 for the READ SECTOR(S) command inputs.

Table 95 — READ SECTOR(S) command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred.
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 20h

7.35.4 Outputs

7.35.5 Normal Outputs

See table 212.

7.35.6 Outputs for PACKET feature set devices

In response to this command, ATAPI shall report command aborted and place the ATAPI device signature in the LBA field (23:8), see table 217 for the list of signatures.

7.35.7 Error Outputs

The validity of the data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 245.

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

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7.36 READ SECTOR(S) EXT - 24h, PIO Data-In

7.36.1 Feature Set

This 48-bit command is for devices implementing the 48-bit Address feature set (see 4.4).

7.36.2 Description

The READ 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.

7.36.3 Inputs

See table 96 for the READ SECTOR(S) EXT command inputs.

Table 96 — READ SECTOR(S) EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred.
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 24h

7.36.4 Normal Outputs

See table 223.

7.36.5 Error Outputs

The validity of the data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 257.

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

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7.37 READ STREAM DMA EXT - 2Ah, DMA

7.37.1 Feature Set

This 48-bit command is for devices that implement the Streaming feature set (see 4.24).

7.37.2 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.

7.37.3 Inputs

7.37.3.1 Inputs Overview

See table 97 for the READ STREAM DMA EXT command inputs.

Table 97 — READ STREAM DMA EXT command inputs

Name	Description
Feature	**Bit Description** 15:8 Command Completion Time Limit (CCTL) – See 7.37.3.2. 7 Obsolete 6 Read Continuous (RC) – See 7.37.3.3. 5 Not Sequential (NS) – See 7.37.3.4. 4 Obsolete 3 Reserved 2:0 Stream ID – See 7.37.3.5.
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred.
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7 Obsolete 6 Shall be set to one. 5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 2Ah

7.37.3.2 Command Completion Time Limit (CCTL)

the CCTL field specifies the time allowed for the device to process the command before reporting command completion.

If the CCTL field is not cleared to zero, then the device shall report command completion within (CCTL × (IDENTIFY DEVICE data words 98..99 (see 7.17.7.52)) microseconds. The device shall measure the time before reporting command completion from command acceptance.

If the CCTL field is cleared to zero, and the Default CCTL field was not set to zero in the most recent CONFIGURE STREAM command (see 7.8) for the Stream ID, then the device shall report command completion within the time specified by the Default CCTL field (see 7.8.3.4).

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If the CCTL field is cleared to zero, and the Default CCTL field was set to zero in the most recent CONFIGURE STREAM command (see 7.8) for the Stream ID, or the CCTL field is set to zero and no previous CONFIGURE STREAM command was used to specify a Default CCTL for this Stream ID, then the result is vendor specific.

7.37.3.3 Read Continuous (RC)

If the RC bit is set to one, then:

a) the device shall not stop processing the command due to errors associated with reading the media;
b) if an error occurs during data transfer, while reading data from the media before command completion, before the amount of time allowed for command completion based on the setting of the CCTL field (see 7.37.3.2), or the Default CCTL field (see 7.8.3) is reached, then the device:
   1) shall continue to transfer the amount of data requested;
   2) may continue reading data from the media;
   3) shall report command completion after all data for the command has been transferred; and
   4) shall save the error information in the Read Streaming Error log;

   or
c) if the amount of time allowed for command completion based on the setting of the CCTL field (see 7.37.3.2) or the Default CCTL field (see 7.8.3) is reached, then the device:
   1) shall stop processing the command;
   2) shall report command completion; and
   3) shall set the Command Completion Time Out bit in the Read Streaming Error log to one.

If the RC bit is cleared to zero and an error occurs, then the device:

a) may continue transferring data; and
b) shall report command completion after the data transfer has been completed.

7.37.3.4 Not Sequential (NS)

If the NS bit is set to one, then the next READ STREAM command with the same Stream ID may not be sequential in the LBA space. Any read of the device media or internal device buffer management as a result of the state of the NS bit is vendor specific.

7.37.3.5 Stream ID

The Stream ID field specifies the stream to be read. The device shall operate according to the parameters specified by the most recent successful CONFIGURE STREAM command specifying this Stream ID.

7.37.4 Normal Outputs

See table 216 for the definition of Normal Outputs.

7.37.5 Error Outputs

If:

a) the RC bit was set to one in the READ STREAM DMA EXT command, and
b) the device is able to return the amount of data requested for the READ STREAM DMA EXT command (e.g., an error occurred while reading from the media),

then the device shall set the Stream Error bit to one and clear the Error bit to zero.

If:

a) the RC bit was set to one in the READ STREAM DMA EXT command, and
b) the device is not able to return the amount of data requested for the READ STREAM DMA EXT command (e.g., an Interface CRC error is reported at command completion),

then the device shall clear Stream Error bit to zero and set the Error bit to one.

If:

a) the RC bit was cleared to zero;

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b) the CCTL field was not set to zero, or the CCTL field was cleared to zero and the Default CCTL field specified in the most recent CONFIGURE STREAM command for the Stream ID (see 7.8) was not cleared to zero; and
c) the time specified for command completion by the CCTL field (see 7.37.3.2) or the Default CCTL field (see 7.8.3) has been reached,

in the READ STREAM EXT command, then the device shall clear the Stream Error bit to zero, set the Error bit to one, and set:

a) the Command Completion Timeout bit to one; or
b) the Abort bit to one.

If:

a) the RC bit was cleared to zero;
b) the CCTL field was cleared to zero; and
c) the Default CCTL field was cleared to zero in the most recent CONFIGURE STREAM command for the Stream ID (see 7.8),

in the READ STREAM EXT command, then the device shall clear the Stream Error bit to zero, set the Error bit to one, Interface CRC bit to one, ID Not Found bit to one, and/or Abort bit to one (i.e., indicating the error type).

The validity of the data transferred is indeterminate. See table 246.

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7.38 READ STREAM EXT - 2Bh, PIO Data-In

7.38.1 Feature Set

This 48-bit command is for devices that implement the Streaming feature set (see 4.24).

7.38.2 Description

See 7.37.2.

7.38.3 Inputs

See table 98 for the READ STREAM EXT command inputs.

Table 98 — READ STREAM EXT command inputs

Name	Description
Feature	**Bit Description** 15:8 Command Completion Time Limit (CCTL) – See 7.37.3.2. 7 Obsolete 6 Read Continuous (RC) – See 7.37.3.3. 5 Not Sequential (NS) – See 7.37.3.4. 4 Obsolete 3 Reserved 2:0 Stream ID – See 7.37.3.5.
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred.
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7 Obsolete 6 Shall be set to one. 5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 2Bh

7.38.4 Normal Outputs

See 7.37.4.

7.38.5 Error Outputs

See 7.37.5.

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7.39 READ VERIFY SECTOR(S) - 40h, Non-Data

7.39.1 Feature Set

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

7.39.2 Description

The READ VERIFY SECTOR(S) command verifies a maximum of 256 logical sectors as specified in the Count field, without transferring data to the application client. The device shall begin verifying at the logical sector specified in the LBA field. The device shall read the data from the non-volatile media and verify that there are no errors.

7.39.3 Inputs

See table 99 for the READ VERIFY SECTOR(S) command inputs.

Table 99 — READ VERIFY SECTOR(S) command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be verified. A value of 00h indicates that 256 logical sectors are to be verified.
LBA	LBA of first logical sector to be verified.
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 40h

7.39.4 Normal Outputs

See table 212.

7.39.5 Error Outputs

See table 245.

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7.40 READ VERIFY SECTOR(S) EXT - 42h, Non-Data

7.40.1 Feature Set

This 48-bit command is for devices implementing the 48-bit Address feature set (see 4.4).

7.40.2 Description

The READ VERIFY SECTOR(S) EXT command verifies a maximum of 65 536 logical sectors as specified in the Count field, without transferring data to the application client. The device shall begin verifying at the logical sector specified in the LBA field. The device shall read the data from the non-volatile media and verify that there are no errors.

7.40.3 Inputs

See table 100 for the READ VERIFY SECTOR(S) EXT command inputs.

Table 100 — READ VERIFY SECTOR(S) EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be verified. A value of 0000h indicates that 65 536 logical sectors are to be verified.
LBA	LBA of first logical sector to be verified.
Device	**Bit Description** 7 Obsolete 6 Shall be set to one. 5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 42h

7.40.4 Normal Outputs

See table 223.

7.40.5 Error Outputs

See table 257.

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7.41 REQUEST SENSE DATA EXT - 0Bh, Non-Data

7.41.1 Feature Set

This 48-bit command is for devices implementing the Sense Data Reporting feature set (see 4.22).

7.41.2 Description

The REQUEST SENSE DATA EXT command allows the reporting of the most recent sense data from the device.

7.41.3 Inputs

See table 101 for the REQUEST SENSE DATA EXT command inputs.

Table 101 — REQUEST SENSE DATA EXT command inputs

Name	Description
Feature	Reserved
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 0Bh

7.41.4 Normal Outputs

When sense data is available, the sense key, additional sense code, and additional sense code qualifier fields shall be set to values that are defined in the SPC-4 standard. Otherwise, the sense key, additional sense code, and additional sense code qualifier shall be cleared to zero.

See table 229.

7.41.5 Error Outputs

See table 235.

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7.42 Sanitize Device

7.42.1 Sanitize Device Overview

Individual Sanitize Device commands are identified by the value placed in the Feature field. Table 102 shows these Feature field values.

Table 102 — Sanitize Device Feature Field Values

Value	Command
0000h	SANITIZE STATUS EXT (see 7.42.6)
0001h..0010h	Reserved
0011h	CRYPTO SCRAMBLE EXT (see 7.42.3)
0012h	BLOCK ERASE EXT (see 7.42.2)
0013h	Reserved
0014h	OVERWRITE EXT (see 7.42.4)
0015h..001Fh	Reserved
0020h	SANITIZE FREEZE LOCK EXT (see 7.42.5)
0021h..FFFFh	

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7.42.2 BLOCK ERASE EXT – B4h/0012h, Non-Data

7.42.2.1 Feature Set

This 48-bit command is for devices that implement the Sanitize Device feature set (see 4.19).

7.42.2.2 Description

The BLOCK ERASE EXT command shall start a sanitize operation that shall cause block erase operations on the internal media that stores user data. The BLOCK ERASE EXT command shall:

a) render data held in caches unreadable; and
b) remove NV Cache Pinned Set attributes (see 4.15).

The BLOCK ERASE EXT command shall only be reported as supported if the internal media supports block erase operations.

After the block erase method has been successfully applied, the contents of the user data area are indeterminate.

The BLOCK ERASE EXT command shall only be processed if:

a) the Sanitize Device feature set is supported;
b) the BLOCK ERASE EXT command is supported; and
c) the device is in the Sanitize Idle state, the Sanitize Operation Failed state, or the Sanitize Operation Succeeded state.

7.42.2.3 Inputs

7.42.2.3.1 Overview

See table 103 for the BLOCK ERASE EXT command inputs.

Table 103 — BLOCK ERASE EXT command inputs

Name	Description
Feature	0012h
Count	**Bit Description** 15:5 Reserved 4 Failure Mode (see 7.42.2.3.2) 3:0 Reserved
LBA	**Bit Description** 47:32 Reserved 31:0 426B_4572h
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 B4h

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7.42.2.3.2 Failure Mode

If the Failure Mode bit is set to one, then the device may exit the Sanitize Operation Failed state with successful processing of a SANITIZE STATUS EXT command. If the Failure Mode bit is cleared to zero, then the Sanitize Operation Failed state shall only allow additional Sanitize operations (see figure 15).

7.42.2.4 Normal Outputs

See table 230.

7.42.2.5 Error Output

The Abort bit shall be set to one if a SANITIZE DEVICE FREEZE LOCK EXT command has successfully completed since the last power-on reset. See table 269.

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7.42.3 CRYPTO SCRAMBLE EXT – B4h/0011h, Non-Data

7.42.3.1 Feature Set

This 48-bit command is for devices that implement the Sanitize Device feature set (see 4.19).

7.42.3.2 Description

The CRYPTO SCRAMBLE EXT command shall start a sanitize operation which shall change the internal encryption keys that are used for user data. The CRYPTO SCRAMBLE EXT command shall:

a) render data held in caches unreadable; and
b) remove NV Cache Pinned Set attributes (see 4.15).

The CRYPTO SCRAMBLE EXT command shall only be reported as supported if all user data is affected by changing internal encryption keys.

After a successful cryptographic scramble, the contents of the user data area may be indeterminate.

The CRYPTO SCRAMBLE EXT command shall only be processed if:

a) the Sanitize Device feature set is supported; and
b) the device is in the Sanitize Idle state, the Sanitize Operation Failed state, or the Sanitize Operation Succeeded state.

7.42.3.3 Inputs

See table 104 for the CRYPTO SCRAMBLE EXT command inputs.

Table 104 — CRYPTO SCRAMBLE EXT command inputs

Name	Description
Feature	0011h
Count	**Bit Description** 15:5 Reserved 4 Failure Mode (see 7.42.2.3.2) 3:0 Reserved
LBA	**Bit Description** 47:32 Reserved 31:0 4372_7970h
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 B4h

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7.42.3.4 Normal Outputs

See table 230.

7.42.3.5 Error Output

The Abort bit shall be set to one if a SANITIZE DEVICE FREEZE LOCK EXT command has successfully completed since the last power-on reset. See table 269.

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7.42.4 OVERWRITE EXT – B4h/0014h, Non-Data

7.42.4.1 Feature Set

This 48-bit command is for devices that implement the Sanitize Device feature set (see 4.19).

7.42.4.2 Description

The OVERWRITE EXT command shall start a sanitize operation which fills the user data area with a four byte pattern passed in the LBA field of the command. Parameters for the OVERWRITE EXT command include a count for multiple overwrites and the option to invert the four byte pattern between consecutive overwrite passes. The OVERWRITE EXT command shall:

a) render data held in caches unreadable; and
b) remove NV Cache Pinned Set attributes (see 4.15).

After the overwrite method has been successfully applied, affected data blocks shall be readable without error.

The OVERWRITE EXT command shall only be processed if:

a) the Sanitize Device feature set is supported; and
b) the device is in the Sanitize Idle state, the Sanitize Operation Failed state, or the Sanitize Operation Succeeded state.

7.42.4.3 Inputs

See table 105 for the OVERWRITE EXT command inputs.

Table 105 — OVERWRITE EXT command inputs

Name	Description
Feature	0014h
Count	**Bit** **Description** 15:8 Reserved 7 Invert pattern between overwrite operations. 6:5 Reserved 4 Failure Mode (see 7.42.2.3.2) 3:0 Count of OVERWRITE operations, a count of zero requests sixteen overwrites.
LBA	**Bit** **Description** 47:32 4F57h 31:0 Overwrite pattern (DWord).
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 B4h

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7.42.4.4 Normal Outputs

See table 230.

7.42.4.5 Error Output

The Abort bit shall be set to one if a SANITIZE DEVICE FREEZE LOCK EXT command has successfully completed since the last power-on reset. See table 269.

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7.42.5 SANITIZE FREEZE LOCK EXT – B4h/0020h, Non-Data

7.42.5.1 Feature Set

This 48-bit command is for devices that implement the Sanitize Device feature set (see 4.19).

7.42.5.2 Description

The SANITIZE FREEZE LOCK EXT command shall set the device to the Sanitize Frozen state. After command completion all Sanitize commands other than SANITIZE STATUS EXT command shall return command aborted. Sanitize Frozen state shall be disabled by power-off or hardware reset.

7.42.5.3 Inputs

See table 106 for the SANITIZE FREEZE LOCK EXT command inputs.

Table 106 — SANITIZE FREEZE LOCK EXT command inputs

Name	Description
Feature	0020h
Count	Reserved
LBA	**Bit Description** 47:32 Reserved 31:0 4672_4C6Bh
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 B4h

7.42.5.4 Normal Outputs

See table 230.

7.42.5.5 Error Output

See table 269.

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7.42.6 SANITIZE STATUS EXT – B4h/0000h, Non-Data

7.42.6.1 Feature Set

This 48-bit command is for devices that implement the Sanitize Device feature set (see 4.19).

7.42.6.2 Description

The SANITIZE STATUS EXT command returns information about current or previously completed Sanitize operations. This includes:

a) progress indication on a current Sanitize operation;
b) whether a previous Sanitize operation completed successfully or unsuccessfully; and
c) if an unsupported sanitize device command was received.

The SANITIZE STATUS EXT command may be processed at any phase in the Sanitize Device sequence.

7.42.6.3 Inputs

7.42.6.3.1 Overview

See table 107 for the SANITIZE STATUS EXT command inputs.

Table 107 — SANITIZE STATUS EXT command inputs

Name	Description
Feature	0000h
Count	**Bit** **Description** 15:1 Reserved 0 Clear Sanitize Operation Failed.
LBA	Reserved
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 B4h

7.42.6.3.2 Clear Sanitize Operation Failed

If in a Sanitize operation:

a) the Failure Mode bit was set to one in the Sanitize Device command that caused the Sanitize operation;
b) the Sanitize operation failed; and
c) the Clear Sanitize Operation Failed bit is set to one in the SANITIZE STATUS EXT command,

then the Sanitize state machine shall transition from the Sanitize Failed state to the Sanitize Idle state.

If Clear Sanitize Operation Failed bit is set to one in the SANITIZE STATUS EXT command, and the Failure Mode bit was set to zero in the Sanitize Device command that caused the Sanitize operation, the SANITIZE STATUS EXT command shall return command aborted.

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7.42.6.4 Normal Outputs

See table 230.

7.42.6.5 Error Output

After the Sanitize operation has completed, if any physical sector that is available to be allocated for user data was not successfully sanitized, then this command shall return the Abort bit set to one. See table 269.

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7.43 SECURITY DISABLE PASSWORD - F6h, PIO Data-Out

7.43.1 Feature Set

This 28-bit command is for devices that implement the Security feature set (see 4.20).

7.43.2 Description

The SECURITY DISABLE PASSWORD command transfers 512 bytes of data from the host. Table 109 defines the content of this information.

If the password selected by word 0 (see table 109) matches the password previously saved by the device, then the device shall disable the User password, and return the device to the SEC1 state (see figure 16).

This command shall not change the Master password or the Master Password Identifier (see 4.20.11).

If security is disabled, then:

a) if the Identifier bit is cleared to zero (i.e., compare User password), then the device shall return command aborted; or
b) if the Identifier bit is set to one (i.e., compare Master password), then the device may compare the password supplied with the stored Master password.

If security is enabled and the Master Password Capability bit (see 4.20.3) is cleared to zero (i.e., High), then:

a) if the Identifier bit is set to one (i.e., compare Master password), then the password supplied shall be compared with the stored Master password; or
b) if the Identifier bit is cleared to zero (i.e., compare User password), then the password supplied shall be compared with the stored User password.

If security is enabled and the Master Password Capability bit (see 4.20.3) is set to one (i.e., Maximum), then:

a) if the Identifier bit is set to one (i.e., compare Master password), then the device shall return command aborted, even if the supplied Master password is valid; or
b) if the Identifier bit is cleared to zero (i.e., compare User password), then the password supplied shall be compared with the stored User password.

Upon successful completion of this command, fields in IDENTIFY DEVICE data or the IDENTIFY PACKET DEVICE data shall be updated as follows:

a) word 85, bit 1 (see 7.17.7.41) shall be cleared to zero (i.e., there is no active User password);
b) word 128, bit 1 (see 7.17.7.66) shall be equal to word 85, bit 1 (see 7.17.7.41); and
c) word 128, bit 8 (see 7.17.7.66) shall be cleared to zero (i.e., the Master Password Capability is not Maximum).

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7.43.3 Inputs

See table 108 for the SECURITY DISABLE PASSWORD command inputs.

Table 108 — SECURITY DISABLE PASSWORD command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12. 3:0 Reserved
Command	7:0 F6h

7.43.4 Normal Outputs

See table 212.

7.43.5 Error Outputs

The device shall return command aborted if:

a) the Security feature set is not supported;
b) security is Locked (i.e., the device is in SEC4 state (see figure 16));
c) security is Frozen (i.e., the device is in SEC2 state or SEC6 state (see figure 16)); or
d) the password received in the data for the command does not match the password previously saved by the device.

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 236.

7.43.6 Output From the Host to the Device Data Structure

Table 109 — SECURITY DISABLE PASSWORD data content

Word	Description
0	Control word **Bit** **Field Name** **Description** 15:1 Reserved 0 Identifier 0=compare User password 1=compare Master password
1..16	Password (32 bytes)
17..255	Reserved

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7.44 SECURITY ERASE PREPARE - F3h, Non-Data

7.44.1 Feature Set

This 28-bit command is for devices that implement the Security feature set (see 4.20).

7.44.2 Description

The SECURITY ERASE PREPARE command shall be issued immediately before the SECURITY ERASE UNIT command.

7.44.3 Inputs

See table 110 for the SECURITY ERASE PREPARE command inputs.

Table 110 — SECURITY ERASE PREPARE command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 F3h

7.44.4 Normal Outputs

See table 212.

7.44.5 Error Outputs

The Abort bit shall be set to one if the device is in Frozen mode. See table 235.

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7.45 SECURITY ERASE UNIT - F4h, PIO Data-Out

7.45.1 Feature Set

This 28-bit command is for devices that implement the Security feature set (see 4.20).

7.45.2 Description

The SECURITY ERASE UNIT command transfers 512-bytes of data from the host. Table 112 defines the content of this information.

The SECURITY ERASE PREPARE command shall be completed immediately prior to the SECURITY ERASE UNIT command. If the device receives a SECURITY ERASE UNIT command and the previous command was not a successful SECURITY ERASE PREPARE command, the device shall return command aborted for the SECURITY ERASE UNIT command.

When security is disabled and the Identifier bit (see table 112) is cleared to zero (i.e.,compare User password), then the device shall return command aborted.

When security is enabled:

a) Identifier bit (see table 112) is set to one (i.e.,compare Master password), then the password supplied shall be compared with the stored Master password; or
b) Identifier bit (see table 112) is cleared to zero (i.e.,compare User password), then the password supplied shall be compared with the stored User password.

When Normal Erase mode (see table 112) is specified, the SECURITY ERASE UNIT command shall replace the contents of LBA 0 to the LBA reported by the larger of READ NATIVE MAX command or READ NATIVE MAX EXT command with all binary zeroes or all binary ones. If the device replaces the contents of native max address + 1 to the Maximum LBA reported in DEVICE CONFIGURATION IDENTIFY data words 3..6 (see table 35), then the device shall use the same data pattern found in LBA 0. IDENTIFY DEVICE data word 89 (see 7.17.7.43) or IDENTIFY PACKET DEVICE data word 89 (see 7.18.6.37) gives an estimate of the time required to complete the erasure.

IDENTIFY DEVICE data word 128 bit 5 (see 7.17.7.66) or IDENTIFY PACKET DEVICE data word 128 bit 5 (see 7.18.6.51) indicates whether the mode is supported. When Enhanced Erase mode is specified, the device shall write vendor specific data patterns from LBA 0 to the Maximum LBA reported in DEVICE CONFIGURATION IDENTIFY data words 3..6 (see table 35). In Enhanced Erase mode, all previously written user data shall be overwritten, including sectors that are no longer in use due to reallocation. IDENTIFY DEVICE data word 90 (see 7.17.7.44) or IDENTIFY PACKET DEVICE data word 90 (see 7.18.6.38) gives an estimate of the time required to complete the erasure.

On successful completion, this command shall disable Security (e.g., returns the device to SEC1 state (see figure 16)), and invalidate any existing User password. Any previously valid Master password and Master Password Identifier remains valid.

Upon successful completion, the fields in the IDENTIFY DEVICE data (see table 50) or the IDENTIFY PACKET DEVICE data (see table 61) shall be updated as follows:

a) word 85, bit 1 shall be cleared to zero (i.e., there is no active User password);
b) word 128, bit 1 shall be cleared to zero (i.e., there is no active User password); and
c) word 128, bit 8 shall be cleared to zero (i.e., the Master Password Capability is set to High).

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7.45.3 Inputs

See table 111 for the SECURITY ERASE UNIT command inputs.

Table 111 — SECURITY ERASE UNIT command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 F4h

7.45.4 Normal Outputs

See table 212.

7.45.5 Error Outputs

The device shall return command aborted if:

a) this command was not immediately preceded by a SECURITY ERASE PREPARE command;
b) Enhanced mode was requested but the device does not support that mode;
c) the password received in the data for the command does not match the password previously saved by the device;
d) an invalid password was specified; or
e) if the data area is not successfully overwritten.

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 236.

7.45.6 Output From the Host to the Device Data Structure

Table 112 — SECURITY ERASE UNIT data content

Word	Description
0	Control word **Bit** **Field Name** **Description** 15:2 Reserved 1 Erase mode 0=Normal Erase 1=Enhanced Erase 0 Identifier 0=Compare User password 1=Compare Master password
1..16	Password (32 bytes)
17..255	Reserved

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7.46 SECURITY FREEZE LOCK - F5h, Non-Data

7.46.1 Feature Set

This 28-bit command is for devices that implement the Security feature set (see 4.20).

7.46.2 Description

The SECURITY FREEZE LOCK command shall set the device to Frozen mode. After command completion any other commands that update the device Lock mode shall return command aborted. Frozen mode shall be disabled by power-off or hardware reset. If a SECURITY FREEZE LOCK command is issued when the device is in Frozen mode, then the command executes and the device shall remain in Frozen mode.

See table 7 for a list of commands disabled by the SECURITY FREEZE LOCK command.

Upon successful completion, IDENTIFY DEVICE data word 128 bit 3 (see 7.17.7.66) or IDENTIFY PACKET DEVICE data word 128 bit 3 (see 7.18.6.51) shall be set to one.

7.46.3 Inputs

See table 113 for the SECURITY FREEZE LOCK command inputs.

Table 113 — SECURITY FREEZE LOCK command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 F5h

7.46.4 Normal Outputs

See table 212.

7.46.5 Error Outputs

The Abort bit shall be set to one if the device is in the SEC3: Powered down/Security Enabled/ Locked/ Not Frozen state or the SEC4: Security Enabled/ Locked/ Not Frozen state (see figure 16). See table 235.

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7.47 SECURITY SET PASSWORD - F1h, PIO Data-Out

7.47.1 Feature Set

This 28-bit command is for devices that implement the Security feature set (see 4.20).

7.47.2 Description

7.47.2.1 Overview

The SECURITY SET PASSWORD command transfers 512 bytes of data from the host. Table 115 defines the content of this information. The command sets only one password at a time.

7.47.2.2 Setting the Master Password

If a Master password (see 4.20.2.3) is specified, the device shall save the supplied Master password in a non-volatile location. The Master Password Capability (see 4.20.3) shall remain unchanged. This does not cause any changes to IDENTIFY DEVICE data words 85 or 128 (see table 50) or IDENTIFY PACKET DEVICE words 85 or 128 (see table 61).

If the device supports the Master Password Identifier feature (see 4.20.11) and a valid identifier is supplied (see 4.20.11), the device shall save the identifier in a non-volatile location. This new value shall be returned in IDENTIFY DEVICE data word 92 (see 7.17.7.46) or IDENTIFY PACKET DEVICE data word 92 (see 7.18.6.40). If the host attempts to set the Master Password Identifier to 0000h or FFFFh, then the device shall preserve the existing Master Password Identifier and return successful command completion.

If the device does not support the Master Password Identifier feature, then the device shall not:

a) validate the Identifier field;
b) change IDENTIFY DEVICE data word 92 (see 7.17.7.46);
c) change IDENTIFY PACKET DEVICE data word 92 (see 7.18.6.40); and
d) return command aborted based on the value supplied in the Master Password Identifier field (see 4.20.11).

7.47.2.3 Setting the User Password

If a User password (see 4.20.2.2) is specified, then the device shall save the User password in a non-volatile location and update the Master Password Capability (see 4.20.3). The Master Password Identifier (see 4.20.11) shall not be changed. These fields in the IDENTIFY DEVICE data (see table 50) or the IDENTIFY PACKET DEVICE data (see table 61) shall be updated as follows:

a) word 85, bit 1 shall be set to one (i.e., security is enabled);
b) word 128, bit 1 shall be set to one (i.e., security is enabled); and
c) word 128, bit 8 shall indicate the Master Password Capability (see 4.20.3).

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7.47.3 Inputs

See table 114 for the SECURITY SET PASSWORD command inputs.

Table 114 — SECURITY SET PASSWORD command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 F1h

7.47.4 Normal Outputs

See table 212.

7.47.5 Error Outputs

If the device is locked (see 4.20.2.2) or in Frozen mode (see 4.20.4), then the device shall return command aborted. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 236.

7.47.6 Output From the Host to the Device Data Structure

Table 115 — SECURITY SET PASSWORD data content

Word	Description
0	Control word **Bit / Field Name / Description** 15:9 Reserved 8 Master Password Capability: 0=High, 1=Maximum 7:1 Reserved 0 Identifier: 0=set User password, 1=set Master password
1..16	Password (32 bytes)
17	Master Password Identifier. This word is valid if word 0 bit 0 is set to one.
18..255	Reserved

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7.48 SECURITY UNLOCK - F2h, PIO Data-Out

7.48.1 Feature Set

This 28-bit command is for devices that implement the Security feature set (see 4.20).

7.48.2 Description

The SECURITY UNLOCK command transfers 512 bytes of data from the host. Table 117 defines the content of this information.

When security is disabled and the Identifier bit (see table 117) is cleared to zero (i.e., compare User password), then the device shall return command aborted.

If security is enabled, and the Master Password Capability (see 4.20.3) is cleared to zero (i.e., High), then:

a) if the Identifier bit is set to one (i.e., compare Master password), then the password supplied shall be compared with the stored Master password; or
b) if the Identifier bit is cleared to zero (i.e., compare User password), then the password supplied shall be compared with the stored User password.

If security is enabled and the Master Password Capability is set to Maximum, then:

a) if the Identifier bit is set to one (i.e., compare Master password), then the device shall return command aborted; or
b) if the Identifier bit is cleared to zero (i.e., compare User password), then the password supplied shall be compared with the stored User password.

If the password received in the data for the command does not match the password previously saved by the device, then the device shall return command aborted and decrement the password attempt counter. When this counter reaches zero, IDENTIFY DEVICE data word 128 bit 4 (see 7.17.7.66) or IDENTIFY PACKET DEVICE data word 128 bit 4 (see 7.18.6.51) shall be set to one, and the SECURITY UNLOCK command and the SECURITY ERASE UNIT command shall return command aborted until a power-on reset or a hardware reset. SECURITY UNLOCK commands issued when the device is unlocked have no effect on the unlock counter.

Upon successful completion of this command, IDENTIFY DEVICE data word 128 bit 2 (see 7.17.7.66) or IDENTIFY PACKET DEVICE data word 128 bit 2 (see 7.18.6.51) shall be cleared to zero (i.e., the device is not in the SEC3: Powered down/Security Enabled/ Locked/ Not Frozen state or the SEC4: Security Enabled/ Locked/ Not Frozen state (see figure 16)).

7.48.3 Inputs

See table 116 for the SECURITY UNLOCK command inputs.

Table 116 — SECURITY UNLOCK command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 F2h

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7.48.4 Normal Outputs

See table 212.

7.48.5 Error Outputs

If the device is in Frozen mode (see 4.20.4), an invalid password is supplied, or the password attempt counter has decremented to zero, then the device shall return command aborted.

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 236.

7.48.6 Output From the Host to the Device Data Structure

Table 117 — SECURITY UNLOCK data content

Word	Description
0	Control word **Bit** **Field Name** **Description** 15:1 Reserved 0 Identifier 0=compare User password 1=compare Master password
1..16	Password (32 bytes)
17..255	Reserved

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7.49 SET FEATURES - EFh, Non-Data

7.49.1 Feature Set

This 28-bit command is mandatory for ATA devices (see 4.2) and ATAPI devices (see 4.3).

7.49.2 Description

The SET FEATURES command is used by the host to establish parameters that affect the processing of certain device features. Table 118 defines these features.

After a power-on reset or a hardware reset, the settings specified by the subcommands are vendor specific unless otherwise specified in this standard. Software reset is described in the individual subcommands as needed.

Table 118 — SET FEATURES Feature field definitions (part 1 of 3)

Value	Description
00h	Reserved
01h	If the device implements the CFA feature set, then enable 8-bit PIO transfer mode (see 7.49.3); otherwise this value is reserved.
02h	Enable volatile write cache (see 7.49.4)
03h	Set transfer mode (see 7.49.5)
04h	Obsolete
05h	Enable the APM feature set (see 7.49.6)
06h	Enable the PUIS feature set (see 7.49.7)
07h	PUIS feature set device spin-up (see 7.49.8)
08h	Reserved
09h	If the device implements the CFA feature set, then this subcommand is reserved for CFA. Otherwise, this subcommand is reserved for Address Offset Reserved Area Boot Method.
0Ah	Enable CFA power mode 1 (see 7.49.9)
0Bh	Enable Write-Read-Verify feature set (see 7.49.10)
0Ch..0Fh	Reserved
10h	Enable use of SATA feature (see 7.49.15)
11h..1Fh	Reserved
20h	Reserved for TLC
21h	Reserved for TLC
22h..30h	Reserved
31h	Obsolete
32h	Reserved
33h	Obsolete
34h..40h	Reserved
41h	Enable the Free-fall Control feature set (see 7.49.14)
42h	Obsolete
43h	Set Maximum Host Interface Sector Times (see 7.49.11)
44h	Obsolete
45h..49h	Reserved
4Ah	Extended Power conditions (see 7.49.18)
4Bh..53h	Reserved
54h	Obsolete
55h	Disable read look-ahead feature (see 7.49.12)

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Table 118 — SET FEATURES Feature field definitions (part 2 of 3)

Value	Description
56h..5Ch	Vendor Specific
5Dh..5Eh	Obsolete
5Fh	Reserved for DDT
60h..61h	Reserved
62h	Long Physical Sector Alignment Error Reporting Control (see 7.49.17)
63h..65h	Reserved
66h	Disable reverting to power-on defaults (see 7.49.13)
67h..68h	Reserved
69h	If the device implements the CFA feature set, then this subcommand is reserved for CFA; otherwise this value is reserved.
6Ah..76h	Reserved
77h	Obsolete
78h..80h	Reserved
81h	If the device implements the CFA feature set, then disable 8-bit PIO transfer mode (see 7.49.3); otherwise this value is reserved.
82h	Disable volatile write cache (see 7.49.4)
83h	Reserved
84h	Obsolete
85h	Disable the APM feature set (see 7.49.6)
86h	Disable the PUIS feature set (see 7.49.7)
87h	Reserved
88h	Obsolete
89h	If the device implements the CFA feature set, then this subcommand is reserved for CFA; otherwise this subcommand is reserved for Address Offset Reserved Area Boot Method.
8Ah	Disable CFA power mode 1 (see 7.49.9)
8Bh	Disable Write-Read-Verify feature set (see 7.49.10)
8Ch..8Fh	Reserved
90h	Disable use of SATA feature (see 7.49.15)
91h..94h	Reserved
95h	Obsolete
96h..99h	Reserved
99h	Obsolete

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Table 118 — SET FEATURES Feature field definitions (part 3 of 3)

Value	Description
9Ah	Obsolete
9Bh..A9h	Reserved
AAh	Enable read look-ahead feature (see 7.49.12)
ABh	Obsolete
ACh..BAh	Reserved
BBh	Obsolete
BCh..C0h	Reserved
C1h	Disable the Free-fall Control feature set (see 7.49.14)
C2h	Obsolete
C3h	Enable/Disable the Sense Data Reporting feature set (see 7.49.16)
C4h..CBh	Reserved
CCh	Enable reverting to power-on defaults (see 7.49.13)
CDh..D5h	Reserved
D6h..DCh	Vendor Specific
DDh.DEh	Obsolete
DFh	Reserved for DDT
E0h	Vendor Specific
E1h..EFh	Reserved
F0h..F3h	Reserved for assignment by the CompactFlash Association
F4h..FFh	Reserved

7.49.3 Enable/disable 8-bit PIO data transfer

Subcommand codes 01h and 81h allow the host to enable or disable 8-bit PIO data transfers. CFA-APT devices shall support 8-bit PIO data transfers. All other devices shall not support 8-bit PIO data transfers. See the CFA specification for more information.

7.49.4 Enable/disable volatile write cache

Subcommand codes 02h and 82h allow the host to enable or disable volatile write cache in devices that implement volatile write cache. When the disable volatile write cache subcommand is issued, the device shall initiate the sequence to flush volatile cache to non-volatile media before command completion (see 7.15). These subcommands may affect caching for commands in the Streaming feature set. Support for the enable/disable volatile write cache subcommands are mandatory when a volatile write cache is implemented.

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7.49.5 Set transfer mode

The set transfer mode subcommand is mandatory. The transfer mechanism is selected by Set Transfer Mode, subcommand code 03h, and specifying a value in the Count field. Bits (7:3) define the type of transfer and bits (2:0) encode the mode value. The selected modes may be changed by the SET FEATURES command. Table 119 shows the available transfer modes.

Table 119 — 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 7.17.7.24, 7.17.7.25, 7.17.7.42)		

If a device receives a SET FEATURES command with a Set Transfer Mode subcommand and the Count field value set to 0000_0000b, then the device shall set the default PIO mode. If the Count field is set to 0000_0001b and the device supports disabling of IORDY (see ATA8-APT), then the device shall set the default PIO mode and disable IORDY. A device shall support all PIO modes below the highest mode supported (e.g., if PIO mode 1 is supported PIO mode 0 shall be supported).

Support of IORDY is mandatory when PIO mode 3 or above is the current mode of operation.

A device shall support all Multiword DMA modes below the highest mode supported (e.g., if Multiword DMA mode 1 is supported Multiword DMA mode 0 shall be supported).

A device shall support all Ultra DMA modes below the highest mode supported (e.g., if Ultra DMA mode 1 is supported Ultra DMA mode 0 shall be supported).

If an Ultra DMA mode is enabled any previously enabled Multiword DMA mode shall be disabled by the device. If a Multiword DMA mode is enabled any previously enabled Ultra DMA mode shall be disabled by the device.

For PATA systems using a cable assembly, the host should determine that an 80-conductor cable assembly is connecting the host with the device(s) before enabling any Ultra DMA mode greater than 2 in the device(s) (see ATA8-APT).

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7.49.6 Enable/disable the APM feature set

Subcommand code 05h enables APM (see 4.5). The APM level is a scale from the lowest power consumption setting of 01h to the maximum performance level of FEh. Table 120 shows these values.

Table 120 — APM levels

Count	Level
00h	Reserved
01h	Minimum power consumption with Standby
02h-7Fh	Intermediate power management levels with Standby
80h	Minimum power consumption without Standby
81h-FDh	Intermediate power management levels without Standby
FEh	Maximum performance
FFh	Reserved

Device performance may increase with increasing APM levels. Device power consumption may increase with increasing power management levels. The APM levels may contain discrete bands (e.g., a device may implement one APM method from 80h to A0h and a higher performance, higher power consumption method from level A1h to FEh). APM levels 80h and higher do not permit the device to spin down to save power.

Subcommand code 85h disables APM. Subcommand 85h may not be implemented on all devices that implement SET FEATURES subcommand 05h.

7.49.7 Enable/disable the PUIS feature set

Subcommand code 06h enables the PUIS feature set (see 4.18). When this feature set is enabled, the device shall power-up into the PM4: PUIS state (i.e., the device shall be ready to receive commands but shall not spin-up) (see 4.18). Once this feature set is enabled, it shall only be disabled by a subsequent SET FEATURES command disabling this feature set. This feature set shall not be disabled by a power-on reset, a hardware reset, or a software reset.

Subcommand code 86h disables the PUIS feature set. When this feature set is disabled, the device shall power-up into Active mode. The factory default for this feature set shall be disabled.

7.49.8 PUIS feature set device spin-up

Subcommand code 07h shall cause a device that has powered-up into Standby to go to the Active state (see 4.18 and figure 14).

7.49.9 Enable/disable CFA power mode 1

Subcommand code 0Ah causes a CFA device to transition to CFA Power Mode 1. CFA devices may consume up to 500 mA maximum average RMS current for either 3.3 V or 5 V operation in Power Mode 1.

Subcommand 8Ah causes a CFA device to transition to CFA Power Mode 0. CFA devices may consume up to 75 mA maximum average RMS current for 3.3 V or 100 mA maximum average RMS current for 5 V operation in Power Mode 0.

If a CFA device is in CFA Power Mode 0, then the device shall transition to CFA Power Mode 1 after processing of a power-on reset or a hardware reset.

If a CFA device is in CFA Power Mode 0 and in the Reverting to defaults enabled mode (see 7.49.13), then the device shall transition to CFA Power Mode 1 after processing of a software reset.

If a CFA device is in CFA Power Mode 0 and in the Reverting to defaults disabled mode (see 7.49.13), then the device shall not transition to CFA Power Mode 1 after processing of a software reset.

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Enabling CFA Power Mode 1 does not cause a spin-up.

A device in Power Mode 0 shall accept the following commands:

a) IDENTIFY DEVICE;
b) SET FEATURES (subcommand codes 0Ah and 8Ah);
c) STANDBY;
d) STANDBY IMMEDIATE;
e) SLEEP;
f) CHECK POWER MODE;
g) EXECUTE DEVICE DIAGNOSTICS; and
h) CFA REQUEST EXTENDED ERROR.

A device in Power Mode 0 may accept any command that the device is capable of processing within the Power Mode 0 current restrictions. Commands that require more current than specified for Power Mode 0 shall be rejected with an abort error.

7.49.10 Enable/Disable Write-Read-Verify feature set

Subcommand code 0Bh enables the Write-Read-Verify feature set.

Bits (7:0) of the LBA field in the SET FEATURES command specify the Write-Read-Verify mode. Table 121 defines the Write-Read-Verify modes.

Table 121 — Write-Read-Verify modes

Mode	Description
00h [a]	Always enabled (i.e., the device shall perform a Write-Read-Verify for all logical sectors for all write commands).
01h [a]	The device shall perform a Write-Read-Verify on the first 65 536 logical sectors written after: a) spin-up; or b) the device completes a SET FEATURES command setting the Write-Read-Verify mode without error.
02h [a]	The number of logical sectors on which a device performs a Write-Read-Verify is vendor specific.
03h	The device shall perform a Write-Read-Verify on the first n logical sectors written by the host after: a) spin-up; or b) the device completes a SET FEATURES command setting the Write-Read-Verify mode without error. n=x × 1 024 where: x=number specified by the Count field.
04h-FFh	Reserved
[a] The Count field shall be ignored.	

Subcommand code 8Bh disables the Write-Read-Verify feature set.

A device shall set the Write-Read-Verify feature set to its factory default setting after processing a power-on reset or if the Software Settings Preservation feature set is disabled and a hardware reset is processed. If the Software Settings Preservation feature set is enabled and a hardware reset is processed, then the device shall not change the settings of the Write-Read-Verify feature set.

If a device is in the reverting to defaults enabled mode (see 7.49.13), then the device shall set the Write-Read-Verify feature set to its factory default setting after processing of a software reset.

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If a device is in the reverting to defaults disabled mode (see 7.49.13), then the device shall not change the settings of the Write-Read-Verify feature set after processing of a software reset.

7.49.11 Set Maximum Host Interface Sector Times

Subcommand code 43h allows the host to inform the device of a host interface rate limitation. This information shall be used by the device to meet the Command Completion Time Limits of the commands of the Streaming feature set. To inform the device of a host interface rate limitation, the host writes the value of its Typical PIO Host Interface Sector Time (see table 122) to the Count field (7:0) and LBA (7:0) field and writes the value of its Typical DMA Host Interface Sector Time (see table 122) to the LBA (23:8) field. The Typical Host Interface Sector Times (see table 122) have the same units as IDENTITY DEVICE data word 96 (see 7.17.7.50) for DMA and IDENTITY DEVICE data word 104 (see 7.17.7.54) for PIO. A value of zero indicates that the host interface shall be capable of transferring data at the maximum rate allowed by the selected transfer mode. The Typical PIO Mode Host Interface Sector Time includes the host's interrupt service time.

Upon completion of SET FEATURES subcommand 43h, the device may adjust IDENTIFY DEVICE data words 96..97 (see 7.17.7.50 and 7.17.7.51) to allow for the specified host interface sector time. See table 122 for the Count field and LBA field definitions.

Table 122 — Maximum Host Interface Sector Times

Field	Bits	Description
Count	15:8	Reserved
	7:0	Typical PIO Mode Host Interface Sector Time (7:0)
LBA	47:24	Reserved
	23:8	Typical DMA Mode Host Interface Sector Time
	7:0	Typical PIO Mode Host Interface Sector Time (15:8)

7.49.12 Enable/disable read look-ahead

Subcommand codes AAh and 55h enables or disables read look-ahead. Error recovery performed by the device is vendor specific.

7.49.13 Enable/disable reverting to defaults

Subcommand codes CCh and 66h enables or disables the reverting to defaults mode.

A device is in the reverting to defaults disabled mode after completing a SET FEATURES command with subcommand code 66h without error. A device should enter the reverting to defaults disabled mode after power-on reset or hardware reset. A device in the reverting to defaults disabled mode, shall not reset parameters to their default power-on values during the processing of a software reset.

A device is in the Reverting to defaults enabled mode after the device completes a SET FEATURES command with subcommand CCh without error. A device in the reverting to defaults enabled mode may reset parameters to their default power-on values during the processing of a software reset.

7.49.14 Enable/Disable the Free-fall Control feature set

Subcommand codes 41h and C1h allow the host to enable or disable the Free-fall Control feature set (see 4.9). To enable the Free-fall Control feature set, the host writes the Count field with the requested free-fall control sensitivity setting and processes a SET FEATURES command with subcommand code 41h.

The sensitivity is selected on a scale from 00h to FFh. A value of zero selects the device vendor's recommended setting. Other values are vendor specific. The higher the sensitivity value, the more sensitive the device is to changes in acceleration.

Enabling or disabling of the Free-fall Control feature set, and the current free-fall sensitivity setting shall be preserved by the device across all forms of reset (i.e., power-on reset, hardware reset, and software resets).

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7.49.15 Enable/Disable SATA feature

7.49.15.1 Overview

Subcommand codes 10h and 90h allow the host to enable or disable Serial ATA features. The Count field contains the specific Serial ATA feature to enable or disable. The specific Serial ATA features in which SET FEATURES is applicable are defined in table 123.

Table 123 — SATA features

Count	Description
00h	Reserved for Serial ATA
01h	Non-zero Buffer Offsets
02h	DMA Setup FIS Auto-Activate optimization
03h	Device-initiated interface power state transitions
04h	Guaranteed In-Order Data Delivery
05h	Asynchronous Notification
06h	Software Settings Preservation
07h-FFh	Reserved for Serial ATA

7.49.15.2 Enable/Disable Non-Zero Buffer Offsets

A Count field value of 01h is used to enable or disable non-zero buffer offsets for commands in the NCQ feature set (see 4.14). By default, non-zero buffer offsets are disabled. The enable/disable state for non-zero offsets shall be preserved across software reset. The enable/disable state for non-zero offsets shall be reset to its default state upon COMRESET. See SATA 2.6 for more information.

7.49.15.3 Enable/Disable DMA Setup FIS Auto-Activate Optimization

A Count field value of 02h is used to enable or disable DMA Setup FIS Auto-Activate optimization. See SATA 2.6 for more information. The enable/disable state for the auto-activate optimization shall be preserved across software reset. The enable/disable state for the auto-activate optimization shall be reset to its default state upon COMRESET.

7.49.15.4 Enable/Disable Device-Initiated Interface Power State Transitions

A Count field value of 03h is used to enable or disable device initiation of interface power state transitions. By default, the device is not permitted to initiate interface power state transitions. See SATA 2.6 for more information. The enable/disable state for device initiated power management shall persist across software reset. The enable/disable state shall be reset to its default disabled state upon COMRESET.

If device initiated interface power management is enabled, the device shall not attempt to initiate an interface power state transition between reset and the delivery of the device reset signature (see table 217).

7.49.15.5 Enable/Disable Guaranteed in-Order Data Delivery

A Count field value of 04h is used to enable or disable guaranteed in-order data delivery for commands in the NCQ feature set (see 4.14). This setting is only valid when non-zero buffer offsets are enabled. By default, guaranteed in-order data delivery is disabled. See SATA 2.6 for more information. The enable/disable state for guaranteed in-order data delivery shall be preserved across software reset. The enable/disable state for guaranteed in-order data delivery shall be reset to its default state upon COMRESET.

7.49.15.6 Enable/Disable Asynchronous Notification

For ATAPI devices, a Count field value of 05h is used to enable or disable asynchronous notification. By default, asynchronous notification is disabled. See SATA 2.6 for more information. The enable/disable state for asynchronous notification shall be preserved across software reset. The enable/disable state for asynchronous notification shall be reset to its default state upon COMRESET.

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7.49.15.7 Enable/Disable Software Settings Preservation

See table 13 for a list of the preserved feature sets and settings. A Count field value of 06h is used to enable or disable software settings preservation. By default, if the device supports software settings preservation the feature is enabled when it processes a power-on reset. The enable/disable state for software settings preservation shall persist across software reset. The enable/disable state for software settings preservation shall be reset to its default state upon COMRESET. The host may disable software settings preservation in order to cause software settings to revert to their power-on default state when the device receives a COMRESET.

7.49.16 Enable/Disable the Sense Data Reporting feature set

Subcommand code C3h allows the application client to enable the Sense Data Reporting feature set (see 4.22) by issuing this subcommand with bit zero of the count field set to one.

The Sense Data Reporting feature set shall be disabled by issuing this subcommand with bit zero of the Count field cleared to zero.

All other sub-command specific fields are reserved.

7.49.17 Long Physical Sector Alignment Error Reporting Control

Subcommand code 62h allows the application client to control the reporting of errors associated with the LPS feature set (see 4.13). IDENTIFY DEVICE data word 69 bit 13 (see 7.17.7.30) indicates that Long Physical Sector Alignment Error Reporting is supported. IDENTIFY DEVICE data word 49 bits (1:0) (see 7.17.7.17) indicate the current Long Physical Sector Alignment Error Reporting setting.

If the Count field is cleared to zero, then the device shall disable Alignment Error reporting;

If the Count field is set to one, then the device shall process the command and shall report an Alignment (see 6.2.2) when the application client issues a write command in which:

a) the first byte of data transfer does not begin at the first byte of a physical sector (see 7.17.7.76); or
b) the last byte of data transfer does not end at the last byte of a physical sector (see 7.17.7.76).

If the Count field is set to two, then the device shall report an Alignment Error (see 6.2.2) and Command Aborted, leaving the condition of the data unknown, if the application client issues a write command in which:

a) the first byte of data transfer does not begin at the first byte of a physical sector (see 7.17.7.76); or
b) the last byte of data transfer does not end at the last byte of a physical sector (see 7.17.7.76).

If the Count field is set to 03h..FFh, the device shall report command aborted.

If Long Physical Sector Alignment Error Reporting Control is supported, then the device shall support the Long Physical Sector Mis-alignment log (see A.11).

This setting shall be preserved across all resets.

7.49.18 Extended power conditions

7.49.18.1 Overview

Subcommand code 4Ah enables, disables, and configures the use of the Extended Power Conditions feature set (see 4.8). If the EPC feature is not supported, then the device shall

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return command aborted. Table 124 describes the EPC subcommands and table 125 describes the power condition IDs.

Table 124 — Extended Power Conditions Subcommands

EPC Subcommand	Description
0h	Restore Power Condition Settings (see 7.49.18.2)
1h	Go To Power Condition (see 7.49.18.3)
2h	Set Power Condition Timer (see 7.49.18.4)
3h	Set Power Condition State (see 7.49.18.5)
4h	Enable the EPC feature set (see 7.49.18.6)
5h	Disable the EPC feature set (see 7.49.18.7)
6h..Fh	Reserved

Table 125 — Power Condition IDs

Power Condition ID	Power Condition Name	Description
00h	Standby_z	A substate of the PM2:Standby state [a]
01h	Standby_y	A substate of the PM2:Standby state [a]
02h..80h		Reserved
81h	Idle_a	A substate of the PM1:Idle state [a]
82h	Idle_b	A substate of the PM1:Idle state [a]
83h	Idle_c	A substate of the PM1:Idle state [a]
84h..FEh		Reserved
FFh	All	All EPC power conditions

[a] See 4.17.4 for the description of the power states.

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7.49.18.2 Restore Power Condition Settings subcommand

7.49.18.2.1 Description

On successful completion of this EPC subcommand, the device shall update the Power Conditions log (see A.8) for the selected Power Condition ID(s) as follows:

1) if Default is set to one, then:
   A) copy the Default Timer Settings field (see A.8) to the Current Timer Settings field (see A.8); and
   B) copy the Default Timer Enabled field (see A.8) to the Current Timer Enabled field (see A.8);
2) if Default is cleared to zero, then:
   A) copy the Saved Timer Settings field (see A.8) to the Current Timer Settings field (see A.8); and
   B) copy the Saved Timer Enabled field (see A.8) to the Current Timer Enabled field (see A.8);

   and
3) if Save is set to one and the power condition is saveable, then:
   A) copy the Current Timer Settings field (see A.8) to the Saved Timer Settings field (see A.8); and
   B) copy the Current Timer Enabled field (see A.8) to the Saved Timer Enabled field (see A.8).

7.49.18.2.2 Inputs

See table 126 for the SET FEATURES command inputs.

Table 126 — Restore Power Condition Settings inputs

Name	Description
Count	Power Condition (see table 125)
LBA	**Bit** **Description** 27:7 Reserved 6 Default 1 = Restore from Default settings 0 = Restore from Saved settings 5 Reserved 4 Save 1 = Save settings on completion 0 = Do not save settings on completion 3:0 0h (i.e., Restore Power Condition subcommand (see table 124))

7.49.18.2.3 Normal Outputs

See table 212.

7.49.18.2.4 Error Outputs

If any selected Power Condition:

a) is not supported;
b) is not changeable; or
c) the Save bit is set to one and any selected power condition is not saveable,

then the device shall return command aborted. See table 235.

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7.49.18.3 Go To Power Condition subcommand

7.49.18.3.1 Description

On successful completion of this EPC subcommand, the device shall:

1) stop all enabled EPC timers (see 4.8.3);
2) enter the selected EPC power condition (see 4.8.2) after command completion of the SET FEATURES command without having to wait for any timers to expire; and
3) the device shall remain in the selected power condition until the device processes the next command or reset.

7.49.18.3.2 Inputs

See table 127 for the SET FEATURES command inputs.

Table 127 — Go To Power Condition inputs

Name	Description
Count	Power Condition (see table 125)
LBA	**Bit** **Description** 27:4 Reserved 3:0 1h (i.e., Go To Power Condition subcommand (see table 124))

7.49.18.3.3 Normal Outputs

See table 212.

7.49.18.3.4 Error Outputs

If the Power condition ID is FFh, a reserved value, or is not supported, then the device shall return command aborted. See table 235.

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7.49.18.4 Set Power Condition Timer subcommand

7.49.18.4.1 Description

On successful completion of this EPC subcommand, the device shall update the Power Conditions log (see A.8) for the selected and supported Power Condition (see 4.8.2) as follows:

1) copy the Timer field to the Current Timer Settings field;
2) if Enable is set to one and the Timer field is non-zero, then enable the Current Timer;
3) if Enable is set to one and the Timer field is zero, then disable the Current Timer;
4) if Enable is cleared to zero, then disable the Current Timer; and
5) if Save is set to one and the Power Condition settings are saveable, then:
   A) copy the Current Timer Settings field to the Saved Timer Settings field; and
   B) copy the Current Timer Enabled field to the Saved Timer Enabled field.

7.49.18.4.2 Inputs

See table 128 for the SET FEATURES command inputs.

Table 128 — Set Power Condition Timer inputs

Name	Description
Count	Power Condition (see table 125)
LBA	**Bit Description** 27:24 Reserved 23:8 Timer (15:0) (see 7.49.18.4.3) 7 Timer Units (see 7.49.18.4.4) 6 Reserved 5 Enable 1 = Enable the selected power condition 0 = Disable the selected power condition 4 Save 1 = Save settings on completion 0 = Do not save settings on completion 3:0 2h (i.e., Set Power Condition Timer subcommand (see table 124))

7.49.18.4.3 Timer (15:0)

If the new timer value is greater than the maximum value setting, then the device may set the value to the maximum setting. If the new timer value is less than the minimum setting, then the device may set the value to the minimum setting.

7.49.18.4.4 Timer Units

If the Timer Units bit is cleared to zero, then the Timer (15:0) shall be specified in units of 100 ms.

If the Timer Units bit is set to one, then the Timer (15:0) shall be specified in units of 1 min.

7.49.18.4.5 Normal Outputs

See table 212.

7.49.18.4.6 Error Outputs

The device shall return command aborted If:

a) the new timer value is:
   A) less than the maximum setting;
   B) greater than the minimum setting; and

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C) not supported by the device;

b) the Power Condition field is invalid;

c) the power condition is not changeable or not supported;

d) the Save bit is set to one and the selected power condition is not saveable;

e) the new time value is greater than the maximum setting (see A.8) and the device did not set the timer to the maximum setting; or

f) the new time value is less than the minimum setting (see A.8) and the device did not set the timer to the minimum setting.

If command aborted is returned, then the device shall make no modifications to the power condition settings. See table 235.

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7.49.18.5 Set Power Condition State subcommand

7.49.18.5.1 Description

On successful completion of this EPC subcommand, the device shall update the Power Conditions log (see A.8) for the Power Condition(s) as follows:

1) If the Enable bit (see A.8) is set to one, then enable the Current Timer (see A.8); otherwise disable the Current Timer; and
2) If the Save bit (see A.8) is set to one, then copy the Current Timer Enabled field to the Saved Timer Enabled field.

7.49.18.5.2 Inputs

See table 129 for the SET FEATURES command inputs.

Table 129 — Set Power Condition State inputs

Name	Description
Count	Power Condition (see table 125)
LBA	**Bit** **Description** 27:6 Reserved 5 Enable 1 = Enable the selected power condition 0 = Disable the selected power condition 4 Save 1 = Save settings on completion 0 = Do not save settings on completion 3:0 3h (i.e., Set Power Condition State subcommand (see table 124))

7.49.18.5.3 Normal Outputs

See table 212.

7.49.18.5.4 Error Outputs

If the Power Condition is invalid, not changeable, or not supported, then the device shall return command aborted. If the Save bit is set to one and the selected power condition is not saveable, then the device shall return command aborted. If command aborted is returned, then the device shall make no modifications to the power condition settings. See table 235.

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7.49.18.6 Enable the EPC feature set subcommand

7.49.18.6.1 Description

On successful completion of this EPC subcommand, the device shall:

a) enable the EPC feature set;
b) set IDENITFY DEVICE data word 120 bit 7 to one; and
c) disable the APM feature set.

If the EPC feature set is enabled, then the EPC feature set shall remain enabled across all resets (i.e., power-on reset, hardware reset, and software reset).

7.49.18.6.2 Inputs

See table 127 for the SET FEATURES command inputs.

Table 130 — Enable the EPC feature set inputs

Name	Description
Count	Reserved
LBA	**Bit** **Description** 27:4 Reserved 3:0 4h (i.e., Enable the EPC feature set (see table 124))

7.49.18.6.3 Normal Outputs

See table 212.

7.49.18.6.4 Error Outputs

See table 235.

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7.49.18.7 Disable the EPC feature set subcommand

7.49.18.7.1 Description

On successful completion of this EPC subcommand, the device shall:

a) disable the EPC feature set; and
b) clear IDENITFY DEVICE data word 120 bit 7 to zero.

If the EPC feature set is disabled, then the EPC feature set shall remain disabled across all resets (i.e., power-on reset, hardware reset, and software reset).

7.49.18.7.2 Inputs

See table 127 for the SET FEATURES command inputs.

Table 131 — Disable the EPC feature set inputs

Name	Description
Count	Reserved
LBA	**Bit** **Description** 27:0 Reserved 3:0 5h (i.e., Disable the EPC feature set (see table 124))

7.49.18.7.3 Normal Outputs

See table 212.

7.49.18.7.4 Error Outputs

See table 235.

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7.49.19 Inputs

See table 132 for the SET FEATURES command inputs.

Table 132 — SET FEATURES command inputs

Name	Description
Feature	Subcommand Code – See table 118
Count	Subcommand specific
LBA	Subcommand specific
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 EFh

7.49.20 Normal Outputs

See table 212.

7.49.21 Error Outputs

The Abort bit shall be set to one if any subcommand input value is not supported or is invalid. See table 235.

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7.50 SET MAX

7.50.1 SET MAX Overview

Individual SET MAX commands are identified by the value placed in the Feature field. Table 133 shows these Feature field values.

Table 133 — SET MAX Feature field values

Value	Command
00h	Obsolete
01h	SET MAX SET PASSWORD (see 7.50.5)
02h	SET MAX LOCK (see 7.50.4)
03h	SET MAX UNLOCK (see 7.50.7)
04h	SET MAX FREEZE LOCK (see 7.50.3)
05h	SET MAX SET PASSWORD DMA (see 7.50.6)
06h	SET MAX UNLOCK DMA (see 7.50.8)
07h..FFh	Reserved

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7.50.2 SET MAX ADDRESS - F9h, Non-Data

7.50.2.1 Feature Set

This 28-bit command is for devices that implement the HPA feature set (see 4.11).

7.50.2.2 Description

The SET MAX ADDRESS command shall cause all read and write access attempts to an LBA greater than the LBA specified by the successful SET MAX ADDRESS command to be rejected with the ID Not Found bit (see 6.3.6) set to one. IDENTIFY DEVICE data words 60..61 (see 7.17.7.22) shall reflect the maximum LBA set with this command.

If the device successfully processes a SET MAX ADDRESS command with an LBA less than the native max without error, and the 48-bit Address feature set is supported, then the value placed in IDENTIFY DEVICE data words 100..103 (see 7.17.7.53) shall be the same as the value placed in IDENTIFY DEVICE data words 60..61.

A host should not issue more than one non-volatile SET MAX ADDRESS command or SET MAX ADDRESS EXT command after a power-on reset or hardware reset.

A device shall not change the content in IDENTIFY DEVICE data words 60..61 or IDENTIFY DEVICE data words 100..103 during processing of a software reset.

The contents of IDENTIFY DEVICE data and the maximum LBA shall not be changed if a SET MAX ADDRESS command fails.

After a successful SET MAX ADDRESS command using a new maximum LBA the content of all IDENTIFY DEVICE data words shall comply with 4.11.4 and the content of IDENTIFY DEVICE data words 60..61 shall be equal to the new Maximum LBA + 1.

A successful READ NATIVE MAX ADDRESS command should immediately precede a SET MAX ADDRESS command. If the SET MAX ADDRESS command is not preceded by a successful READ NATIVE MAX ADDRESS command, the device shall return command aborted for the SET MAX ADDRESS command or process one of the following commands:

a) SET MAX SET PASSWORD;
b) SET MAX LOCK;
c) SET MAX UNLOCK; or
d) SET MAX FREEZE LOCK.

The result depends on the value of the Feature field (see table 134).

When the device successfully processes a SET MAX ADDRESS command with the value returned by the READ NATIVE MAX ADDRESS command, the device shall:

a) If the value returned by the READ NATIVE MAX EXT command is greater than the value returned by the READ NATIVE MAX command, then IDENTIFY DEVICE data words 100..103 shall indicate the value returned by the READ NATIVE MAX EXT command and IDENTIFY DEVICE data words 60..61 shall comply with 4.11.4; or
b) Otherwise IDENTIFY DEVICE data words 60..61 shall indicate the value returned by the READ NATIVE MAX command and IDENTIFY DEVICE data words 100..103 shall comply with 4.11.4.

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7.50.2.3 Inputs

7.50.2.3.1 Overview

See table 134 for the SET MAX ADDRESS command inputs.

Table 134 — SET MAX ADDRESS command inputs

Name	Description
Feature	N/A
Count	**Bit Description** 7:1 N/A 0 Volatile_Value (V_V) – See 7.50.2.3.2.
LBA	Maximum LBA
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 F9h

7.50.2.3.2 Volatile_Value (V_V)

If the V_V bit is set to one, then during processing of a power-on reset or a hardware reset, a device shall not change the content in IDENTIFY DEVICE data words 60..61 (see 7.17.7.22) or IDENTIFY DEVICE data 100..103 (see 7.17.7.53).

If the V_V bit is cleared to zero, then during processing of a power-on reset or a hardware reset, a device shall change the content in IDENTIFY DEVICE data words 60..61 (see 7.17.7.22) and IDENTIFY DEVICE data words 100..103 (see 7.17.7.53) to be a value one greater than the value of either:

a) the value in the LBA field in the most recent SET MAX ADDRESS command or SET MAX ADDRESS EXT command that completed without error in which the V_V bit was set to one; or
b) if no SET MAX ADDRESS command or SET MAX ADDRESS EXT command has completed without error, then the native max address.

7.50.2.4 Normal Outputs

See Table 220.

7.50.2.5 Error Outputs

If:

a) the value in the LBA field exceeds the capacity of the device;
b) a host protected area has been established by a SET MAX ADDRESS EXT command;
c) the device is HPA Locked (see 4.11.6); or
d) the device has successfully processed a SET MAX FREEZE LOCK command,

then the device shall return command aborted.

If the Maximum LBA is less than the native max address, then the ID Not Found bit (see 6.3.6) shall be set to one if a previous non-volatile SET MAX ADDRESS command has been processed since the last power-on reset or hardware reset. The Abort bit shall be set to one if the maximum value requested exceeds the device capacity, a host protected area has been established by a SET MAX ADDRESS EXT command, the device is HPA Locked (see 4.11.6)

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or has successfully processed a SET MAX FREEZE LOCK command, or the command is not immediately preceded by a READ NATIVE MAX ADDRESS command. See table 247.

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7.50.3 SET MAX FREEZE LOCK - F9h/04h, Non-Data

7.50.3.1 Feature Set

This 28-bit command is for devices that implement the HPA security extensions (see 4.11.2).

7.50.3.2 Description

The SET MAX FREEZE LOCK command shall cause any subsequent SET MAX commands to return command aborted until a power-on reset has been processed by the device.

The following commands are disabled by the SET MAX FREEZE LOCK command:

a) SET MAX ADDRESS;
b) SET MAX SET PASSWORD;
c) SET MAX LOCK;
d) SET MAX UNLOCK; and
e) SET MAX ADDRESS EXT.

This command should not be immediately preceded by a READ NATIVE MAX ADDRESS command. If this command is immediately preceded by a READ NATIVE MAX ADDRESS command, it shall be interpreted as a SET MAX ADDRESS command.

7.50.3.3 Inputs

See table 135 for the SET MAX FREEZE LOCK command inputs.

Table 135 — SET MAX FREEZE LOCK command inputs

Name	Description
Feature	04h
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 F9h

7.50.3.4 Normal Outputs

See table 212.

7.50.3.5 Error Outputs

See table 238.

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7.50.4 SET MAX LOCK - F9h/02h, Non-Data

7.50.4.1 Feature Set

This 28-bit command is for devices that implement the HPA security extensions (see 4.11.2).

7.50.4.2 Description

if the device successfully processes a SET MAX LOCK command, then:

a) the device is HPA Locked;
b) the HPA Security Extensions unlock counter (see 4.11.6) shall be set to a value of five; and
c) any other SET MAX commands except SET MAX UNLOCK command and SET MAX FREEZE LOCK command shall return command aborted.

The device shall remain in this state until a power-on reset has been processed or command completion without error of a SET MAX UNLOCK command or SET MAX FREEZE LOCK command.

This command should not be immediately preceded by a READ NATIVE MAX ADDRESS command. If this command is immediately preceded by a READ NATIVE MAX ADDRESS command, it shall be interpreted as a SET MAX ADDRESS command.

7.50.4.3 Inputs

See table 136 for the SET MAX FREEZE LOCK command inputs.

Table 136 — SET MAX FREEZE LOCK command inputs

Name	Description
Feature	02h
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 F9h

7.50.4.4 Normal Outputs

See table 212.

7.50.4.5 Error Outputs

The Abort bit shall be set to one if the device is HPA Locked (see 4.11.6)

or has successfully processed a SET MAX FREEZE LOCK command. See table 238.

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7.50.5 SET MAX SET PASSWORD - F9h/01h, PIO Data-Out

7.50.5.1 Feature Set

This 28-bit command is for devices that implement the HPA security extensions (see 4.11.2).

7.50.5.2 Description

The SET MAX SET PASSWORD command requests a transfer of a single 512-byte block of data from the host. Table 138 defines the content of this 512-byte block of data. The password is not retained by the device after the device has processed a power-on reset.

NOTE This password is not related to the passwords that are part of the Security feature set (see 4.20).

This command should not be immediately preceded by a READ NATIVE MAX ADDRESS command. If this command is immediately preceded by a READ NATIVE MAX ADDRESS command, it shall be interpreted as a SET MAX ADDRESS command.

7.50.5.3 Inputs

See table 137 for the SET MAX SET PASSWORD command inputs.

Table 137 — SET MAX SET PASSWORD command inputs

Name	Description
Feature	01h
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 F9h

7.50.5.4 Normal Outputs

See table 212.

7.50.5.5 Error Outputs

If a device is HPA Locked (see 4.11.6) or has successfully processed a SET MAX FREEZE LOCK command, then the device shall return command aborted. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 247.

7.50.5.6 Output From the Host to the Device Data Structure

Table 138 — SET MAX SET PASSWORD data content

Word	Description
0	Reserved
1..16	Password (32 bytes)
17..255	Reserved

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7.50.6 SET MAX SET PASSWORD DMA - F9h/05h, DMA

7.50.6.1 Feature Set

This 28-bit command is for devices that implement the HPA security extensions (see 4.11.2).

7.50.6.2 Description

See 7.50.5.2.

7.50.6.3 Inputs

See table 139 for the SET MAX SET PASSWORD DMA command inputs.

Table 139 — SET MAX SET PASSWORD DMA command inputs

Name	Description
Feature	05h
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 F9h

7.50.6.4 Normal Outputs

See 7.50.5.4.

7.50.6.5 Error Outputs

See 7.50.5.5.

7.50.6.6 Output From the Host to the Device Data Structure

See 7.50.5.6.

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7.50.7 SET MAX UNLOCK - F9h/03h, PIO Data-Out

7.50.7.1 Feature Set

This 28-bit command is mandatory for devices that implement the HPA security extensions (see 4.11.2).

7.50.7.2 Description

The SET MAX UNLOCK command requests a transfer of a single 512-byte block of data from the host. Table 138 defines the content of this data.

The password supplied in the data transferred shall be compared with the password set by the SET MAX SET PASSWORD command.

If the device is locked from HPA commands and the password compare fails, then the device shall return command aborted and decrement the HPA Security Extensions unlock counter (see 4.11.6). This counter shall be decremented for each password mismatch when the SET MAX UNLOCK command is issued and the device is locked from HPA commands. When this counter reaches zero in a device, then the device shall return command aborted for all subsequent SET MAX UNLOCK commands until after the device has processed a power-on reset.

NOTE The HPA Security Extensions unlock counter is not related to the Security feature set unlock counter.

If the device is HPA Locked, the HPA Security Extensions unlock counter is not zero, and the password compare matches, then the device is HPA Unlocked (see 4.11.6) and all SET MAX commands shall be accepted.

This command should not be immediately preceded by a READ NATIVE MAX ADDRESS command. If this command is immediately preceded by a READ NATIVE MAX ADDRESS command, it shall be interpreted as a SET MAX ADDRESS command.

7.50.7.3 Inputs

See table 140 for the SET MAX UNLOCK command inputs.

Table 140 — SET MAX UNLOCK command inputs

Name	Description
Feature	03h
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 F9h

7.50.7.4 Normal Outputs

See table 212.

7.50.7.5 Error Outputs

If a device is not HPA Locked (see 4.11.6), then the device shall return command aborted. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 239.

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7.50.7.6 Output From the Host to the Device Data Structure

See 7.50.5.6.

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7.50.8 SET MAX UNLOCK DMA - F9h/06h, DMA

7.50.8.1 Feature Set

This 28-bit command is for devices that implement the HPA security extensions (see 4.11.2).

7.50.8.2 Description

See 7.50.7.2.

7.50.8.3 Inputs

See table 141 for the SET MAX UNLOCK DMA command inputs.

Table 141 — SET MAX UNLOCK DMA command inputs

Name	Description
Feature	06h
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 F9h

7.50.8.4 Normal Outputs

See 7.50.7.4.

7.50.8.5 Error Outputs

See 7.50.7.5.

7.50.8.6 Output From the Host to the Device Data Structure

See 7.50.7.6.

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7.51 SET MAX ADDRESS EXT - 37h, Non-Data

7.51.1 Feature Set

This 48-bit command is for devices that implement both the HPA feature set (see 4.11) and the 48-bit Address feature set (see 4.4).

7.51.2 Description

The SET MAX ADDRESS EXT command shall cause all read and write access attempts to an LBA greater than the LBA specified by the successful SET MAX ADDRESS EXT command to be rejected with an ID Not Found error.

A host should not issue more than one non-volatile SET MAX ADDRESS EXT command after a power-on reset or hardware reset.

The contents of IDENTIFY DEVICE data (see table 50) and the maximum LBA shall not be changed if a SET MAX ADDRESS EXT command fails.

After a successful SET MAX ADDRESS EXT command using a new maximum LBA the content of all IDENTIFY DEVICE data words shall comply with 4.11.4.

A successful READ NATIVE MAX EXT command should immediately precede SET MAX ADDRESS EXT command. If the device receives a SET MAX ADDRESS EXT command that is not immediately preceded by READ NATIVE MAX EXT command, then the device shall report command aborted.

7.51.3 Inputs

7.51.3.1 Overview

See table 142 for the SET MAX ADDRESS EXT command inputs.

Table 142 — SET MAX ADDRESS EXT command inputs

Name	Description
Feature	N/A
Count	**Bit Description** 15:1 N/A 0 Volatile_Value (V_V) – See 7.51.3.2.
LBA	Maximum LBA
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 37h

7.51.3.2 Volatile_Value (V_V)

If the V_V bit is set to one, then during processing of a power-on reset or a hardware reset, a device shall not change the content in IDENTIFY DEVICE data words 60..61 (see 7.17.7.22) or IDENTIFY DEVICE data 100..103 (see 7.17.7.53).

If the V_V bit is cleared to zero, then during processing of a power-on reset or hardware reset, a device shall:

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a) change the content in IDENTIFY DEVICE data words 100..103 to be a value one greater than the value of either:
   A) the value in the LBA field in the most recent SET MAX ADDRESS command or SET MAX ADDRESS EXT command that completed without error in which the V_V bit was set to one; or
   B) if no SET MAX ADDRESS command or SET MAX ADDRESS EXT command has completed without error, then the native max address;
   and
b) change the content in IDENTIFY DEVICE data words 60..61 to be the value in IDENTIFY DEVICE data words 100..103 or 0FFF_FFFFh, whichever is less.

Regardless of the setting of the V_V bit, a device shall not change the content in IDENTIFY DEVICE data words 60..61 or IDENTIFY DEVICE data 100..103 during processing of a software reset.

7.51.4 Normal Outputs

See table 224.

7.51.5 Error Outputs

If:

a) the value in the LBA field exceeds the capacity of the device;
b) a host protected area has been established by a SET MAX ADDRESS command;
c) this command is not immediately preceded by a READ NATIVE MAX ADDRESS EXT command;
d) the device is HPA Locked (see 4.11.6); or
e) the device has successfully processed a SET MAX FREEZE LOCK command,

then the device shall return command aborted.

If the Maximum LBA (see 4.11.4) is less than the native max address, then the ID Not Found bit (see 6.3.6) shall be set to one if a previous non-volatile SET MAX ADDRESS EXT command has been processed since the last power-on reset or hardware reset. See table 259.

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7.52 SET MULTIPLE MODE - C6h, Non-Data

7.52.1 Feature Set

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

7.52.2 Description

The SET MULTIPLE MODE command establishes the number of logical sectors in the DRQ data block count for the READ MULTIPLE command, READ MULTIPLE EXT command, WRITE MULTIPLE command, and WRITE MULTIPLE EXT command. The content of the Count field shall be less than or equal to the value in IDENTIFY DEVICE data word 47 bits (7:0) (see 7.17.7.15). The host should set the content of the Count field to 1, 2, 4, 8, 16, 32, 64, or 128.

Devices shall support the DRQ data block size specified in the IDENTIFY DEVICE data word 47 bits (7:0) (see 7.17.7.15), and may also support smaller values.

Upon receipt of the command, the device checks the Count field. If the content of the Count field is not zero, the Count field contains a valid value, and the DRQ data block count is supported, then the value in the Count field is used for all subsequent READ MULTIPLE commands, READ MULTIPLE EXT commands, WRITE MULTIPLE commands, WRITE MULTIPLE EXT commands, and WRITE MULTIPLE FUA EXT commands and their processing is enabled.

If the content of the Count field is zero and the SET MULTIPLE command completes without error, then the device shall respond to any subsequent READ MULTIPLE command, READ MULTIPLE EXT command, WRITE MULTIPLE command, WRITE MULTIPLE EXT command, and WRITE MULTIPLE FUA EXT command with command aborted until a subsequent successful SET MULTIPLE command completion where the Count field is not set to zero.

If the content of the Count field is zero, then the device may:

a) disable multiple mode (i.e., respond with command aborted for all subsequent READ MULTIPLE commands, READ MULTIPLE EXT commands, WRITE MULTIPLE commands, WRITE MULTIPLE EXT commands, and WRITE MULTIPLE FUA EXT commands);
b) return command aborted for all SET MULTIPLE MODE commands; or
c) retain the previous multiple mode settings.

After a successful SET MULTIPLE command the device shall report the valid value set by that command in IDENTIFY DEVICE data word 59 (see 7.17.7.21).

After a power-on reset or hardware reset, if IDENTIFY DEVICE data word 59 bit 8 is set to one and IDENTIFY DEVICE data word 59 bits (7:0) are cleared to zero, a SET MULTIPLE command is required before issuing a READ MULTIPLE command, READ MULTIPLE EXT command, WRITE MULTIPLE command, or WRITE MULTIPLE EXT command. If bit 8 is set to one and bits (7:0) are not cleared to zero, a SET MULTIPLE command may be issued to change the multiple value required before issuing a READ MULTIPLE command, READ MULTIPLE EXT command, WRITE MULTIPLE command, or WRITE MULTIPLE EXT command.

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7.52.3 Inputs

See table 143 for the SET MULTIPLE MODE command inputs.

Table 143 — SET MULTIPLE MODE command inputs

Name	Description
Feature	N/A
Count	DRQ data block count
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 C6h

7.52.4 Normal Outputs

See table 212.

7.52.5 Error Outputs

The Abort bit shall be set to one if the block count is not supported. See table 235.

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7.53 SLEEP - E6h, Non-Data

7.53.1 Feature Set

This 28-bit command is for devices implementing the Power Management feature set (see 4.17).

7.53.2 Description

The SLEEP command causes the device to enter Sleep mode. The device shall exit Sleep (i.e., PM3 state (see 4.17.4)) only after processing a hardware reset, a software reset, or a DEVICE RESET command.

A device shall not power-on in Sleep mode.

7.53.3 Inputs

See table 144 for the SLEEP command inputs.

Table 144 — SLEEP command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 E6h

7.53.4 Normal Outputs

See table 212.

7.53.5 Error Outputs

See table 235.

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7.54 SMART

7.54.1 Overview

Individual SMART commands are identified by the value placed in the Feature field. Table 145 shows these values.

Table 145 — SMART Feature field values

Value	Command
00h..CFh	Reserved
D0h	SMART READ DATA (see 7.54.6)
D1h	Obsolete
D2h	SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE (see 7.54.3)
D3h	Obsolete
D4h	SMART EXECUTE OFF-LINE IMMEDIATE (see 7.54.5)
D5h	SMART READ LOG (see 7.54.7)
D6h	SMART WRITE LOG (see 7.54.9)
D7h	Obsolete
D8h	SMART ENABLE OPERATIONS (see 7.54.4)
D9h	SMART DISABLE OPERATIONS (see 7.54.2)
DAh	SMART RETURN STATUS (see 7.54.8)
DBh	Obsolete
DCh..DFh	Reserved
E0h..FFh	vendor specific

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7.54.2 SMART DISABLE OPERATIONS - B0h/D9h, Non-Data

7.54.2.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.21).

7.54.2.2 Description

The SMART DISABLE OPERATIONS command shall disable all SMART operations. After completion of this command without error the device shall report command aborted for all other SMART commands (e.g., SMART DISABLE OPERATIONS commands), except for the SMART ENABLE OPERATIONS command and the SCT Command Transport commands, which shall be processed as defined. The state of SMART (i.e., enabled or disabled) shall be preserved by the device during all power-on reset events.

7.54.2.3 Inputs

See table 146 for the SMART DISABLE OPERATIONS command inputs.

Table 146 — SMART DISABLE OPERATIONS command inputs

Name	Description
Feature	D9h
Count	N/A
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.54.2.4 Normal Outputs

See table 212.

7.54.2.5 Error Outputs

The Abort bit shall be set to one if SMART is not enabled, or if an input value is invalid. See table 235.

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7.54.3 SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE - B0h/D2h, Non-Data

7.54.3.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.21).

7.54.3.2 Description

The SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE command enables and disables the attribute autosave feature of the device. This command may either allow the device, after some vendor specified event, to save the device updated attributes to non-volatile memory, or this command may cause the autosave feature to be disabled. The state of the attribute autosave feature, either enabled or disabled, shall be preserved by the device during all power and reset events.

The Count field set to zero shall cause the device to disable the attribute autosave feature. Disabling this feature does not preclude the device from saving SMART data to non-volatile memory during some other normal operation (e.g., during a power-on or power-off sequence or during an error recovery sequence).

The Count field set to F1h shall cause the device to enable the attribute autosave feature. If the Count field is not set to 00h or F1h, then the actions taken by a device are vendor specific.

If the device receives a command while processing the autosave routine the device shall begin processing the command within 2 s.

7.54.3.3 Inputs

See table 147 for the SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE command inputs.

Table 147 — SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE command inputs

Name	Description
Feature	D2h
Count	**Value** **Description** 00h Disable attribute autosave 01h-F0h Vendor specific F1h Enable attribute autosave F2h-FFh Vendor specific
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B0h

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7.54.3.4 Normal Outputs

See table 212.

7.54.3.5 Error Outputs

The Abort bit shall be set to one if SMART is not enabled, or if an input value is invalid. See table 235.

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7.54.4 SMART ENABLE OPERATIONS - B0h/D8h, Non-Data

7.54.4.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.21).

7.54.4.2 Description

The SMART ENABLE OPERATIONS command enables access to all available SMART capabilities within the device. The state of SMART, either enabled or disabled, shall be preserved by the device during all power and reset events. Once enabled, the receipt of subsequent SMART ENABLE OPERATIONS commands shall not affect any SMART data or functions.

7.54.4.3 Inputs

See table 148 for the SMART ENABLE OPERATIONS command inputs.

Table 148 — SMART ENABLE OPERATIONS command inputs

Name	Description
Feature	D8h
Count	N/A
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.54.4.4 Normal Outputs

See table 212.

7.54.4.5 Error Outputs

See table 235.

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7.54.5 SMART EXECUTE OFF-LINE IMMEDIATE - B0h/D4h, Non-Data

7.54.5.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.21).

7.54.5.2 Description

7.54.5.2.1 Overview

The SMART EXECUTE OFF-LINE IMMEDIATE command causes the device to initiate the set of activities that collect SMART data in an off-line mode and then preserve this data across power and reset events, or process a vendor specific self-diagnostic test routine in either captive or off-line mode. Table 149 lists the SMART EXECUTE OFF-LINE IMMEDIATE Subcommands.

Table 149 — SMART EXECUTE OFF-LINE IMMEDIATE Subcommands

Value	Description of subcommand to be processed
00h	Execute SMART off-line routine (see 7.54.5.2.4) in off-line mode [a]
01h	Execute SMART Short self-test routine (see 7.54.5.2.5) in off-line mode [a]
02h	Execute SMART Extended self-test routine (see 7.54.5.2.6) in off-line mode [a]
03h	Execute SMART Conveyance self-test routine (see 7.54.5.2.7) in off-line mode [a]
04h	Execute SMART Selective self-test routine (see 7.54.5.2.8) in off-line mode [a]
05h..3Fh	Reserved
40h..7Eh	Vendor specific
7Fh	Abort off-line mode self-test routine
80h	Reserved
81h	Execute SMART Short self-test routine (see 7.54.5.2.5) in captive mode [b]
82h	Execute SMART Extended self-test routine (see 7.54.5.2.6) in captive mode [b]
83h	Execute SMART Conveyance self-test routine (see 7.54.5.2.7) in captive mode [b]
84h	Execute SMART Selective self-test routine (see 7.54.5.2.8) in captive mode [b]
85h..8Fh	Reserved
90h..FFh	Vendor specific

[a] See 7.54.5.2.2
[b] See 7.54.5.2.3

7.54.5.2.2 Off-line mode

The following describes the protocol for processing a SMART EXECUTE OFF-LINE IMMEDIATE subcommand routine, including a self-test routine, in the off-line mode:

1) the device shall report command completion before processing the subcommand routine;
2) the device shall remain ready to receive a new command during processing of the subcommand routine;
3) if the device is in the process of performing the subcommand routine and is interrupted by any new command from the host except a SLEEP command, SMART DISABLE OPERATIONS command, SMART EXECUTE OFF-LINE IMMEDIATE command, or STANDBY IMMEDIATE command, then the device shall suspend or abort the subcommand routine and begin processing the new command within 2 s after receipt of the new command. After servicing the interrupting command, the device may re-initiate or resume the subcommand routine without any additional commands from the host (see 7.54.6.10);
4) if the device is in the process of performing a subcommand routine and is interrupted by a SLEEP command from the host, then the device may abort the subcommand routine and process the SLEEP command. If the device is in the process of performing any self-test routine and is interrupted by a SLEEP command, then the device shall abort the subcommand routine and process the SLEEP command;

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5) if the device is in the process of performing the subcommand routine and is interrupted by a SMART DISABLE OPERATIONS command, then the device shall suspend or abort the subcommand routine and begin processing the new command within 2 s after receipt of the command. Upon receipt of the next SMART ENABLE OPERATIONS command the device may, either re-initiate the subcommand routine or resume the subcommand routine from where it had been previously suspended;
6) if the device is in the process of performing the subcommand routine and is interrupted by a SMART EXECUTE OFF-LINE IMMEDIATE command, then the device shall abort the subcommand routine and begin processing the new command within 2 s after receipt of the command. The device shall then process the new SMART EXECUTE OFF-LINE IMMEDIATE subcommand;
7) if the device is in the process of performing the subcommand routine and is interrupted by a STANDBY IMMEDIATE command or IDLE IMMEDIATE command, then the device shall suspend or abort the subcommand routine, and begin processing the new command within 2 s after receipt of the command. After receiving a new command that causes the device to exit a power saving mode, the device shall initiate or resume the subcommand routine without any additional commands unless these activities were aborted by the host;
8) while the device is performing the subcommand routine it shall not change power states (e.g., as a result of its Standby timer (see 4.17.3) expiring); and
9) if a test failure occurs while a device is performing a self-test routine, then the device may discontinue the testing and place the test results in the Self-test execution status byte (see table 152).

7.54.5.2.3 Captive mode

When processing a self-test in captive mode, the device processes the self-test routine after receipt of the command. At the end of the self-test routine the device places the results of this self-test routine in the Self-test execution status byte (see table 152) and reports command completion. If an error occurs while a device is performing the self-test routine, then the device may discontinue its testing, place the results of this self-test routine in the Self-test execution status byte, and complete the command.

7.54.5.2.4 SMART off-line routine

The SMART off-line routine shall only be processed in the off-line mode (see 7.54.5.2.2). The results of this routine are placed in the Off-line data collection status byte (see table 153).

7.54.5.2.5 SMART Short self-test routine

Depending on the value in the LBA field (7:0) (see table 149), the SMART Short self-test routine may be processed in either the captive mode or the off-line mode. The SMART Short self-test routine should take on the order of minutes to complete (see table 152).

7.54.5.2.6 SMART Extended self-test routine

Depending on the value in the LBA field (7:0) (see table 149), the SMART Extended self-test routine may be processed in either the captive mode or the off-line mode. The SMART Extended self-test routine should take on the order of tens of minutes to complete (see table 152).

7.54.5.2.7 SMART Conveyance self-test routine

Depending on the value in the LBA field (7:0) (see table 149), the SMART Conveyance self-test routine may be processed in either the captive mode or the off-line mode. The SMART Conveyance self-test routine may identify damage incurred during transporting of the device. The SMART Conveyance self-test routine should take on the order of minutes to complete (see table 152).

7.54.5.2.8 SMART Selective self-test routine

If the SMART Selective self-test routine is implemented, then all features of this self-routine shall be implemented. Support for the SMART Selective self-test routine is indicated in off-line data collection capabilities (see 7.54.6.10). When the value in the LBA field (7:0) is 4 or 132, the SMART Selective self-test routine shall be processed. This self-test routine shall include the initial tests performed by the Extended self-test routine plus a selectable read scan. The

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host should not write the Selective self-test log while the processing of a SMART Selective self-test routine is in progress.

A read scan of the specified areas of the media is requested by setting the test spans to be read scanned in the Selective self-test log (see A.15). The device shall process the specified test spans and they shall be read scanned in their entirety. If bit 1 in the Feature flags field of the Selective self-test log (see A.15) is cleared to zero, then the device shall not perform an off-line scan following the Selective self-test.

The Selective self-test log is updated as the self-test proceeds indicating test progress. When all specified test spans have been completed, the test is terminated and the appropriate self-test execution status is reported in the SMART READ DATA response depending on the occurrence of errors. Figure 17 shows an example of a Selective self-test definition with three test spans defined. In this example, the test terminates when all three test spans have been scanned.

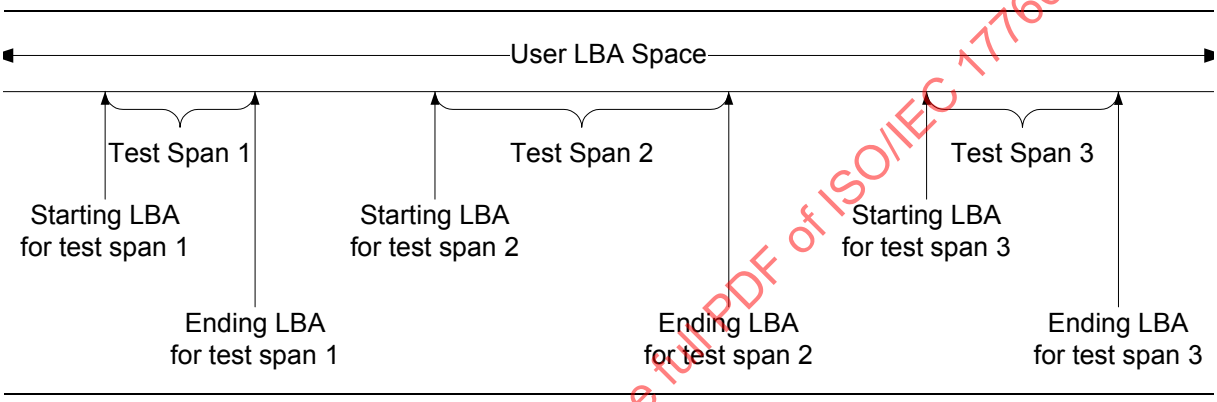

Figure 17 — Selective self-test span example

If bit 1 of the Feature flags field in the Selective self-test log (see A.15) is set to one, then after the scan of the selected spans described in this subclause, the device shall scan the rest of media in an off-line mode. If an error occurs during the scanning of the test spans, the error is reported in the self-test execution status in the SMART READ DATA response and the off-line scan is not processed. When the test spans defined have been scanned, then the device shall:

a) set the off-line scan pending and active flags in the Selective self-test log to one;
b) set the span under test to a value greater than five;
c) set the self-test execution status in the SMART READ DATA response to 00h;
d) set a value of 03h in the off-line data collection status in the SMART READ DATA response; and
e) proceed to process an off-line read scan through all areas not included in the test spans.

This off-line read scan shall be completed with no pauses between block reads. Any errors encountered shall not be reported to the host. Error locations may be logged for future reallocation. If the device is powered-down before the off-line scan is completed, then the off-line scan shall resume when the device is powered up. From power-up, the resumption of the scan shall be delayed the time indicated in the Selective self-test pending time field in the Selective self-test log (see A.15). During this delay time the pending flag shall be set to one and the active flag shall be set to zero in the Selective self-test log. Once the time expires, the active flag shall be set to one, and the off-line scan shall resume. When the entire media has been scanned, the off-line scan shall terminate, both the pending and active flags shall be cleared to zero, and the off-line data collection status in the SMART READ DATA response shall be set to 02h indicating completion.

The time to complete off-line testing and the self-test polling times do not apply to the selective self-test. Progress through the test spans is indicated in the selective self-test log.

When bit 3 in the Selective self-test feature flags field is set to one (see A.15), a device shall continue processing the Selective self-test after processing a hardware reset or a software

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reset. When bit 3 in the Selective self-test feature flags field is cleared to zero, a device shall abort the Selective self-test during processing a hardware reset or a software reset.

If a device receives a SMART EXECUTE OFF-LINE IMMEDIATE command with the Abort off-line test routine subcommand, then the device shall abort the Selective self-test.

If a device receives a SMART EXECUTE OFF-LINE IMMEDIATE command specifying that the device perform a self-test while a selective self-test is in progress, the device shall abort the selective self-test and process the specified self-test.

7.54.5.3 Inputs

See table 150 for the SMART EXECUTE OFF-LINE IMMEDIATE command inputs.

Table 150 — SMART EXECUTE OFF-LINE IMMEDIATE command inputs

Name	Description
Feature	D4h
Count	N/A
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 Table 149 defines the subcommand that shall be processed
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.54.5.4 Normal Outputs

See table 221.

7.54.5.5 Error Outputs

The ID Not Found bit shall be set to one if the SMART data is not available. The Abort bit shall be set to one if SMART is not enabled or if a self-test fails while executing a sequence in captive mode. See table 250.

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7.54.6 SMART READ DATA - B0h/D0h, PIO Data-In

7.54.6.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.21).

7.54.6.2 Description

The SMART READ DATA command returns the Device SMART data structure to the host.

7.54.6.3 Inputs

See table 151 for the SMART READ DATA command inputs.

Table 151 — SMART READ DATA command inputs

Name	Description
Feature	D0h
Count	N/A
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.54.6.4 Normal Outputs

See table 212.

7.54.6.5 Error Outputs

If SMART data is uncorrectable, then the device shall return command completion with the Uncorrectable bit set to one. If the SMART data is not available or the data structure checksum is invalid, then the device shall return command completion with the ID Not Found bit set to one. If SMART is not enabled or if field values are invalid, then the device shall return command aborted. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 256.

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

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7.54.6.6 Input From the Device to the Host Data Structure

Table 152 defines the 512 bytes that make up the Device SMART data structure.

Table 152 — Device SMART data structure

Offset	F/V	Description
0..361	X	Vendor specific
362	V	Off-line data collection status
363	X	Self-test execution status byte
364..365	V	Total time in seconds to complete off-line data collection activity (word)
366	X	Vendor specific
367	F	Off-line data collection capability
368..369	F	SMART capability
370	F	Error logging capability 7:1 Reserved 0 1=Device error logging supported
371	X	Vendor specific
372	F	Short self-test routine recommended polling time (in minutes) (see 7.54.6.12)
373	F	Extended self-test routine recommended polling time in minutes. If FFh, use bytes 375 and 376 for the polling time (see 7.54.6.12)
374	F	Conveyance self-test routine recommended polling time in minutes (see 7.54.6.12)
375..376	F	Extended self-test routine recommended polling time in minutes (word) (see 7.54.6.12)
377..385	R	Reserved
386..510	X	Vendor specific
511	V	Data structure checksum

Key:
F = the content of the byte is fixed and does not change.
V = the content of the byte is variable and may change depending on the state of the device or the commands processed by the device.
X = the content of the byte is vendor specific and may be fixed or variable.
R = the content of the byte is reserved and shall be zero.

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7.54.6.7 Off-line collection status byte

The value of the off-line data collection status byte defines the current status of the off-line activities of the device. Table 153 lists the values and their respective definitions.

Table 153 — Off-line data collection status byte values

Value	Description
00h or 80h	Off-line data collection activity was never started.
01h	Reserved
02h or 82h	Off-line data collection activity was completed without error.
03h	Off-line activity in progress.
04h or 84h	Off-line data collection activity was suspended by an interrupting command from host.
05h or 85h	Off-line data collection activity was aborted by an interrupting command from host.
06h or 86h	Off-line data collection activity was aborted by the device with a fatal error.
07h..3Fh	Reserved
40h..7Fh	Vendor specific
81h	Reserved
83h	Reserved
87h..BFh	Reserved
C0h..FFh	Vendor specific

7.54.6.8 Self-test execution status byte

The self-test execution status byte reports the status of the self-test routine as follows:

a) for bits (3:0) (i.e., Percent Self-Test Remaining), the value indicates an approximation of the percent of the self-test routine remaining until completion in ten percent increments. Valid values are nine through zero. A value of zero indicates that the self-test routine is complete. A value of nine indicates 90 % of total test time is remaining; and
b) for bits (7:4) (i.e., Self-test Execution Status), the value:
   A) indicates the current Self-test Execution Status (see table 154);
   B) may be cleared to zero when the device processes a power-on reset; and
   C) shall be retained when the device processes a software reset or hardware reset.

Table 154 — Self-test execution status values

Value	Description
0h	Indicates a previous self-test routine completed without error or no self-test status is available.
1h	The self-test routine was aborted by the host.
2h	The self-test routine was interrupted by the host with a hardware or software reset.
3h	A fatal error or unknown test error occurred while the device was executing its self-test routine and the device was unable to complete the self-test routine.
4h	The previous self-test completed having a test element that failed and the test element that failed is not known.
5h	The previous self-test completed having the electrical element of the test failed.
6h	The previous self-test completed having the servo and/or seek test element of the test failed.
7h	The previous self-test completed having the read element of the test failed.
8h	The previous self-test completed having a test element that failed and the device is suspected of having handling damage.
9h..Eh	Reserved.
Fh	Self-test routine in progress.

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7.54.6.9 Total time to complete off-line data collection

The total estimated time in seconds to complete off-line data collection activity word specifies how many seconds the device requires to complete the sequence of off-line data collection activity. Valid values for this word are from 0001h to FFFFh. If this field is set to FFFFh then the total time to complete off-line data collection is greater than 65_534 seconds.

7.54.6.10 Off-line data collection capabilities

Table 155 defines the off-line data collection capability bits. If the value of all of these bits is cleared to zero, then no off-line data collection is implemented by this device.

Table 155 — Offline Data Collection Capabilities

Bit	Description
7	Reserved
6	Selective self-test implemented – If this bit is cleared to zero, the device does not implement the Selective self-test routine. If this bit is set to one, the device implements the Selective self-test routine.
5	Conveyance self-test implemented – If this bit is cleared to zero, the device does not implement the Conveyance self-test routines. If this bit is set to one, the device implements the Conveyance self-test routines.
4	Self-test implemented – If this bit is cleared to zero, the device does not implement the Short and Extended self-test routines. If this bit is set to one, the device implements the Short and Extended self-test routines.
3	Off-line read scanning implemented – If this bit is cleared to zero, the device does not support off-line read scanning. If this bit is set to one, the device supports off-line read scanning.
2	Abort/restart off-line by host – If this bit is set to one, then the device shall abort all off-line data collection activity initiated by a SMART EXECUTE OFF-LINE IMMEDIATE command upon receipt of a new command within 2 s of receiving the new command. If this bit is cleared to zero, the device shall suspend off-line data collection activity after an interrupting command and resume off-line data collection activity after some vendor-specified event.
1	Vendor specific.
0	EXECUTE OFF-LINE IMMEDIATE implemented – If this bit is set to one, then the SMART EXECUTE OFF-LINE IMMEDIATE command is implemented by this device. If this bit is cleared to zero, then the SMART EXECUTE OFF-LINE IMMEDIATE command is not implemented by this device.

7.54.6.11 SMART capabilities

The following defines the SMART capabilities bits:

a) If bit 0 is set to one, then the device saves SMART data prior to going into a power saving mode (i.e., Idle, Standby, or Sleep) or upon return to Active mode or Idle mode from a Standby mode (see 4.17.4). If bit 0 is cleared to zero, then the device does not save SMART data prior to going into a power saving mode (Idle, Standby, or Sleep) or upon return to Active mode or Idle mode from a Standby mode;
b) Bit 1 shall be set to one to indicate that the device supports the SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE command; and
c) Bits (15:2) are reserved.

7.54.6.12 Self-test routine recommended polling time

The self-test routine recommended polling time shall be equal to the estimated number of minutes that is the minimum recommended time before which the host should begin polling for test completion status. Actual test time may be several times this value. The host should wait at least this long before sending the first SMART READ DATA command to check for test completion status. Polling before this time may extend the self-test processing time or abort the test depending on the state of Offline Data Collection Capabilities bit 2 (see table 155). Subsequent checking by the host should be at a vendor specific interval.

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7.54.6.13 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.

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7.54.7 SMART READ LOG - B0h/D5h, PIO Data-In

7.54.7.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.21).

7.54.7.2 Description

The SMART READ LOG command returns the specified log to the host. See table A.2 for the list of logs.

7.54.7.3 Inputs

See table 156 for the SMART READ LOG command inputs.

Table 156 — SMART READ LOG command inputs

Name	Description
Feature	D5h
Count	Specifies the number of log pages to be read from the specified log. The log transferred by the ATA device shall start at the first page in the specified log, regardless of the Count requested.
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 Log Address – Specifies the log to be read as described in table A.2. See 7.29.3.3 for more information.
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.54.7.4 Normal Outputs

See table 212.

7.54.7.5 Error Outputs

The Uncorrectable Error bit shall be set to one if SMART data is uncorrectable. The ID Not Found bit shall be set to one if the data is not available or the data structure checksum is invalid. The Abort bit shall be set to one if SMART is not enabled, if the Count field is cleared to zero, or if field values are invalid. The Abort bit shall be set to one if the Count is larger than the log size reported in the SMART Log Directory (see A.3). A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 256.

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7.54.8 SMART RETURN STATUS - B0h/DAh, Non-Data

7.54.8.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.21).

7.54.8.2 Description

The SMART RETURN STATUS command causes the device to communicate the reliability status of the device to the host.

7.54.8.3 Inputs

See table 157 for the SMART RETURN STATUS command inputs.

Table 157 — SMART RETURN STATUS command inputs

Name	Description
Feature	DAh
Count	N/A
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.54.8.4 Normal Outputs

See table 222.

7.54.8.5 Error Outputs

The Abort bit shall be set to one if SMART is not enabled. See table 235.

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7.54.9 SMART WRITE LOG - B0h/D6h, PIO Data-Out

7.54.9.1 Feature Set

This 28-bit command is for devices that implement the SMART feature set (see 4.21).

7.54.9.2 Description

The SMART WRITE LOG command specifies the log to be written as described in table A.2. This command causes the device to write the specified number of log pages to the specified log. See table A.2 for the list of logs.

7.54.9.3 Inputs

7.54.9.3.1 Overview

See table 158 for the SMART WRITE LOG command inputs.

Table 158 — SMART WRITE LOG command inputs

Name	Description
Feature	D6h
Count	Specifies the number of log pages that shall be written. The data transferred to the device shall be stored starting at the first block in the specified log. If the device receives a value of zero in this field, then the device shall report command aborted.
LBA	**Bit Description** 27:24 N/A 23:8 C24Fh 7:0 Log Address – See 7.54.9.3.2
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B0h

7.54.9.3.2 Log Address

A device may support a subset of the available logs. Support for individual logs is determined by support for the associated feature set. Support of the associated log(s) is mandatory for devices implementing the associated feature set. If the host attempts to write to a read only log address, the device shall return command aborted.

7.54.9.4 Normal Outputs

See table 212.

7.54.9.5 Error Outputs

If the SMART data is not available, then the device shall return command completion with the ID Not Found bit set to one. If SMART is not enabled, the log is not implemented, or the Count field is cleared to zero, then the device shall return command aborted for the command. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 248.

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7.55 STANDBY - E2h, Non-Data

7.55.1 Feature Set

This 28-bit command is for devices that implement the Power Management feature set (see 4.17).

7.55.2 Description

The STANDBY command causes the device to enter the Standby mode (see 4.17.4).

If the Count field is non-zero, then the Standby timer (see 4.17.3) shall be enabled. The value in the Count field shall be used to determine the time programmed into the Standby timer (see table 63).

If the Count field is zero, then the Standby timer is disabled.

See 4.8.4 for interactions with the EPC feature set.

7.55.3 Inputs

See table 159 for the STANDBY command inputs.

Table 159 — STANDBY command inputs

Name	Description
Feature	N/A
Count	This value shall determine the time period programmed into the Standby timer. Table 63 defines these values.
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 E2h

7.55.4 Normal Outputs

See table 212.

7.55.5 Error Outputs

See table 235.

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7.56 STANDBY IMMEDIATE - E0h, Non-Data

7.56.1 Feature Set

This 28-bit command is for devices that implement the Power Management feature set (see 4.17).

7.56.2 Description

The STANDBY IMMEDIATE command causes the device to enter the Standby mode (see 4.17.4).

Processing a STANDBY IMMEDIATE command should cause the device to prepare for a power cycle.

See 4.8.4 for interactions with the EPC feature set.

7.56.3 Inputs

See table 160 for the STANDBY IMMEDIATE command inputs.

Table 160 — STANDBY IMMEDIATE command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 E0h

7.56.4 Normal Outputs

See table 212.

7.56.5 Error Outputs

See table 235.

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7.57 TRUSTED NON-DATA - 5Bh, Non-Data

7.57.1 Feature Set

This 28-bit command is for devices implementing the Trusted Computing feature set (see 4.25).

7.57.2 Description

The TRUSTED NON-DATA command delivers the SP Specific field (see 7.58.6) using the specified Security Protocol.

7.57.3 Inputs

7.57.3.1 Overview

See table 161 for the TRUSTED NON-DATA command inputs.

Table 161 — TRUSTED NON-DATA command inputs

Name	Description
Feature	Security Protocol (see 7.58.3.2)
Count	Reserved
LBA	**Bit Description** 27:25 Reserved 24 0 – Non-Data TRUSTED SEND, 1 – Non-Data TRUSTED RECEIVE 23:8 SP Specific (15:0) – Security Protocol Specific (see 7.58.6) 7:0 Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 5Bh

7.57.3.2 Security Protocol

If Bit 24 is cleared to zero, then see 7.60.3.2, otherwise, see 7.58.3.2.

7.57.4 Normal Outputs

If Bit 24 is cleared to zero, then see 7.60.4, otherwise, see 7.58.4.

7.57.5 Error Outputs

If Bit 24 is cleared to zero, then see 7.60.5, otherwise, see 7.58.5.

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7.58 TRUSTED RECEIVE - 5Ch, PIO Data-In

7.58.1 Feature Set

This 28-bit command is for devices implementing the Trusted Computing feature set (see 4.25).

7.58.2 Description

The TRUSTED RECEIVE command retrieves security protocol information (see 7.58.6) 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 163). If the device has no data to transfer (e.g., the results for any previous TRUSTED SEND commands are not yet available), the device may transfer data indicating it has no other data to transfer.

Indications of data overrun or underrun and the mechanism, if any, for processing retries depend on the protocol specified by the Security Protocol field (see table 163).

For Security Protocol field set to 00h, the format of the data is described in 7.58.6. The format of the data for other Security Protocol values is specified by the group that owns the associated Security Protocol value.

Data transfer lengths for the TRUSTED RECIEVE command shall be non-zero multiples of 512 bytes. Pad bytes are appended as needed to meet this requirement. Pad bytes shall have a value of 00h.

The device shall retain data resulting from a TRUSTED SEND command awaiting retrieval by a TRUSTED RECEIVE command until one of the following events is processed:

a) the data is delivered according to the Security Protocol field (see table 163) specific rules for the TRUSTED RECEIVE command;
b) any reset; or
c) loss of communication with the host that sent the TRUSTED SEND command.

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7.58.3 Inputs

7.58.3.1 Overview

See table 162 for the TRUSTED RECEIVE command inputs.

Table 162 — TRUSTED RECEIVE command inputs

Name	Description
Feature	Security Protocol (see 7.58.3.2)
Count	Transfer Length (7:0) – See 7.58.3.4
LBA	**Bit Description** 27:24 Reserved 23:8 SP Specific (15:0) – Security Protocol Specific (see 7.58.3.3) 7:0 Transfer Length (15:8) – See 7.58.3.4
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 5Ch

7.58.3.2 Security Protocol

The Security Protocol field identifies which security protocol is being used. This determines the format of the SP Specific field and of the data that is transferred (see table 163). If the Security Protocol field is set to a reserved value, the device shall return command aborted.

Table 163 — TRUSTED RECEIVE Security Protocol field description

Value	Description
00h	Return security protocol information (see 7.58.6)
01h..06h	Reserved for TCG
07h..1Fh	Reserved
20h	Reserved for T10
21h..ECh	Reserved
EDh	Defined by SDCard TrustedFlash Security Systems Specification 1.1.3
EEh	Defined by IEEE 1667
EFh	Reserved for T10
F0h..FFh	Vendor Specific.

7.58.3.3 SP Specific

The SP Specific field provides Security Protocol field specific information. The meaning of these fields are defined by each security protocol.

7.58.3.4 Transfer Length

The Transfer Length is security protocol specific.

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7.58.4 Normal outputs

See table 223.

7.58.5 Error outputs

The device shall return command aborted if an unrecoverable error occurred during the processing of the command. The amount of data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 237.

7.58.6 Security Protocol 00h Description

7.58.6.1 Overview

The Security Protocol 00h returns basic information about the device. A TRUSTED RECEIVE command with Security Protocol field set to 00h is not linked to an earlier TRUSTED SEND command.

The Transfer Length field contains the number of 512-byte blocks of data to be transferred (e.g., one means 512 bytes, two means 1 024 bytes). A transfer length of zero is invalid.

If the length of the TRUSTED RECEIVE parameter data is greater than the Transfer Length, then the device shall return the TRUSTED RECEIVE parameter data truncated to the requested Transfer Length.

When the Security Protocol field is set to 00h, the SP Specific field is shown in table 164.

Table 164 — Security Protocol 00h – SP Specific field descriptions for Protocol 00h

SP Specific	Description	Support
0000h	Return supported security protocol list (see 7.58.6.2)	Mandatory
0001h	Return a certificate (see 7.58.6.3)	Mandatory
0002h..FFFFh	Reserved	

If the SP Specific field is set to a reserved value, the command shall be aborted.

Each time a TRUSTED RECEIVE command with Security Protocol field set to 00h is received, the device shall transfer the data starting with byte 0.

7.58.6.2 Supported security protocols list description

When the Security Protocol field is set to 00h, and the SP Specific field is set to 0000h in a TRUSTED RECEIVE command, the parameter data shall have the format shown in table 165.

Table 165 — TRUSTED RECEIVE parameter data for SP Specific=0000h

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	List Length (M-7) bits (15:8)							
7	List Length (M-7) bits (7:0)							
8	Supported Security Protocol List							
M								
M+1	Pad bytes (if any)							
511								

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The List Length field indicates the total length, in bytes, of the supported security protocol list.

The Supported Security Protocol List field shall contain a list of all supported Security Protocol field values. Each byte indicates a supported Security Protocol field value. The values shall be in ascending order starting with 00h.

The total data length shall be 512 bytes. Pad bytes are appended as needed to meet this requirement. Pad bytes shall have a value of 00h.

7.58.6.3 Certificate data description

7.58.6.3.1 Certificate overview

A certificate is either an X.509 Attribute Certificate (see clause 2) or an X.509 Public Key Certificate (see clause 2) depending on the capabilities of the device.

When the Security Protocol field of the TRUSTED RECEIVE command is set to 00h, and the SP Specific field is 0001h, the parameter data shall have the format shown in table 166.

Table 166 — TRUSTED RECEIVE parameter data for SP Specific=0001h

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved							
2	(MSB)	CERTIFICATE LENGTH (M – 3)						
3								(LSB)
4	X.509 certificate bytes							
M								
M+1	Pad bytes (if any)							
511								

The CERTIFICATE LENGTH indicates the total length, in bytes, of the certificate(s). This length includes one or more certificates. If the device has no certificate to return, then the certificate length is set to 0000h, the 4 byte header, and 508 pad bytes are returned.

The contents of the certificate fields are defined in 7.58.6.3.2 and 7.58.6.3.3.

The total data length shall conform to the Transfer Length field (see 7.58.3.4) requirements.

7.58.6.3.2 Public Key certificate description

RFC 3280 defines the certificate syntax for certificates consistent with the X.509v3 Public Key Certificate Specification.

7.58.6.3.3 Attribute certificate description

RFC 3281 defines the certificate syntax for certificates consistent with the X.509v2 Attribute Certificate Specification.

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7.59 TRUSTED RECEIVE DMA - 5Dh, DMA

7.59.1 Feature Set

This 28-bit command is for devices implementing the Trusted Computing feature set (see 4.25).

7.59.2 Description

See 7.58.2.

7.59.3 Inputs

See table 167 for the TRUSTED RECEIVE DMA command inputs.

Table 167 — TRUSTED RECEIVE DMA command inputs

Name	Description
Feature	Security Protocol (see 7.58.3.2)
Count	Transfer Length (7:0) – See 7.58.3.4
LBA	**Bit Description** 27:24 Reserved 23:8 SP Specific (15:0) – Security Protocol Specific (see 7.58.3.3) 7:0 Transfer Length (15:8) – See 7.58.3.4
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 5Dh

See 7.58.3.

7.59.4 Normal Outputs

See 7.58.4.

7.59.5 Error Outputs

See 7.58.5.

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7.60 TRUSTED SEND - 5Eh, PIO Data-Out

7.60.1 Feature Set

This 28-bit command is for devices implementing the Trusted Computing feature set (see 4.25).

7.60.2 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 169). 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 169).

Data transfer lengths for the TRUSTED SEND command shall be non-zero multiples of 512 bytes. Pad bytes are appended as needed to meet this requirement. Pad bytes shall have a value of 00h.

7.60.3 Inputs

7.60.3.1 Overview

See table 168 for the TRUSTED SEND command inputs.

Table 168 — TRUSTED SEND command inputs

Name	Description
Feature	Security Protocol (see 7.60.3.2)
Count	Transfer Length (7:0) – See 7.60.3.4
LBA	**Bit Description** 27:24 Reserved 23:8 SP Specific (15:0) – Security Protocol Specific (see 7.60.3.3) 7:0 Transfer Length (15:8) – See 7.60.3.4
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 5Eh

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7.60.3.2 Security Protocol

The Security Protocol field identifies which security protocol is being used. This determines the format of the parameters and of the data that is transferred (see table 169). If the Security Protocol field is set to a reserved value, the device shall return command aborted.

Table 169 — TRUSTED SEND – Security Protocol field description

Value	Description
00h	Reserved
01h..06h	Reserved for TCG
07h..1Fh	Reserved
20h	Reserved for T10
21h..ECh	Reserved
EDh	Reserved for SDCard
EEh	Reserved for IEEE 1667
EFh	Reserved for T10
F0h..FFh	Vendor Specific

7.60.3.3 SP Specific

The meaning of the security protocol-specific field is defined by each security protocol.

7.60.3.4 Transfer Length

The Transfer Length is security protocol specific.

7.60.4 Normal outputs

See table 223.

7.60.5 Error outputs

The device shall return command aborted if an unrecoverable error occurred during the processing of the command. The amount of data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 237.

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7.61 TRUSTED SEND DMA - 5Fh, DMA

7.61.1 Feature Set

This 28-bit command is for devices implementing the Trusted Computing feature set (see 4.25).

7.61.2 Description

See 7.60.2.

7.61.3 Inputs

See table 170 for the TRUSTED SEND DMA command inputs.

Table 170 — TRUSTED SEND DMA command inputs

Name	Description
Feature	Security Protocol (see 7.60.3.2)
Count	Transfer Length (7:0) – See 7.60.3.4
LBA	**Bit Description** 27:24 Reserved 23:8 SP Specific (15:0) – Security Protocol Specific (see 7.60.3.3) 7:0 Transfer Length (15:8) – See 7.60.3.4
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 5Fh

See 7.60.3.

7.61.4 Normal Outputs

See 7.60.4.

7.61.5 Error Outputs

See 7.60.5.

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7.62 WRITE BUFFER - E8h, PIO Data-Out

7.62.1 Feature Set

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

7.62.2 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.

7.62.3 Inputs

See table 171 for the WRITE BUFFER command inputs.

Table 171 — WRITE BUFFER command inputs

Name	Description
Feature	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 E8h

7.62.4 Normal Outputs

See table 212.

7.62.5 Error Outputs

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 236.

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7.63 WRITE BUFFER DMA - EBh, DMA

7.63.1 Feature Set

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

7.63.2 Description

See 7.62.2.

7.63.3 Inputs

See table 172 for the WRITE BUFFER DMA command inputs.

Table 172 — WRITE BUFFER DMA command inputs

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

7.63.4 Normal Outputs

See 7.62.4.

7.63.5 Error Outputs

See 7.62.5.

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7.64 WRITE DMA - CAh, DMA

7.64.1 Feature Set

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

7.64.2 Description

The WRITE DMA command writes data using the DMA data transfer protocol.

7.64.3 Inputs

See table 173 for the WRITE DMA command inputs.

Table 173 — WRITE DMA command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred.
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 CAh

7.64.4 Normal Outputs

See table 212.

7.64.5 Error Outputs

See table 261.

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7.65 WRITE DMA EXT - 35h, DMA

7.65.1 Feature Set

This 48-bit command is for devices that implement the 48-bit Address feature set (see 4.4).

7.65.2 Description

The WRITE DMA EXT command writes data using the DMA data transfer protocol.

7.65.3 Inputs

See table 174 for the WRITE DMA EXT command inputs.

Table 174 — WRITE DMA EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred.
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 35h

7.65.4 Normal Outputs

See table 223.

7.65.5 Error Outputs

See table 251.

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7.66 WRITE DMA FUA EXT - 3Dh, DMA

7.66.1 Feature Set

This 48-bit command is for devices that implement the 48-bit Address feature set (see 4.4).

7.66.2 Description

The WRITE 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.

7.66.3 Inputs

See table 175 for the WRITE DMA FUA EXT command inputs.

Table 175 — WRITE DMA FUA EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred.
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 3Dh

7.66.4 Normal Outputs

See table 223.

7.66.5 Error Outputs

See table 251.

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7.67 WRITE FPDMA QUEUED - 61h, DMA Queued

7.67.1 Feature Set

This 48-bit command is for devices implementing the NCQ feature set (see 4.14).

7.67.2 Description

The WRITE FPDMA QUEUED command causes data to be transferred from the host to the device.

7.67.3 Inputs

7.67.3.1 Overview

See table 176 for the WRITE FPDMA QUEUED command inputs.

Table 176 — WRITE FPDMA QUEUED command inputs

Name	Description
Feature	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred.
Count	**Bit Description** 15 PRIO – See 7.28.3.2 14:8 Reserved 7:3 NCQ Tag – See 6.5.2 2:0 Reserved
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7 FUA – See 7.67.3.2 6 Shall be set to one 5 Reserved 4 Shall be set to zero 3:0 Reserved
Command	7:0 61h

7.67.3.2 Forced Unit Access (FUA)

When the FUA bit is set to one regardless of whether volatile and/or non-volatile write caching in the device is enabled or not, the user data shall be written to non-volatile media before command completion is reported. When the FUA bit is cleared to zero the device may return command completion before the data is written to the non-volatile media.

7.67.4 Command Acceptance Outputs

See table 227.

7.67.5 Normal Outputs

See table 228.

7.67.6 Error Outputs

If the Error bit is set to one, then the device aborted the command due to LBA out of range, a duplicate tag number, an invalid tag number, or an Interface CRC error, see table 266 for more information.

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Errors that occur during the processing of this command are reported by returning a transport dependent indicator with additional information available in the NCQ Command Error log, see table 267 for more information.

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7.68 WRITE LOG EXT - 3Fh, PIO Data-Out

7.68.1 Feature Set

This 48-bit command is for devices that implement the General Purpose Logging feature set (see 4.10).

7.68.2 Description

The WRITE LOG EXT command writes a specified number of 512 byte blocks of data to the specified log. See table A.2 for the list of logs.

7.68.3 Inputs

7.68.3.1 Overview

See table 177 for the WRITE LOG EXT command inputs.

Table 177 — WRITE LOG EXT command inputs

Name	Description
Feature	Reserved
Count	Log Page Count – See 7.68.3.2
LBA	**Bit Description** 47:40 Reserved 39:32 Page # (15:8) – See 7.68.3.3 31:16 Reserved 15:8 Page # (7:0) – See 7.68.3.3 7:0 Log Address – Specifies the log to be written as described in table A.2. See 7.54.9.3.2
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 3Fh

7.68.3.2 Log Page Count

Specifies the number of log pages that shall be written to the specified log. If the number is zero, or the number is greater than the number indicated in the GPL Directory (see table A.3), the device shall return command aborted.

7.68.3.3 Page

Specifies the first page number to be written to the specified log address. Pages are numbered starting with zero.

7.68.4 Normal Outputs

See table 223.

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7.68.5 Error Outputs

A device shall return command aborted for the command if:

a) the Count field is cleared to zero;
b) the feature set associated with the log specified in the LBA field (7:0) is not supported or not enabled;
c) the values in the Feature, Count, or LBA (47:8) fields are invalid;
d) the host attempts to write to a read only log address; or
e) the value in the Page # field plus the value in the Log Page Count field is larger than the log size reported in the GPL Directory (see A.2).

If the log data is not available or a data structure checksum error occurred, then the device shall return command completion for the command with the ID Not Found bit set to one.

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred.

See table 249.

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7.69 WRITE LOG DMA EXT - 57h, DMA

7.69.1 Feature Set

This 48-bit command is for devices implementing the General Purpose Logging feature set (see 4.10).

7.69.2 Description

See 7.68.2.

7.69.3 Inputs

See table 178 for the WRITE LOG DMA EXT command inputs.

Table 178 — WRITE LOG DMA EXT command inputs

Name	Description
Feature	Reserved
Count	Log Page Count – See 7.68.3.2
LBA	**Bit** **Description** 47:40 Reserved 39:32 Page # (15:8) – See 7.68.3.3 31:16 Reserved 15:8 Page # (7:0) – See 7.68.3.3 7:0 Log Address – Specifies the log to be written as described in table A.2. See 7.54.9.3.2
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 57h

7.69.4 Normal Outputs

See 7.68.4.

7.69.5 Error Outputs

See 7.68.5.

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7.70 WRITE MULTIPLE - C5h, PIO Data-Out

7.70.1 Feature Set

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

7.70.2 Description

The WRITE MULTIPLE command writes the number of logical sectors specified in the Count field.

The number of logical sectors per DRQ data block is defined by the content of IDENTIFY DEVICE data word 59 (see 7.17.7.21).

If the number of requested logical sectors is not evenly divisible by the DRQ data block count, as many full blocks as possible are transferred, followed by a final, partial block transfer.

Device errors encountered during WRITE MULTIPLE commands shall be returned after the attempted device write of the DRQ data block or partial DRQ data block is transferred. The command ends with the logical sector in error, even if the error was in the middle of a DRQ data block. Subsequent DRQ data blocks are not transferred in the event of an error.

The contents of the Command Structure following the transfer of a DRQ data block that had a logical sector in error are undefined. The host should retry the transfer as individual requests to obtain valid error information.

If IDENTIFY DEVICE data word 59 bit 8 is cleared to zero or IDENTIFY DEVICE data word 59 bits (7:0) (see 7.17.7.21) are set to zero, and a WRITE MULTIPLE command is received by the device, and no successful SET MULTIPLE MODE command has been processed by the device, the device shall return command aborted. A successful SET MULTIPLE MODE command should precede a WRITE MULTIPLE command.

7.70.3 Inputs

See table 179 for the WRITE MULTIPLE command inputs.

Table 179 — WRITE MULTIPLE command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred.
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 C5h

7.70.4 Normal Outputs

See table 212.

7.70.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 260.

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7.71 WRITE MULTIPLE EXT - 39h, PIO Data-Out

7.71.1 Feature Set

This 48-bit command is for devices that implement the 48-bit Address feature set (see 4.4).

7.71.2 Description

The WRITE MULTIPLE EXT command writes the number of logical sectors specified in the Count field.

The number of logical sectors per DRQ data block is defined by the content of IDENTIFY DEVICE data word 59 (see 7.17.7.21).

If the number of requested logical sectors is not evenly divisible by the DRQ data block count, as many full blocks as possible are transferred, followed by a final, partial block transfer.

Device errors encountered during WRITE MULTIPLE EXT commands shall be returned after the attempted write of the DRQ data block or partial DRQ data block is transferred. The command ends with the logical sector in error, even if the error was in the middle of a DRQ data block. Subsequent DRQ data blocks are not transferred in the event of an error.

The contents of the Command Structure following the transfer of a data block that had a logical sector in error are undefined. The host should retry the transfer as individual requests to obtain valid error information.

If IDENTIFY DEVICE data word 59 bit 8 (see 7.17.7.21) is cleared to zero or IDENTIFY DEVICE data word 59 bits (7:0) (see 7.17.7.21) are set to zero, and a WRITE MULTIPLE EXT command is received by the device, and no successful SET MULTIPLE MODE command has been processed by the device, the device shall return command aborted. A successful SET MULTIPLE MODE command should precede a WRITE MULTIPLE EXT command.

7.71.3 Inputs

See table 180 for the WRITE MULTIPLE EXT command inputs.

Table 180 — WRITE MULTIPLE EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred.
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 39h

7.71.4 Normal Outputs

See table 223.

7.71.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred. The amount of data

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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 251.

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7.72 WRITE MULTIPLE FUA EXT - CEh, PIO Data-Out

7.72.1 Feature Set

This 48-bit command is for devices that implement the 48-bit Address feature set (see 4.4).

7.72.2 Description

The WRITE MULTIPLE FUA EXT command writes the number of logical sectors specified in the Count field. The user data shall be written to non-volatile media before command completion is reported regardless of whether or not volatile and/or non-volatile write caching in the device is enabled.

The number of logical sectors per DRQ data block is defined by the content of IDENTIFY DEVICE data word 59 (see 7.17.7.21).

If the number of requested logical sectors is not evenly divisible by the DRQ data block count, as many full blocks as possible are transferred, followed by a final, partial block transfer.

Device errors encountered during WRITE MULTIPLE EXT commands shall be returned after the attempted write of the DRQ data block or partial DRQ data block is transferred. The command ends with the logical sector in error, even if the error was in the middle of a DRQ data block. Subsequent DRQ data blocks are not transferred in the event of an error.

The contents of the Command Structure following the transfer of a data block that had a logical sector in error are undefined. The host should retry the transfer as individual requests to obtain valid error information.

If IDENTIFY DEVICE data word 59 bit 8 (see 7.17.7.21) is cleared to zero or IDENTIFY DEVICE data word 59 bits (7:0) (see 7.17.7.21) are set to zero, and a WRITE MULTIPLE FUA EXT command is received by the device, and no successful SET MULTIPLE MODE command has been processed by the device, the device shall return command aborted. A successful SET MULTIPLE MODE command should precede a WRITE MULTIPLE FUA EXT command.

7.72.3 Inputs

See table 181 for the WRITE MULTIPLE FUA EXT command inputs.

Table 181 — WRITE MULTIPLE FUA EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred.
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 CEh

7.72.4 Normal Outputs

See table 223.

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7.72.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 251.

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7.73 WRITE SECTOR(S) - 30h, PIO Data-Out

7.73.1 Feature Set

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

7.73.2 Description

The WRITE SECTOR(S) command writes from 1 to 256 logical sectors as specified in the Count field.

7.73.3 Inputs

See table 182 for the WRITE SECTOR(S) command inputs.

Table 182 — WRITE SECTOR(S) command inputs

Name	Description
Feature	N/A
Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred.
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7:5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 30h

7.73.4 Normal Outputs

See table 212.

7.73.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 260.

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7.74 WRITE SECTOR(S) EXT - 34h, PIO Data-Out

7.74.1 Feature Set

This 48-bit command is for devices that implement the 48-bit Address feature set (see 4.4).

7.74.2 Description

The WRITE SECTOR(S) EXT command writes from 1 to 65 536 logical sectors as specified in the Count field.

7.74.3 Inputs

See table 183 for the WRITE SECTOR(S) EXT command inputs.

Table 183 — WRITE SECTOR(S) EXT command inputs

Name	Description
Feature	Reserved
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred.
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 34h

7.74.4 Normal Outputs

See table 223.

7.74.5 Error Outputs

If an unrecoverable error occurs while the device is processing this command, then the device shall return command completion with the Error bit set to one and the LBA field set to the LBA of the logical sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate. A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 251.

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7.75 WRITE STREAM DMA EXT - 3Ah, DMA

7.75.1 Feature Set

This 48-bit command is for devices that implement the Streaming feature set (see 4.24).

7.75.2 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.

7.75.3 Inputs

7.75.3.1 Inputs overview

See table 184 for the WRITE STREAM DMA EXT command inputs.

Table 184 — WRITE STREAM DMA EXT command inputs

Name	Description
Feature	**Bit Description** 15:8 Command Completion Time Limit (CCTL) – See 7.37.3.2. 7 Obsolete 6 Write Continuous (WC) – See 7.75.3.2 5 Flush – See 7.75.3.3 4 Obsolete 3 Reserved 2:0 Stream ID – See 7.75.3.4
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred
LBA	LBA of first logical sector to be transferred
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 3Ah

7.75.3.2 Write Continuous (WC)

The WC bit specifies whether the Write Continuous mode is enabled or disabled.

If the WC bit is set to one, then:

a) the device shall not stop processing the command due to errors;
b) if an error occurs during data transfer or while writing data to media before command completion or before the amount of time allowed for command completion based on the setting of CCTL (see 7.37.3.2) or Default CCTL (see 7.8.3) is reached, then the device:
   1) shall continue to transfer the amount of data requested;
   2) may continue writing data to the media;
   3) shall report command completion after all data for the command has been transferred; and

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4) shall save the error information in the Write Streaming Error log (see A.18);

or

c) if the amount of time allowed for command completion based on the setting of the CCTL field (see 7.37.3.2) or Default CCTL (see 7.8.3) is reached, then the device:
   1) shall stop processing the command;
   2) shall report command completion;
   3) shall set the Command Completion Time Out bit in the Write Streaming Error log to one; and
   4) may continue writing data to the media.

If the WC bit is cleared to zero and an error occurs, then the device:

a) shall stop processing the command and report command completion; and
b) may continue writing data to the media.

7.75.3.3 Flush

If the Flush bit is set to one, the Default CCTL field is set to zero, and the CCTL field is cleared to zero, then the device shall write all data for the specified stream to the media before command completion is reported.

If the Flush bit is set to one and the Default CCTL field was not set to zero in the most recent CONFIGURE STREAM command (see 7.8) for the Stream ID, then the device shall report command completion within the time specified by the Default CCTL field (see 7.8.3.4).

If the Flush bit is set to one and the CCTL field is not set to zero, then the device shall report command completion within (CCTL × (IDENTIFY DEVICE data words 98..99 µs)) (see 7.17.7.52) .

If the Flush bit is set to one and either the Default CCTL field was not set to zero in the most recent CONFIGURE STREAM command (see 7.8) for the Stream ID, or the CCTL field is not set to zero, then the device:

a) shall measure the time before reporting command completion from command acceptance;
b) shall set the Command Completion Time Out (see 6.3.4) to one if all of the data for the command has been received by the device, but the device has not yet written all of the data to its media; and
c) should continue writing data to its media after reporting command completion.

7.75.3.4 Stream ID

The Stream ID field specifies the stream to be written. The device shall operate according to the parameters specified by the most recent successful CONFIGURE STREAM command specifying this Stream ID. Any write to the device media or internal device buffer management as a result of the Stream ID is vendor specific.

7.75.4 Normal Outputs

See table 216 for the definition of Normal Outputs.

7.75.5 Error Outputs

If:

a) The WC bit was set to one in the command; and
b) the device is able to accept the amount of data requested for the command (e.g., an error occurred while writing to the media),

then the device shall set the Stream Error bit to one and clear the Error bit to zero.

If:

a) The WC bit was set to one in the command; and
b) the device is not able to return the amount of data requested for the command (e.g., an Interface CRC error shall be reported at command completion),

then the device shall clear the Stream Error bit to zero and set the Error bit to one.

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If:

a) The WC bit was cleared to zero in the command;
b) The CCTL field was not set to zero in the command, or the CCTL field was cleared to zero in the command and the Default CCTL field specified in the most recent CONFIGURE STREAM command (see 7.8) for the Stream ID field was not cleared to zero; and
c) the time specified for command completion by the CCTL field (see 7.37.3.2) or the Default CCTL (see 7.8.3) has been reached,

then the device shall clear the Stream Error bit to zero, set the Error bit to one, and set the Abort bit to one whether or not all data has been flushed to media.

If:

a) the WC bit was cleared to zero in the command;
b) the CCTL field was set to zero in the command; and
c) the Default CCTL field was set to zero in the most recent CONFIGURE STREAM command (see 7.8) for the Stream ID field,

then the device shall clear the Stream Error bit to zero, set the Error bit to one, and set the Interface CRC bit to one, ID Not Found bit to one, and/or Abort bit to one (i.e., indicating the error type).

A device may return command completion with the Error bit set to one if an Interface CRC error has occurred. See table 252.

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7.76 WRITE STREAM EXT - 3Bh, PIO Data-Out

7.76.1 Feature Set

This 48-bit command is for devices that implement the Streaming feature set (see 4.24).

7.76.2 Description

See 7.75.2.

7.76.3 Inputs

See table 185 for the WRITE STREAM EXT command inputs.

Table 185 — WRITE STREAM EXT command inputs

Name	Description
Feature	**Bit Description** 15:8 Command Completion Time Limit (CCTL) – See 7.37.3.2. 7 Obsolete 6 Write Continuous (WC) – See 7.75.3.2 5 Flush – See 7.75.3.3 4 Obsolete 3 Reserved 2:0 Stream ID – See 7.75.3.4
Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65 536 logical sectors are to be transferred.
LBA	LBA of first logical sector to be transferred.
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 3Bh

7.76.4 Normal Outputs

See 7.75.4.

7.76.5 Error Outputs

See 7.75.5.

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7.77 WRITE UNCORRECTABLE EXT - 45h, Non-Data

7.77.1 Feature Set

This 48-bit command is for ATA devices (see 4.2) and prohibited for ATAPI devices (see 4.3). The WRITE UNCORRECTABLE EXT command is not part of any feature set.

7.77.2 Description

7.77.2.1 Overview

The WRITE UNCORRECTABLE EXT command causes the device to report an uncorrectable error when the specified logical sectors are subsequently read.

When the device processes a read command, it shall set the Uncorrectable Error bit to one and the Error bit to one when a pseudo uncorrectable logical sector or flagged uncorrectable logical sector is read. Reading a flagged logical sector or pseudo uncorrectable logical sector may affect the Number of Reallocated Logical Sectors device statistic (see A.5.6.6).

If the device completes a write command to a pseudo uncorrectable logical sector or flagged uncorrectable logical sector without error, then the device:

a) shall write the data to the logical sector;
b) shall only cause the specified logical sectors to become valid;
c) shall not cause any other logical sectors (e.g., other logical sectors in the same physical sector) to become valid;
d) shall clear the pseudo uncorrectable attribute or flagged uncorrectable attribute of the logical sector; and
e) should verify that the logical sector may now be read without error.

The pseudo uncorrectable attribute or flagged uncorrectable attribute of a logical sector shall remain set during the processing of all power and reset events. If the device is unable to process a WRITE UNCORRECTABLE EXT command for any reason the device shall return command aborted.

7.77.2.2 Pseudo Uncorrectable Logical Sectors

When the Feature field (7:0) contains a value of 55h the WRITE UNCORRECTABLE EXT command shall cause the device to indicate a failure when subsequent reads to any of the logical sectors that are contained in the physical block of the specified logical sector are performed. These logical sectors are referred to as pseudo uncorrectable logical sectors. Whenever a pseudo uncorrectable logical sector is accessed via a read command the device shall perform normal error recovery to the fullest extent until:

a) the error recovery process is completed, the Uncorrectable Error bit is set to one, and the Error bit is set to one; or
b) a command time-out that applies to error recovery control occurs before error recovery is completed and an error is reported as a result of the command time-out (see 8.3.3).

When reading a pseudo uncorrectable logical sector, the device shall perform error logging (e.g., SMART, device statistics) in the same manner as an Uncorrectable error (see 6.3.13).

7.77.2.3 Flagged Uncorrectable Logical Sectors

When the Feature field (7:0) contains a value of AAh the WRITE UNCORRECTABLE EXT command shall cause the device to mark the specified logical sectors as flagged uncorrectable. Marking a logical sector as flagged uncorrectable shall cause the device to indicate a failure when subsequent reads to the specified logical sector are processed. When reading a flagged uncorrectable logical sector, the device should not perform error logging (e.g., SMART, device statistics) in the same manner as an Uncorrectable error (see 6.3.13).

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7.77.3 Inputs

See table 186 for the WRITE UNCORRECTABLE EXT command inputs.

Table 186 — WRITE UNCORRECTABLE EXT command inputs

Name	Description
Feature	**Bit Description** 15:8 Reserved 7:0 Uncorrectable options **Value Description** 00h..54h Reserved 55h Create a pseudo-uncorrectable error with logging 56h..59h Reserved 5Ah Vendor specific 5Bh..A4h Reserved A5h Vendor Specific A6h..A9h Reserved AAh Create a flagged error without logging ABh..FFh Reserved
Count	The number of logical sectors to be marked. A value of 0000h indicates that 65 536 logical sectors are to be marked.
LBA	LBA of first logical sector to be marked
Device	**Bit Description** 7 Obsolete 6 Shall be set to one 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 45h

7.77.4 Normal Outputs

See table 212.

7.77.5 Error Outputs

See table 235.

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8 SCT Command Transport

8.1 General

8.1.1 Overview

The SCT Command Transport provides a method for a host to send commands and data to a device and for a device to send data and status to a host using logs. Log Address E0h (i.e., SCT Command/Status) (see 8.2.3 and 8.2.5) is used to issue commands and return status. Log Address E1h (i.e., SCT Data Transfer) (see 8.2.4) is used to transport data.

The following methods are used to access the logs defined for the SCT Command Transport:

a) using the SMART READ LOG command and SMART WRITE LOG command; and
b) using READ LOG (DMA) EXT command and WRITE LOG (DMA) EXT command.

These sets of commands access the same logs and provide the same capabilities. The two methods are also used in the same way (e.g., a command is issued, data is transferred, if necessary, and status may be retrieved multiple times).

If the SMART feature set (see 4.21) is supported and not enabled, then a device that implements this feature set shall support the SMART READ LOG command and SMART WRITE LOG command to the SCT Command/Status log and the SCT Data Transfer log.

Sending a key 512-byte block of data (i.e., key data block) to the SCT Command/Status log starts the command process. The key data block specifies an Action Code and Function Code along with the parameters that are required to process the action. The SCT command response (i.e., error or command) is the same for both methods of issuing commands.

SCT commands are processed like other ATA commands, therefore they take precedence over any background activity the device may be performing when the SCT command is issued (i.e., a function initiated by a SMART EXECUTE OFFLINE IMMEDIATE command). Some SCT commands indicate command completion and return status while the SCT command is still processing.

A device supporting the SCT Command Transport should report a length of one in the General Purpose Log Directory (see A.2) and the SMART Log Directory (see A.3) for the SCT Command/Status log and the SCT Data Transfer log. The length of the SCT Data Transfer log does not indicate the length of an SCT Command Transport data transfer. This differs from the requirement in this standard that the GPL Directory (see A.2) and the SMART Log Directory (see A.3) report the actual length of the specified log pages.

8.1.2 SCT command nesting and interspersing with standard commands

Standard ATA commands may be interspersed with some SCT commands, but SCT commands shall not be nested. If an SCT command has not completed processing and another SCT command is received by the device (i.e., the host writes the SCT command/status log), then the first SCT command shall be aborted and the new SCT command shall be processed. SCT commands that do not require a subsequent data transfer operation are not interspersed with any ATA commands or each other. SCT commands that require data transfer shall not be nested (i.e., if the device receives another SCT command before all available data is transferred, then the device shall abort the current SCT operation and process the new SCT command without reporting an error).

8.1.3 Resets

A device shall terminate processing an SCT command during the processing of a software reset, hardware reset, or power-on reset. This may result in partial command processing or data loss. There is no indication once the device becomes ready that the previous command was terminated.

A device shall clear the SCT Status Response fields (i.e., Extended Status Code, Action Code, and Function Code) during the processing of a power-on reset and a hardware reset. A device shall clear the Extended status code during processing of a software reset and the other content of the SCT Status Response fields shall not be affected by the device processing the reset.

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8.2 Processing SCT commands

8.2.1 Processing SCT commands overview

The following phases are required to process SCT commands:

1) Capability identification (see 8.2.2);
2) SCT Command transfer (see 8.2.3);
3) Data transfer (see 8.2.4); and
4) Status (see 8.2.5).

8.2.2 SCT capability identification

IDENTIFY DEVICE data word 206 indicates support for the SCT Command Transport and SCT commands (see 7.17.7.75).

8.2.3 SCT command transfer

Transfer of an SCT command occurs when a 512-byte data packet is written to the SCT Command/Status log (see A.1). The 512-byte data packet contains a single command as defined in the SCT Command Transport.

Table 187 defines the SCT command format, contained in the input data of the SMART WRITE LOG command (see 7.54.9).

Table 187 — Fields to issue an SCT command using SMART WRITE LOG

Name	Description
Feature	D6h (i.e., SMART WRITE LOG)
Count	01h
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 E0h (i.e., SCT Command/Status log address)
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B0h

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Table 188 defines the SCT command format, contained in the input data of the WRITE LOG (DMA) EXT command (see 7.68).

Table 188 — Fields to issue an SCT command using WRITE LOG (DMA) EXT

Name	Description
Feature	Reserved
Count	0001h
LBA	**Bit** **Description** 47:40 Reserved 39:32 00h 31:16 Reserved 15:8 00h 7:0 E0h (i.e., SCT Command/Status log address)
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 3Fh (i.e., WRITE LOG EXT) 57h (i.e., WRITE LOG DMA EXT)

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Table 189 defines how a device shall set the fields after successful completion of an SCT command.

Table 189 — Successful SCT command response

Name	Description
Error	00h
Count	SCT Command Dependent Data
LBA	SCT Command Dependent Data
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5:1 N/A 0 Error – See 6.2.9

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Table 190 defines how a device shall set the fields after an error occurred during processing of an SCT command.

Table 190 — SCT command error response

Name	Description
Error	**Bit** **Description** 7:5 N/A 4 ID Not Found – See 6.3.6. 3 N/A 2 Abort – See 6.3.2. 1 N/A 0 Obsolete
Count	Extended Status Code (7:0) (see table 191)
LBA	**Bit** **Description** 27:24 Reserved 23:8 SCT Command dependent. 7:0 Extended Status Code (15:8) (see table 191)
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent – See 6.2.12. 5:1 N/A 0 Error – See 6.2.9

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Table 191 — Extended Status codes

Extended Status Code	Description
0000h	Command complete without error
0001h	Invalid Function Code
0002h	Input LBA out of range
0003h	Request 512-byte data block count overflow. The number of data blocks requested to transfer (Count field) in the log command is larger than specified by the SCT command
0004h	Invalid Function code in Error Recovery command
0005h	Invalid Selection code in Error Recovery command
0006h	Host read command timer is less than minimum value
0007h	Host write command timer is less than minimum value
0008h	Background SCT command was aborted because of an interrupting host command
0009h	Background SCT command was terminated because of unrecoverable error
000Ah	Obsolete
000Bh	SCT data transfer command was issued without first issuing an SCT command
000Ch	Invalid Function code in SCT Feature Control command
000Dh	Invalid Feature code in SCT Feature Control command
000Eh	Invalid New State value in SCT Feature Control command
000Fh	Invalid Option Flags value in SCT Feature Control command
0010h	Invalid SCT Action code
0011h	Invalid Table ID (table not supported)
0012h	Command was aborted due to device security being locked
0013h	Invalid revision code in SCT data
0014h	Foreground SCT operation was terminated because of unrecoverable error
0015h	The most recent non-SCT command completed with an error due to the SCT Error Recovery Control Read Command Timer or SCT Error Recovery Control Write Command Timer expiring.
0016h..BEFFh	Reserved
BF00h..BFFFh	Reserved for Serial ATA
C000h..FFEFh	Vendor specific
FFF0h..FFFEh	Reserved
FFFFh	SCT command executing in background

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8.2.4 SCT data transfer

Once an SCT command for a data transfer has been issued, status is checked and data is transferred using the SCT Data Transfer log (see A.1). Up to 255 data blocks of 512-bytes each may be transferred at a time. If the SCT command requires more than 255 blocks of data transfer and SMART READ LOG commands and SMART WRITE LOG commands are used to transfer the data, then the data may be written or read in up to 255 data block increments. If GPL feature set (see 4.10) commands are used to transfer data, then up to 65 535 data blocks of 512-bytes each may be transferred by a single command. If more than 65 535 data blocks are required, then multiple GPL feature set commands may be issued. Table 192 shows how to perform an SCT data transfer using a SMART READ LOG command (see 7.54.7) or SMART WRITE LOG command (see 7.54.9).

Table 192 — SCT data transfer using SMART

Name	Description
Feature	D6h (i.e., SMART WRITE LOG) D5h (i.e., SMART READ LOG)
Count	Number of 512-byte data blocks to transfer
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 E1h (i.e., SCT Data Transfer)
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B0h

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Table 193 defines the fields for data transfer using a GPL feature set (see 4.10) command.

Table 193 — SCT data transfer using the GPL feature set

Name	Description
Feature	Reserved
Count	Number of 512-byte data blocks to transfer
LBA	**Bit** **Description** 47:40 Reserved 39:32 00h 31:16 Reserved 15:8 00h 7:0 E1h (i.e., SCT Data Transfer)
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 2Fh (i.e., READ LOG EXT) 47h (i.e., READ LOG DMA EXT) 3Fh (i.e., WRITE LOG EXT) 57h (i.e., WRITE LOG DMA EXT)

8.2.5 SCT status

Status for an SCT command may be read at any time by reading the SCT Command/Status log (see A.1). If the command involves data transfer, the host should check status before data is transferred to ensure that the device is ready. The host should also check status when the command is complete to confirm that the data was transferred without error. When the command is complete, the host may check status a third time to determine if the command succeeded, failed, or partially succeeded.

Once an SCT command has been issued, status is reported in the ATA fields. This status indicates that the command was accepted or that an error occurred. This ATA status return does not indicate successful completion of the SCT actions, except foreground SCT Write Same commands (see 8.3.2) that require the completion of the SCT action (i.e., SCT Write Same with function code 0101h and 0102h). Some commands may take several minutes or even hours to process. The host may determine processing progress by requesting SCT status. Some commands may require setup time before a device is ready to receive data. SCT status indicates when the device is ready to receive data.

Reading the SCT Command/Status log retrieves the status information. The SCT status may be acquired any time that the host is allowed to send a command to the device. This command shall not change the power state of the device, nor terminate any background activity, including any SCT command in progress (i.e., if the device is in the Standby state or Idle state (see 4.17.4), then the log request shall succeed).

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Table 194 defines shows how to get the SCT status using a SMART READ LOG command (see 7.54.7).

Table 194 — SCT status request using SMART READ LOG

Name	Description
Feature	D5h (i.e., SMART READ LOG)
Count	01h
LBA	**Bit** **Description** 27:24 N/A 23:8 C24Fh 7:0 E0h (i.e., SCT Command/Status log address)
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 B0h

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Table 195 defines the fields for retrieving status using a READ LOG EXT command (see 7.29) or READ LOG DMA EXT command (see 7.30).

Table 195 — SCT status request using the GPL feature set

Name	Description
Feature	Reserved
Count	0001h
LBA	**Bit** **Description** 47:40 Reserved 39:32 00h 31:16 Reserved 15:8 00h 7:0 E0h (i.e., SCT Command/Status log address)
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Command	7:0 2Fh (i.e., READ LOG EXT) 47h (i.e., READ LOG DMA EXT)

Table 196 defines the format of the status response information that shall be set by the device in the SCT Command/Status log.

Table 196 — Format of SCT status response (part 1 of 2)

Offset	Type	Field Name	Description
0..1	Word	Format Version	0003h – Status Response format version number.
2..3	Word	SCT Version	Manufacturer's vendor specific implementation version number
4..5	Word	SCT Spec.	Obsolete
6..9	DWord	Status Flags	Bits (31:1) – Reserved Bit 0 – Segment Initialized Flag. If this bit is set to one, then an SCT Write Same command (see 8.3.2) to all logical blocks has completed without error. This bit shall be cleared to zero when any user LBA is written, even if write cache is enabled. This bit shall also be cleared to zero if the capacity of the device is changed via a SET MAX ADDRESS command (see 7.50.2), SET MAX ADDRESS EXT command (see 7.51), DEVICE CONFIGURATION SET DMA command (see 7.10.7), or DEVICE CONFIGURATION SET command (see 7.10.6). This bit is preserved during the processing of all power and reset events.

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Table 196 — Format of SCT status response (part 2 of 2)

Offset	Type	Field Name	Description
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 last SCT command issued. FFFFh if SCT command processing in background (see table 191).
16..17	Word	Action Code	Action code of last SCT command issued. If the Extended Status Code is FFFFh this is the Action Code of the command that is currently processing.
18..19	Word	Function Code	Function code of last SCT command issued. If the Extended Status Code is FFFFh this is the Function Code of the command that is currently processing.
20..39	Byte [20]	reserved	
40..47	QWord	LBA	Current LBA of SCT command processing in background. If there is no command currently processing in the background, this field is undefined.
48..199	Byte [152]	reserved	
200	Byte	HDA Temp	Current device temperature in degrees Celsius. This is a two's complement integer. 80h indicates that this value is invalid.
201	Byte	Min Temp	Minimum device temperature in degrees Celsius since the last power-on event. This is a two's complement integer. 80h indicates that this value is invalid.
202	Byte	Max Temp	Maximum device temperature in degrees Celsius since the last power-on event. This is a two's complement integer. 80h indicates that this value is invalid.
203	Byte	Life Min Temp	Minimum device temperature in degrees Celsius seen for the life of the device. This is a two's complement integer. 80h indicates that this value is invalid.
204	Byte	Life Max Temp	Maximum device temperature in degrees Celsius seen for the life of the device. This is a two's complement integer. 80h indicates that this value is invalid.
205	Byte	reserved	
206..209	DWord	Over Limit Count	Number of temperature recording intervals since the last power-on reset where the recorded temperature was greater than Max Op Limit. See table 208 for information about this interval.
210..213	DWord	Under Limit Count	Number of temperature recording intervals since the last power-on reset where the recorded temperature was less than Min Op Limit. See table 208 for information about this interval.
214..479	Byte [266]	reserved	
480..511	Byte [32]	Vendor Specific	

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8.3 SCT Command Set

8.3.1 Overview

An SCT command shall be 512 bytes long. While an SCT command is being processed a host may use an SCT status request to retrieve status information (e.g., to determine if a command is active or complete, the current LBA, or error information) about the current SCT command.

Table 197 defines the format of an SCT command written to the SCT Command/Status log (see A.1).

Table 197 — SCT command format

Offset	Field	Words	Description
0..1	Action Code	1	This field specifies the command type and the type of data being accessed, or the action being performed. (See table 198 for definition of the Action Code field contents.)
2..3	Function Code	1	This field specifies the type of access and varies by command.
4..x	Parameter1	Depends on command	Depends on command
x+1..y	Parameter2	Depends on command	Depends on command
…	…	…	…
	Total Words	256	

Table 198 — SCT Action Codes

Action Code	Description
0000h	Reserved
0001h	Obsolete
0002h	SCT Write Same command (see 8.3.2)
0003h	SCT Error Recovery Control command (see 8.3.3)
0004h	SCT Feature Control command (see 8.3.4)
0005h	SCT Data Tables command (see 8.3.5)
0006h	Vendor specific
0007h	Reserved for Serial ATA
0008h..BFFFh	Reserved
C000h..FFFFh	Vendor specific

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8.3.2 SCT Write Same command

The SCT Write Same command specifies that the device shall write a specific pattern to its media.

The SCT Write Same command shall cause the device to begin writing logical sectors from the first logical sector specified by the Start field (see table 199) in incrementing order until the number of logical sectors specified by the Count field (see table 199) have been written. If the Count field contains all zeros, then the device shall write all logical sectors beginning with the logical sector specified by the Start field through the last user addressable logical sector (see 4.11.4). If the HPA feature (see 4.11) set is implemented by the device and the HPA feature set is enabled, then this feature set shall determine the last user addressable logical sector (see 4.11.4). This command shall not write over a hidden partition when hidden partitions are enabled using the HPA feature set (see 4.11). Automatic sector reallocation is permitted during the processing of this SCT command.

If the Start field or the Start field plus the Count field specify an LBA greater than the last user addressable logical sector (see 4.11.4), then the device shall report an error and return command aborted. If the Start field and the Count field contain zero, then the device shall write the specified pattern to all user addressable logical sectors (see 4.11.4) on the device.

Any new command other than an SCT status request (e.g., IDENTIFY DEVICE command (see 7.17)), received by the device while this command is in progress shall terminate the SCT Write Same command and the device shall process the new command.

Repeat write data block (i.e., function code 0002h) and Repeat write data block foreground (i.e., function code 0102h) cause the device to accept one block of data from the host and then repeatedly write that block of data in the user area starting from the LBA value contained in the Start field for the number of logical sectors specified in the Count field.

While an SCT Write Same command with function code 0001h or function code 0002h is processed as a background activity, the SCT status error code shall be set to FFFFh. If the background activity completes without error, then the SCT status error code shall be set to 0000h. If any error occurs during the background activity, then the SCT status error code shall be set to a value less than FFFFh and greater than 0000h.

Once the key data block (see 8.1.1) has been issued, if the Function Code was 0002h and the input data structure indicates that the device is ready to receive data, the SCT Data Transfer log (see A.1) should be written to transfer the data.

For the SCT Write Same command with function code 0101h the Command Completion Status of the write to the SCT Command/Status log (see A.1) shall indicate the success or failure of this command. For the SCT Write Same command with function Code 0102h the Command Completion Status of the write to the SCT Data Transfer log shall indicate the success or failure of this SCT Write Same command. The Status field and Error field indicate the status values and error values as defined in clause 6. In the case of an error an SCT Status Request may be made by reading the SCT Command/Status log (see A.1) to obtain a more detailed analysis of the error.

The Write Same command may change the Segment Initialized Flag (see table 196). If the Write Same command writes all of the user data area and completes without an error or being aborted, then the Segment Initialized Flag (i.e., bit 0 of the Status Flags in the SCT status) shall be set to one. A write within the user data area on the device, except one caused by another SCT Write Same command with the Start field and the Count field set to zero (i.e., an SCT Write Same command causing the device to write to all of the user data area), shall cause the Segment Initialized Flag to be cleared. Reallocations as a result of reading data, either in the foreground or background, shall not clear the Device Zeroed flag.

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Table 199 defines the format of a SCT Write Same command written to the SCT Command/Status log (see A.1).

Table 199 — SCT Write Same command

Word	Name	Value	Description
0	Action Code	0002h	This action writes a pattern or 512-byte data block repeatedly to the media.
1	Function Code	0000h	Reserved
		0001h	Repeat write pattern
		0002h	Repeat write data block
		0003h..0100h	Reserved
		0101h	Repeat write pattern foreground
		0102h	Repeat write data block foreground
		0103h..FFFFh	Reserved
2..5	Start	QWord	First logical sector to write 63:48 Reserved 47:0 First LBA
6..9	Count	QWord	Number of logical sectors to fill
10..11	Pattern	DWord	If the Function Code is 0001h or 0101h, this field contains a 32-bit pattern that is used to fill the user data area starting with the first byte of the sector specified in Start through that last byte specified by Start plus count.

Table 200 defines the format of the status response for a SCT Write Same command.

Table 200 — SCT Write Same command status response

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found – See 6.3.6. 3 N/A 2 Abort – See 6.3.2. 1 N/A 0 Obsolete
Count	Reserved
LBA	

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Table 200 — SCT Write Same command status response

Name	Description
	Bit Description 27:24 Reserved 23:8 0000h – If FC=0001h or FC=0101h 0001h – If FC=0002h or FC=0102h 7:0 Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5:1 N/A 0 Error – See 6.2.9

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8.3.3 SCT Error Recovery Control command

The SCT Error Recovery Control command sets time limits for read and write error recovery. For commands that are not NCQ commands (see 4.14), these, these timers apply to command completion. For NCQ commands where in-order data delivery is enabled, these timers begin counting when the device begins to process the command, not when the command is sent to the device. These timers do not apply to streaming commands (see 4.24) or to queued commands (see 4.14) when out-of-order data delivery is enabled.

Table 201 defines the format of an SCT Error Recovery Control command written to the SCT Command/Status log (see A.1).

Table 201 — SCT Error Recovery Control command

Word	Name	Value	Description
0	Action Code	0003h	Set the read and write error recovery time
1	Function Code	0000h	Reserved
		0001h	Set New Value
		0002h	Return Current Value
		0003h..FFFFh	Reserved
2	Selection Code	0000h	Reserved
		0001h	Read Command Timer
		0002h	Write Command Timer
		0003h..FFFFh	Reserved
3	Recovery Time Limit		If the Function Code is 0001h, then this field contains the recovery time limit in 100 ms units (e.g., a value of 1 = 100 ms, 2 = 200 ms). The tolerance is vendor specific.

If the Selection Code field is set to 0001h, then:

a) the Recovery Time Limit field specifies the upper limit of the amount of time a device shall processes a read command in total;
b) the device shall set the Read Command Timer to the value of the Recovery Time Limit fields; and
c) if the Recovery Time Limit field is set to zero, then the device shall perform all available error recovery procedures (i.e., the Read Command Timer is disabled).

The device shall report command completion or stop processing the command and report an Uncorrectable Error (see 6.3.13) for the LBA that caused error recovery to be invoked prior to Read Command Timer expiration. Extended status code 0015h should be returned in the SCT Status data if the Read Command Timer expires. A failed logical sector may be recovered if the Recovery Time Limit is increased.

If the Selection Code field is set to 0002h, then:

a) the Recovery Time Limit field specifies the upper limit of the amount of time a device shall processes a write command in total;
b) the device shall set the Write Command Timer to the value of the Recovery Time Limit fields; and
c) if the Recovery Time Limit field is set to zero, then the device shall perform all available error recovery procedures (i.e., the Write Command Timer is disabled).

A large Write Command Timer value allows the device to use more available error recovery procedures. If the Write Command Timer is about to expire, then the device should attempt to reallocate the data before the Write Command Timer expires. Extended status code 0015h should be returned in the SCT Status data if the Write Command Timer expires. If the device is unable to complete data reallocation before the Write Command Timer expires, then the device fails the command when the Write Command Timer expires. When write cache is enabled the operation of the Write Command Timer is vendor specific.

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A host implementor should use the Write Command Timer with great caution as a very small timer value may cause a device to permanently reallocate good logical sectors as the result of temporary, external conditions (e.g., induced vibration).

The Extended status code shall be cleared when the next non-SCT command is processed by the device, except when processing a read of the NCQ Command Error log (see A.12).

Read Command Timer and Write Command Timer values are set to default values after processing a power-on reset but may be altered by an SCT command at any time. A device shall not change these settings while processing a hardware reset or a software reset.

Table 202 defines the format of the status response for a SCT Error Recovery Control command.

Table 202 — SCT Error Recovery Control command status response

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found – See 6.3.6. 3 N/A 2 Abort – See 6.3.2. 1 N/A 0 Obsolete
Count	If Function Code was 0002h, then this is the requested recovery limit (7:0); otherwise, this field is reserved.
LBA	**Bit Description** 27:8 Reserved 7:0 If the Function Code was 0002h, then this is the requested recovery limit (15:8); otherwise, this field is reserved.
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5:1 N/A 0 Error – See 6.2.9

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8.3.4 SCT Feature Control command

The SCT Feature Control command reports and sets the state (i.e., enabled or disabled) of the features specified by the command.

Table 203 defines the format of a SCT Feature Control command written to the SCT Command/Status log (see A.1).

Table 203 — SCT Feature Control command

Word	Name	Value	Description
0	Action Code	0004h	Set or return the state of device features defined in table 204
1	Function Code	0000h	Reserved
		0001h	Set state for a feature
		0002h	Return the current state of a feature
		0003h	Return feature option flags
		0004h..FFFFh	Reserved
2	Feature Code		See table 204 for definition of the Feature Code
3	State		Feature Code dependent value
4	Option Flags		**Bit** **Description** 15:1 Reserved 0 If the function code is 0001h, then setting bit 0 to one shall cause the requested feature state change to be preserved during all power and reset events. If the function code is 0001h, then clearing bit 0 to zero shall cause the requested feature state change to be volatile (i.e., a hard reset causes the device to revert to the default value or to the last non-volatile setting).

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Table 204 — Feature Code list

Feature Code	State Definition
0000h	Reserved
0001h	If State is set to 0001h, then the SET FEATURES command (see 7.49) shall determine the state of the write cache (see 7.49.4). If State is set to 0002h, then write cache shall be enabled. If State is set to 0003h, then write cache shall be disabled. If State is set to 0002h or 0003h, then write cache shall be set to the specified state, and any attempt to change the write cache settings using a SET FEATURES command shall not result in an error and shall not change the operational state of the write cache. In all cases, IDENTIFY DEVICE data word 85 bit 5 (see 7.17.7.41) shall reflect the current operational state of write cache (i.e., if set to one, then volatile write cache is enabled, and if cleared to zero, then write cache is disabled). The default is State set to 0001h.
0002h	If State is set to 0001h, then volatile Write Cache Reordering shall be enabled (i.e., disk write scheduling may be reordered by the device), regardless of the enabled or disabled state of the volatile write cache. If State is set to 0002h, then volatile Write Cache Reordering shall be disabled, and disk write scheduling is processed on a first-in-first-out (FIFO) basis, regardless of the enabled or disabled state of the volatile write cache. If volatile write cache is disabled, then the current volatile Write Cache Reordering state has no effect on writes. The state of volatile Write Cache Reordering has no effect on NCQ commands (see 4.14). The default is State set to 0001h.
0003h	The value in State sets the time interval for temperature logging. State set to 0000h is invalid. State may be set to 0001h to FFFFh to specify the temperature logging interval in minutes. This value applies to the Absolute HDA Temperature History (see table 208). Issuing this command shall cause: a) the queue to be reset and any prior values in the queues to be lost; b) the Queue Index (see table 208) to be set to zero; c) the first queue location to be set to the current value and all remaining queue locations set to 80h; and d) the Sample Period value, Max Op Limit value, Over Limit value, Min Op Limit value, and Under Limit value to be preserved (see table 208). The default is State set to 0001h.
0004h..0005h	Reserved for Serial ATA
0006h..CFFFh	Reserved
D000h..FFFFh	Vendor Specific

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Table 205 defines the format of the status response for a SCT Feature Control command.

Table 205 — SCT Feature Control command status response

Name	Description
Error	**Bit** **Description** 7:5 N/A 4 ID Not Found – See 6.3.6. 3 N/A 2 Abort – See 6.3.2. 1 N/A 0 Obsolete
Count	If the Function Code was set to 0002h, then this is the Feature State (7:0). If the Function Code was set to 0003h, then this is the Option Flags (7:0). Otherwise this field is reserved.
LBA	**Bit** **Description** 27:8 Reserved 7:0 If the Function Code was set to 0002h, then this is the Feature State (15:8). If the Function Code was set to 0003h, then this is the Option Flags (15:8). Otherwise this field is reserved.
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent – See 6.2.12. 5:1 N/A 0 Error – See 6.2.9

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8.3.5 SCT Data Table command

The SCT Data Table command reads the specified data table.

Table 206 defines the format of an SCT Data Table command written to the SCT Command/Status log (see A.1).

Table 206 — SCT Data Table command

Word	Name	Value	Description
0	Action Code	0005h	Read a data table
1	Function Code	0000h	Reserved
		0001h	Read Table
		0002h..FFFFh	Reserved
2	Table ID	Word	See Table 207 for a list of SCT data tables.

Table 207 — SCT Data Tables (by Table Identifier)

Table Id	Description
0000h	Invalid
0001h	Reserved
0002h	HDA Temperature History Table (in degrees Celsius). See table 208 for more information.
0003h..0004h	Reserved for Serial ATA
0005h..CFFFh	Reserved
D000h..FFFFh	Vendor Specific

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Table 208 — Absolute HDA Temperature (part 1 of 2)

Offset	Size	Field Name	Description
0..1	Word	Format Version	0002h – Data table format version.
2..3	Word	Sampling Period	Absolute HDA Temperature sampling period in minutes. This is how often the device samples its temperature sensor. This period takes precedence over new read operations or write operations, but does not interrupt operations in process. The Sampling Period may be smaller than the timer interval between entries in the history queue. A value of 0000h in this field indicates that sampling is disabled.
4..5	Word	Interval	The timer interval between entries in the history queue. The default value of this field is vendor specific. This value should not be less than the Sampling Period.
6	Byte	Max Op Limit	Maximum recommended continuous operating temperature [c]. This is a two's complement number that allows a range from -127 °C to +127 °C to be indicated. 80h is an invalid value. This is a fixed value.
7	Byte	Over Limit	Maximum temperature limit. Operating the device above this temperature may cause physical damage to the device [c]. This is a two's complement number that allows a range from -127 °C to +127 °C to be indicated. 80h is an invalid value. This is a fixed value.
8	Byte	Min Op Limit	Minimum recommended continuous operating limit [c]. This is a two's complement number that allows a range from -127 °C to +127 °C to be indicated. 80h is an invalid value. This is a fixed value.
9	Byte	Under Limit	Minimum temperature limit. Operating the device below this temperature may cause physical damage to the device [c]. This is a two's complement number that allows a range from -127 °C to +127 °C to be indicated. 80h is an invalid value. This is a fixed value.
10..29	Byte [20]	reserved	
30..31	Word	CB Size	Number of entry locations in history buffer. This number shall be in the range of 128..478.
32..33	Word	CB Index	Last updated entry in buffer. CB Index is zero-based, so CB Index 0000h is the first location in the buffer (i.e., at offset 34). The most recent temperature entered in the buffer is at CB Index + 34 [a b].

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Table 208 — Absolute HDA Temperature (part 2 of 2)

Offset	Size	Field Name	Description
34..(CB Size + 33)	Byte [CB Size]	CB	This is a circular buffer of absolute HDA Temperature values. Other device activities (e.g., data transfer), take priority over writing this data to non-volatile storage. These are two's complement numbers that allow a range from -127 °C to +127 °C to be indicated. A value of 80h indicates an initial value or a discontinuity in temperature recording. The time between samples may vary because commands shall not be interrupted. The sampling period is the minimum time between samples [a]. If the host changes the logging interval using the volatile option, then the interval between entries in the queue may change between power cycles with no indication to the host.
(CB Size + 34)..511	Byte [512 – CB Size – 34]	reserved	Shall be zero.

[a] The Absolute HDA Temperature History is preserved during the processing of all power events and reset events with the requirement that when the device powers up, a new entry is made in the history queue with a value of 80h (i.e., an invalid absolute temperature value) to indicate the discontinuity in temperature resulting from the device being turned off. If the device does not sample temperatures during a certain power state (e.g., Sleep or Standby) (see 4.17.4), then a value of 80h is entered into the history queue to indicate that temperature sensing has resumed.

[b] When the Absolute HDA Temperature history is cleared (e.g., for new devices or after changing the Logging Interval) the Queue Index shall be set to zero and the first queue location shall be set to the current Absolute HDA Temperature value. All remaining queue locations shall be set to 80h.

[c] These values should take into account the accuracy of the temperature sensor. The placement, accuracy, and granularity of temperature sensors to support table 208 are vendor specific.

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Table 209 defines the format of the status response for an SCT Data Table command.

Table 209 — SCT Data Table command status response

Name	Description
Error	**Bit** **Description** 7:5 N/A 4 ID Not Found – See 6.3.6. 3 N/A 2 Abort – See 6.3.2. 1 N/A 0 Obsolete
Count	Reserved
LBA	**Bit** **Description** 27:24 Reserved 23:8 For Table ID 0002h, 0001h (i.e., Number of data blocks requested); otherwise reserved. 7:0 Reserved.
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent – See 6.2.12. 5:1 N/A 0 Error – See 6.2.9

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9 Normal and Error Outputs

9.1 Overview

The commands listed in clause 7 each have subclauses labeled Normal Outputs and Error Outputs. Subclauses 9.2 and 9.3 document the return data format for all the commands described in clause 7. Each command in clause 7 may provide additional information about a normal or error output, however, all the information specified in clause 9 shall also apply to the command.

The references preceding each table indicate each command that generates the output in the table.

9.2 Normal Outputs

The tables in this subclause specify the Normal Outputs a command returns.

Table 210 specifies the normal outputs for the commands defined in 7.2.

Table 210 — Error Bit Defined For Normal Output

Name	Description
Error	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12. 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 211 specifies the normal outputs for the commands defined in 7.3.

Table 211 — Extended Error Code for Normal Output

Name	Description
Error	Extended error code (see table 23)
Count	Vendor Specific
LBA	Vendor Specific
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5:2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 212 specifies the normal outputs for the commands defined in 7.10.5, 7.10.2, 7.10.3, 7.10.6, 7.15, 7.17, 7.18, 7.19, 7.21, 7.22.4, 7.21.11, 7.24, 7.26, 7.31, 7.35, 7.39, 7.43, 7.44, 7.45, 7.46, 7.47, 7.48, 7.49, 7.49.18.2.3, 7.49.18.3.3, 7.49.18.4.5, 7.49.18.5.3, 7.50.5, 7.50.4, 7.50.7, 7.50.3, 7.52, 7.53, 7.54.2, 7.54.3, 7.54.4, 7.54.6, 7.54.7, 7.54.9, 7.55, 7.56, 7.62, 7.64, 7.70, 7.73, and 7.77.

Table 212 — Generic Normal Output (No LBA Return Value) for Normal Output

Name	Description
Error	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12. 2 N/A or Alignment Error – See 6.2.2 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 213 specifies the normal outputs for the commands defined in 7.12 and 7.13.

Table 213 — Download Microcode Normal Output

Name	Description
Error	N/A
Count	If Download with offsets and save microcode for immediate and future use was specified (see 7.12), 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 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12. 2 N/A or Alignment Error – See 6.2.2 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 214 specifies the normal outputs for the commands defined in 7.4, 7.5, and 7.6.

Table 214 — CFA Normal Output

Name	Description
Error	N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12 5:2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 215 specifies the normal outputs for the commands defined in 7.7.

Table 215 — Check Power Mode Normal Output (part 1 of 2)

Name	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 4.8) 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 4.8.2). 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 4.8.2). 02h..3Fh Reserved 40h Device is: a) in the PM0:Active state (see 4.17.4); b) the NV Cache power mode (see 4.16) is enabled; and c) the spindle is spun down or spinning down. 41h Device is: a) in the PM0:Active state; b) the NV Cache power mode is enabled; and c) the spindle is spun up or spinning up. 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 4.8.2). 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 4.8.2). 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 4.8.2). 84h..FEh Reserved FFh Device is in the PM0:Active state or PM1:Idle State.
LBA	N/A

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Table 215 — Check Power Mode Normal Output (part 2 of 2)

Name	Description
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 216 specifies the normal outputs for the commands defined in 7.8, 7.37, and 7.75.

Table 216 — Stream Normal Output

Name	Description
Error	N/A
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12 5 Stream Error – See 6.2.11 4 N/A 3 Transport Dependent – See 6.2.12 2 N/A or Alignment Error – See 6.2.2 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 217 specifies the normal outputs for the commands defined in 3.1.79, 7.11, 7.14, 7.17, and 7.35.

Table 217 — Device Signatures for Normal Output

<table>
<tr><th>Name</th><th>Description</th></tr>
<tr><td>Error</td><td>Diagnostic Results – The diagnostic code as described in table 46 is returned.
This field shall be reserved for the DEVICE RESET command (see 7.11). For the READ SECTOR(S) command (see 7.35) or the IDENTIFY DEVICE command (see 7.17), bit 2 of this field shall be set to one and the remaining bits are N/A.</td></tr>
<tr><td>Count

LBA</td><td>
<table>
<tr><th>Bit</th><th>ATA Device [a]</th><th>ATAPI Device [a]</th><th>Reserved for SATA [a]</th><th>Reserved for SATA [a]</th><th>Obsolete [a]</th></tr>
<tr><td>Count (7:0)</td><td>01h</td><td>01h</td><td>01h</td><td>01h</td><td>N/A</td></tr>
<tr><td>LBA (27:24)</td><td>Reserved</td><td>Reserved</td><td>Reserved</td><td>Reserved</td><td>Reserved</td></tr>
<tr><td>LBA (23:16)</td><td>00h</td><td>EBh</td><td>C3h</td><td>96h</td><td>AAh</td></tr>
<tr><td>LBA (15:8)</td><td>00h</td><td>14h</td><td>3Ch</td><td>69h</td><td>CEh</td></tr>
<tr><td>LBA (7:0)</td><td>01h</td><td>01h</td><td>01h</td><td>01h</td><td>N/A</td></tr>
</table>
</td></tr>
<tr><td>Device</td><td>
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>7</td><td>Obsolete</td></tr>
<tr><td>6</td><td>N/A</td></tr>
<tr><td>5</td><td>Obsolete</td></tr>
<tr><td>4</td><td>Transport Dependent – See 6.2.12</td></tr>
<tr><td>3:0</td><td>Reserved</td></tr>
</table>
</td></tr>
<tr><td>Status</td><td>
<table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>7:6</td><td>Transport Dependent – See 6.2.12</td></tr>
<tr><td>5</td><td>Device Fault – See 6.2.7</td></tr>
<tr><td>4</td><td>N/A</td></tr>
<tr><td>3</td><td>Transport Dependent – See 6.2.12</td></tr>
<tr><td>2</td><td>N/A</td></tr>
<tr><td>1</td><td>Sense Data Available – See 6.2.10</td></tr>
<tr><td>0</td><td>Shall be cleared to zero</td></tr>
</table>
</td></tr>
<tr><td colspan="2">[a] All other values are reserved</td></tr>
</table>

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Table 218 specifies the normal outputs for the commands defined in 7.20.

Table 218 — IDLE Unload Normal Output

Name	Description
Error	N/A
Count	N/A
LBA	**Bit** **Description** 27:8 N/A 7:0 C4h
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent – See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 219 specifies the normal outputs for the commands defined in 7.23.6.

Table 219 — ATAPI Normal Output

Name	Description
Error	N/A
Interrupt Reason	**Bit Description** 7:2 Obsolete 1 Input/Output – See 6.4.3 0 Command/Data – See 6.4.2
LBA	**Bit Description** 27:24 N/A 23:8 Byte Count 7:0 N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7 Transport Dependent – See 6.2.12 6 N/A 5:4 Obsolete 3 Transport Dependent – See 6.2.12 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9. Shall be cleared to zero

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Table 220 specifies the normal outputs for the commands defined in 7.33 and 7.50.2.

Table 220 — HPA Normal Output

Name	Description
Error	N/A
Count	N/A
LBA	Maximum LBA
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent – See 6.2.12 5:2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 221 specifies the normal outputs for the commands defined in 7.54.5.

Table 221 — SMART Off-Line Immediate Normal Output

Name	Description
Error	N/A
Count	N/A
LBA	**Bit** **Description** 27:24 N/A 23:8 **Value** **Description** C24Fh The subcommand specified a captive self-test that has completed without error. All Other Values The subcommand specified an off-line routine including an off-line self-test routine. 7:0 N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent – See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 222 specifies the normal outputs for the commands defined in 7.54.8.

Table 222 — SMART Return Status Normal Output

Name	Description
Error	N/A
Count	N/A
LBA	**Bit** **Description** 27:24 N/A 23:8 **Value** **Description** C24Fh The subcommand specified a captive self-test that has completed without error. 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 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent – See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 223 specifies the normal outputs for the commands defined in 7.9, 7.16, 7.21.5, 7.27, 7.29, 7.32, 7.36, 7.40, 7.58, 7.60, 7.65, 7.66, 7.68, 7.71, 7.72, and 7.74.

Table 223 — Generic Extended Normal Output

Name	Description
Error	Reserved
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12 2 N/A or Alignment Error – See 6.2.2 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 224 specifies the normal outputs for the commands defined in 7.34 and 7.51.

Table 224 — SETMAX Extended Normal Output

Name	Description
Error	Reserved
Count	Reserved
LBA	Maximum LBA
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent – See 6.2.12 5:2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 225 specifies the normal outputs for the commands defined in 7.21.3, 7.21.7, 7.21.8, and 7.21.9.

Table 225 — NV Cache Normal Output

Name	Description
Error	Reserved
Count	Reserved
LBA	Number of unpinned logical blocks remaining
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 226 specifies the normal outputs for the commands defined in 7.21.4.

Table 226 — NV Cache Flush Normal Output

Name	Description
Error	Reserved
Count	Reserved
LBA	Number of unflushed logical blocks remaining
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 227 specifies the normal outputs for the commands defined in 7.28.4 and 7.67.4.

Table 227 — NCQ Command Acceptance Normal Output

Name	Description
Error	Shall be cleared to zero
Count	N/A
LBA	N/A
Device	**Bit Description** 7:4 N/A 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

Table 228 specifies the normal outputs for the commands defined in 7.28.5 and 7.67.5.

Table 228 — NCQ Normal Outputs

Name	Description
SATA Status	Transport Dependent
Error	Shall be cleared to zero
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12. 2 N/A or Alignment Error – See 6.2.2 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9
SActive	**Bit Description** 31:0 Transport dependent completion indicator

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Table 229 specifies the normal outputs for the commands defined in 7.41.

Table 229 — REQUEST SENSE DATA EXT Normal Output

Name	Description
Error	Reserved
Count	Reserved
LBA	**Bit** **Description** 47:24 Vendor Specific 23:20 Reserved 19:16 Sense Key (see 7.41.4) 15:8 Additional Sense Code (see 7.41.4) 7:0 Additional Sense Code Qualifier (see 7.41.4)
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent – See 6.2.12. 5:2 Reserved 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 230 specifies the normal outputs for the commands defined in 7.42.

Table 230 — Sanitize Device Normal Output

Name	Description
Error	Reserved
Count	**Bit** **Description** 15 Sanitize operation completed without error. If the device processes BLOCK ERASE EXT command (see 7.42.2), CRYPTO SCRAMBLE EXT command (see 7.42.3), or a OVERWRITE EXT command (see 7.42.4), then this bit shall be cleared to zero. 14 Sanitize operation in progress 13 Device is in the Sanitize Frozen state (see figure 15) 12:0 Reserved
LBA	**Bit** **Description** 47:16 Reserved 15:0 Sanitize Progress Indication – Progress indicator for the current sanitize operation. This value shall be FFFFh if a sanitize operation is not in process. The returned value is a numerator that has 65 536 (1_0000h) as its denominator.
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12. 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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9.3 Error Outputs

The tables in this subclause specify the Error Outputs a command returns. References to these tables are found in clause 7.

If the Sense Data Reporting feature set is enabled and there is sense data available, then the Error field shall be set to 7Fh and the Error bit in the Status field shall be set to one. If the Sense Data Reporting feature set has been enabled with the Sense Data Available status bit reporting set to one (see 7.49.16), then the device notifies the host of additional information by setting the Sense Data Available bit in the Status field to one.

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Table 231 specifies the error outputs for the commands defined in 7.1.9.

Table 231 — Unsupported Command Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort – See 6.3.2 1:0 N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7:4 N/A 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5:2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 232 specifies the error outputs for the commands defined in 7.2.

Table 232 — CFA Erase Error

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found – See 6.3.6 3 N/A 2 Abort – See 6.3.2 1 N/A 0 Media Error – See 6.3.11
Count	N/A
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4:2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 233 specifies the error outputs for the commands defined in 7.5 and 7.6.

Table 233 — CFA Write Error

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found – See 6.3.6 3 N/A 2 Abort – See 6.3.2 1 N/A 0 Media Error – See 6.3.11
Count	N/A
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 Transport Dependent – See 6.2.12 3:2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 234 specifies the error outputs for the commands defined in 7.3, 7.4, and 7.7.

Table 234 — CFA Abort Error and Check Power Mode Abort Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort – See 6.3.2 1:0 N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4:2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 235 specifies the error outputs for the commands defined in 7.10.5, 7.10.2, 7.19, 7.20, 7.41, 7.44, 7.46, 7.49.21, 7.49.18.2.4, 7.49.18.3.4, 7.49.18.4.6, 7.49.18.5.4, 7.52, 7.53, 7.54.2, 7.54.3, 7.54.4, 7.54.8, 7.55, 7.56, and 7.77.

Table 235 — Generic Abort wo/ICRC Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort – See 6.3.2 1:0 N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 236 specifies the error outputs for the commands defined in 7.10.3, 7.12, 7.17.6, 7.18, 7.24, 7.43, 7.45, 7.47, 7.48, and 7.62.

Table 236 — Generic Abort Error

Name	Description
Error	**Bit Description** 7 Interface CRC – See 6.3.10 6:3 N/A 2 Abort – See 6.3.2 1:0 N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 237 specifies the error outputs for the commands defined in 7.58 and 7.60.

Table 237 — Trusted Abort Error

Name	Description
Error	**Bit Description** 7 Interface CRC – See 6.3.10 6:3 N/A 2 Abort – See 6.3.2 1:0 N/A
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 238 specifies the error outputs for the commands defined in 7.33, 7.50.4, and 7.50.3.

Table 238 — Generic SET MAX Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort – See 6.3.2 1:0 N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5:2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 239 specifies the error outputs for the commands defined in 7.50.7.

Table 239 — SET MAX Unlock Error

Name	Description
Error	**Bit Description** 7 Interface CRC – See 6.3.10 6:3 N/A 2 Abort – See 6.3.2 1:0 N/A
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 240 specifies the error outputs for the commands defined in 7.8.

Table 240 — Configure Stream Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort – See 6.3.2 1:0 N/A
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Stream Error – See 6.2.11 4 N/A 3 Transport Dependent – See 6.2.12. 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 241 specifies the error outputs for the commands defined in 7.15.

Table 241 — Flush Cache Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort – See 6.3.2 1:0 N/A
Count	N/A
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12. 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 242 specifies the error outputs for the commands defined in 7.16.

Table 242 — Flush Cache Ext Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort – See 6.3.2 1:0 N/A
Count	Reserved
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12. 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 243 specifies the error outputs for the commands defined in 7.27.

Table 243 — Read DMA Ext Error

Name	Description
Error	**Bit Description** 7 Interface CRC – See 6.3.10 6 Uncorrectable Error – See 6.3.13. 5 Obsolete 4 ID Not Found – See 6.3.6 3 Obsolete 2 Abort – See 6.3.2 1:0 Obsolete
Count	Reserved
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12. 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 244 specifies the error outputs for the commands defined in 7.29.

Table 244 — Read Log Ext Error

Name	Description
Error	**Bit Description** 7 Interface CRC – See 6.3.10 6 Uncorrectable Error – See 6.3.13. 5 N/A 4 ID Not Found – See 6.3.6 3 N/A 2 Abort – See 6.3.2. 1 N/A 0 Obsolete
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12. 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 245 specifies the error outputs for the commands defined in 7.26, 7.31, 7.35, and 7.39.

Table 245 — Read PIO Error

Name	Description
Error	**Bit Description** 7 Interface CRC – See 6.3.10 6 Uncorrectable Error – See 6.3.13 5 Obsolete 4 ID Not Found – See 6.3.6 3 Obsolete 2 Abort – See 6.3.2 1:0 Obsolete
Count	N/A
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12. 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 246 specifies the error outputs for the commands defined in 7.37.

Table 246 — Read Stream Error

Name	Description
Error	**Bit Description** 7 Interface CRC – See 6.3.10 6 Uncorrectable Error – See 6.3.13. 5 Obsolete 4 ID Not Found – See 6.3.6 3 Obsolete 2 Abort – See 6.3.2 1 Obsolete 0 Command Completion Time Out – See 6.3.4
Count	Length of Stream Error – number of contiguous logical sectors containing potentially bad data, beginning with the LBA of the first logical sector with an uncorrectable error.
LBA	LBA of first unrecoverable error.
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Stream Error – See 6.2.11. 4 Deferred Write Error – See 6.2.6. 3 Transport Dependent – See 6.2.12. 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 247 specifies the error outputs for the commands defined in 7.50.2 and 7.50.5.

Table 247 — HPA Error

Name	Description
Error	**Bit Description** 7:5 N/A 4 ID Not Found – See 6.3.6. 3 N/A 2 Abort – See 6.3.2. 1 N/A 0 Obsolete
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12. 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 248 specifies the error outputs for the commands defined in 7.54.9.

Table 248 — Write Log Error

Name	Description
Error	**Bit Description** 7 Interface CRC – See 6.3.10 6:5 N/A 4 ID Not Found – See 6.3.6. 3 N/A 2 Abort – See 6.3.2. 1 N/A 0 Obsolete
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 249 specifies the error outputs for the commands defined in 7.9 and 7.68.

Table 249 — Write Log Ext Error or Data Set Management Error

Name	Description
Error	**Bit Description** 7 Interface CRC – See 6.3.10 6:5 N/A 4 ID Not Found – See 6.3.6. 3 N/A 2 Abort – See 6.3.2. 1 N/A 0 Obsolete
Count	Reserved
LBA	Reserved
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 250 specifies the error outputs for the commands defined in 7.54.5.

Table 250 — SMART Error

Name	Description
Error	**Bit** **Description** 7:5 N/A 4 ID Not Found – See 6.3.6. 3 N/A 2 Abort – See 6.3.2. 1 N/A 0 Obsolete
Count	Reserved
LBA	**Bit** **Description** 27:24 N/A 23:8 **Value** **Description** C24Fh Subcommand specified a captive self-test and some error other than a self-test routine failure occurred (i.e., if the sub-command is not supported or field values are invalid). 2CF4h the subcommand specified a captive self-test routine that has failed during processing. All Other Values the subcommand specified an off-line routine including an off-line self-test routine. 7:0 N/A
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12. 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 251 specifies the error outputs for the commands defined in 7.65, 7.66, 7.71, 7.72 and 7.74.

Table 251 — Write Extended Error

Name	Description
Error	**Bit Description** 7 Interface CRC – See 6.3.10 6:5 Obsolete. 4 ID Not Found – See 6.3.6 3 Obsolete 2 Abort – See 6.3.2 1 Obsolete 0 N/A
Count	Reserved
LBA	LBA of first unrecoverable error
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 252 specifies the error outputs for the commands defined in 7.75.

Table 252 — Write Stream Error

Name	Description
Error	**Bit Description** 7 Interface CRC – See 6.3.10 6:5 Obsolete 4 ID Not Found – See 6.3.6 3 Obsolete 2 Abort – See 6.3.2 1 Obsolete 0 Command Completion Time Out – See 6.3.4
Count	Length of Stream Error – number of contiguous logical sectors containing potentially bad data, beginning with the LBA of the first logical sector with an uncorrectable error.
LBA	LBA of first unrecoverable error.
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Stream Error – See 6.2.11. 4 Deferred Write Error – See 6.2.6. 3 Transport Dependent – See 6.2.12. 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9.

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Table 253 specifies the error outputs for the commands defined in 7.10.6.

Table 253 — DCO Set Error

Name	Description
Error	**Bit** **Description** 7 Interface CRC – See 6.3.10 6:3 N/A 2 Abort – See 6.3.2 1:0 N/A
Count	Vendor Specific
LBA	**Bit** **Description** 27:24 N/A 23:16 Word Location – If the command was aborted because an attempt was made to modify a bit that shall not be modified with the device in its current state, then this field shall contain the offset of the first word encountered that the device shall not change. If an illegal maximum LBA is encountered, then this field shall be set to 03h. If a checksum error occurred, then this field shall be set to FFh. A value of 00h indicates that the Data Structure Revision was invalid. 15:0 Bit Location – If the command was aborted because an attempt was made to disable at least one mode or feature that shall not be disabled with the device in its current state, then this field shall contain an array of bits that correspond to the device configuration overlay data structure listed in Table 11 relative to the word indicated in bits (23:16) (i.e., Word Location). A one in this array indicates that the requested mode or feature shall not be disabled by the device. If the bit location is not reported, then the value shall be 0000h.
Device	**Bit** **Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit** **Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12. 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 254 specifies the error outputs for the commands defined in 7.22.

Table 254 — NOP Error

Name	Description
Error	**Bit Description** 7:3 N/A 2 Abort – See 6.3.2 1:0 N/A
Count	Initial Value
LBA	Initial Value
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12. 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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Table 255 specifies the error outputs for the commands defined in 7.23.

Table 255 — PACKET command Error

Name	Description
Error	**Bit Description** 7:4 Sense Key – See 6.3.12 3 N/A 2 Abort – See 6.3.2 1 End of Media – See 6.3.5 0 Illegal Length Indicator – See 6.3.7
Interrupt Reason	**Bit Description** 7:2 Obsolete 1 Input/Output – See 6.4.3. Shall be set to one 0 Command/Data – See 6.4.2. Shall be set to one
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 N/A 4 Obsolete. 3 Transport Dependent – See 6.2.12. 2 N/A 1 Sense Data Available – See 6.2.10 0 Check Condition – See 6.2.4.

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Table 256 specifies the error outputs for the commands defined in 7.54.6 and 7.54.7.

Table 256 — SMART Read Log/SMART Read Data Error

Name	Description
Error	**Bit Description** 7 Interface CRC – See 6.3.10 6 Uncorrectable Error – See 6.3.13. 5 N/A 4 ID Not Found – See 6.3.6 3 N/A 2 Abort – See 6.3.2. 1 N/A 0 Obsolete
Count	N/A
LBA	N/A
Device	**Bit Description** 7 Obsolete 6 N/A 5 Obsolete 4 Transport Dependent – See 6.2.12 3:0 Reserved
Status	**Bit Description** 7:6 Transport Dependent – See 6.2.12. 5 Device Fault – See 6.2.7 4 N/A 3 Transport Dependent – See 6.2.12. 2 N/A 1 Sense Data Available – See 6.2.10 0 Error – See 6.2.9

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