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Interested committees:

Title: Draft BS IEC 17760-103 Information technology – AT Attachment. Part 103: ATA/ATAPI Command Set – 3 (ACS-3).

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



JTC1-SC25/2891/CDV

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SECRETARIAT:

Germany

SECRETARY:

Mr Jürgen Tretter

OF INTEREST TO THE FOLLOWING COMMITTEES:

PROPOSED HORIZONTAL STANDARD:



Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.

FUNCTIONS CONCERNED:

☐ EMC

☐ ENVIRONMENT

☐ QUALITY ASSURANCE

☐ SAFETY

☐ SUBMITTED FOR CENELEC PARALLEL VOTING

☒ NOT SUBMITTED FOR CENELEC PARALLEL VOTING

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TITLE:

ISO/IEC 17760-103: Information technology – AT Attachment – Part 103: ATA/ATAPI Command Set – 3 (ACS-3)

PROPOSED STABILITY DATE: 2024

NOTE FROM TC/SC OFFICERS:

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INFORMATION TECHNOLOGY – AT ATTACHMENT –

Part 103: ATA/ATAPI Command Set - 3 (ACS-3)

- 1) ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.
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International Standard ISO/IEC 17760-103 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 (ATA)*, 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 described in 3.3.

IMPORTANT - The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

Introduction

This International Standard encompasses the following:

- Clause 1 describes the scope.
- Clause 2 provides normative references for the entire standard.
- Clause 3 provides definitions, abbreviations, and conventions used within the entire standard.
- Clause 4 describes the general operating requirements of the command layer.
- Clause 5 describes the ATA protocols used by the commands in this standard.
- Clause 6 describes Normal and Error Output fields.
- Clause 7 describes commands.
- Clause 8 describes the SCT Command Transport.
- Clause 9 describes command normal and error outputs.
- Annex A describes logs.
- Annex B provides command summaries.
- Annex C provides a tutorial on how to use SCT.
- Annex D 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 document and the ATA implementation standards described in AT Attachment - 8 ATA/ATAPI Architecture Model (ATA8-AAM). Figure 1 shows the relationship of this document to the other standards and related projects in the ATA and SCSI families of standards and specifications.

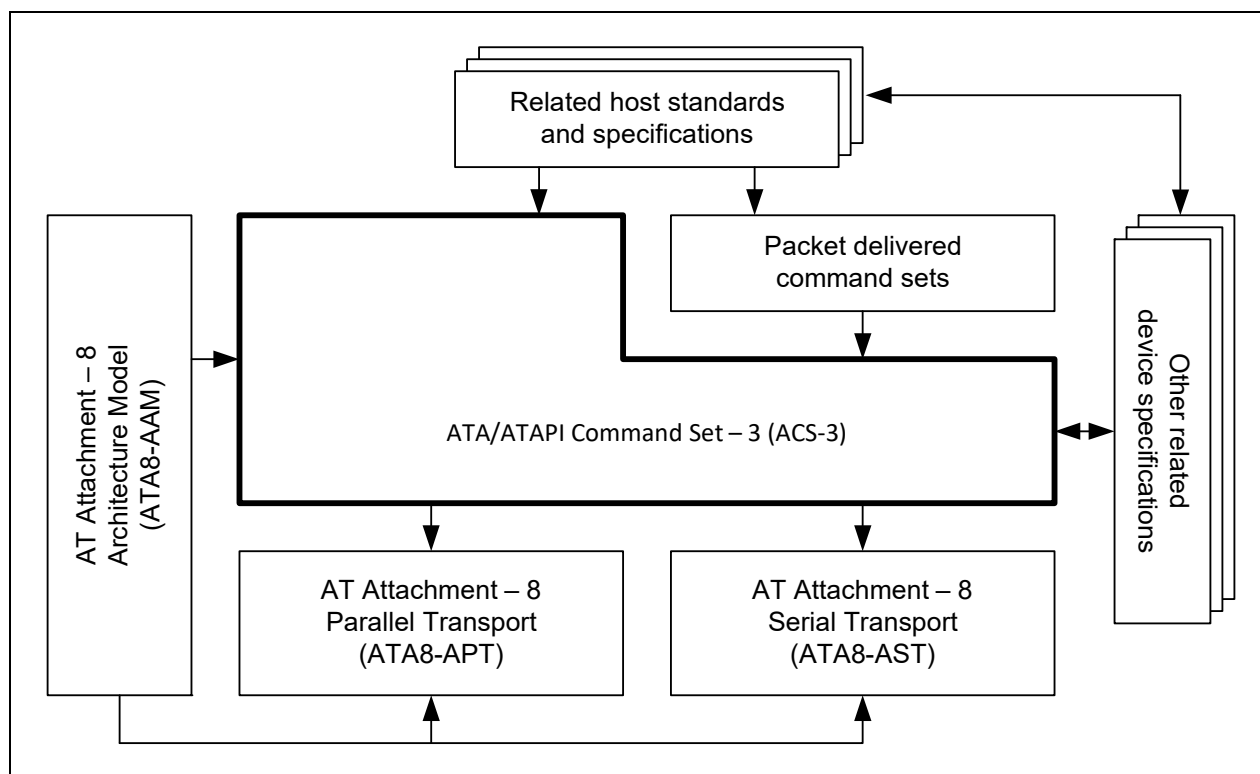


Figure 1 — ATA document relationships

The International Electrotechnical Commission (IEC) and the International Organization for Standardization (ISO) draw attention to the fact that it is claimed that compliance with this document may involve the use of a patent.

IEC and ISO take no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured IEC and ISO that he/she is willing to negotiate licences either free of charge or under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this putative patent right is registered with IEC and ISO. Information may be obtained from:

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INFORMATION TECHNOLOGY – AT ATTACHMENT –

Part 103: ATA/ATAPI Command Set - 3 (ACS-3)

1 Scope

This part of ISO/IEC 17760 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 ACS-2 standard, ISO/IEC 17760-102, 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 7779:1999, *Acoustics – Measurement of airborne noise emitted by information technology and telecommunications equipment*

ISO/IEC 17760-102, *Information technology – ATA/ATAPI Command Set - 2 (ACS-2)*

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

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

INCITS 513-2015 *SCSI Primary Commands - 4 (SPC-4)* (planned as ISO/IEC 14776-454)

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

Serial ATA revision 3.1 (SATA 3.1) ²

RFC 3280, Internet X.509 Public Key Infrastructure: Certificate and Certificate Revocation List (CRL) Profile, IETF, 2002. ³

RFC 3281, An Internet Attribute Certificate: Profile for Authorization, IETF, 2002 ³

JEDEC JESD220A – Universal Flash Storage (UFS 1.1) standard ⁴

IEEE 1667-2009 – Standard Protocol for Authentication in Host Attachments of Transient Storage Devices ⁵

FIPS PUB 140-2 – SECURITY REQUIREMENTS FOR CRYPTOGRAPHIC MODULES, May 25, 2001 ⁶

FIPS PUB 140-3 (Revised DRAFT 09/11/09) – SECURITY REQUIREMENTS FOR CRYPTOGRAPHIC MODULES, 09/11/09 ⁶

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

2. Serial ATA specifications are available from the Serial ATA International Organization (see <http://www.sata-io.org>).

3. RFCs are available from the Internet Engineering Task Force (IETF) (see <http://www.ietf.org/>).

4. JEDEC® is a registered trademark of the JEDEC Solid State Technology Association. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO. JEDEC standards are available from the JEDEC Solid State Technology Association (see <http://www.jedec.org>).

5. IEEE documents are available from the IEEE (see <http://ieeexplore.ieee.org/>).

6. FIPS standards are available from the National Institute of Standards and Technology (see <http://csrc.nist.gov/publications/>).

3 Terms, definitions, abbreviations, and conventions

3.1 Terms and definitions

3.1.1

28-bit command

command that uses the FEATURE field (7:0), COUNT field (7:0), LBA field (27:0), DEVICE field (15:8) and COMMAND field (7:0) to specify its arguments

3.1.2

48-bit command

command that uses the FEATURE field (15:0), COUNT field (15:0), LBA field (47:0), DEVICE field (15:8) and COMMAND field (7:0) to specify its arguments

3.1.3

accessible max address

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

3.1.4

Active mode

power condition specified by the PM0: Active state (see 4.15.4)

3.1.5

additional sense code

combination of ADDITIONAL SENSE CODE field and ADDITIONAL SENSE CODE QUALIFIER field (see 7.35 and A.14)

3.1.6

administrator

person who is responsible for the administration of one or more devices (e.g., the establishment of passwords in the Security feature set (see 4.18))

3.1.7

application client

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

Note 1 to entry: See ATA8-AAM.

3.1.8

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.

3.1.9

ATA device

AT Attachment device

device that implements the General feature set (see 4.2)

3.1.10

ATA string

set of ASCII characters (see 3.1.8) in the format specified in 3.3.10

3.1.11

ATAPI

AT Attachment Packet Interface device

device that implements the PACKET feature set (see 4.3)

3.1.12**background activity**

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

3.1.13**basic Input/Output System****BIOS**

application client that is run when power is applied whose primary function is to initialize various components (e.g., storage devices)

3.1.14**byte**

sequence of eight contiguous bits considered as a unit

Note 1 to entry: See 3.3.9.

3.1.15**cache**

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

3.1.16**CFA-APT device**

device that implements the CFA feature set

Note 1 to entry: CFA-APT devices implement the ATA8-APT transport, and not the ATA8-AST transport.

Note 2 to entry: See 4.7

3.1.17**circular buffer**

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

3.1.18**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

3.1.19**command acceptance**

positive acknowledgement of a command being received by a device

3.1.20**command completion**

completion by the device of processing in which the device:

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

3.1.21**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.

3.1.22**COMRESET**

commanded hardware reset in the Serial ATA transport

Note 1 to entry: See ATA8-AST.

3.1.23**device****data storage peripheral**

EXAMPLE - A disk drive.

Note 1 to entry: See 3.1.9 and 3.1.11.

3.1.24**DMA****direct memory access data transfer**

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

3.1.25**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

3.1.26**DQWord**

sequence of 16 contiguous bytes considered as a unit

Note 1 to entry: See 3.3.9.

3.1.27**DWord**

sequence of four contiguous bytes considered as a unit

Note 1 to entry: See 3.3.9.

3.1.28**Frame Information Structure****FIS**

frame structure used by the Serial ATA transport

Note 1 to entry: See ATA8-AST.

3.1.29**flush command**

command that flushes the volatile write cache

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

3.1.30**free-fall**

vendor specific condition of acceleration

3.1.31**hardware reset**

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

3.1.32**host**

object that originates commands and device management functions

Note 1 to entry: See ATA8-AAM.

3.1.33**host interface**

service delivery subsystem

Note 1 to entry: See ATA8-AAM.

3.1.34**ID Not Found error**

command completion with the ID NOT FOUND bit set to one

Note 1 to entry: See 6.3.5.

3.1.35**Idle mode**

one or all of the power conditions associated with the PM1: Idle state (see 4.15.4)

3.1.36**Invalid LBA**

LBA that is greater than or equal to the largest value reported in IDENTIFY DEVICE data words 60..61 (see 7.12.7.22), the ACCESSIBLE CAPACITY field (see A.11.4.2), or IDENTIFY DEVICE data words 230..233 (see 7.12.7.87)

3.1.37**LBA****Logical Block Address**

value used to reference a logical sector

3.1.38**logical block****logical sector**

set of words accessed and referenced as a unit (see IDENTIFY DEVICE data words 118..117 (see 7.12.7.61)) that contain user data and are referenced by LBA (see 3.1.37)

3.1.39**log**

named sequence of one or more log pages

Note 1 to entry: See Annex A.

3.1.40**log address**

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

3.1.41**log command**

SMART READ LOG command (see 7.48.7), SMART WRITE LOG command (see 7.48.9), or GPL feature set (see 4.11) command

3.1.42**log page**

512-byte block of data associated with a log

Note 1 to entry: See Annex A.

3.1.43**least significant bit****LSB**

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.

3.1.44**media**

material on which user data is stored

3.1.45**media access command**

command that causes the device to access non-volatile media

3.1.46**most significant bit****MSB**

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.

3.1.47**native max address**

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

3.1.48**NCQ command**

command in the NCQ feature set

Note 1 to entry: See 4.14.

3.1.49**non-volatile media**

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

3.1.50**Organizationally Unique Identifier****OUI**

numeric identifier that is assigned by the IEEE such that no assigned identifiers are identical

Note 1 to entry: The IEEE maintains a tutorial describing the OUI at <http://standards.ieee.org/regauth/oui/>

3.1.51**partition**

range of LBAs specified by an application client

3.1.52**PATA device****Parallel ATA device**

device that implements the parallel ATA transport

Note 1 to entry: See ATA8-APT.

3.1.53**physical sector**

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

3.1.54**Programmed Input/Output****PIO**

data transfers performed using PIO commands and protocol

3.1.55**power condition**

PM0: Active state (see 4.15.4), PM3: Sleep state (see 4.15.4), or one of the following power management substates: Idle_a, Idle_b, Idle_c, Standby_y or Standby_z

Note 1 to entry: See 4.9.

3.1.56**power cycle**

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

Note 1 to entry: See ATA8-AAM.

3.1.57**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.

3.1.58**queued command**

NCQ command that has reported command acceptance but not command completion

3.1.59**QWord**

sequence of eight contiguous bytes considered as a unit

Note 1 to entry: See 3.3.9.

3.1.60**read command**

command that causes the device to transfer user data from the device to the host

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

3.1.61**read stream command**

command that causes the device to transfer user data from the device to the host

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

3.1.62**SATA device****Serial ATA device**

device implementing the serial ATA transport

Note 1 to entry: See ATA8-AST.

3.1.63**SCSI CDB**

structure used to communicate a SCSI command

Note 1 to entry: See SPC-4.

3.1.64**SCT Command**

command that writes to the SCT command/status log

Note 1 to entry: See clause 8.

3.1.65**SCT Status**

command that reads from the SCT command/status log

Note 1 to entry: See clause 8.

3.1.66**SEND FPDMA QUEUED****SFQ**

prefix that identifies a subcommand of the SEND FPDMA QUEUED command (see 7.43)

3.1.67**sense data**

sense key and additional sense code (see 3.1.5)

3.1.68**Serial ATAPI device**

device that implements the Serial ATA transport (see ATA8-AST) and the PACKET feature set

3.1.69**signature**

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

Note 1 to entry: See table 204.

3.1.70**signed**

value that is encoded using two's complement

3.1.71**Sleep mode**

power condition specified by the PM3: Sleep state

Note 1 to entry: See 4.15.4.

3.1.72**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.

3.1.73**spin-down**

process of bringing a rotating media device's media to a stop

3.1.74**spin-up**

process of bringing a rotating media device's media to operational speed

3.1.75**Standby mode**

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

Note 1 to entry: See 4.15.4.

3.1.76**Stream**

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

3.1.77**transport**

mechanism used to communicate with a device

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

3.1.78**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

3.1.79**unrecoverable error**

error that causes the device to set either the ERROR bit or the DEVICE FAULT bit to one in the STATUS field at command completion

3.1.80**user data**

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

3.1.81**user data area**

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

3.1.82**vendor specific**

bits, bytes, fields, and code values that are reserved for vendor specific purposes and 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.

3.1.83**volatile cache**

cache that does not retain data through power cycles

3.1.84**word**

sequence of two contiguous bytes considered as a unit

Note 1 to entry: See 3.3.9.

3.1.85**write command**

command that causes the device to transfer user data from the host to the device

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

3.1.86**write stream command**

command that causes the device to transfer user data from the host to the device

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

3.1.87**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 7.12.7.58) and IDENTIFY PACKET DEVICE data words 108..111 (see 7.13.6.44)

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	AT Attachment with Packet Interface Extension
ATA8-AAM	AT Attachment-8 - ATA/ATAPI Architecture Model (see clause 2)
ATA8-ACS	AT Attachment - 8 ATA/ATAPI Command Set (see clause 2)
ATA8-APT	AT Attachment-8 - Parallel Transport (see clause 2)
ATA8-AST	AT Attachment-8 - Serial Transport (see clause 2)
BIOS	Basic Input/Output System
CCTL	Command Completion Time Limit (see 7.4.3.4 and 7.30.3.2)
CDB	Command Descriptor Block (see SPC-4)
CFA	CompactFlash Association (see www.compactflash.org)
CFA-CF	CompactFlash specification (see clause 2)
CFast	CompactFlash ATA Serial Transport (see clause 2)
CRC	Cyclic Redundancy Check
DMA	Direct Memory Access

Abbreviation Meaning

DRQ	Data ReQuest
DSN	Device Statistics Notification
EPC	Extended Power Conditions
EXT	Command that uses the extended (48-bit LBA) format parameters
FIS	Frame Information Structure
FUA	Forced Unit Access
GPL	General Purpose Logging
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
OUI	Organizationally Unique Identifier
PATA	Parallel ATA
PIO	Programmed Input/Output
PUIS	Power-Up In Standby
RMW	Read-Modify-Write
SATA	Serial ATA
SATA-IO	Serial ATA International Organization (see www.sata-io.org)
SCT	SMART Command Transport (see clause 8)
SFQ	SEND FPDMA QUEUED
SMART	Self-Monitoring Analysis and Reporting Technology
SPC-4	SCSI Primary Commands - 4 (see clause 2)
SSP	Software Settings Preservation
T10	INCITS Technical Committee T10
TCG	Trusted Computing Group (see www.trustedcomputinggroup.org)
VS	Vendor Specific
WWN	World Wide Name

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 Mathematical operators

Mathematical operators used in this standard:

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

3.2.4 Other Symbols

Symbols used in this standard:

Symbol	Meaning
®	registered trademark

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).

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

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

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

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

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

3.3.3.2 Unordered lists

An unordered list is one in which the order of the listed items is unimportant (i.e., it does not matter where in the list an item occurs as all items have equal importance). Each list item shall start with a lower case letter followed

by a close parenthesis. If it is necessary to subdivide a list item further with an additional unordered list (i.e., have a nested unordered list), then the nested unordered list shall be indented and each item in the nested unordered list shall start with an upper case letter followed by a close parenthesis.

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

The following are the items for the assembly:

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

3.3.3.3 Ordered lists

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

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

The following are the instructions for the assembly:

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

3.3.4 Keywords

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

Note 1 to entry: A field defined as N/A 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, then 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.

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

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

3.3.4.9**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: This keyword 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

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

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

3.3.6 Bit conventions

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

3.3.7 Number range convention

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

3.3.8 State diagram conventions

All state diagrams use the notation shown in Figure 2.

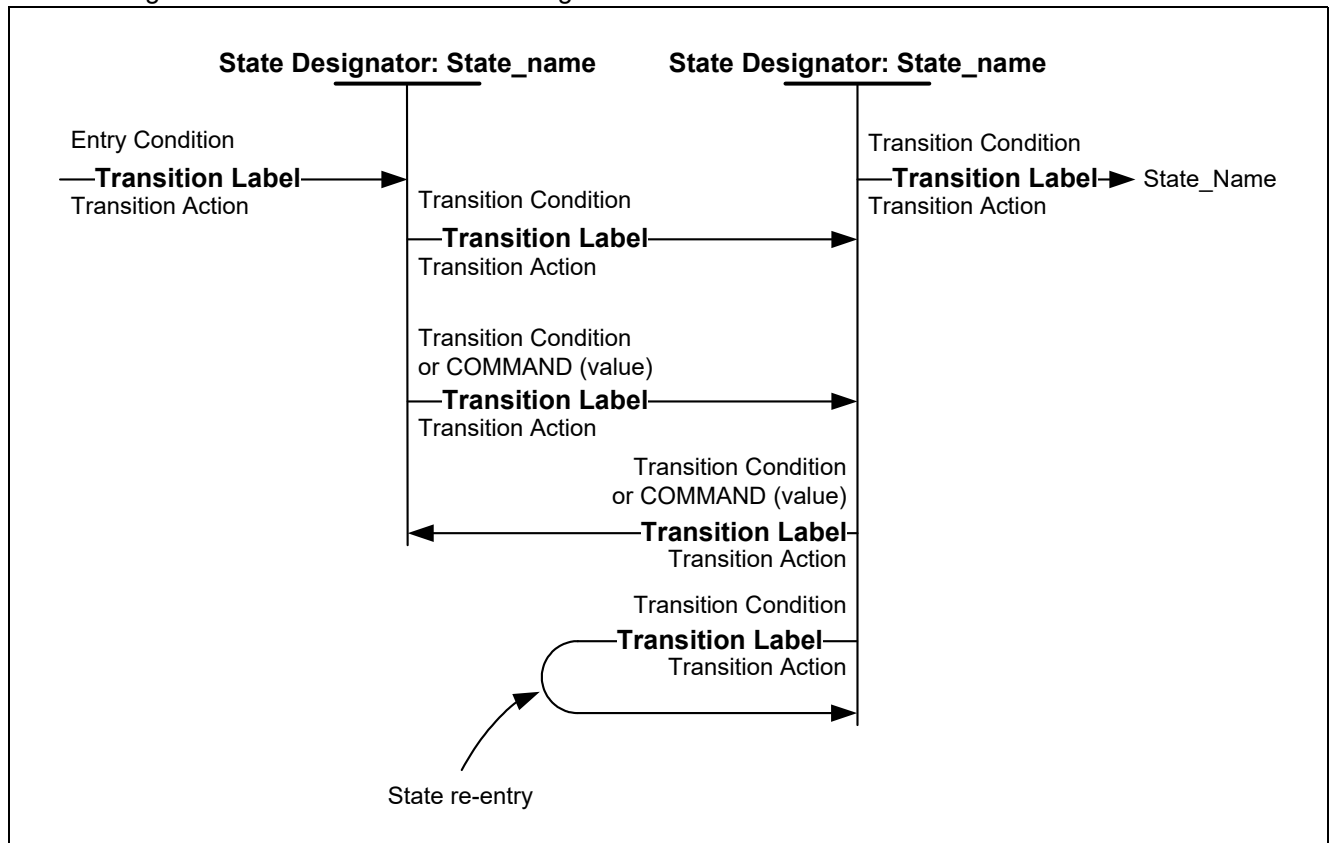


Figure 2 — State diagram convention

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

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

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

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

All transitions shall be instantaneous.

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

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

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

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

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

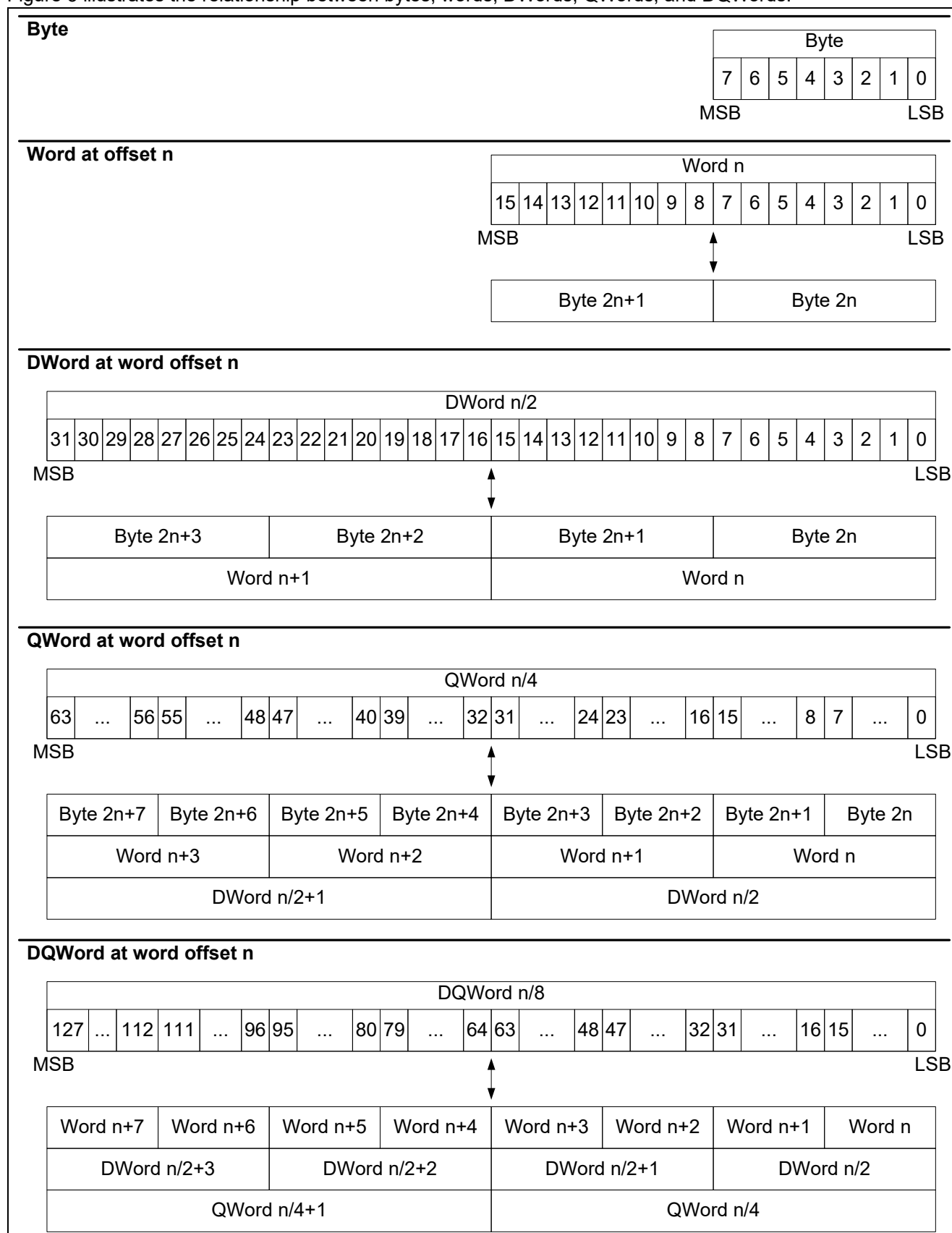


Figure 3 — Byte, word, DWord, QWord, and DQWord relationships

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

EXAMPLE 1 - if the two-byte field (i.e., word) in SCT command (see table 186) 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 43) 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 188) 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 7.12.7.58;
- c) the command packet in the PACKET command (see 7.18) is formatted as defined by the applicable command standard; and
- d) parameter data in the TRUSTED RECEIVE command (see 7.52), TRUSTED RECEIVE DMA command (see 7.53), TRUSTED SEND command (see 7.54), and TRUSTED SEND DMA command (see 7.55) is formatted as defined in those sections or in the standard defining the security protocol.

3.3.10 ATA string convention

ATA strings (e.g., the MODEL NUMBER field (see A.11.7.4)) are sequences of bytes containing ASCII graphic characters in the range of 20h-7Eh. ATA strings shall not contain values in the range of 00h-1Fh or 7Fh-FFh.

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

Table 2 — ATA string byte swapping

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

Using the ATA string that contains firmware revision information as an example, table 3 shows the contents of the FIRMWARE REVISION field (see A.11.7.3) in the Strings page (see A.11.7) in IDENTIFY DEVICE data log (see A.11). In this example, the firmware revision string is “abcdefg”, including one padding space character at the end of the string. Table 3 also shows the copy of the FIRMWARE REVISION field that uses the word format of the IDENTIFY DEVICE input from device to host data structure (see 7.12.7).

Table 3 — FIRMWARE REVISION field example

Strings page ^a offset	Value	Copy of FIRMWARE REVISION field in IDENTIFY DEVICE data ^b		
		Offset	Word	Value
32	62h (i.e., “b”)	46	23	6162h (i.e., “ba”)
33	61h (i.e., “a”)	47		
34	64h (i.e., “d”)	48	24	6364h (i.e., “dc”)
35	63h (i.e., “c”)	49		
36	66h (i.e., “f”)	50	25	6566h (i.e., “fe”)
37	65h (i.e., “e”)	51		
38	20h (i.e., “ ”, the space character)	52	26	6720h (i.e., “ g”)
39	67h (i.e., “g”)	53		
^a See Strings page (see A.11.7) in IDENTIFY DEVICE data log (see A.11).				
^b See table 43.				

3.3.11 Offset Convention

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

4 Feature set definitions

4.1 Overview

4.1.1 Feature set summary

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

Table 4 — Feature set summary

Feature set	ATA devices	ATAPI devices
48-Bit Address feature set (see 4.4)	O	P
Accessible Max Address Configuration (see 4.5)	O	P
Advanced Power Management (APM) feature set (see 4.6)	O	O
CompactFlash Association (CFA) feature set (see 4.7)	O	P
Device Statistics Notifications (DSN) feature set (see 4.8)	O	P
Extended Power Conditions (EPC) feature set (see 4.9)	O	P
Free-fall Control feature set (see 4.10)	O	P
General feature set (see 4.2)	M	P
General Purpose Logging (GPL) feature set (see 4.11)	M	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
PACKET feature set (see 4.3)	P	M
Power Management feature set (see 4.15)	M	O
Power-Up In Standby (PUIS) feature set (see 4.16)	O	O
Sanitize Device feature set (see 4.17)	O	P
SATA Hardware feature control (see 4.22)	O	P
Security feature set (see 4.18)	O	Obsolete
Self-Monitoring, Analysis, and Reporting Technology (SMART) feature set (see 4.19)	O	P
Sense Data Reporting feature set (see 4.20)	O	P
Software Settings Preservation (SSP) feature set (see 4.21)	O	P
Streaming feature set (see 4.23)	O	P
Trusted Computing feature set (see 4.24)	O	P
Write-Read-Verify feature set (see 4.25)	O	P
Key: M – Mandatory, O – Optional, P – Prohibited		

4.1.2 Capacity reporting

If the ATA device supports the Accessible Max Address Configuration feature set (see 4.5) and the host issues a SET ACCESSIBLE MAX ADDRESS EXT command (see 7.2.3), then IDENTIFY DEVICE data words and the Capacity page (see A.11.4) of the IDENTIFY DEVICE data log may be affected as shown in table 5.

Table 5 — IDENTIFY DEVICE capacity reporting

Device Settings		Current Capacity Settings		Reported Capacities			
IDENTIFY DEVICE data word 83 bit 10 (48-bit support)	IDENTIFY DEVICE data word 69 bit 3	accessible max address ≤ 0FFF_FFFFh	accessible max address ≤ FFFF_FFFFh	IDENTIFY DEVICE data words 60..61	IDENTIFY DEVICE data words 100..103	IDENTIFY DEVICE data words 230..233	ACCESSIBLE CAPACITY field ^a
0	N/A	N/A	N/A	accessible max address + 1	reserved	reserved	accessible max address + 1
1	0	yes	yes	accessible max address + 1	accessible max address + 1	reserved	accessible max address + 1
1	0	no	no	0000_0000_0FFF_FFFFh	accessible max address + 1	reserved	accessible max address + 1
1	0	no	yes	0000_0000_0FFF_FFFFh	accessible max address + 1	reserved	accessible max address + 1
1	1	yes	yes	accessible max address + 1	accessible max address + 1	accessible max address + 1	accessible max address + 1
1	1	no	no	0000_0000_0FFF_FFFFh	less than or equal to accessible max address + 1 ^b	accessible max address + 1	accessible max address + 1
1	1	no	yes	0000_0000_0FFF_FFFFh	less than or equal to accessible max address + 1 ^b	accessible max address + 1	accessible max address + 1
^a The ACCESSIBLE CAPACITY field is defined in A.11.4.2.							
^b IDENTIFY DEVICE data words 100..103 may be limited to ≤ 0000_0000_FFFF_FFFFh							

A device shall not change the content in the ACCESSIBLE CAPACITY field (see A.11.4.2), IDENTIFY DEVICE data words 60..61, or IDENTIFY DEVICE data words 230..233, during the processing of all resets (e.g., a power-on reset).

4.2 General feature set

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

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

- a) EXECUTE DEVICE DIAGNOSTIC (see 7.9);
- b) IDENTIFY DEVICE (see 7.12); and
- c) SET FEATURES (see 7.45).

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

- a) DATA SET MANAGEMENT (see 7.5);
- b) DOWNLOAD MICROCODE (see 7.7);
- c) DOWNLOAD MICROCODE DMA (see 7.8);
- d) FLUSH CACHE (see 7.10);
- e) NOP (see 7.17);
- f) READ BUFFER (see 7.19);
- g) READ BUFFER DMA (see 7.20);
- h) READ DMA (see 7.21);
- i) READ MULTIPLE (see 7.26);
- j) READ SECTOR(S) (see 7.28);
- k) READ VERIFY SECTOR(S) (see 7.32);
- l) SET DATE & TIME (see 7.44);
- m) SET MULTIPLE MODE (see 7.46);
- n) WRITE BUFFER (see 7.56);
- o) WRITE BUFFER DMA (see 7.57);
- p) WRITE DMA (see 7.58);
- q) WRITE MULTIPLE (see 7.64);
- r) WRITE SECTOR(S) (see 7.67); and
- s) WRITE UNCORRECTABLE EXT (see 7.71).

The following commands are prohibited for devices that implement the General feature set:

- a) DEVICE RESET (see 7.6);
- b) IDENTIFY PACKET DEVICE (see 7.13); and
- c) PACKET (see 7.18).

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

- a) IDENTIFY DEVICE data log (see A.11).

4.3 The PACKET feature set

4.3.1 Overview

The PACKET feature set is the feature set implemented by ATAPI devices.

ATAPI devices transfer SCSI CDBs via the PACKET command and respond in ways that differ from ATA devices.

The following commands are mandatory for devices that implement the PACKET feature set:

- a) DEVICE RESET (see 7.6);
- b) EXECUTE DEVICE DIAGNOSTIC (see 7.9);
- c) IDENTIFY DEVICE (see 7.12);
- d) IDENTIFY PACKET DEVICE (see 7.13);
- e) NOP (see 7.17);
- f) PACKET (see 7.18);
- g) READ SECTOR(S) (see 7.28); and
- h) SET FEATURES (see 7.45).

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 7.13.6.2) and are not described in this standard.

For ATAPI devices, the IDENTIFY DEVICE command (see 7.12) and the READ SECTOR(S) command (see 7.28) are command aborted and return the ATAPI device signature (see table 204).

The following commands are optional for devices that implement the PACKET feature set:

- a) FLUSH CACHE (see 7.10);
- b) READ LOG DMA EXT (see 7.25);
- c) READ LOG EXT (see 7.24);
- d) WRITE LOG DMA EXT (see 7.63); and
- e) WRITE LOG EXT (see 7.62).

The following commands are prohibited for devices that implement the PACKET feature set:

- a) DATA SET MANAGEMENT (see 7.5);
- b) FLUSH CACHE (see 7.10);
- c) READ BUFFER (see 7.19);
- d) READ BUFFER DMA (see 7.20);
- e) READ DMA (see 7.21);
- f) READ MULTIPLE (see 7.26);
- g) READ VERIFY SECTOR(S) (see 7.32);
- h) SET MULTIPLE MODE (see 7.46);
- i) WRITE BUFFER (see 7.56);
- j) WRITE BUFFER DMA (see 7.57);
- k) WRITE DMA (see 7.58);
- l) WRITE MULTIPLE (see 7.64);
- m) WRITE SECTOR(S) (see 7.67); and
- n) WRITE UNCORRECTABLE EXT (see 7.71); and
- o) commands for feature sets that are prohibited for ATAPI devices in table 4.

4.3.2 Identification of PACKET feature set devices

The IDENTIFY PACKET DEVICE command (see 7.13) is used by the host to get identifying parameter information for a device that implement the PACKET feature set. Devices the implement the PACKET feature set process IDENTIFY DEVICE commands (see 7.12) as described in 7.12.5.

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 204).

4.3.4 The PACKET command

The PACKET command (see 7.18) allows a host to send a command to the device via a SCSI CDB packet.

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:

- a) FLUSH CACHE EXT (see 7.11);
- b) READ DMA EXT (see 7.22);
- c) READ MULTIPLE EXT (see 7.27);
- d) READ SECTOR(S) EXT (see 7.29);
- e) READ VERIFY SECTOR(S) EXT (see 7.33);
- f) WRITE DMA EXT (see 7.59);
- g) WRITE DMA FUA EXT (see 7.60);
- h) WRITE MULTIPLE EXT (see 7.65);

- i) WRITE MULTIPLE FUA EXT (see 7.66); and
- j) WRITE SECTOR(S) EXT (see 7.68).

Devices that implement 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 by setting the 48-BIT SUPPORTED bit (see A.11.5.2.16) to one.

4.5 Accessible Max Address Configuration feature set

4.5.1 Overview

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

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

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

ATA devices indicate support for this feature set by setting the AMAX ADDR SUPPORTED bit (see A.11.5.2.34) to one.

4.5.2 SET ACCESSIBLE MAX ADDRESS EXT description

The SET ACCESSIBLE MAX ADDRESS EXT command (see 7.2.3) limits read commands and write commands to LBAs from zero to the LBA specified by the last SET ACCESSIBLE MAX ADDRESS EXT command that returned command completion without an error. The accessible max address is the native max address unless a SET ACCESSIBLE MAX ADDRESS EXT command has been completed without error.

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

4.5.3 Device Statistics data

ATA devices supporting this feature set may alter device statistics after a SET ACCESSIBLE MAX ADDRESS EXT command (see 7.2.3) returns completion without an error.

4.6 Advanced Power Management (APM) feature set

The APM feature set is a feature set that allows the host to select a power management level in a device. The power management level (see table 104) is specified using a scale from the lowest power consumption setting of 01h to the highest power consumption of FEh (i.e., maximum performance level). Device performance may increase with increasing power management levels. Device power consumption may increase as the power management setting numerically increases.

A device may implement one APM method for two or more contiguous power management levels (e.g., a device may implement one APM method from level 80h to A0h and a higher performance, higher power consumption method from level A1h to FEh). APM levels 80h and greater do not permit a device with rotating media to spin down as a result of an APM method.

The APM feature set uses the following subcommands:

- a) a mandatory enable APM subcommand of the SET FEATURES command (see 7.45.9) that allows the host to set the APM level; and
- b) an optional disable APM subcommand of the SET FEATURES command (see 7.45.9).

The APM feature set is independent of the Standby timer (see 4.15.3). If the APM feature set is enabled and the Standby timer is enabled, then the device shall go to the PM:2 Standby state if:

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

The device shall indicate:

- a) feature set support in the APM SUPPORTED bit (see A.11.5.2.19) and IDENTIFY PACKET DEVICE data word 83 bit 3 (see 7.13.6.34);
- b) feature set enabled in the APM ENABLED bit (see A.11.6.2.11) and IDENTIFY PACKET DEVICE data word 86 bit 3 (see 7.13.6.35); and
- c) APM level in the APM LEVEL field (see A.11.6.3.2) and (see 7.12.7.45) and IDENTIFY PACKET DEVICE data word 91 (see 7.13.6.39).

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

4.7 CompactFlash Association (CFA) feature set

The CompactFlash Association (CFA) feature set provides support for devices that implement the CFA specifications (e.g., CFA-CF, CFAST).

4.8 Device Statistics Notification (DSN) feature set

4.8.1 Overview

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

Each device statistic in the Device Statistics log (see A.5) indicates support for device statistics notifications and if the monitored DSN Condition Definition for that device statistic is met (see table A.8).

In the Device Statistics Notifications log (see A.25), the Definition log pages (see table A.77) allow the setting of DSN CONDITION FLAGS field (see table A.78) that include device statistic threshold comparison conditions and device statistic validity conditions. Device statistic threshold comparison values are specified in the same format and units as the referenced device statistic.

The Summary log page (see table A.75) of the Device Statistics Notifications log contains a list of the active device statistics notifications (i.e., notifications of monitored device statistics with test conditions that are met when the page is read).

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

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

Devices that implement this feature set shall support the:

- a) General Purpose Logging feature set (see 4.11);
- b) Sense Data Reporting feature set (see 4.20);
- c) Device Statistics Notifications log (see A.25);
- d) Device Statistics log (see A.5); and
- e) SET FEATURES command with the FEATURE field set to 63h (see 7.45.21).

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

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

4.8.2 DSN notifications

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

The device sets the SENSE DATA AVAILABLE bit (see 6.2.10) in the STATUS field to one in the normal outputs and error outputs for a command, if:

- a) the referenced device statistic supports DSN (see table A.8);

- b) a DSN Condition Definition (see table A.77) is configured for that device statistic;
- c) the DSN Condition Definition for that device statistic is met; and
- d) the Sense Data Reporting feature set (see 4.20) is enabled.

If the device is reporting changes based on DSN Condition Definitions that have been met in response to a REQUEST SENSE EXT command, then the normal outputs shall contain:

- a) the SENSE KEY field set to NO SENSE (i.e., 0h); and
- b) the additional sense code set to WARNING – DEVICE STATISTICS NOTIFICATION ACTIVE (i.e., 0Bh/09h).

The contents of the Summary page (i.e., 00h) of the Device Statistics Notifications log (see A.25) are always valid while the DSN ENABLED bit (see A.11.6.2.2) is set to one. The validity of the Device Statistics Notifications log is not affected by the value of the SENSE DATA ENABLED bit (see A.11.6.2.6) or the value of the NCQ AUTOTENSE SUPPORTED bit (see A.11.10.2.21). The host may read the Summary page to check for notification status changes. The Summary page shall not be changed by:

- a) a READ LOG EXT command (see 7.24) or READ LOG DMA EXT (see 7.25) command addressing the:
 - A) Summary page of the Device Statistics Notifications log (see A.25); or
 - B) NCQ Command Error log (see A.14);
 or
- b) a REQUEST SENSE DATA EXT command (see 7.35).

4.8.3 DSN notifications setup

The host requests specific device statistics notifications by writing to the Definition pages (see table A.77) of the Device Statistics Notifications log (see A.25). In each Definition page, the host may write one or more pairs of QWords with each pair forming one device statistic notification entry as follows:

- 1) a Device Statistics Location QWord that specifies a device statistic in the Device Statistics log (see A.5) that is to be tested for the device statistics notification; and
- 2) a Device Statistics Condition Definition QWord that specifies the test to be made.

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

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

- a) refers to a device statistic that is not supported (see table A.8);
- b) refers to a device statistic that does not support device statistic notification (see table A.8);
- c) contains a threshold value that is out of range for the referenced device statistic (see table A.78); or
- d) contains a Comparison Type that is reserved (see table A.78),

then:

- 1) none of the Definition pages being written to the Device Statistics Notifications log shall be saved by the device; and
- 2) the command shall return command aborted (see table 228).

4.9 Extended Power Conditions (EPC) feature set

4.9.1 Overview

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

- a) defining power conditions (i.e., Idle_a, Idle_b and Idle_c) within the PM1: Idle state in the Power Management feature set (see 4.15);
- b) defining power conditions (i.e., Standby_y and Standby_z) within the PM2: Standby state in the Power Management feature set;
- c) enabling and initializing any of the power condition timers to specify that the device wait for a period of inactivity before transitioning to a specified power condition; and
- d) allowing the host to determine the power condition settings of the device.

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

- a) the SET FEATURES command Extended Power Conditions subcommand (see 7.45.20);
- b) the Power Conditions log (see A.8);
- c) the additional status values returned by the CHECK POWER MODE command (see 7.3);
- d) the EPC SUPPORTED bit (see A.11.5.2.27); and
- e) the EPC ENABLED bit (see A.11.6.2.3).

4.9.2 Power conditions

Idle_a, Idle_b, and Idle_c are power conditions within the PM1: Idle state (see 4.15.4). Standby_y and Standby_z are power conditions within the PM2: Standby state (see 4.15.4). The power conditions shall be ordered from highest power consumption to lowest power consumption as follows:

$$\text{Idle_a power} \geq \text{Idle_b power} \geq \text{Idle_c power} \geq \text{Standby_y power} \geq \text{Standby_z power}$$

In this ordering, a power condition:

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

The Standby timer (see 4.15.3) is controlled using:

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

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

Each of these power conditions has a set of current, saved and default settings (see A.8). Default settings are not changeable. Default and saved settings shall persist across all resets (e.g., power-on resets). The current settings shall not persist across power cycles.

4.9.3 Power condition timers

The device shall have manufacturer specified power-on default settings for the power condition timers. Power condition timers are changeable with the SET FEATURES command Extended Power Conditions subcommand (see 7.45.20). Configured settings for the timers are readable in the Power Conditions log (see A.8).

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

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

If a command is accepted that requires a transition to PM0: Active state (see 4.15.4), all enabled power condition timers shall be stopped. If a command is accepted that does not require a transition to PM0: Active state (e.g., a CHECK POWER MODE command), then the timers shall continue to run.

On command completion, all power condition timers that were stopped shall be initialized with their current timer values (see A.8) and started.

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

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

If volatile write cache is enabled (i.e., if the VOLATILE WRITE CACHE ENABLED bit (see A.11.6.2.4) is set to one), then prior to entering into any power condition that prevents access to the media (e.g., before a hard drive stops its spindle motor during a transition to the Standby_z power condition), the device shall write all cached data to the media for the device (e.g., as a device does in response to a flush command).