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Partie 302: Jeu de commande 2-(ZAC-2) ATA de dispositif de zones

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Foreword (This foreword is not part of American National Standard INCITS 549-2022.)

This standard specifies the command set that host systems use to access storage devices that implement one or more of the zones feature sets. This provides a common command set for systems manufacturers, system integrators, software suppliers, and suppliers of storage devices that provide one or more of the zones feature sets.

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

This standard was processed and approved for submittal to ANSI by the InterNational Committee for Information Technology Standards (INCITS). Committee approval of this standard does not necessarily imply that all committee members voted for approval. At the time it approved this standard, INCITS had the following members:

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Introduction

This standard encompasses the following:

Clause 1 describes the scope.

Clause 2 provides normative references for the entire standard.

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

Clause 4 describes the features defined by this standard.

Clause 5 describes commands.

Clause 6 describes logs.

Clause 7 describes command normal and error outputs.

Annex A describes zoned devices from a host's perspective.

Annex B describes zone domains and zone realms activate/deactivate scenarios.

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1 Scope

The set of AT Attachment standards consists of this standard and the ATA implementation standards described in AT Attachment - 8 ATA/ATAPI Architecture Model (ATA8-AAM). This standard specifies the command set that host systems use to access storage devices that implement the Host Aware Zones feature set (see 4.3), the Host Managed Zones feature set (see 4.4), the Zone Domains feature set (see 4.5), and the Zone Realms feature set (see 4.6). This standard provides a common command set for systems manufacturers, system integrators, software suppliers, and suppliers of storage devices that provide one or more of the zones feature sets. Figure 1 shows the relationship of this standard to other ATA standards as well as related device and host standards and specifications (e.g., SCSI standards and SATA-IO specifications).

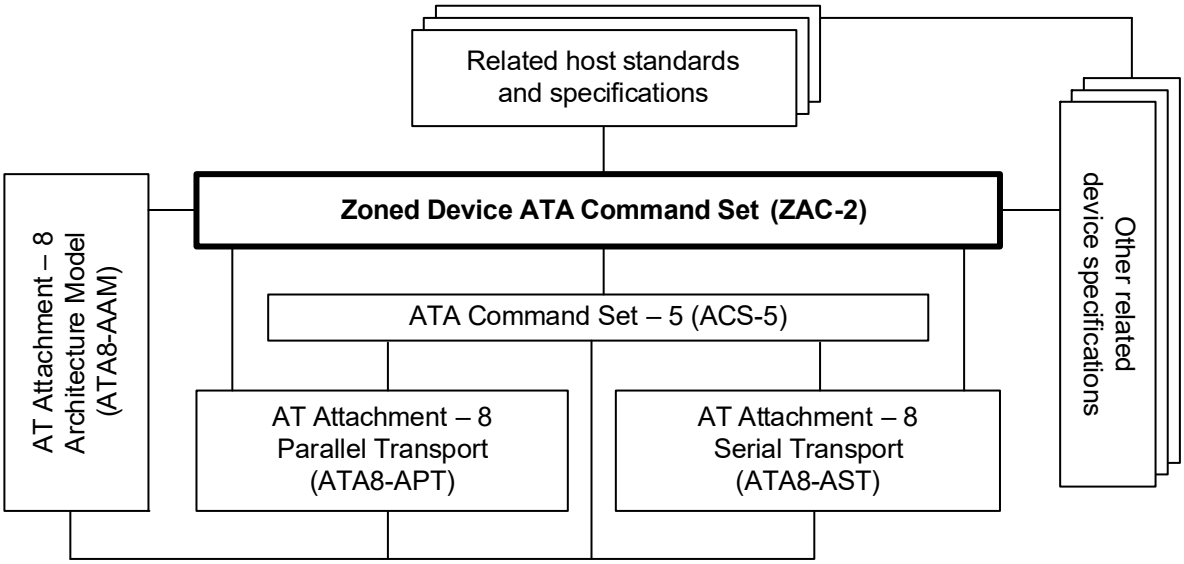


Figure 1 — ATA document relationships

This standard maintains compatibility with the ACS-5 standard, INCITS 558-202x, while providing additional functions.

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2 Normative references

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

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

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

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

T13/INCITS BSR 558, *ATA Command Set - 5 (ACS-5)* (under consideration)

T10/INCITS BSR 566, *SCSI Primary Commands - 6 (SPC-6)* (under consideration)

[1] ANSI INCITS 4-1986 (R2017), *Information Systems – Coded Character Sets – 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII)*

3 Definitions, abbreviations, and conventions

3.1 Definitions

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

Note 1 to entry: See ACS-5.

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

Note 1 to entry: See ACS-5.

3.1.3 access pattern requirements
rules for read commands and write commands for a zone type

3.1.4 activate
cause a write pointer zone to become an active zone

3.1.5 active zone
write pointer zone that has a Zone Condition other than INACTIVE

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

Note 1 to entry: See ACS-5.

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 ATA device
device that implements the General feature set

Note 1 to entry: See ACS-5.

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

3.1.10 byte
sequence of eight contiguous bits considered as a unit

Note 1 to entry: See ACS-5.

3.1.11 cache
data storage area outside the area accessible by hosts

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

3.1.12 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

Note 1 to entry: See ACS-5.

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

Note 1 to entry: See ACS-5.

3.1.14 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

Note 1 to entry: See ACS-5.

3.1.15 conventional zone
zone that is not associated with a write pointer

Note 1 to entry: See 4.8.2.

3.1.16 deactivate
cause a write pointer zone to become an inactive zone

3.1.17 device
data storage peripheral

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

3.1.18 device configuration changing command
command with the potential to change the configuration of logical sectors in a device

Note 1 to entry: In addition to the device configuration changing commands defined in ACS-5, the following command defined in this standard is a device configuration changing command: ZONE ACTIVATE EXT (see 5.2.13).

3.1.19 DWord
sequence of four contiguous bytes considered as a unit

Note 1 to entry: See ACS-5.

3.1.20 ending LBA
highest numbered LBA of a read command or write command

3.1.21 flush command
command that flushes the volatile write cache

Note 1 to entry: See ACS-5.

3.1.22 gap zone
zone between two domains

Note 1 to entry: See 4.8.4

3.1.23 highest LBA
highest numbered LBA of a range of LBAs

3.1.24 host
object that originates commands and device management functions

Note 1 to entry: See ATA8-AAM.

3.1.25 inactive zone
write pointer zone that has a Zone Condition of INACTIVE

3.1.26 LBA
value used to reference a logical sector

3.1.27 log
named sequence of one or more log pages

Note 1 to entry: See ACS-5.

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

Note 1 to entry: See ACS-5.

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

Note 1 to entry: See ACS-5.

3.1.30 logical sector
set of words accessed and referenced as a unit that contain user data and are referenced by an LBA

Note 1 to entry: See ACS-5.

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3.1.31 lowest LBA
lowest numbered LBA of a range of LBAs

3.1.32 media
material on which user data is stored

3.1.33 NCQ command
command that is in the NCQ feature set

Note 1 to entry: See ACS-5.

3.1.34 non-NCQ command
command that is not in the NCQ feature set (see ACS-5)

3.1.35 non-sequential write command
write command processed on a write pointer zone for which the lowest LBA for that command is not equal to the write pointer for that write pointer zone

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

3.1.37 open zone
zone with a Zone Condition of IMPLICITLY OPENED or EXPLICITLY OPENED

3.1.38 open zone resources
zone resources that are available only to an open zone

Note 1 to entry: See 4.8.3.1.3.

3.1.39 persistent zone resources
zone resources that persist across a power-on reset

Note 1 to entry: For a zone in any Zone Condition other than IMPLICITLY OPENED or EXPLICITLY OPENED, all zone resources are persistent zone resources.

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

Note 1 to entry: See ACS-5.

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

Note 1 to entry: See ACS-5.

3.1.42 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 ACS-5.

3.1.43 QWord
sequence of eight contiguous bytes considered as a unit

Note 1 to entry: See ACS-5.

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

Note 1 to entry: See ACS-5.

Note 2 to entry: This standard defines requirements for read commands (see 4.8.3.2.2.2, 4.8.3.3.2.2, and 4.8.3.4.2.2) that are in addition to the requirements defined in ACS-5.

3.1.45 read FUA command
read command that specifies that the device read user data from non-volatile media

Note 1 to entry: The READ FPDMA QUEUED command (see ACS-5) with the FUA bit set to one is the read FUA command.

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3.1.46 realm
set of zone ranges, each in a different zone domain, and an indicated relationship among those zone ranges

Note 1 to entry: See 4.6

3.1.47 realm attribute
named property associated with a realm

Note 1 to entry: In the absence of other conditions or actions (e.g., actions by the host), realm attributes do not affect the operation of the Zone Condition state machine.

Note 2 to entry: See 4.6.4.

3.1.48 SATA device
device implementing the serial ATA transport

Note 1 to entry: See ATA8-AST.

3.1.49 sense data
sense key and additional sense code

Note 1 to entry: See ACS-5.

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

Note 1 to entry: See ACS-5 and SPC-6.

3.1.51 Sequential Or Before Required zone
write pointer zone in which the device allows write commands that specify a starting LBA that is less than or equal to the LBA indicated by that zone's write pointer

Note 1 to entry: See 4.8.3.4

3.1.52 Sequential Write Preferred zone
write pointer zone in which the device allows write commands that specify a starting LBA that is within the zone but is not equal to the LBA indicated by that zone’s write pointer

Note 1 to entry: See 4.8.3.2.

3.1.53 Sequential Write Required zone
write pointer zone in which the device requires that write commands specify a starting LBA that is equal to the LBA indicated by that zone's write pointer

Note 1 to entry: See 4.8.3.3.

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

Note 1 to entry: See ACS-5.

3.1.55 starting LBA
lowest numbered LBA of a read command or a write command

3.1.56 state machine variable
variable that exists within the context of a state machine

Note 1 to entry: A state machine variable may contain status from one state that is used in another state of the same state machine.

Note 2 to entry: The value contained in a state machine variable may affect subsequent state transitions or state machine outputs.

3.1.57 stored data
user data that has been stored by a write command

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3.1.58 substitute data pattern
data that is substituted for data being read as user data if no user data is available

Note 1 to entry: The device shall store the data in the substitute data pattern by writing the data to a non-volatile location.

Note 2 to entry: The substitute data pattern may be written as user data by the FINISH ZONE EXT command (see 5.2.6).

Note 3 to entry: The substitute data pattern for Sequential Write Preferred zones is described in 4.8.3.2.2.3.

Note 4 to entry: The substitute data pattern for Sequential Write Required zones is described in 4.8.3.3.2.3.

Note 5 to entry: The substitute data pattern for Sequential or Before Required zones is described in 4.8.3.4.2.3.

3.1.59 transport
mechanism used to communicate with a device

Note 1 to entry: See ATA8-AST.

3.1.60 unmet prerequisite
requirement that, if not met, prevents the activation of one or more zones

Note 1 to entry: Unmet prerequisites are indicated by bits in the Zone Activation Results Header (see 5.2.13.6.2.3) as described in 5.2.13.2.4.

3.1.61 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

Note 1 to entry: See ACS-5.

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

3.1.63 user data area
area of the media that is addressable from LBA 0 to the zoned maximum address

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

3.1.65 word
sequence of two contiguous bytes considered as a unit

Note 1 to entry: See ACS-5.

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

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

Note 2 to entry: This standard defines requirements for the SCT Write Same that may make the SCT Write Same command a write command (see 4.9.10)

Note 3 to entry: This standard defines requirements for write commands (e.g., see 4.8.3.2.2.1, 4.8.3.3.2.1, and 4.8.3.4.2.1) that are in addition to the requirements defined in ACS-5.

3.1.67 write FUA command
write command that specifies that the device transfer user data from the host to non-volatile media before reporting command completion

Note 1 to entry: The WRITE FPDMA QUEUED command (see ACS-5) with the FUA bit set to one, the WRITE MULTIPLE FUA EXT command (see ACS-5), and the WRITE DMA FUA EXT command (see ACS-5) are the write FUA commands.

3.1.68 write pointer
pointer to a logical sector in a write pointer zone that is one higher than the highest logical sector written in that write pointer zone since the most recent time that a Reset Write Pointer function (see 4.8.3.5.14) was performed

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on that zone

Note 1 to entry: Write pointer usage is specified by zone type as described in 4.8.3.

3.1.69 write pointer zone
zone that has an associated write pointer

Note 1 to entry: See 4.8.3.

3.1.70 zone
one of a set of disjoint contiguous ranges of LBAs that comprise a device

Note 1 to entry: See 4.2.

3.1.71 zone attribute
named property associated with a zone

Note 1 to entry: In the absence of other conditions or actions (e.g., actions by the host), zone attributes do not affect the operation of the Zone Condition state machine.

Note 2 to entry: See 4.7.

3.1.72 zone domain
zone range in which all of the zones are able to be active zones at the same time

Note 1 to entry: See 4.5

3.1.73 zone ID
the lowest LBA of a zone

3.1.74 zone range
contiguous set of zones specified by a zone ID and a non-zero integer number of zones

3.1.75 zone resources
device resources that are used by a zone

Note 1 to entry: This standard defines open zone resources and persistent zone resources.

Note 2 to entry: Zone resources include zone attributes.

3.1.76 zoned device
device that supports the Host Aware Zones feature set (see 4.3), the Host Managed Zones feature set (see 4.4), the Zone Domains feature set (see 4.5), or the Zone Realms feature set (see 4.6)

3.1.77 zoned maximum address
maximum LBA as indicated by the MAXIMUM LBA field (see 5.2.10.6.4) returned by the REPORT ZONES EXT command

Note 1 to entry: See 4.9.2

3.2 Symbols and abbreviations

3.2.1 Abbreviations

Abbreviations used in this standard:

Abbreviation	Meaning
ACS	ATA Command Set
ASCII	American Standard Code for Information Interchange
ATA	AT Attachment
ATA8-AAM	AT Attachment-8 - ATA/ATAPI Architecture Model
ATA8-AST	AT Attachment-8 - Serial Transport
DMA	Direct Memory Access
LBA	Logical Block Address
NCQ	Native Command Queueing
SATA	Serial ATA

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Abbreviation	Meaning
SATA-IO	Serial ATA International Organization (http://www.sata-io.org)
TCG	Trusted Computing Group (see www.trustedcomputinggroup.org)
ZAC	Zoned Device ATA Command Set

3.2.2 Units

Units used in this standard:

Unit	Meaning
min	minute (unit of time)
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)

3.2.3 Symbols

Symbols used in this standard:

Symbol	Meaning
©	copyright
®	registered trademark

3.2.4 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
AND	logical AND

3.3 Keywords

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

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

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

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

3.3.4 N/A
keyword that indicates a field is not applicable and has no defined value

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

3.3.5 obsolete
keyword indicating that the designated bits, bytes, words, fields, and code values that may have been defined in

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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.

3.3.6 optional
keyword that describes features that are not required by this standard

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

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

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

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

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

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

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

3.3.9 retired
keyword indicating that the designated bits, bytes, words, fields, and code values that had been defined in previous standards are not defined in this standard and may be reclaimed for other uses in future standards

Note 1 to entry: If retired bits, bytes, words, fields, or code values are used before they are reclaimed, they shall have the meaning or functionality as described in previous standards.

3.3.10 shall
keyword indicating a mandatory requirement

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

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

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

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

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

3.4 Conventions

3.4.1 Overview

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

Quantities having a defined numeric value are identified by large uppercase letters (e.g., the command code in the IDENTIFY DEVICE command).

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Quantities having a discrete but unspecified value are identified using small uppercase letters (e.g., SEQUENTIAL WRITE PREFERRED is one possible value of the Zone Type zone attribute). Such quantities are associated with an observable behavior or value that is specific to a given implementation standard.

Names of fields are in small uppercase (e.g., COUNT). 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. (See 3.4.5 for the naming convention used for numbering bits.)

The expression “word n” or “bit n” indicates the content of word n or the content of bit n.

3.4.2 Precedence

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

3.4.3 Lists

3.4.3.1 Lists overview

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

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

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

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

3.4.3.2 Unordered lists

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

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

EXAMPLE - The following are the items for the assembly:

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

3.4.3.3 Ordered lists

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

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

EXAMPLE - The following are the instructions for the assembly:

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

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3) take a break.

3.4.4 Numbering

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

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

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

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

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

Table 1 — Numbering conventions

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

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

3.4.5 Bit conventions

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

3.4.6 Number range convention

The verbal form “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).

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3.4.7 State diagram convention

All state diagrams in this standard use the notation shown in figure 2.

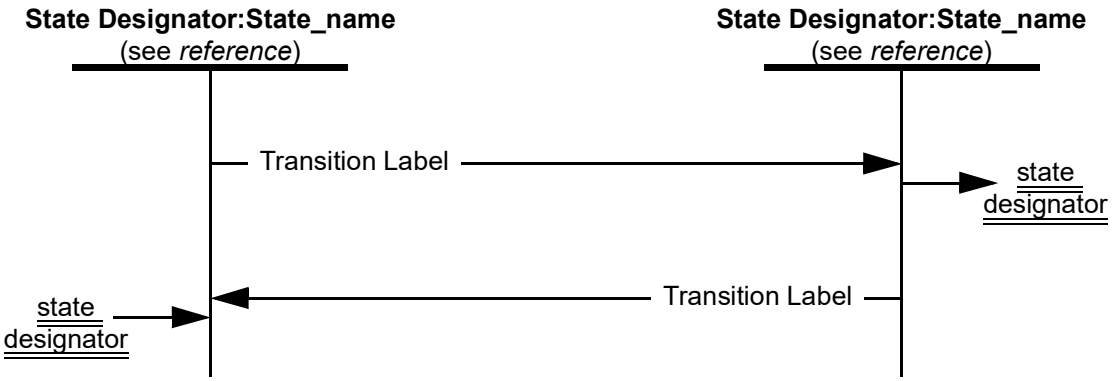


Figure 2 — State diagram convention

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 purpose of the state, and the same state name may appear in more than one state diagram. The reference below that state name is a link to the subclause that contains a full definition of the state.

Transitions between states are indicated by lines with arrows. Each transition includes a transition reference to the paragraph or paragraphs that contains a full definition of the transition. If the transition exits a figure or enters a figure, the transition line goes to or from a state designator with double underlines rather than to or from a state.

3.4.8 Offset convention

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

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