To: T10 Technical Committee
From: Robert Sheffield, Intel (robert.l.sheffield@intel.com)
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Subject: 05-247r1 SAT: Add 16-byte CDBs and PIO modes

Revision history

Revision 0 (16 June 2005) - First revision
Revision 1 (19 August 2005) - incorporated feedback from July, 2005 SAT meetings

Related documents

SAT-r05 - SCSI / ATA Translation revision 5

Overview

Reflector traffic prompted the SAT WG to discuss the need to define SAT translations for block commands using the 16-byte CDB format, such as READ CAPACITY (16), and others. The reasoning is that because SAT defines translations involving ATA devices implementing the 48-bit Address feature set, an ATA device may be installed with a capacity that cannot be fully addressed using the 32-bit LBA field provided in the SCSI 10 and 12 byte CDB read/write type commands. READ CAPACITY (16), for example, must be used to determine the capacity of an ATA device with a capacity greater than 2 Tebibytes accessed through a SATL. This proposal is to add text defining the translations for the following SCSI commands:

a) READ (16) 88h
b) READ CAPACITY(16) 9Eh
c) SYNCHRONIZE CACHE (16) 91h
d) VERIFY (16) 8Fh
e) WRITE (16) 8Ah
f) WRITE AND VERIFY (12) AEh
g) WRITE AND VERIFY (16) 8Eh

These translations may involve use of the following ATA device commands:

a) FLUSH CACHE
b) FLUSH CACHE EXT
c) READ DMA
d) READ DMA EXT
e) READ DMA QUEUED
f) READ DMA QUEUED EXT
g) READ MULTIPLE
h) READ MULTIPLE EXT
i) READ SECTOR(S)
j) READ SECTOR(S) EXT
k) READ VERIFY SECTOR(S)
l) READ VERIFY SECTOR(S) EXT
m) WRITE DMA
n) WRITE DMA EXT
o) WRITE DMA FUA EXT
p) WRITE DMA QUEUED
q) WRITE DMA QUEUED EXT
r) WRITE DMA QUEUED FUA EXT
s) WRITE MULTIPLE
t) WRITE MULTIPLE EXT
u) WRITE MULTIPLE FUA EXT
v) WRITE SECTOR(S)
w) WRITE SECTOR(S) EXT
x) READ FPDMA QUEUED (SATAII-EXT)
y) WRITE FPDMA QUEUED (SATAII-EXT)

This proposal also adds text to set the general rules for translating LBA and transfer length for block storage read/write command translations added to an initial subclause under the block commands subclause, and applies several corrections, clarifications, and editorial changes to text throughout the block commands clause.

Suggested Changes:

Add the following definitions

3.1.1 ATA flush command: .A FLUSH CACHE or FLUSH CACHE EXT command defined in ATA/ATAPI-7.

3.1.2 ATA LBA: .If the attached ATA device is a PATA device, this is the set of registes comprised of the LBA High, LBA Mid, and LBA Low registers in the ATA Command Block registers. If the attached ATA device is a SATA device, this is the set of fields in the SATA Command FIS comprised if the LBA Low, LBA Mid, LBA High, LBA Low (ext), LBA Mid (ext), and LBA High (ext) fields.

3.1.3 ATA read command: An ATA device block read type command which is one of the following: READ DMA, READ DMA EXT, READ DMA QUEUED, READ DMA QUEUED EXT, READ MULTIPLE, READ MULTIPLE EXT, READ SECTOR(S), or READ SECTOR(S) EXT defined in ATA/ATAPI-7; or READ FPDMA QUEUED defined in SATAII-EXT.

3.1.4 ATA Sector Count: If the attached ATA device is a PATA device this is the Sector Count register. If the attached device is a SATA device this is the Sector Count and Sector Count (ext) fields in a SATA Command FIS.

3.1.5 ATA verify command: .A READ VERIFY SECTOR(S) or READ VERIFY SECTOR(S) EXT command defined in ATA/ATAPI-7.

3.1.6 ATA write command: An ATA device block write type command which is one of the following: WRITE DMA, WRITE DMA EXT, WRITE DMA FUA EXT, WRITE DMA QUEUED, WRITE DMA QUEUED EXT, WRITE DMA QUEUED FUA EXT, WRITE MULTIPLE, WRITE MULTIPLE EXT, WRITE MULTIPLE FUA EXT, WRITE SECTOR(S), or WRITE SECTOR(S) EXT defined in ATA/ATAPI-7; or WRITE FPDMA QUEUED defined in SATAII-EXT.

3.1.7 ATA write FUA command sequence: A sequence of commands that writes logical blocks to an attached ATA device in a way that forces media access and consists of one of the following:

a) a WRITE DMA, WRITE DMA QUEUED, WRITE FPDMA QUEUED, WRITE MULTIPLE, or WRITE SECTOR(S) command followed by a READ VERIFY SECTOR(S) command defined in ATA/ATAPI-7;
b) a WRITE DMA FUA EXT, WRITE DMA QUEUED FUA EXT, or WRITE MULTIPLE FUA EXT command defined in ATA/ATAPI-7, or
c) a WRITE FPDMA QUEUED command defined in SATAII-EXT with the FUA bit in the Device/Head field set to one.

See 5.3 for a description of multiple command seuqence error handling.

3.1.8 SCSI read command: A SCSI READ (6), READ (10), READ (12), or READ (16) command defined in SBC-2.

3.1.9 SCSI synchronize cache command: .A SCSI SYNCHRONIZE CACHE(10), or SYNCHRONIZE CACHE (16) command defined in SBC-2

3.1.10 SCSI verify command: .A SCSI VERIFY (10), VERIFY (12), or VERIFY (16) command defined in SBC-2.

3.1.11 SCSI write command: .A SCSI WRITE (6), WRITE (10), WRITE (12), or WRITE (16) command defined in SBC-2.

3.1.12 SCSI write and verify command: .A SCSI WRITE AND VERIFY (10), WRITE AND VERIFY(12), or WRITE AND VERIFY (16) command defined in SBC-2.

Add the following to subclause 3.2 Symbols and abbreviations

FUA	Force Unit Access

Add subclause 5.3 under clause 5 SCSI Architectural Elements as shown below

5.3 Handling errors in ATA multi-command sequences

Emulation of several SCSI commands involves issueing multiple ATA commands to the attached ATA device. Errors may be reported by any of these ATA commands.

Unless otherwise specified in the subclause describing the translation for a particular SCSI command, when an error is returned by an ATA device processing a given ATA command that is part of a series of commands required to emulate the behavior of a SCSI command, the SATL shall terminate processing of the SCSI command and return CHECK CONDITION status and additional sense data as specified in clause 12 (fix cross-reference).

Add subclause 9.1 under clause 9 SCSI Block Commands (SBC-2) Mapping as shown below

9.1 Translating LBA and transfer length and ATA command use constraints

A SATL emulates SCSI logical blocks of the size indicated by the SCSI BLOCK LENGTH IN BYTES field in the READ CAPACITY data (see 9.7.2 and 9.8.2) using ATA device logical sectors containing the same or a greater number of bytes indicated by the Logical Sector Size[1] in the ATA IDENTIFY DEVICE data (see ATA/ATAPI-7). The SATL assigns an eqivalence between the logical block address in the SCSI CDB and the ATA LBA.

ATA commands the SATL may use to implement the functions specified by SCSI block commands depend upon:

a) the value of the LOGICAL BLOCK ADDRESS and TRANSFER LENGTH fields specified in the SCSI CDB, and
b) the capabilities of the attached ATA device and the ATA host within the SATL.

[1] The Logical Sector Size indicated by an ATA device is the number of words in a logical sector. The number of bytes in an ATA device logical sector is twice the value indicated in the Logical Sector Size.

Table 1 relates selection conditions to allowable ATA commands used to implement SCSI block storage data transfer commands.

Table 1 — Read and write type command translation selection

Selection Conditions[a]					**Allowed ATA commands**
SCSI CDB	**ATA feature sets supported and enabled**[d]				
(TRANSFER LENGTH + LBA) ≤ 2^{28}	**48-bit Address**[b]	**DMA**[c]	**Overlap**	**SATA IIe NCQ**	
N/A	N/A	N/A	N/A	N/A	FLUSH CACHE[f], FLUSH CACHE EXT[g]
yes [b,e]	N/A	N/A	N/A	N/A	READ MULTIPLE, READ SECTOR(S), READ VERIFY SECTOR(S), WRITE MULTIPLE, WRITE SECTOR(S)
yes [b,e]	N/A	yes	N/A	N/A	READ DMA, WRITE DMA
yes [b,e]	N/A	yes	yes	N/A	READ DMA QUEUED, WRITE DMA QUEUED
N/A	yes	yes	N/A	N/A	READ DMA EXT, WRITE DMA EXT, WRITE DMA FUA EXT
N/A	yes	yes	yes	N/A	READ DMA QUEUED EXT, WRITE DMA QUEUED EXT, WRITE DMA QUEUED FUA EXT
N/A	yes	N/A	N/A	N/A	READ MULTIPLE EXT, READ SECTOR(S) EXT, READ VERIFY SECTOR(S) EXT, WRITE MULTIPLE EXT, WRITE MULTIPLE FUA EXT, WRITE SECTOR(S) EXT
N/A	N/A	N/A	N/A	yes	READ FPDMA QUEUED, WRITE FPDMA QUEUED

[a] An ATA command may be used to implement a SCSI block command only if all the prerequisites in the prerequisite columns for that command marked “yes” are satisfied.

[b] The SATL should not receive a request to access an LBA beyond (2^{28}-1) if the attached ATA device does not support the 48-bit Address feature set or NCQ (see SATAII-EXT) (i.e., because the SATL reports a capacity less than 2^{28}).

[c] The DMA prerequisite requires both the ATA host in the SATL and the attached ATA device to support and have enabled the same DMA transfer mode (i.e. bit 8 of word 49 in the IDENTIFY DEVICE data is set to one and at least one DMA mode is enabled in word 63 or word 88 of the IDENTIFY DEVICE data).

[d] See ATA/ATAPI-7.

[e] The SATL may transfer the number of logical blocks requested in the TRANSFER LENGTH field by sending multiple ATA commands, each time incrementing the ATA LBA by the ATA Sector Count transferred.

[f] The FLUSH CACHE command may be used if ATA IDENTIFY DEVICE data indicates the command is supported in word 83 bit 12, and the command is enabled in word 86 bit 12 (see ATA/ATAPI-7).

[g] The FLUSH CACHE EXT command may be used if ATA IDENTIFY DEVICE data indicates the command is supported in word 83 bit 13, and the command is enabled in word 86 bit 13 (see ATA/ATAPI-7).

The SATL may use ATA commands listed in table 1 in the translation of SCSI read command (see 3.1.8), SCSI write command (see 3.1.6), SCSI write and verify command (see 3.1.12), SCSI verify command (see 3.1.10), and SCSI synchronize cache (see 3.1.9) command if the prerequisites defined for the command as shown in table 1 are satisfied. The translations for specific SCSI block commands in this clause further constrain the use of the available ATA commands in implementing the translation.

If the logical block address plus the transfer length specified in the SCSI CDB is greater than 2^{28} and the attached ATA device supports neither the 48-bit Address feature set nor SATAII-EXT NCQ, the SATL shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to LOGICAL BLOCK ADDRESS OUT OF RANGE (see SBC-2).

For SCSI read (see 3.1.8), SCSI verify (see 3.1.10), SCSI write (see 3.1.11), and SCSI write and verify (see 3.1.12) commands received with 6-byte CDBs, if the TRANSFER LENGTH or VERIFICATION LENGTH field is zero, the SATL shall issue ATA commands specifying an ATA Sector Count to operate on 256 logical sectors. If the CDB is 10, 12, or 16 bytes or if the transfer count on a 6-byte CDB is non-zero, the SATL shall transfer or operate on the number of logical sectors specified.

Modify subclause 9.1 FORMAT UNIT command as shown below

9.2 FORMAT UNIT command (4h)

9.2.1 Command summary

The FORMAT UNIT command verifies that all logical block addresses ~~visible~~ accessible to ~~external~~ SCSI application clients are formatted and may be accessed. ~~All sectors of the visible address space are written to zero~~.

Table 2 — FORMAT UNIT command CDB fields

Field	SATType	Description or reference
OPERATION CODE	E	If no defect list header is provided or a defect list header is provided with the DCRT bit set to one the SATL shall return completion status without issuing any commands to the device with a status of GOOD. If the SATL supports certification of media and a defect list header is provided with the DCRT bit set to zero the SATL shall certify the media as described in 9.2.3
DEFECT LIST FORMAT	E	If the DEFECT LIST FORMAT field is the mandatory format (000b) or the vendor specific format (110b) the defect list length shall be zero (see SBC-2). If the DEFECT LIST FORMAT field is any other value the SATL shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN ~~PARAMETER LIST~~ CDB.
CMPLIST	E~~U~~	If a CMPLIST is specified the SATL shall terminate the command with a CHECK CONDITION with sense key set to ILLEGAL REQUEST and additional sense code set to INVALID FIELD IN CDB.
FMTDATA	E	If set to ~~0~~ zero no data shall be transferred from the data-out buffer. If set to 1 the FORMAT UNIT parameter list shall be transferred from the client's data out buffer. The SATL may accept a FORMAT UNIT parameter list specifying the IMMED bit and an initialization pattern. The SATL shall ignore any defect list descriptors and any other fields provided in the FORMAT UNIT parameter list (see 9.2.2).
LONGLIST	U	~~The SATL may implement this field as defined in SBC-2.~~
FMTPINFO	U	~~The SATL may implement this field as defined in SBC-2.~~
CONTROL	U~~I~~	See 6.4.

The SATL shall process commands received during the processing of the FORMAT UNIT command as specified in SBC-2.

Editor’s Note 1: Add Key for SATType column to tables as in SAT-r05.

9.2.2 FORMAT UNIT parameter list

If the FORMAT command CDB specifies a FMTDATA bit of one, the SATL shall accept a FORMAT UNIT parameter list consisting of a short or long defect list header and may accept an initialization pattern descriptor. The SATL shall ignore any defect descriptors provided. Table 3 defines the SATL handling of fields in the FORMAT UNIT defect list header.

Table 3 — FORMAT parameter list header

Field[a]	SATType	Description or reference
FOV	E/U	The SATL shall implement this field as defined in SBC-2.
DPRY	E	The SATL shall ignore this field.
DCRT	E	(see 9.2.3)
STPF	U	~~The SATL may implement this field as defined in SBC-2.~~
IP	E	~~The SATL may implement this field as defined in SBC-2. If supported, the SATL shall write the specified pattern by issuing WRITE SECTOR(S) or WRITE SECTOR(S) EXT commands to the attached non-packet device.~~ See 9.2.4.
IMMED	E	The SATL shall implement this field as defined in SBC-2.
DEFECT LIST LENGTH	E	The SATL shall ignore any defect descriptors provided.

[a] If IMMED is one or if FOV is zero or if FOV is one, DCRT is one, and IP is zero, then the SATL may complete the FORMAT UNIT command immediately with SUCCESSFUL status. If IMMED is zero, FOV is one, and either DCRT is zero or IP is one, the SATL may terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST with the additional sense code set to INVALID FIELD PARAMETER LIST. Otherwise, the SATL shall issue the required ATA read and ATA write commands to certify and initialize the media as specified by DCRT and IP, and shall then return SUCCESSFUL status if no unrecoverable write errors are encountered.

9.2.3 DCRT bit

If a value of zero is specified and supported the SATL shall issue ~~READ VERIFY SECTOR(S) or READ VERIFY SECTOR(S) EXT~~ ATA verify commands (see 3.1.5) to access every block on the media. If any unrecoverable read errors are encountered the SATL shall issue an ~~WRITE SECTOR(S) or WRITE SECTOR(S) EXT~~ ATA write command (see 3.1.6) to the defective sector to ~~force~~ attempt to cause allocation of an alternate. The data written shall be vendor-specific or the data pattern specified by the initialization pattern descriptor if one is provided. After writing the block, the SATL shall again issue an ~~READ VERIFY SECTOR(S) or READ VERIFY SECTOR(S) EXT~~ ATA verify command (see 3.1.5) to the same sector to verify the alternate block is not defective. The process (i.e., verify, write, verify, write, ...) shall repeat until the logical block is verified successfully or the disk reports a fatal error other than an unrecoverable read error (e.g., device fault). Subclause 5.3 describes error handling for multiple ATA command sequences.

9.2.4 IP bit

If the SATL supports an ip value of one and the ip bit is set to one, the SATL shall process the command as follows:

a) If the attached ATA device supports the SCT LBA Segment Access (TR-) command and the value of the INITIALIZATION PATTERN LENGTH field in the initialization pattern descriptor is 4, and the value of the IP MODIFIER FIELD in the initialization pattern descriptor is zero, the SATL should issue an SCT LBA Segment Access (TR-) command to the attached ATA device with the Function Code set to 0001b (Repeat Write Pattern), the Start and Count fields set to zero, and the Pattern field set to the value of the INITIALIZATION PATTERN field from the FORMAT command initialization pattern descriptor.
b) Otherwise, the SATL shall write the specified pattern by issueing ATA write commands (see 3.1.6 and 9.1) to the attached ATA device.

If the ip bit is zero the SATL shall return GOOD status.

NOTE 1 - If the SATL has reserved a portion of the logical block address space for exclusive use of the SATL, the SATL should either use ATA write commands or multiple SCT LBA Segment Access (TR-) commands with appropriate values in the Start and Count fields to avoid overwriting any persistent data maintained in the area of the ATA LBA address space reserved for exclusive use of the SATL.

NOTE 2 - The SATL should reverse the order of the bytes between the Pattern field in the SCD LBA Segment Access (TR-) command and the value stored in the INITIALIZATION PATTERN field in the FORMAT command initialization pattern descriptor to adjust for the translation from little-endian to big-endian byte ordering.

Modify subclause 9.2 READ (6) command as shown below

9.3 READ (6) command (8h)

9.3.1 Command summary

The READ(6) command is used to request the device to transfer logical blocks of user data to the requester. ~~Different versions of the command support different LBA sizes and different transfer lengths.~~ Data may be read from medium or, data may be read from the device cache if the most recent copy is in the cache ~~and has not been transferred to the medium~~ (see SBC-2)

Table 4 — READ(6) command CDB fields

Field	SATType	Description or reference
OPERATION CODE	I	9.3.2
LOGICAL BLOCK ADDRESS	E	~~(see 9.3.3)~~9.3.2
TRANSFER LENGTH	E	The transfer length shall be used to set the ATA Sector Count ~~(see 9.3.4)~~9.3.2.[a]
CONTROL	U	See 6.4.

[a] A transfer length of zero specifies to transfer 256 logical blocks from the attached ~~non-packet~~ ATA device to the application client (see SBC-2).

9.3.2 READ operation code translations

~~Table 5 shows the translation for SCSI READ commands to ATA or SATAII-EXT commands based on the capabilities of the attached non-packet device. This subclause applies to the translation of SCSI READ(6), READ(10), and READ(12).~~

~~Table 5 — READ command summary~~

~~Translated to ATA or SATAII-EXT read commands using the following criterion~~		
~~Is Queuing enabled?[a]~~	~~Are ATA Extended Commands Enabled~~	~~Translated ATA Opcode[b]~~
~~No~~	~~No~~	~~READ DMA~~
~~No~~	~~Yes~~	~~READ DMA EXT[c]~~
~~Yes~~	~~No~~	~~READ DMA QUEUED~~
~~Yes~~	~~Yes~~	~~READ DMA QUEUED EXT[d]~~
~~Yes~~	~~Yes or No~~	~~READ FPDMA QUEUED (See SATAII-EXT)[e]~~

~~[a] Refers to either the non-packet device support of the ATA/ATAPI-7 Overlapped feature set or the Native Command Queing (NCQ) feature of SATAII-EXT.~~

~~[b] The SATL may attempt READ MULTIPLE, READ MULTIPLE EXT, READ SECTOR(S) or READ SECTOR(S) EXT as a retry operation if the specified ATA or SATAII-EXT command fails. The selected ATA commands shall have enough bits in the logical sector address to avoid truncation of the LBA supplied in the SCSI CDB.~~

~~[c] The SATL may substitute READ DMA if the LBAs accessed can be represented in 28 bits.~~

~~[d] The SATL may substitute READ DMA QUEUED if the LBAs accessed can be represented in 28 bits.~~

~~[e] The SATL may use these commands only if NCQ is enabled (see SATAII-EXT).~~

This subclause applies to the translation of SCSI READ(6), READ(10), READ(12), and READ(16) commands.

The SATL shall issue ATA read commands (see 3.1.3) in accordance with the constraints specified in subclause 9.1 to cause the ATA device to transfer the logical blocks specified in the SCSI read command (see 3.1.8) to the ATA host in the SATL.

The SATL shall transfer the ~~The~~ requested sector(s) ~~shall be returned~~ to the SCSI application client if successfully retrieved from the ~~non-packet~~ ATA device. If the LBA plus the transfer length minus 1 is greater than the ~~maximum~~ highest numbered sector that can be addressed ~~in medium~~ on the ATA device the SATL device server shall ~~return~~ terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to LOGICAL BLOCK ADDRESS OUT OF RANGE (see SBC-2).

If the SATL encounters an error other than an ILLEGAL REQUEST while processing the command the SATL device server may transfer a vendor-specific amount of data before terminating the command.

~~9.3.3 LOGICAL BLOCK ADDRESS field~~

~~The SATL shall transfer data blocks starting with the LBA specified.~~

~~9.3.4 TRANSFER LENGTH field~~

~~If the TRANSFER LENGTH field is zero, the SATL shall transfer 256 data blocks.~~

~~If the TRANSFER LENGTH is not zero, the SATL shall transfer the specified number of sectors from the device to the application client.~~

Modify subclause 9.3 READ (10) command as shown below

9.4 READ (10) command (28h)

9.4.1 Command summary

The SATL shall process the READ(10) command the same as the READ(6) command (see 9.3.2). with the additional fields in the CDB implemented as described in ~~the following paragraphs~~ table 6 and subclause 9.4.2.

Table 6 — READ(10) command CDB fields

Field	SATType	Description or reference
OPERATION CODE	I	See 9.4.2.
RDPROTECT	U	~~See SBC-2~~
DPO	U	~~Ignored~~
FUA	E	The SATL may support the FUA bit as defined in SBC-2 (see 9.4.2).
FUA_NV	E	If the FUA_NV bit is set to one the SATL shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.
LOGICAL BLOCK ADDRESS	I	~~(see 9.3.3)~~See 9.3.2.
GROUP NUMBER	U	~~The SATL may implement this field as defined in SBC-2.~~
TRANSFER LENGTH	I/E	The transfer length shall be used to set the ATA Sector Count ~~(see 9.4.3)~~(see 9.3.2).[a] The SATL shall issue as many ATA read commands as needed to satisfy the transfer length specified by the READ (10) command.
CONTROL	U~~I~~	See 6.4.

[a] A transfer length of ~~0~~ zero indicates that a data transfer shall not take place. If the transfer length is not zero, the SATL shall transfer the number of sectors specified from the device to the application client.

9.4.2 ~~READ(10,12)~~ READ (10), READ (12) and READ (16) OPERATION CODE and the FUA bit

~~The SATL may support FUA.~~ If the SATL does not support ~~FUA~~ force unit access and the FUA bit is set to one, the SATL shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.

~~If the FUA bit is set to one and the attached device supports NCQ the SATL shall issue a SATAII-EXT READ FPDMA QUEUED command with the FUA bit in the Device/Head field set to one. If the FUA bit is set to one and the attached device does not support NCQ, the SATL shall issue an ATA READ VERIFY or READ VERIFY EXT command followed by an ATA read command as specified in subclause 9.3.2. If the FUA bit is set to zero the SATL shall issue a read command as specified in subclause 9.3.2.~~

The SATL shall process a SCSI read command with the FUA bit set to one differently as follows depending on whether or not the attached ATA device supports NCQ:

a) If the attached device supports NCQ (i.e., bit-8 in word 77 of ATA IDENTIFY DEVICE data is set to one) the SATL shall issue a READ FPDMA QUEUED command (see SATAII-EXT) with the FUA bit in the Device/Head field set to one;
b) otherwise, the SATL shall issue an an ATA read command as specified in subclause 9.3.2.

NOTE 3 - The SATL ignores the FUA bit if the attached ATA device does not support NCQ.

If the FUA bit is set to zero the SATL shall issue an ATA read command as specified in subclause 9.3.2.

Editor's Note 2: (Applies to this proposal) To implement the FUA function with an ATA device that does not support NCQ, the SATL could issue an ATA READ VERIFY or READ VERIFY EXT command followed by an ATA read command, but the recommendation from the July 11, 2005 SAT WG was to ignore FUA if the ATA device does not support NCQ. Another option would be to terminate the command with CHECK CONDITION status.

Editor's Note 3: (Applies to this proposal) SATAII-EXT defines an indication of NCQ support in a READ LOG EXT log page, but it's not clear if this indication should be used in place of the IDENTIFY DEVICE data, and it's not clear which bit of which byte of which page applies if it does. So no reference to this is made in this proposal.

~~9.4.3 TRANSFER LENGTH field~~

~~If the TRANSFER LENGTH field is zero, the SATL shall not transfer any data blocks to the application client.~~

~~If the TRANSFER LENGTH is not zero, the SATL shall transfer the specified number of sectors from the device to the application client.~~

Modify subclause 9.4 READ (12) command as shown below

9.5 READ (12) command (A8h)

9.5.1 Command summary

The READ(12) command is used to request the device to transfer logical blocks of user data to the requester. ~~Different versions of the command support different LBA sizes and different transfer lengths.~~ Data may be read from medium or, data may be read from the device cache if the most recent copy is in the cache ~~and has not been transferred to the medium~~ (see SBC-2)

Table 7 — READ(12) command CDB fields

Field	SATType	Description or reference
OPERATION CODE	I	(see 9.4.2)
RDPROTECT	U	~~See SBC-2~~
DPO ~~(disable page out)~~	U	~~Ignored~~
FUA ~~(force unit access)~~	E	~~The SATL shall implement FUA if the attached device supports NCQ.~~ The SATL may support the FUA bit as defined in SBC-2 (see 9.4.2).
FUA_NV ~~(force unit access nonvolatile cache)~~	E	If the FUA_NV bit is set to one the SATL shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.
LOGICAL BLOCK ADDRESS	I	~~(see 9.3.3)~~(see 9.3.2)
GROUP NUMBER	U	~~The SATL may implement this field as defined in SBC-2.~~
TRANSFER LENGTH	I/E	The transfer length shall be used to set the ATA Sector Count ~~(see 9.4.3)~~(see 9.3.2).[a] The SATL shall issue as many ATA read commands as needed to satisfy the transfer length specified by the READ (12) command.
CONTROL	U~~I~~	See 6.4.

[a] A transfer length of ~~0~~ zero indicates that a data transfer shall not take place. If the transfer length is not zero, the SATL shall transfer the number of sectors specified from the device to the application client.

~~9.5.2 TRANSFER LENGTH field~~

~~The SATL shall transfer the number of sectors specified in the TRANSFER LENGTH field to the application client. If the TRANSFER LENGTH field is greater than 0xFFFF the SATL device server shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.~~

~~NOTE 4 - This is because the ATA command set supports a maximum of a 16 bit SECTOR COUNT field.~~

Add subclause 9.6 READ (16) command as shown below

9.6 READ (16) command (88h)

9.6.1 Command summary

The READ (16) command is used to request the device to transfer logical blocks of user data to the requester. Data may be read from medium or, data may be read from the device cache if the most recent copy is in the cache (see SBC-2)

Table 8 — READ(16) command CDB fields

Field	SATType	Description or reference
OPERATION CODE	I	(see 9.4.2)
RDPROTECT	U	
DPO	U	
FUA	E	The SATL may support the FUA bit as defined in SBC-2 (see 9.4.2).
FUA_NV	E	If the FUA_NV bit is set to one the SATL shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.
LOGICAL BLOCK ADDRESS	I	(see 9.3.2)
GROUP NUMBER	U	
TRANSFER LENGTH	I/E	The transfer length shall be used to set the ATA Sector Count (see 9.3.2).[a] The SATL shall issue as many ATA read commands as needed to satisfy the transfer length specified by the READ (16) command.
CONTROL	U	See 6.4.

[a] A transfer length of zero indicates that a data transfer shall not take place. If the transfer length is not zero, the SATL shall transfer the number of sectors specified from the device to the application client.

Add subclause 9.8 READ CAPACITY (16) command as shown below

9.8 READ CAPACITY (16) command (9Eh)

9.8.1 Command summary

The READ CAPACITY (16) command shall request information about the capacity of the block device being addressed.

Table 9 — READ CAPACITY(16) command CDB fields

Field	SATType	Description or reference
OPERATION CODE	E	The SATL shall use ATA IDENTIFY DEVICE information to compute the maximum user addressable medium capacity.[a]
LOGICAL BLOCK ADDRESS	E	If the LOGICAL BLOCK ADDRESS is not 0000000h the SATL device server shall terminate the command with CHECK CONDITION STATUS with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.
PMI	E	If the PMI bit is not zero the SATL device server shall terminate the command with CHECK CONDITION STATUS with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.
CONTROL	U	See 6.4.

[a] A SATL may use part of the capacity of the attached ATA device to store persistent state information for management of the emulated SCSI target device.

9.8.2 READ CAPACITY data

The SATL shall return READ CAPACITY data as defined by SBC-2. Table 10 describes the translaiton of fields in the READ CAPACITY data..

Table 10 — READ CAPACITY data

Field	SATType	Description or reference
RETURNED LOGICAL BLOCK ADDRESS	E	See 9.8.3.
BLOCK LENGTH IN BYTES	I	The SATL shall return a block length no greater than the number of bytes in an ATA logcial block as indicated by the ATA Logical Block Length[a].
RTO_EN	U	
PROT_EN	U	

[a] The number of bytes in an ATA logical block is twice the number of words indicated by the ATA Logical Block Length (see ATA/ATAPI-7).

9.8.3 RETURNED LOGICAL BLOCK ADDRESS

The SATL shall return a value no larger the LBA of the last logical block addressable on the ATA device (i.e. one less than the value from words 100 through 103 in the ATA IDENTIFY DEVICE data if the ATA device supports the 48-bit address feature set, or one less than the value from words 60 and 61 in the ATA IDENTIFY DEVICE data if the ATA device does not support the 48-bit address feature set). The bytes shall be swapped to match SCSI big-endian format.

NOTE 5 - The SATL may report less than the addressable medium capacity returned in the ATA IDENTIFY DEVICE information.

Editor’s Note 4: Make sure READ CAPACITY (10) is consistent with READ CAPACITY (16) as defined in this proposal.

Modify subclause 9.8 SYNCHRONIZE CACHE (10) command as shown below

9.11 SYNCHRONIZE CACHE (10) command (35h)

9.11.1 Command summary

The SYNCHRONIZE CACHE(10) command is used to flush the most recent data values in the device cache to physical medium. Unlike in SCSI, ATA does not provide a way to specify a particular LBA to start flushing the device cache.

Table 11 — SYNCHRONIZE CACHE(10) command CDB fields

Field	SATType	Description or reference
OPERATION CODE	I	~~Translated into the FLUSH CACHE command (E7h) or FLUSH CACHE EXT command (EAh).~~ The SATL shall issue an ATA flush command (see 3.1.1) in accordance with the constraints described in 9.1
SYNC_NV	U	
IMMED	E~~U~~	~~The SATL shall ignore this bit.~~ If one return GOOD status immediately then issue an ATA flush command. If zero, issue an ATA flush command and return status upon completion.
LOGICAL BLOCK ADDRESS	E~~U~~	The SATL shall ignore this field and shall process this command as though this field contained a value of zero.
GROUP NUMBER	U	~~The SATL may implement this field as defined in SBC-2.~~
NUMBER OF BLOCKS	E~~U~~	The SATL shall ignore this field and shall process this command as though this field contained a value of zero (i.e., synchronize all logical blocks starting with the one specified in the LOGICAL BLOCK ADDRESS field to the last logical block on the medium).
CONTROL	U~~I~~	See 6.4.

~~Editor’s Note 5: There is a proposal being developed that will describe general rules for selecting among ATA 24-bit commands, ATA 48-bit commands, and SATA II FPDMA commands depending on the CDB received and the capabilities of the attached device. This proposal will cover selection of ATA/SATA commands involved in emulation of SYNCHRONIZE CACHE.~~

Add subclause 9.12 SYNCHRONIZE CACHE (16) command as shown below

9.12 SYNCHRONIZE CACHE (16) command (91h)

9.12.1 Command summary

The SYNCHRONIZE CACHE(16) command is used to flush the most recent data values in the device cache to physical medium. Unlike in SCSI, ATA does not provide a way to specify a particular LBA to start flushing the device cache.

Table 12 — SYNCHRONIZE CACHE(10) command CDB fields

Field	**SATType**	**Description or reference**
OPERATION CODE	I	The SATL shall issue an ATA flush command (see 3.1.1) in accordance with the constraints described in 9.1
SYNC_NV	U	
IMMED	E	If one return GOOD status immediately then issue an ATA flush command. If zero, issue an ATA flush command and return status upon completion.
LOGICAL BLOCK ADDRESS	E	The SATL shall ignore this field and shall process this command as though this field contained a value of zero.
GROUP NUMBER	U	
NUMBER OF BLOCKS	E	The SATL shall ignore this field and shall process this command as though this field contained a value of zero (i.e., synchronize all logical blocks starting with the one specified in the LOGICAL BLOCK ADDRESS field to the last logical block on the medium).
CONTROL	U	See 6.4.

Remove subclause 9.9 VERIFY (6) command (not defined in SBC-2)

~~9.9 VERIFY (6) command (13h)~~

~~The VERIFY(6) command is not defined for direct-attach storage devices (disk). The SATL shall terminate the command with CHECK CONDITION STATUS with the sense key set to INVALID REQUEST and the additional sense code set to INVALID COMMAND OPERATION CODE.~~

Modify subclause 9.8 VERIFY (10) command as shown below

9.14 VERIFY (10) command (2Fh)

9.14.1 Command summary

The VERIFY(10) command is used to verify data on medium which includes user data and protection data. ~~This SCSI command is directly translated into ATA read verify sectors command or the extended version of that command~~.Table 13 describes the translatoin of fields in the VERIFY (10) CDB.

Table 13 — VERIFY(10) command CDB fields

Field	SATType	Description or reference
OPERATION CODE	I	The SATL shall issue an ATA ~~READ VERIFY SECTOR(S)~~ verify command (see 3.1.5) in accordance with the constraints described in 9.1~~, or if the device supports 48 bit mode, the SATL shall issue an ATA READ VERIFY EXTENDED command~~.
VRPROTECT	U	~~See SBC-2~~
DPO	U	~~Ignored~~
BYTCHK	E~~U~~	If the application client specifies a value ~~of one~~ other than zero in this field, the SATL device server shall terminate the command with CHECK CONDITION STATUS with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.
LOGICAL BLOCK ADDRESS	E~~U~~	(see 9.1) ~~If the LOGICAL BLOCK ADDRESS is larger than what can be accommodated using 28 bits and the device does not support 48 bit mode, the SATL shall return a CHECK CONDITION with sense key set to ILLEGAL REQUEST and additional sense code set to LOGICAL BLOCK ADDRESS OUT OF RANGE.~~
GROUP NUMBER	U	T~~he SATL may implement this field as defined in SBC-2.~~
VERIFICATION LENGTH	E~~U~~	The verification length shall be used to set the ATA Sector Count (see 9.1).
CONTROL	U~~I~~	See 6.4.

~~9.14.2 Miscellaneous notes~~

~~The SATL LBA mapping algorithm shall assign the LSB of the LBA field from the SCSI CDB, i.e. byte 5, to LBALow in the ATA FIS, byte 4 from SCSI CDB to LBAMid, byte 3 from SCSI CDB to LBAHigh. If the device supports 48-bit addressing byte 2 of the SCSI CDB shall be assigned to LBALowExp.~~

~~The SectorCount in the ATA FIS shall be derived from the LSB, i.e. byte 8, of the VERIFICATION LENGTH of the SCSI CDB. If the device supports 48-bit addressing, the SectorCountExp is assigned byte 7 of the SCSI CDB, which is the MSB of the VERIFICATION LENGTH field.~~

~~Commands the SATL issues to the non-packet device to process this command shall not be queued.~~

> ~~NOTE 6 - A performance degradation may be expected when a command such as VERIFY is issued as it must run in a single thread.~~

Modify subclause 9.9 VERIFY (12) command as shown below

9.15 VERIFY (12) command (AFh)

~~The VERIFY(12) command is not defined for SAT. The SATL shall terminate the command with CHECK CONDITION STATUS with the sense key set to INVALID REQUEST and the additional sense code set to INVALID COMMAND OPERATION CODE.~~

9.15.1 Command summary

Table 14 describes the translatoin of fields in the VERIFY (12) CDB.

Table 14 — VERIFY(12) command CDB fields

Field	SATType	Description or reference
OPERATION CODE	I	The SATL shall issue an ATA verify command (see 3.1.5) in accordance with the constraints described in 9.1.
VRPROTECT	U	
DPO	U	
BYTCHK	E	If the application client specifies a value other than zero in this field, the SATL device server shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.
LOGICAL BLOCK ADDRESS	E	(see 9.1)
GROUP NUMBER	U	
VERIFICATION LENGTH	E	The verification length shall be used to set the ATA Sector Count (see 9.1).
CONTROL	U	See 6.4.

Add subclause 9.16 VERIFY (16) command as shown below

9.16 VERIFY (16) command (8Fh)

9.16.1 Command summary

Table 15 describes the translatoin of fields in the VERIFY (16) CDB.

Table 15 — VERIFY(16) command CDB fields

Field	SATType	Description or reference
OPERATION CODE	I	The SATL shall issue an ATA verify command (see 3.1.5) in accordance with the constraints described in 9.1.
VRPROTECT	U	
DPO	U	
BYTCHK	E	If the application client specifies a value other than zero in this field, the SATL device server shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.
LOGICAL BLOCK ADDRESS	E	(see 9.1)
GROUP NUMBER	U	
VERIFICATION LENGTH	E	The verification length shall be used to set the ATA Sector Count (see 9.1).
CONTROL	U	See 6.4.

Modify subclause 9.12 WRITE (6) command as shown below

9.17 WRITE (6) command (0Ah)

9.17.1 Command summary

The WRITE(6) command is used to request the device to transfer user data to device medium or cache. ~~Different versions of the command support different LBA sizes and or different transfer lengths.~~ Data may be written to medium or the device cache.

Table 16 — WRITE(6) command CDB fields

Field	SATType	Description or reference
OPERATION CODE	I	See 9.17.2.
TRANSFER LENGTH	I	The transfer length shall be used to set the ATA Sector Count.[a]
LOGICAL BLOCK ADDRESS	I	~~For WRITE(6) commands (0Ah), a 21 bit LBA shall be derived from bytes 3, 2, 1:5 in the CDB, with byte 3 being the LSB and the 5 bits from byte 1 being the MSB.~~ See 9.17.2
CONTROL	U~~I~~	See 6.4

[a] A transfer length of zero specifies to transfer 256 logical blocks from the application client to the attached ~~non-packet~~ ATA device (see SBC-2).

9.17.2 WRITE command OPERATION CODE translation

~~Table 17 shows the translation for SCSI WRITE(6), WRITE(10), and WRITE(12) commands to ATA or SATAII-EXT commands based on the capabilities of the attached non-packet device.~~

~~Table 17 — Write command summary~~

~~Translated to ATA or SATAII-EXT write commands using the following criterion~~			
~~Is Queueing enabled?[a]~~	~~Are ATA Extended Commands enabled~~	~~FUA~~	~~Translated ATA command(s)[b]~~
~~No~~	~~No~~	~~N~~	~~WRITE DMA~~
~~No~~	~~No~~	~~Y~~	~~WRITE DMA, READ VERIFY SECTORS~~
~~No~~	~~Yes~~	~~N~~	~~WRITE DMA EXT[c]~~
~~No~~	~~Yes~~	~~Y~~	~~WRITE DMA FUA EXT~~
~~Yes~~	~~No~~	~~N~~	~~WRITE DMA QUEUED~~
~~Yes~~	~~No~~	~~Y~~	~~WRITE DMA QUEUED, READ VERIFY SECTORS~~
~~Yes~~	~~Yes~~	~~N~~	~~WRITE DMA QUEUED EXT[d]~~
~~Yes~~	~~Yes~~	~~Y~~	~~WRITE DMA QUEUED FUA EXT~~
~~Yes~~	~~Yes or No~~	~~Y or N~~	~~WRITE FPDMA QUEUED (see SATAII-EXT)[e]~~

~~[a] Refers to either the non-packet device support of the ATA/ATAPI-7 Overlapped feature set or the Native Command Queing (NCQ) feature of SATAII-EXT.~~

~~[b] The SATL may attempt WRITE MULTIPLE, WRITE MULTIPLE EXT, WRITE SECTOR(S) or WRITE SECTOR(S) EXT as a retry operation if the specified ATA or SATAII-EXT command fails. The selected ATA commands shall have enough bits in the logical sector address to avoid truncation of the LBA supplied in the SCSI CDB.~~

~~[c] The SATL may substitute WRITE DMA if the LBAs accessed can be represented in 28 bits.~~

~~[d] The SATL may substitute WRITE DMA QUEUED if the LBAs accessed can be represented in 28 bits.~~

~~[e] The SATL may use these commands only if NCQ is enabled (see SATAII-EXT).~~

This subclause applies to the translation of SCSI WRITE (6), WRITE (10), WRITE (12), and WRITE (16).

The SATL shall transfer the logical blocks specified in the SCSI write command (see 3.1.11) from the SCSI application client and shall issue ATA write commands (see 3.1.6) in accordance with the constraints specified in subclause 9.1 to transfer the specified logical blocks through the ATA host in the SATL to the ATA device.

Data blocks specified in the LOGICAL BLOCK ADDRESS field shall be transferred to the specified ~~non-packet~~ ATA device, and the device may transfer the data to its cache or medium. ~~CHECK CONDITION shall be reported back if~~ If the LOGICAL BLOCK ADDRESS or the LOGICAL BLOCK ADDRESS plus one less than the TRANSFER LENGTH is greater than the maximum sector that can be addressed in medium the SATL shall terminate the command with CHECK CONDITION status ~~where~~ with the sense key set to ILLEGAL REQUEST and additional sense code set to INVALID FIELD IN CDB.

Modify subclause 9.13 WRITE (10) command as shown below

9.18 WRITE (10) command (2Ah)

9.18.1 Command summary

The WRITE(10) command is used to request the device to transfer user data to device medium or cache. ~~Different versions of the command support different LBA sizes and or different transfer lengths.~~ Data may be written to medium or the device cache.

Table 18 — WRITE(10) command CDB fields

Field	SATType	Description or reference
OPERATION CODE	I	~~See 9.17.2~~See 9.17.2.
WRPROTECT	U	~~See SBC-2~~
DPO ~~(disable page out)~~	U	~~Ignored~~
FUA ~~(force unit access)~~	~~U~~ I/E	~~See 9.17.2~~ The SATL may support the FUA bit as defined in SBC-2 (see 9.18.2).
FUA_NV ~~(force unit access nonvolatile cache)~~	E~~U~~	If the FUA_NV bit is set to one the SATL shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.
LOGICAL BLOCK ADDRESS	I	See 9.17.2. ~~A 32 bit LBA shall be derived from bytes 2 through 5, where byte 5 is the LSB and byte 2 is the MSB.~~
GROUP NUMBER	U	~~The SATL may implement this field as defined in SBC-2.~~
TRANSFER LENGTH	I	The transfer length shall be used to set the ATA Sector Count (see 9.17.2).[a] The SATL shall issue as many ATA write commands as needed to satisfy the transfer length specified by the WRITE (10) command.
CONTROL	U~~I~~	See 6.4.

[a] A transfer length of zero indicates that a data transfer shall not take place. If the transfer length is not zero, the SATL shall transfer the number of sectors specified from the device to the application client.

9.18.2 WRITE command OPERATION CODE and FUA bit translation

This subclause applies to the translation of SCSI WRITE (10), WRITE (12), and WRITE (16).

If the FUA bit is zero the SATL shall process this command as described in 9.17.2.

If the FUA bit is one the SATL shall issue an ATA write FUA command sequence (see 3.1.7) to the attached ATA device in accordance with the constraints described in subclause 9.1.

Modify subclause 9.14 WRITE (12) command as shown below

9.19 WRITE (12) command (AAh)

9.19.1 Command summary

The WRITE(12) command is used to request the device to transfer user data to device medium or cache. ~~Different versions of the command support different LBA sizes and or different transfer lengths.~~ Data may be written to medium or the device cache.

Table 19 — WRITE(12) command CDB fields

Field	SATType	Description or reference
OPERATION CODE	I	~~See 9.17.2~~See 9.17.2.
WRPROTECT	U	~~See SBC-2~~
DPO ~~(disable page out)~~	U	~~Ignored~~
FUA ~~(force unit access)~~	~~U~~ I/E	~~See 9.17.2~~The SATL may support the FUA bit as defined in SBC-2 (see 9.18.2).
FUA_NV ~~(force unit access nonvolatile cache)~~	E~~U~~	If the FUA_NV bit is set to one the SATL shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.
LOGICAL BLOCK ADDRESS	I	See 9.17.2. ~~A 32 bit LBA shall be derived from bytes 2 through 5, where byte 5 is the LSB and byte 2 is the MSB.~~
GROUP NUMBER	U	~~The SATL may implement this field as defined in SBC-2.~~
TRANSFER LENGTH	I	The transfer length shall be used to set the ATA Sector Count (see 9.17.2).[a] The SATL shall issue as many ATA write commands as needed to satisfy the transfer length specified by the WRITE (12) command. ~~(see 9.17.2)~~
CONTROL	U~~I~~	See 6.4.

[a] A transfer length of zero indicates that a data transfer shall not take place. If the transfer length is not zero, the SATL shall transfer the number of sectors specified from the device to the application client.

Add subclause 9.20 WRITE (16) command as shown below

9.20 WRITE (16) command (8Ah)

9.20.1 Command summary

The WRITE(16) command is used to request the device to transfer user data to device medium or cache. Data may be written to medium or the device cache.

Table 20 — WRITE(16) command CDB fields

Field	**SATType**	**Description or reference**
OPERATION CODE	I	See 9.17.2.
WRPROTECT	U	
DPO	U	
FUA	I/E	The SATL may support the FUA bit as defined in SBC-2 (see 9.18.2).
FUA_NV	E	If the FUA_NV bit is set to one the SATL shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.
LOGICAL BLOCK ADDRESS	I	See 9.17.2.
GROUP NUMBER	U	
TRANSFER LENGTH	I	The transfer length shall be used to set the ATA Sector Count (see 9.17.2).[a] The SATL shall issue as many ATA write commands as needed to satisfy the transfer length specified by the WRITE (16) command.
CONTROL	U	See 6.4.

[a] A transfer length of zero indicates that a data transfer shall not take place. If the transfer length is not zero, the SATL shall transfer the number of sectors specified from the device to the application client.

Modify subclause 9.15 WRITE AND VERIFY (10) command as shown below

9.21 WRITE AND VERIFY(10) command (2Eh)

9.21.1 Command Summary

The WRITE AND VERIFY(10) command is used to transfer application data to medium and then to verify that data was written correctly.

Table 21 — WRITE AND VERIFY(10) command CDB fields

Field	SATType	Description or reference
OPERATION CODE	E	See 9.21.2 ~~The SATL shall issue an ATA write command, and then issue a read verify sector(s) command to the same range of sectors. The WRITE portion of the command translation shall be as specified for the WRITE(10) command (see 9.18).~~ ~~40h for read verify sector command if the device does not support extended commands feature set.~~ ~~42h for READ VERIFY EXTENDED command if the device supports the extended commands feature set.~~
WRPROTECT	U	~~See SBC-2~~
DPO ~~(disable page out)~~	U	~~Ignored~~
BYTCHK	E~~U~~	~~Ignored.~~ If the application client specifies a value other than zero in this field, the SATL device server shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB..
LOGICAL BLOCK ADDRESS	I	See 9.21.2 ~~The SATL shall translate the LBA as specified for the WRITE(10) command (see 9.18)~~.
GROUP NUMBER	U	~~The SATL may implement this field as defined in SBC-2.~~
TRANSFER LENGTH	I	The transfer length shall be used to set the ATA Sector Count[a] (see 9.21.2). The SATL shall issue as many ATA write and ATA verify commands as needed to satisfy the transfer length specified by the WRITE AND VERIFY (10) command.
CONTROL	U~~I~~	See 6.4.

[a] A transfer length of zero indicates that a data transfer shall not take place. If the transfer length is not zero, the SATL shall transfer the number of sectors specified from the device to the application client.

9.21.2 WRITE AND VERIFY command OPERATION CODE and FUA bit translation

This subclause applies to the translation of SCSI WRITE AND VERIFY (10), WRITE WRITE AND VERIFY (12), and WRITE WRITE AND VERIFY (16).

The SATL shall issue an ATA write command (see 3.1.6) in accordance with the constraints defined in subclause 9.1. If the ATA write command fails the SATL shall terminate the WRITE AND VERIFY command with CHECK CONDITION status (see 5.3), otherwise the SATL shall issue an ATA verify command (see 3.1.5).

Add subclauses 9.22 WRITE AND VERIFY (12) and 9.23 WRITE AND VERIFY (16) commands as shown

9.22 WRITE AND VERIFY(12) command (AEh)

9.22.1 Command Summary

The WRITE AND VERIFY(12) command is used to transfer application data to medium and then to verify that data was written correctly.

Table 22 — WRITE AND VERIFY(12) command CDB fields

Field	SATType	Description or reference
OPERATION CODE	E	See 9.21.2
WRPROTECT	U	
DPO	U	
BYTCHK	E	If the application client specifies a value other than zero in this field, the SATL device server shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.
LOGICAL BLOCK ADDRESS	I	See 9.21.2
GROUP NUMBER	U	
TRANSFER LENGTH	I	The transfer length shall be used to set the ATA Sector Count[a] (see 9.21.2). The SATL shall issue as many ATA write and ATA verify commands as needed to satisfy the transfer length specified by the WRITE AND VERIFY (12) command.
CONTROL	U	See 6.4.

[a] A transfer length of zero indicates that a data transfer shall not take place. If the transfer length is not zero, the SATL shall transfer the number of sectors specified from the device to the application client.

9.23 WRITE AND VERIFY(16) command (8Eh)

9.23.1 Command Summary

The WRITE AND VERIFY(16) command is used to transfer application data to medium and then to verify that data was written correctly.

Table 23 — WRITE AND VERIFY(16) command CDB fields

Field	SATType	Description or reference
OPERATION CODE	E	See 9.21.2
WRPROTECT	U	
DPO	U	
BYTCHK	E	If the application client specifies a value other than zero in this field, the SATL device server shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB.
LOGICAL BLOCK ADDRESS	I	See 9.21.2
GROUP NUMBER	U	
TRANSFER LENGTH	I	The transfer length shall be used to set the ATA Sector Count[a] (see 9.21.2). The SATL shall issue as many ATA write and ATA verify commands as needed to satisfy the transfer length specified by the WRITE AND VERIFY (16) command.
CONTROL	U	See 6.4.

[a] A transfer length of zero indicates that a data transfer shall not take place. If the transfer length is not zero, the SATL shall transfer the number of sectors specified from the device to the application client.