To: T10 Technical Committee
From: Rob Elliott, Compaq Computer Corporation (Robert.Elliott@compaq.com)
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Subject: T10/01-199r3 SPC-3 SBC-2 SSC-2 sense data changes

Revision History
Revision 0 (17 July 2001) first revision
Revision 1 (5 November 2001) included maximum sense data length fix from July SRP WG and picked a solution. Incorporated comments from September CAP WG.
Revision 2 (3 December 2001) incorporated comments from November CAP WG, which now wants new sense data page formats.
Revision 3 (17 January 2002) incorporated comments from Jan CAP WG

Related Documents
spc3r02 - SCSI Primary Commands - 3 revision 2
ssc2r07 – SCSI Stream Commands – 2 revision 7
sbc2r03 – SCSI Block Commands – 2 revision 4

Overview
1. SPC-2 includes a long list of device-type specific behavior that more properly belongs in the device command set standards.

2. Sense data includes a 4 byte INFORMATION field that can contain values like an LBA or a residual based on the device types and/or command. This field is not big enough for commands using 8 byte LBAs, commands with 8 byte residuals, or bidirectional commands with multiple residuals.

SBC-2 includes that access > 2 TB like READ(16) and WRITE(16). The LBAs for these commands are 8 bytes long and don't fit in the INFORMATION field. A temporary workaround was added to SPC-2 declaring that if the LBA does not fit in 4 bytes, the VALID bit for the INFORMATION field is set to 0. A complete solution needs to be provided.

SBC-2 includes a bidirectional command that can result in two residuals, one for each direction. Future command sets may define more bidirectional commands with similar properties. The residual size is limited by the size of the transfer length field, which is currently 4 bytes in SBC-2. A pair of these residuals does not fit in the INFORMATION field.

SSC-2 includes a set of commands for an explicit model that use 8 byte LBAs like SBC-2. The definition of INFORMATION is yet to be defined for all these commands, but it might be needed to carry the LBA like in SBC-2 or a long residual reflecting distance from a long LBA.

SSC-2 include a SPACE(16) command, used in both explicit and implicit models, that uses an 8 byte COUNT field. This means an 8 byte residual must be stored in the sense data.

Specific usage of INFORMATION and COMMAND SPECIFIC INFORMATION fields where they store LBAs or residuals:
Today only EXTENDED COPY (SPC-2), REASSIGN BLOCKS (SBC-2), and certain XOR commands (SBC-2) use the COMMAND SPECIFIC INFORMATION field. Many commands use the INFORMATION field.

SPC-3:
a) EXTENDED COPY (7.2.3) stores either a 2 byte segment number (in the "third and fourth" bytes) or a pointer into the sense data in this field in the first or second bytes. It stores a residual in the INFORMATION field. When EXTENDED COPY is expanded to support SBC-2 and SSC-2, none of these fields should grow so no additional work looks necessary.

SBC-2:

b) REASSIGN BLOCKS (5.1.14) stores the first LBA of the first defect descriptor that was not reassigned. The current description discusses storing FFFFFFFF FFFFFFFFh into it if LONGLBA is one, which is not possible. (Editor's note: this section uses "COMMAND-SPECIFIC" rather than "COMMAND SPECIFIC" making searching difficult)

c) In the MEDIUM SCAN description (5.2.3), a REQUEST SENSE following the MEDIUM SCAN is supposed to return an LBA in the "information bytes" and a number of contiguous logical blocks in the "command specific information bytes". (Editor's note: this section uses lower case making searching difficult)

d) in a third party command REBUILD, REGENERATE or XPWRITE EXTENDED (4.2.3.6.4) where a secondary command fails without a CHECK CONDITION from the target, the first byte of the COMMAND SPECIFIC INFORMATION field contains a pointer to the first byte in the sense data where the primary target's sense data in response to the secondary command is stored. (Note: this means the sense data for the primary command plus the secondary command must combine to be less than 252 bytes)

e) in a third party command REBUILD, REGENERATE or XPWRITE EXTENDED (4.2.3.6.4) where a secondary command fails with a CHECK CONDITION from the target, the second byte of the COMMAND SPECIFIC INFORMATION field contains a pointer to the first byte in the sense data that points to the status byte, followed by sense data, of the secondary target. . (Note: this means the sense data for the primary command plus a status byte and sense data for the secondary command must combine to be less than 252 bytes)

f) in a REBUILD or REGENERATE command (4.2.3.6.4), the third byte of the COMMAND SPECIFIC INFORMATION field contains an index pointing to the source descriptor of the failing target for the secondary command.

g) SPC-2 mentions that EXTENDED COPY and REASSIGN BLOCKS use the COMMAND SPECIFIC INFORMATION field (7.20.2). 7.20.3 mentions it in a segment descriptor definition.

SSC-2:

h) SPACE(16) returns a residual in the INFORMATION field.

i) The information field is not defined for LOCATE(10) or LOCATE(16).

j) The information field is not well-defined for ERASE(16), READ(16), READ REVERSE(16), RECOVER BUFFERED DATA(16), and VERIFY(16). Is the residual relative to the original position? If so, the implicit LOCATE means the residual could be eight bytes.

Possible solutions:

a) For each command requiring more than 4 bytes of INFORMATION data, use the 4-byte COMMAND-SPECIFIC INFORMATION field to hold the additional data. Each new command definition would define its use of the field. This solution leaves the sense data format unchanged. Unfortunately, some commands use COMMAND-SPECIFIC INFORMATION for a 2nd LBA.
b) Define a new sense data format (e.g. 72h). This would be incompatible with all existing software.
c) Claim some bytes in the additional sense data (byte 19+). Many vendors use this as vendor-specific data, even though it is marked reserved for definition by commands.
d) Use the INFORMATION field to point to a location in the additional sense data where the long LBA (or whatever) is located – this avoids interfering with any vendor-specific data.

Solution d) was proposed in 01-199r1. Solution b) was requested by the November CAP WG and is proposed in this document.

Goals for the long format:

a) put the fields in order of importance (sense key/ASC/ASCQ first)

b) expand INFORMATION and COMMAND-SPECIFIC INFORMATION to 8 bytes each so current uses of them can accommodate long LBAs and residuals
c) use a self-describing descriptor format so additional fields can be added later.

How to select short vs. long format is an issue.

For REQUEST SENSE commands (on non-autosense protocols), software that can generate SBC-2/SSC-2 commands can use a LONG bit added to the REQUEST SENSE CDB.

For autosense and AER, the format has to be known in advance. Options suggested in November:
a) per-initiator control mode page. It's about time we required this anyway - other fields like AER controls really should be per-initiator too.
b) bit in CONTROL byte of every CDB. Implies that an initiator may mix-and-match short and long formats for different commands. Software using long format will want it everywhere so this is a bit wasteful. For sense data returned with AER, there is no command whose CONTROL byte can be examined, so a control mode page field is probably needed anyway.
c) return long format only for commands requiring it. Software using long format will want it everywhere, and this doesn't work with AER.
d) return long format for SBC-2 and SSC-2 devices, short format for all others. Old software won't be expecting the long format but will still expect to work with these devices. It has to be a feature explicitly turned on.

The control mode page was selected.

Suggested Changes to SPC-3

New outline for REQUEST SENSE:

7.20 REQUEST SENSE command
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7.20.2 Sense data
7.20.2.0 Sense data overview
7.20.2.1 Sense data format
7.20.2.2 Short sense data format
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7.20.2.3.4.5 Segment pointer sense key specific data
7.20.2.3.5 Field replaceable unit sense data descriptor
7.20.2.3.6 Stream commands sense data descriptor
7.20.2.3.7 Block commands sense data descriptor
7.20.2.3.8 Vendor specific sense data descriptor
7.20.3 Current errors
7.20.4 Deferred errors
7.20.5 Sense key and sense code definitions

7.20 REQUEST SENSE command

7.20.1 REQUEST SENSE command introduction

The REQUEST SENSE command (see table 102) requests that the device server transfer sense data to the application client.

Table 102 - REQUEST SENSE command

	7	6	5	4	3	2	1	0
0	OPERATION CODE (03h)							
1	Rsvd	Rsvd	Rsvd	Rsvd	Rsvd	Rsvd	Rsvd	LONG
2	Reserved							
3	Reserved							
4	Reserved							
5	ALLOCATION LENGTH							
6	CONTROL							

The LONG bit indicates which sense data format shall be returned. If LONG is set to one, the long sense data format shall be returned. If LONG is set to zero, the short sense data format shall be returned. The sense data formats are described in 7.20.2. Application clients should request 252 bytes of sense data to ensure they retrieve all the data in the long sense data format.

NOTE: If fewer than 252 bytes are requested, sense data may be lost since the REQUEST SENSE command clears the sense data.

Sense data shall be available and cleared under the conditions defined in SAM-2. If the device server has no other sense data available to return, it shall return a sense key of NO SENSE and an additional sense code of NO ADDITIONAL SENSE INFORMATION.

If the device server is in the standby power condition or idle power condition when a REQUEST SENSE command is received and there is no ACA or CA condition, the device server shall return a sense key of NO SENSE and an additional sense code of LOW POWER CONDITION ON. On completion of the command the logical unit shall return to the same power condition that was active before the REQUEST SENSE command was received. A REQUEST SENSE command shall not reset any active power condition timers.

The device server shall return CHECK CONDITION status for a REQUEST SENSE command only to report exception conditions specific to the REQUEST SENSE command itself. For example:
a) An invalid field value is detected in the CDB;
b) An unrecovered parity error is detected by the service delivery subsystem; or
c) A target malfunction ~~that~~ prevents return of the sense data.

If a recovered error occurs during the processing of the REQUEST SENSE command, the device server shall return the sense data with GOOD status. If a device server returns CHECK CONDITION status for a REQUEST SENSE command, the sense data may be invalid.

NOTE 28 - The sense data appropriate to the selection of an invalid logical unit is defined in SAM-2.

Device servers shall be capable of returning eighteen bytes of data in response to a REQUEST SENSE command. If the allocation length is eighteen or greater, and a device server returns less than eighteen bytes of data, the application client should assume that the bytes not transferred would have been zeros had the device server returned those bytes. Application clients may determine how much sense data has been returned by examining the ALLOCATION LENGTH field in the CDB and the ADDITIONAL SENSE LENGTH field in the sense data. Device servers shall not adjust the additional sense length to reflect truncation if the allocation length is less than the sense data available.

7.20.2 Sense data
[Editor's note: any change bars reflect notable minor changes from SPC-3's 7.20.x wording. Major changes such as new tables/sections are not highlighted.]

7.20.2.0 Sense data overview

Sense data may be returned with the REQUEST SENSE command, autosense, or with AER (see SAM-2). The REQUEST SENSE command may be used to request either the short sense data format or the long sense data format. Autosense and AER return either the short sense data format or the long sense data format based on the control mode page (see 8.3.6).

7.20.2.1 Sense data format

The sense data format is defined in table 103.

Table 103 — Sense data format

	7	6	5	4	3	2	1	0
0	Response -code specific	RESPONSE CODE						
1	Response-code specific							
n								

The RESPONSE CODE field indicates the format of the sense data including the response-code specific portions. Response code values are defined in table 103a.

Table 103a. RESPONSE CODE values

RESPONSE CODE value	Type	Description
00 – 6Fh		Reserved
70h	M	Short sense data format (see 7.20.2.2), current error (see 7.20.43)
71h	O	Short sense data format (see 7.20.2.2), deferred error (see 7.20.54)
72h	L	Long sense data format (see 7.20.2.3), current error (see 7.20.43)
73h	O	Long sense data format (see 7.20.2.3), deferred error (see 7.20.54)
74h – 7Eh		Reserved
7Fh	O	Vendor-specific
Key: M = Command implementation is mandatory. L = Command implementation is mandatory for SBC-2 and SSC-2 devices. O = Command implementation is optional.		

7.20.2.2 Short sense data format

The short sense data format is defined in table 103b. [Editor's note: this is the legacy format]

Table 103b — Short sense data format

	7	6	5	4	3	2	1	0
0	VALID	RESPONSE CODE (70h or 71h)						
1	Obsolete							
2	FILEMARK	EOM	IU	Rsvd	SENSE KEY			
3	(MSB)	INFORMATION						
4								
5								
6								(LSB)
7	ADDITIONAL SENSE LENGTH							
8	(MSB)	COMMAND-SPECIFIC INFORMATION						
9								
10								
11								(LSB)
12	ADDITIONAL SENSE CODE							
13	ADDITIONAL SENSE CODE QUALIFIER							
14	FIELD REPLACEABLE UNIT CODE							
15	SKSV	SENSE-KEY SPECIFIC						
16								
17								
18	Additional sense bytes							
n								

See 7.20.2.1 for definitions of the sense key, additional sense code, and additional sense code qualifier fields. See 7.20.2.3.2 for definitions of the VALID and INFORMATION fields. See 7.20.2.3.3 for the definition of the COMMAND-SPECIFIC INFORMATION field. See 7.20.2.3.4 for definitions of the SKSV and SENSE-KEY SPECIFIC fields. See 7.20.2.3.5 for the definition of the FIELD REPLACEABLE UNIT CODE field. See 7.20.2.3.6 for definitions of the FILEMARK, EOM, and IU fields.
[Editor's note: don't want to define the fields twice. Unfortunately, some of the definitions in the long sense data section have to mention the short sense data format.]

The additional sense bytes may contain ~~command specific data, peripheral device specific data, or~~ vendor specific data that further defines the nature of the ~~CHECK CONDITION status~~exception condition.
[Editor's note: The CAP WG will not allow command standards to define the additional sense bytes due to wide use of vendor specific data, so remove those options from the list.]

7.20.2.3 Long sense data format

7.20.2.3.1 Long sense data format overview

The long sense data format is defined in table 103c:

Table 103c — Long sense data format

	7	6	5	4	3	2	1	0
0	Rsvd	RESPONSE CODE (72h or 73h)						
1	Reserved				SENSE KEY			
2	ADDITIONAL SENSE CODE							
3	ADDITIONAL SENSE CODE QUALIFIER							
4	Reserved							
5	Reserved							
6	Reserved							
7	ADDITIONAL SENSE LENGTH							
8	Sense data descriptors							
n								

The SENSE KEY, ADDITIONAL SENSE CODE and ADDITIONAL SENSE CODE QUALIFIER fields provide a hierarchy of information. The intention of the hierarchy is to provide a top-down approach for an

application client to determine information relating to the error and exception conditions. The sense key provides generic categories in which error and exception conditions may be reported. Application clients typically use sense keys for high level error recovery procedures. Additional sense codes provide further detail describing the sense key. Additional sense code qualifiers add further detail to the additional sense code. The additional sense code and additional sense code qualifier may be used by application clients where sophisticated error recovery procedures require detailed information describing the error and exception conditions.

The SENSE KEY field is mandatory and indicates generic information describing an error or exception condition. The sense keys are defined in 7.20.~~6~~5.

The ADDITIONAL SENSE CODE (ASC) field indicates further information related to the error or exception condition reported in the SENSE KEY field. Device servers shall support the ADDITIONAL SENSE CODE field. Support of the additional sense codes not explicitly required by this standard is optional. A list of additional sense codes is in 7.20.~~6~~5. If the device server does not have further information related to the error or exception condition, the additional sense code is set to NO ADDITIONAL SENSE INFORMATION.

The ADDITIONAL SENSE CODE QUALIFIER (ASCQ) field indicates detailed information related to the additional sense code. The additional sense code qualifier is optional. If the error or exception condition is reportable by the device, the value returned shall be as specified in 7.20.~~6~~5. If the device server does not have detailed information related to the error or exception condition, the additional sense code qualifier is set to zero.

The ADDITIONAL SENSE LENGTH field indicates the number of additional sense bytes to follow. The ADDITIONAL SENSE LENGTH shall be less than or equal to 244, limiting the total length of the sense data to 252 bytes. If the sense data is being returned via a REQUEST SENSE command and the allocation length of the REQUEST SENSE CDB is too small to transfer all of the additional sense bytes, the additional sense length is not adjusted to reflect the truncation.

Sense data descriptors are included in the sense data for some commands and error conditions. Sense data descriptors used in the long sense data format are described in table 103d.

Table 103d — Sense data descriptor format

	7	6	5	4	3	2	1	0
0	SENSE DATA DESCRIPTOR TYPE							
1	SENSE DATA DESCRIPTOR LENGTH							
2	Sense data descriptor specific							
n								

The SENSE DATA DESCRIPTOR TYPE field is defined in table 103e. No more than one sense data descriptor of each type shall be included.

Table 103e. SENSE DATA DESCRIPTOR TYPE values

SENSE DATA DESCRIPTOR TYPE value	Length	Description
00h	12	Information
01h	12	Command-specific information
02h	8	Sense-key specific
03h	4	Field replaceable unit
04h	4	Stream commands
05h	4	Block commands
06h - 7Fh		Reserved
80h - FFh	Vendor-specific	Vendor-specific

The SENSE DATA DESCRIPTOR LENGTH field indicates the length in bytes of the sense data descriptor.

7.20.2.3.2 Information sense data descriptor

The information sense data descriptor is described in table 103f.

Table 103f —Information sense data descriptor

	7	6	5	4	3	2	1	0
0	SENSE DATA DESCRIPTOR TYPE (00h)							
1	SENSE DATA DESCRIPTOR LENGTH (12)							
2	VALID	Reserved						
3	Reserved							
4	(MSB)	INFORMATION						
11								(LSB)

~~A VALID bit of zero indicates that the INFORMATION field is not valid. A VALID bit of one indicates the INFORMATION field contains valid information as defined in the command set standard. Device servers shall implement the VALID bit.~~ In the short sense data format, a VALID bit of one indicates the INFORMATION field contains valid information as defined in the command set standard.

In the long sense data format, presence of an information sense data descriptor indicates the INFORMATION field in that descriptor contains valid information as defined in the command set standard; the VALID bit shall be set to one.

When a four byte quantity is stored in the INFORMATION field, the most significant four bytes shall be set to 0000 0000h.

[Editor's note: Most existing references to INFORMATION mention setting VALID to one, so a bit with that name is included even though it is not needed (presence of the descriptor is enough to provide the INFORMATION field is valid)]

~~The contents of the INFORMATION field is device-type or command specific and is defined within the appropriate standard for the device type or command of interest.~~
[Editor's note: that paragraph seemed to communicate no more information that the others.]

7.20.2.3.3 Command-specific information sense data descriptor

The command-specific information sense data descriptor is described in table 103g.

Table 103g —Command-specific information sense data descriptor

	7	6	5	4	3	2	1	0
0	SENSE DATA DESCRIPTOR TYPE (01h)							
1	SENSE DATA DESCRIPTOR LENGTH (12)							
2	Reserved							
3	Reserved							
4	(MSB)	COMMAND-SPECIFIC INFORMATION						
11								(LSB)

The COMMAND-SPECIFIC INFORMATION field contains information that depends on the command that encountered the exception condition. Further meaning for this field is defined within the command description in the command set standard (e.g., see SBC-2 for the MEDIUM SCAN, REASSIGN BLOCKS, REBUILD, REGENERATE, and XPWRITE EXTENDED commands, or see 7.2 for the EXTENDED COPY command). ~~The COMMAND-SPECIFIC INFORMATION field is mandatory if the device server supports any of the following commands: EXTENDED COPY (see x.y) and REASSIGN BLOCKS (see SBC-2).~~
[Editor's note: Unlike INFORMATION, there is no VALID bit to accompany this field.]

When a four byte quantity is stored in the COMMAND-SPECIFIC INFORMATION field, the most significant four bytes shall be set to 0000 0000h.

7.20.2.3.4 Sense-key-specific sense data descriptor

7.20.2.3.4.1 Sense-key-specific sense data descriptor overview

The sense-key-specific sense data descriptor is described in table 103h.

Table 103h —Sense-key-specific sense data descriptor

	7	6	5	4	3	2	1	0
0	SENSE DATA DESCRIPTOR TYPE (02h)							
1	SENSE DATA DESCRIPTOR LENGTH (8)							
2	Reserved							
3	Reserved							
4	SKSV	SENSE-KEY SPECIFIC						
6								
7	Reserved							

~~**7.20.3 Sense-key specific**~~

In the short sense data format, a~~A~~ SENSE-KEY SPECIFIC VALID (SKSV) bit of one indicates the SENSE-KEY SPECIFIC field contains valid ~~information~~ data as defined in this standard. An SKSV value of zero indicates that the SENSE-KEY SPECIFIC field is not as defined by this standard.

In the long sense data format, presence of a sense key specific sense data descriptor indicates the SENSE-KEY SPECIFIC field contains valid data as defined in this standard; the SKSV bit shall be set to one.~~The SKSV bit and SENSE-KEY SPECIFIC field are optional.~~

The definition of ~~this~~ the SENSE-KEY SPECIFIC field is determined by the value of the SENSE KEY field as listed in table 103i. ~~This field is reserved for sense keys not described below. An SKSV value of zero indicates that this field is not as defined by this standard.~~

Table 103i. SENSE-KEY SPECIFIC fields

SENSE KEY value	SENSE-KEY SPECIFIC field contents
ILLEGAL REQUEST	7.20.2.3.4.2
RECOVERED ERROR, HARDWARE ERROR, or MEDIUM ERROR	7.20.2.3.4.3
NOT READY or NO SENSE	7.20.2.3.4.4
COPY ABORTED	7.20.2.3.4.5
All others	Reserved

[Editor's note: this is like INFORMATION with its VALID bit (SKSV); mere presence of the descriptor indicates it the field is valid. Since it's part of the 3 byte structure used in both short and long formats, I've left SKSV in and said it shall be set to one in the long format.]

7.20.2.3.4.2 Field pointer sense key specific data

If the sense key is ILLEGAL REQUEST~~ and the SKSV bit is set to one~~, then the SENSE-KEY SPECIFIC field shall be as defined as shown in table 104. The FIELD POINTER field indicates which parameters in the CDB or the data parameters are in error.

Table 104 — Field pointer sense-key specific ~~bytes~~data

	7	6	5	4	3	2	1	0
0	SKSV	C/D	Rsvd	Rsvd	BPV	BIT POINTER		
1	(MSB)	FIELD POINTER						
2								(LSB)

The SKSV bit is described in 7.20.2.3.4.1.

A COMMAND DATA (C/D) bit of one indicates that the illegal parameter is in the CDB. A C/D bit of zero indicates that the illegal parameter is in the data parameters sent by the application client in the Data-Out Buffer.

A BIT POINTER VALID (BPV) bit of zero indicates that the value in the BIT POINTER field is not valid. A BPV bit of one indicates that the BIT POINTER field specifies which bit of the byte designated by the FIELD POINTER field is in error.

When a multiple-bit field is in error, the BIT POINTER field shall point to the most-significant (left-most) bit of the field.

The FIELD POINTER field indicates which byte of the CDB or of the parameter data was in error. Bytes are numbered starting from zero, as shown in the tables describing the commands and parameters. When a multiple-byte field is in error, the field pointer shall point to the most-significant (i.e., left-most) byte of the field. If several consecutive bytes are reserved, each shall be treated as a single-byte field.

NOTE 29 - Bytes identified as being in error are not necessarily the place that has to be changed to correct the problem.

7.20.2.3.4.3 Actual retry count sense key specific data

If the sense key is RECOVERED ERROR, HARDWARE ERROR or MEDIUM ERROR~~ and if the SKSV bit is one~~, the SENSE-KEY SPECIFIC field shall be as shown in table 105.

Table 105 — Actual retry count sense key specific ~~bytes~~data

	7	6	5	4	3	2	1	0
0	SKSV	Reserved						
1	(MSB)	ACTUAL RETRY COUNT						
2								(LSB)

The SKSV bit is described in 7.20.2.3.4.1.

The ACTUAL RETRY COUNT field returns vendor specific information on the actual number of retries of the recovery algorithm used in attempting to recover an error or exception condition.
NOTE 30 - This field should computed in the same way as the retry count fields within the error recovery page of the MODE SELECT command.

7.20.2.3.4.4 Progress indication sense key specific data

If the sense key is NOT READY or NO SENSE~~ and the SKSV bit is one~~, the SENSE-KEY SPECIFIC field shall be as shown in table 106.

Table 106 — Progress indication sense key specific ~~bytes~~data

	7	6	5	4	3	2	1	0
0	SKSV	Reserved						
1	(MSB)	PROGRESS INDICATION						
2								(LSB)

The SKSV bit is described in 7.20.2.3.4.1.

The PROGRESS INDICATION field is a percent complete indication in which the returned value is the numerator that has 65 536 (10000h) as its denominator. The progress indication shall be based upon the total operation.

NOTE 31 - It is intended that the progress indication be time related. However, since for example format time varies with the number of defects encountered, etc., it is reasonable for the device server to assign values to various steps within the process. The granularity of these steps should

be small enough to provide reasonable assurances to the application client that progress is being made.

7.20.2.3.4.5 Segment pointer sense key specific data

If the sense key is COPY ABORTED and the SKSV bit is one, the SENSE-KEY SPECIFIC field shall be as shown in table 107.

Table 107 — Segment pointer sense key specific ~~bytes~~data

	7	6	5	4	3	2	1	0
0	SKSV	Rsvd	SD	Rsvd	BPV	BIT POINTER		
1	(MSB)	FIELD POINTER						
2								(LSB)

The SKSV bit is described in 7.20.2.3.4.1.

The SEGMENT DESCRIPTOR (SD) bit indicates whether the field pointer is with reference to the start of the parameter list or to the start of a segment descriptor. An SD value of zero indicates that the field pointer is relative to the start of the parameter list. An SD value of one indicates that the field pointer is relative to the start of the segment descriptor indicated by the third and fourth bytes of the COMMAND SPECIFIC INFORMATION field (see 7.2.3).

A BIT POINTER VALID (BPV) bit of zero indicates that the value in the BIT POINTER field is not valid. A BPV bit of one indicates that the BIT POINTER field specifies which bit of the byte designated by the FIELD POINTER field is in error.

When a multiple-bit field is in error, the BIT POINTER field shall point to the most-significant (i.e., left-most) bit of the field.

The FIELD POINTER field indicates which byte of the parameter list or segment descriptor was in error.
[Editor's note: it would make sense to rename FIELD POINTER to SEGMENT POINTER to avoid confusion with the FIELD POINTER field in the field pointer descriptor. This would require changing the references to it in the EXTENDED COPY section (5 references).]

NOTE 32 - If the parameter list is in excess of 65 528 bytes in length and SD is 0, the FIELD POINTER value may not fit in two bytes provided by the sense key specific format definition.
[Editor's note: we can fix that in the long format by using some of the reserved bytes of the sense-key specific descriptor for this sense key, if desired.]

7.20.2.3.5 Field replaceable unit sense data descriptor

The field replaceable unit sense data descriptor is described in table 103j.

Table 103j —Field replaceable unit sense data descriptor

	7	6	5	4	3	2	1	0
0	SENSE DATA DESCRIPTOR TYPE (03h)							
1	SENSE DATA DESCRIPTOR LENGTH (4)							
2	Reserved							
3	FIELD REPLACEABLE UNIT CODE							

Non-zero values in the FIELD REPLACEABLE UNIT CODE field are used to define a device-specific mechanism or unit that has failed. A value of zero in this field shall indicate that no specific mechanism or unit has been identified to have failed or that the data is not available. The FIELD REPLACEABLE UNIT CODE field is optional. The format of this information is not specified by this standard. Additional information about the field replaceable unit may be available in the ASCII information page (see 8.4.3), if supported by the device server.

7.20.2.3.6 Stream commands sense data descriptor

The stream commands sense data descriptor is described in table 103k. This descriptor contains fields defined for sequential devices.

Table 103k —Stream commands sense data descriptor

	7	6	5	4	3	2	1	0
0	SENSE DATA DESCRIPTOR TYPE (04h)							
1	SENSE DATA DESCRIPTOR LENGTH (4)							
2	Reserved							
4	FILEMARK	EOM	ILI	Rsvd	Rsvd	Rsvd	Rsvd	Rsvd

~~The FILEMARK bit is mandatory for sequential-access devices, and this bit is reserved for all other device types. A FILEMARK bit of one indicates that the current command has read a filemark or setmark. The ADDITIONAL SENSE CODE field may be used to indicate whether a filemark or setmark was read. Reporting of setmarks is optional and indicated by the RSMK bit for sequential-access devices in the configuration parameters page. (See SSC.)~~ The FILEMARK bit is defined in SSC-2 (see the READ, RECOVER BUFFERED DATA, and SPACE commands).

~~The end-of-medium (EOM) bit is mandatory for sequential-access and printer devices, and this bit is reserved for all other device types. An EOM bit of one indicates that an end-of-medium condition (e.g., end-of-partition, beginning-of-partition, or out-of-paper) exists. For sequential-access devices, this bit indicates that the unit is at or past the early-warning if the direction was forward, or that the command was not completed because beginning-of-partition was encountered if the direction was reverse. (See SSC.)~~ The END OF MEDIUM (EOM) bit is defined in SSC-2 (see the LOCATE, READ, READ BLOCK LIMITS, READ REVERSE, RECOVER BUFFERED DATA, SPACE, WRITE, and WRITE FILEMARKS commands, and the device configuration mode page).

~~An incorrect length indicator (ILI) bit of one usually indicates that the requested logical block length did not match the logical block length of the data on the medium. Examples of other conditions indicated by the ILI bit being set to one include media interchange incompatibilities where the recorded logical block length is too large for the device server to read.~~ The INCORRECT LENGTH INDICATOR (ILI) bit is defined in SSC-2 (see the READ and READ REVERSE commands and the data compression mode page).

7.20.2.3.7 Block commands sense data descriptor

The block commands sense data descriptor is described in table 103l. This descriptor contains fields defined for block devices.

Table 103l —Block commands sense data descriptor

	7	6	5	4	3	2	1	0
0	SENSE DATA DESCRIPTOR TYPE (05h)							
1	SENSE DATA DESCRIPTOR LENGTH (4)							
2	Reserved							
4	Rsvd	Rsvd	ILI	Rsvd	Rsvd	Rsvd	Rsvd	Rsvd

The INCORRECT LENGTH INDICATOR (ILI) bit is defined in SBC-2 (see the READ LONG and WRITE LONG commands).

7.20.2.3.8 Vendor specific sense data descriptor

The vendor specific sense data descriptor is described in table 103m.

Table 103m —Vendor specific sense data descriptor

	7	6	5	4	3	2	1	0
0	SENSE DATA DESCRIPTOR TYPE (80h - FFh)							
1	SENSE DATA DESCRIPTOR LENGTH							
2	Vendor specific							
n								

The vendor specific bytes may further define the nature of the ~~CHECK CONDITION status~~exception condition.

7.20.~~4~~ 3 Current errors

Response code~~s~~ 70h and 72h (current error) indicate~~s~~ that the ~~CHECK CONDITION status~~sense data returned is the result of an error or exception condition on the task that returned the CHECK CONDITION status or a protocol specific failure condition. This includes errors generated during processing of the command. It also includes errors not related to any command that are first observed during processing of a command (e.g., disk servo-mechanism failure, off-track errors, or power-up test errors).

[Editor's note: is an initialization unit attention reported as a current error? Should that be added to the e.g. list?]

7.20.~~5~~ 4 Deferred errors

Response code~~s~~ 71h and 73h (deferred error) indicate~~s~~ that the ~~CHECK CONDITION status~~sense data returned is the result of an error or exception condition that occurred during processing of a previous command for which GOOD status has already been returned. Such commands are associated with use of the immediate bit and with some forms of caching. Device servers that implement these features shall implement deferred error reporting.

The deferred error indication may be sent at a time selected by the device server through use of the asynchronous event reporting mechanism (see SAM-2), if AER is supported by both the application client and device server.

If AER is not supported, the deferred error may be indicated by returning CHECK CONDITION status to an application client on the appropriate initiator as described later in this subclause. A subsequent REQUEST SENSE command shall return the deferred error sense information.

If the task terminates with CHECK CONDITION status and the sense data describes a deferred error the command for the terminated task shall not have been processed. After the device server detects a deferred error condition, it shall return a deferred error according to the following rules:

a) If no external intervention is necessary to recover a deferred error, a deferred error indication shall not be posted unless required by the error handling parameters of a MODE SELECT command. The occurrence of the error may be logged if statistical or error logging is supported;

b) If it is possible to associate a deferred error with an initiator and with a particular function or a particular subset of data, and the error is either unrecovered or required to be reported by the mode parameters, a deferred error indication shall be returned to an application client on the initiator associated with the error. If an application client on an initiator other than the initiator associated with the error attempts access to the particular function or subset of data associated with the deferred error and the TST field equals 000b (see 8.3.6), the command attempting the access shall be responded to according to the requirements in SAM-2. If an application client on an initiator other than the initiator associated with the error attempts access to the particular function or subset of data associated with the deferred error and the TST field equals 001b, the command attempting the access shall not be blocked by the deferred error and the cause of the deferred error may result in an error being reported for the command attempting the access;

c) If the device server is unable to associate a deferred error with an initiator or with a particular subset of data, the device server shall return a deferred error indication to an application client on each initiator. If multiple deferred errors have accumulated for an initiator, only the last error shall be returned;

d) If the device server is unable to associate a deferred error with a particular logical unit, the device server shall return a deferred error indication to an application client associated with any logical unit on the appropriate initiator; or

e) If a task has never entered the enabled task state, and a deferred error occurs, the task shall be terminated with CHECK CONDITION status and deferred error information posted in the sense data. If a deferred error occurs after a task has entered the enabled task state and the task is affected by the error, the task shall be terminated by CHECK CONDITION status and the current error information shall be returned in the sense data. In this case, if the current error information does not adequately define the deferred error condition, a deferred error may be returned after the current error information has been recovered. If a deferred error occurs after a task has entered the enabled task state and the task completes successfully, the device server may choose to return the deferred error information after the completion of the current command in conjunction with a subsequent command that has not begun processing.

NOTE 33 - A deferred error may indicate that an operation was unsuccessful long after GOOD status was returned. If the application client is unable to replicate or recover from other sources the data that is being written using buffered write operations, synchronization commands should be performed before the critical data is destroyed in the host. This is necessary to be sure that recovery actions may be taken if deferred errors do occur in the storing of the data. If AER is not implemented, the synchronizing process should provide the necessary commands to allow returning CHECK CONDITION status and subsequent returning of deferred error sense information after all buffered operations are guaranteed to be complete.

7.20.~~6~~ 5 Sense key and sense code definitions

The sense keys are defined in table 108.

Table 108 — Sense key descriptions
[table]

The additional sense codes and additional sense code qualifiers are defined in table 109.

Table 109 — ASC and ASCQ assignments
[huge table]

8.3.6 Control mode page

The control mode page (see table 159) provides controls over several SCSI features that are applicable to all device types such as tagged queuing, asynchronous event reporting, and error logging.

Table 159 - Control mode page

	7	6	5	4	3	2	1	0
0	PS	Rsvd	PAGE CODE					
1	PAGE LENGTH							
2	TST			Rsvd	Rsvd	~~Rsvd~~LONG SENSE	GLTSD	RLEC
3	QUEUE ALGORITHM MODIFIER				Rsvd	QERR		DQUE
4	TAS	RAC	UA_INTLCK_CTRL		SWP	RAERP	UAAERP	EAERP
5	Rsvd	Rsvd	Rsvd	Rsvd	Rsvd	AUTOLOAD MODE		
6	(MSB)	READY AER HOLDOFF PERIOD						
7								(LSB)
8	(MSB)	BUSY TIMEOUT PERIOD						
9								(LSB)
10	(MSB)	EXTENDED SELF-TEST COMPLETION TIME						
11								(LSB)

…

A LONG SENSE bit set to one indicates that the target shall return the long sense data format during autosense and AER. A LONG SENSE bit set to zero indicates the target shall return the short sense data format during autosense and AER.

…

10 Commands for processor type devices

[Editor's note: This proposal moves descriptions of INFORMATION and COMMAND-SPECIFIC INFORMATION usage to the command set standards from the main SPC-3 body. Thus, their descriptions move here for the processor command set.]

10.2 RECEIVE command

The RECEIVE command (see table 195) requests that the device server transfer data to the initiator. The contents of the data are not defined by this standard.

…

The TRANSFER LENGTH field specifies the length in bytes of data that shall be transferred to the Data-In Buffer. A transfer length of zero indicates that no data shall be sent. This condition shall not be considered an error.

If the RECEIVE command fails with a CHECK CONDITION, the INFORMATION field of the sense data shall contain the difference (residue) of the requested length minus the actual length in bytes. Negative values are indicated by two's complement notation;

10.3 SEND command

The SEND command (see table 196) requests that the device server transfer data from the initiator.

…

An asynchronous event reporting (AER) bit of one indicates that the data to be transferred conforms to AER data format as defined in table 197. A SEND command with an AER bit of one shall be only issued to logical unit zero. An AER bit of zero indicates that the data to be transferred are vendor specific.

The TRANSFER LENGTH field specifies the length in bytes of data that shall be transferred from the Data-Out Buffer. A transfer length of zero indicates that no data shall be sent. This condition shall not be considered an error.

If the SEND command fails with a CHECK CONDITION, the INFORMATION field of the sense data shall contain the difference (residue) of the requested length minus the actual length in bytes. Negative values are indicated by two's complement notation;

…

The SCSI-3 bit shall be set to one. A SCSI-3 bit value of zero is obsolete.

The LUN field shall contain the logical unit number on which the asynchronous event occurred. The LUN field shall have the properties defined in SAM-2.

The sense data bytes shall have the format defined in 7.20.2.

Suggested Changes to SBC-2

4.2.1 Direct-access device type model

4.2.1.13 Error reporting

If any of the following conditions occur during the execution of a command, the command shall be terminated with CHECK CONDITION status and the sense key shall be set to the appropriate sense key with the appropriate additional sense code for the condition. Some errors may occur after the completion status has already been reported. For such errors, SPC-2 defines a deferred error reporting mechanism. Table 3 illustrates some error conditions and the applicable sense keys. The list does not provide an exhaustive enumeration of all conditions that may cause the CHECK CONDITION status.

Table 3 - Example error conditions

Condition	Sense key
Invalid logical block address	ILLEGAL REQUEST
Unsupported option requested	ILLEGAL REQUEST
Logical unit reset or medium change since last command from this application client	UNIT ATTENTION
Self diagnostic failed	HARDWARE ERROR
Unrecovered read error	MEDIUM ERROR or HARDWARE ERROR
Recovered read error	RECOVERED ERROR
Overrun or other error that might be resolved by repeating the command	ABORTED COMMAND
Attempt to write on write protected medium	DATA PROTECT

~~In the case of an invalid logical block address, the sense data INFORMATION field shall be set to the logical block address of the first invalid address.~~

~~In the case of an attempt to read a blank or previously unwritten block, the sense data INFORMATION field shall be set to the logical block address of the first blank block encountered. The data read up to that block shall be transferred (optical memory and write-once block devices only).~~

~~In the case of an attempt to write a previously written block when blank checking is enabled, the sense data INFORMATION field shall be set to the logical block address of the first non-blank block encountered (optical memory and write-once block devices only).~~

When an invalid logical block address is encountered, the first invalid logical block address shall be returned in the INFORMATION field of the sense data. When a recovered read error is reported, the INFORMATION field of the sense data shall contain the logical block address of the last recovered error during the trasfer. When an unrecovered read error is reported, the INFORMATION field of the sense data shall contain the logical block address of the unrecovered logical block.

The sense data INCORRECT LENGTH INDICATION (ILI) bit indicates that the requested data length in a READ LONG or WRITE LONG command did not match the length of the data on the medium.

[Editor's note: this is the direct access model, so mentioning optical and write-once here is inappropriate. They have their own error reporting sections below.]

SBC-2 direct access devices shall support both the short and long sense data formats (see SPC-3). If the short sense data format is requested but the sense data contains an INFORMATION or COMMAND-SPECIFIC INFORMATION value too large for the short sense data format, the VALID bit shall be set to zero.

Table xx summarizes use of the sense data fields.

Table xx - Sense data field usage for direct-access devices

Field	SBC-2 usage	Reference
VALID bit and INFORMATION field	REASSIGN BLOCKS MEDIUM SCAN Read-write error recovery mode page	5.1.14 5.2.3 6.2.7
COMMAND-SPECIFIC INFORMATION field	EXTENDED COPY REASSIGN BLOCKS MEDIUM SCAN REBUILD	SPC-3 5.1.14 5.2.3 5.1.15 and 5.1.16

	REGENERATE XPWRITE EXTENDED	5.1.17 and 5.1.18 5.1.44, 5.1.45, and 5.1.46
ILI bit	READ LONG WRITE LONG	5.1.13 5.1.35

4.2.3 Model for XOR commands
4.2.3.6 Error handling considerations
4.2.3.6.4 Secondary errors - errors resulting from the secondary command

The second class of errors consists of exception conditions resulting from the failure of a secondary command. The sense data for such errors shall be passed to the initiator of the primary command in the additional sense code field of the sense data.

If the primary target detects the exception (i.e., by some means other than receiving CHECK CONDITION status from the secondary target) it shall:

1) terminate the primary command with CHECK CONDITION status;
2) set the sense key to ABORTED COMMAND if there are no primary errors to report. Otherwise, the sense key shall be set according to the primary error;
3) set the first byte of the COMMAND SPECIFIC INFORMATION field of the sense data to the starting byte number, relative to the first byte of sense data, of an area that contains the primary target's sense data for the secondary error. A zero value in this byte indicates no secondary error has been detected by the primary target. The secondary sense data shall be built in the standard sense data format as defined for the REQUEST SENSE command; and
4) in the case of a REBUILD or REGENERATE primary command, set the third byte of the COMMAND SPECIFIC INFORMATION field of the sense data to an index value indicating the target identifier of the failing secondary target. This value shall be an index into the source descriptor entries of the parameter data of the primary command, and shall point to the entry containing the target identifier of the failing device; 0 points to the first entry, 1 points to the second entry, etc. This byte shall be ignored if the primary command is not a REBUILD or REGENERATE.

If the secondary target detects the exception, the primary target receives CHECK CONDITION status from the secondary target. The primary target shall recover the sense data associated with the exception condition, clear any exception conditions associated with the CHECK CONDITION status, and shall:

1) terminate the primary command with CHECK CONDITION status;
2) set the sense key to ABORTED COMMAND if there are no primary errors to report. Otherwise, the sense key shall be set according to the primary error;
3) set the second byte of the COMMAND SPECIFIC INFORMATION field of the sense data to the starting byte number, relative to the first byte of sense data, of an area that contains (unchanged) the secondary target's status byte followed by its sense data. A zero value in this byte indicates no secondary error has been reported by the secondary target; and
4) in the case of a REBUILD or REGENERATE (primary) command, set the third byte of the COMMAND SPECIFIC INFORMATION field of the sense data to an index value indicating the target identifier of the failing secondary target. This value shall be an index into the source descriptor entries of the parameter data of the primary command, and shall point to the entry containing the target identifier of the failing device; 0 points to the first entry, 1 points to the second entry, etc. This byte is invalid and shall be ignored if the primary command is not a REBUILD or REGENERATE.

For a given primary command, if errors are generated by more than one secondary command, the sense data shall contain error information for the secondary error first obtained by the primary target.

Since, for secondary errors, the sense key is set to ABORTED COMMAND only if there are no primary errors to report (see item 2 above), the first and second bytes of the COMMAND SPECIFIC INFORMATION field should be checked, even when the sense key is a value other than ABORTED COMMAND, to determine if any secondary errors have occurred.

Note 1 - All three of the above error types might occur during the same third party operation. If this happens, there are three unique pieces of error information contained in the sense data: one for the primary error (starting at byte 0), and two for the secondary errors (in the additional sense code).

4.3 Model for optical memory block devices

4.3.3 Error reporting

If any of the following conditions occur during the execution of a command the device server shall return CHECK CONDITION status and the appropriate sense key shall be set with the appropriate additional sense code for the condition. Table 4 illustrates some error conditions and the applicable sense keys. The list does not provide an exhaustive enumeration of all conditions that may cause the CHECK CONDITION status.

Table 4 - Error condition examples

Condition	Sense key
Invalid logical block address	ILLEGAL REQUEST
Unsupported option requested	ILLEGAL REQUEST
Logical unit reset or medium change since last command from this application client	UNIT ATTENTION
Self diagnostic failed	HARDWARE ERROR
Unrecovered read error	MEDIUM ERROR or HARDWARE ERROR
Recovered read error	RECOVERED ERROR
Overrun or other error that might be resolved by repeating the command	ABORTED COMMAND
Attempt to write on write protected medium	DATA PROTECT
Attempt to read a blank or previously unwritten block	BLANK CHECK
Attempt to write a previously written block and blank checking is enabled	BLANK CHECK
Attempt to write on read-only medium	DATA PROTECT

~~In the case of an invalid logical block address, the sense data INFORMATION field shall be set to the logical block address of the first invalid address.~~

~~In the case of an attempt to read a blank or previously unwritten block, the sense data INFORMATION field shall be set to the logical block address of the first blank block encountered. The data read up to that block shall be transferred.~~

~~In the case of an attempt to write a previously written block when blank checking is enabled, the sense data INFORMATION field shall be set to the logical block address of the first non-blank block encountered.~~

When an invalid logical block address is encountered, the first invalid logical block address shall be returned in the INFORMATION field of the sense data. When a recovered

read error is reported, the INFORMATION field of the sense data shall contain the logical block address of the last recovered error during the transfer. When an unrecovered read error is reported, the INFORMATION field of the sense data shall contain the logical block address of the unrecovered logical block. When an attempt is made to read a blank or previously unwritten block, the first blank or unwritten logical block address shall be returned in the INFORMATION field of the sense data. The data read up to that block shall be transferred. When an attempt is made to write a previously written block when blank checking is enabled, the first non-black logical block address shall be returned in the INFORMATION field of the sense data.

The sense data INCORRECT LENGTH INDICATION (ILI) bit indicates that the requested data length in a READ LONG or WRITE LONG command did not match the length of the data on the medium.

SBC-2 optical memory block devices shall support the short sense data format and may support the long sense data format (see SPC-3). If the short sense data format is requested but the sense data contains an INFORMATION or COMMAND-SPECIFIC INFORMATION value too large for the short sense data format, the VALID bit shall be set to zero.
[Editor's note: this is not possible with any current optical commands.]

Table xx summarizes use of the sense data fields.

Table xx - Sense data field usage for optical memory block devices

Field	SBC-2 usage	Reference
VALID bit and INFORMATION field	REASSIGN BLOCKS MEDIUM SCAN Read-write error recovery mode page	
COMMAND-SPECIFIC INFORMATION field	EXTENDED COPY REASSIGN BLOCKS MEDIUM SCAN	
ILI bit	READ LONG WRITE LONG	

4.4 Model for write-once block devices

4.4.5 Error reporting

If any of the following conditions occur during the execution of a command the device server shall return CHECK CONDITION status and the appropriate sense key shall be set with the additional sense code for the condition. Table 5 illustrates some error conditions and the applicable sense keys. The list does not provide an exhaustive enumeration of all conditions that may cause the CHECK CONDITION status.

Table 5 - Error condition examples

Condition	Sense key
Invalid logical block address	ILLEGAL REQUEST
Unsupported option requested	ILLEGAL REQUEST
Logical unit reset or medium change since last command from this application client	UNIT ATTENTION
Self diagnostic failed	HARDWARE ERROR
Unrecovered read error	MEDIUM ERROR or HARDWARE ERROR
Recovered read error	RECOVERED ERROR
Overrun or other error that might be resolved by repeating the command	ABORTED COMMAND
Attempt to write on write protected medium	DATA PROTECT
Attempt to read a blank or previously unwritten block	BLANK CHECK
Attempt to write a previously written block and blank checking is enabled	BLANK CHECK

~~In the case of an invalid logical block address, the sense data INFORMATION field shall be set to the logical block address of the first invalid address.~~

~~In the case of an attempt to read a blank or previously unwritten block, the sense data INFORMATION field shall be set to the logical block address of the first blank block encountered. The data read up to that block shall be transferred.~~

~~In the case of an attempt to write a previously written block and blank checking is enabled, the sense INFORMATION field shall be set to the logical block address of the first non-blank block encountered.~~

When an invalid logical block address is encountered, the first invalid logical block address shall be returned in the INFORMATION field of the sense data. When a recovered read error is reported, the INFORMATION field of the sense data shall contain the logical block address of the last recovered error during the trasfer. When an unrecovered read error is reported, the INFORMATION field of the sense data shall contain the logical block address of the unrecovered logical block. When an attempt is made to read a blank or previously unwritten block, the first blank or unwritten logical block address shall be returned in the INFORMATION field of the sense data. The data read up to that block shall be transferred. When an attempt is made to write a previously written block when blank checking is enabled, the first non-black logical block address shall be returned in the INFORMATION field of the sense data.

The sense data INCORRECT LENGTH INDICATION (ILI) bit indicates that the requested data length in a READ LONG or WRITE LONG command did not match the length of the data on the medium.

SBC-2 write-once block devices shall support the short sense data format and may support the long sense data format (see SPC-3). If the short sense data format is requested but the sense data contains an INFORMATION or COMMAND-SPECIFIC INFORMATION value too large for the short sense data format, the VALID bit shall be set to zero.
[Editor's note: this is not possible with any current write-once commands.]

Table xx summarizes use of the sense data fields.

Table xx - Sense data field usage for write-once block devices

Field	SBC-2 usage	Reference
VALID bit and INFORMATION field	REASSIGN BLOCKS MEDIUM SCAN Read-write error recovery mode page	
COMMAND-SPECIFIC INFORMATION field	EXTENDED COPY REASSIGN BLOCKS MEDIUM SCAN	
ILI bit	READ LONG WRITE LONG	

5.1.14 REASSIGN BLOCKS command

…

If the block device is unable to successfully complete a REASSIGN BLOCKS command, the command shall terminate with CHECK CONDITION status with the appropriate sense information. The logical block address of the first defect descriptor not reassigned shall be returned in the COMMAND-SPECIFIC INFORMATION field of the sense data.

If information about the first defect descriptor not reassigned is not available, or if all the defects have been reassigned, ~~this~~ the COMMAND-SPECIFIC INFORMATION field shall be set to FFFF FFFFh if the short sense data format is being used or FFFF FFFF FFFF FFFFh if the long sense data format is being used. ~~if LONGLBA is set to zero or FFFFFFFF FFFFFFFFh if LONGLBA is set to one.~~

If the REASSIGN BLOCKS command failed due to an unexpected unrecoverable read error that would cause the loss of data in a block not specified in the defect list, the Logical block address of the unrecoverable block shall be returned in the INFORMATION field of the sense data and the VALID bit shall be set to one.

Note 2 - If the REASSIGN BLOCKS command returns CHECK CONDITION status and the sense data COMMAND-SPECIFIC INFORMATION field contains a valid logical block address, the application client should remove all defect descriptors from the defect list prior to the one returned in the COMMAND-SPECIFIC INFORMATION field. If the sense key is MEDIUM ERROR and the ~~VALID bit is one (the~~ INFORMATION field contains the valid block address~~)~~ the application client should insert that new defective logical block address into the defect list and reissue the REASSIGN BLOCKS command with the new defect list. Otherwise, the application client should perform any corrective action indicated by the sense data and then reissue the REASSIGN BLOCKS command with the new defect list.

[where does it say that information contains a valid block address on a MEDIUM ERROR? Only indirectly from the read-write error recovery page description for unrecoverable errors, plus the table showing unrecoverable errors can generate MEDIUM ERROR sense keys.]

5.2.3 MEDIUM SCAN command

…

A REQUEST SENSE command following a satisfied MEDIUM SCAN command shall:

a) return a sense key of EQUAL if the scan was satisfied by a contiguous set of blocks equal in size to the number of blocks requested. If the PRA bit is one and the scan was satisfied by a contiguous set of blocks less than the number of blocks requested, then a sense key of NO SENSE shall be returned;
b) return the VALID bit set to one;
c) return the logical block address of the first logical block of the contiguous set of blocks that satisfied the scan criteria in the INFORMATION field;

d) return the number of contiguous logical blocks meeting the scan criteria in the COMMAND-SPECIFIC INFORMATION field.

[Editor's note: The MEDIUM SCAN command is currently only available in a short LBA version, so no change is needed to its INFORMATION field descriptions at this time.]

6.2.7 Read-write error recovery page

The read-write error recovery page (see Table 112) specifies the error recovery parameters the device server shall use during any command that performs a read or write operation to the medium (e.g., READ, WRITE, WRITE AND VERIFY, etc.).

...

The individual bit definitions for EER, PER, DTE and DCR are contained in Table 113. The combinations of these bits are explained in Table 114.

...

Table 114 - Combined error recovery parameter descriptions

EER	PER	DTE	DCR	Description
0	0	0	0	The full number of retries (specified in the READ, WRITE or VERIFY RETRY COUNT field) and error correction are attempted to recover the data (EER and DCR equal 0). A CHECK CONDITION is not reported at the completion of the command for recovered errors (PER equal 0). The command terminates with CHECK CONDITION status before the transfer count is exhausted only if an unrecoverable error is detected. If an unrecoverable data error occurred, the data in the block with the unrecoverable error may or may not be transferred to the application client depending on the setting of the transfer block (TB) bit (read operation only).
0	0	0	1	Error correction is disabled (DCR equal one) so only the full number of retries (specified in the READ, WRITE or VERIFY RETRY COUNT field) are attempted to recover the data (EER equal 0). A CHECK CONDITION is not reported at the completion of the command for recoverable errors (PER equal 0). The command terminates with CHECK CONDITION status before the transfer count is exhausted only if an unrecoverable error is detected. If an unrecoverable data error occurred, the data in the block with the unrecoverable error may or may not be transferred to the application client depending on the setting of the transfer block (TB) bit (read operation only).
0	0	1	0	Invalid mode (PER shall be set to one if DTE is one). [1]
0	0	1	1	Invalid mode (PER shall be set to one if DTE is one). [1]
0	1	0	0	The full number of retries (specified in the READ, WRITE or VERIFY RETRY COUNT field) and error correction are attempted to recover the data (EER and DCR equal 0). The command terminates with CHECK CONDITION status before the transfer count is exhausted only if an unrecoverable error is detected. If an unrecoverable data error occurred, the data in the block with the unrecoverable error may or may not be transferred to the application client depending on the setting of the transfer block (TB) bit (read operation only). A CHECK CONDITION with a sense key of RECOVERED ERROR is reported at the completion of the command for any recoverable error that occurs (PER equal 1). The INFORMATION field in the sense data shall contain the logical block address of the last recovered error that occurred during the transfer.
0	1	0	1	Error correction is disabled (DCR equal one) so only the full number of retries (specified in the READ, WRITE or VERIFY RETRY COUNT field) are attempted to recover the data (EER equal 0). The command terminates with CHECK CONDITION status before the transfer count is

				exhausted only if an unrecoverable error is detected. If an unrecoverable data error occurred, the data in the block with the unrecoverable error may or may not be transferred to the application client depending on the setting of the transfer block (TB) bit (read operation only). A CHECK CONDITION with a sense key of RECOVERED ERROR is reported at the completion of the command for any recoverable error that occurs (PER equal 1). The INFORMATION field in the sense data shall contain the logical block address of the last recovered error that occurred during the transfer.
0	1	1	0	The full number of retries (specified in the READ, WRITE or VERIFY RETRY COUNT field) and error correction are attempted to recover the data (EER and DCR equal 0). The command terminates with CHECK CONDITION status before the transfer count is exhausted if any error (recoverable or unrecoverable) is detected (DTE equal 1). The INFORMATION field in the sense data shall contain the logical block address of the block in error. If an unrecoverable data error occurs the data in the block with the error may or may not be transferred to the application client depending on the setting of the transfer block (TB) bit (read operation only.)
0	1	1	1	Error correction is disabled (DCR equal one) so only the full number of retries (specified in the READ, WRITE or VERIFY RETRY COUNT field) are attempted to recover the data (EER equal 0). The command terminates with CHECK CONDITION status before the transfer count is exhausted if any error (recoverable or unrecoverable) is detected (DTE equal 1). The INFORMATION field in the sense data shall contain the logical block address of the block in error. If an unrecoverable data error occurs the data in the block with the error may or may not be transferred to the application client depending on the setting of the transfer block (TB) bit (read operation only).
1	0	0	0	The fewest possible retries and error correction are attempted to recover the data (EER equal one and DCR equal 0). A CHECK CONDITION is not reported at the completion of the command for recoverable errors (PER equal 0). The command terminates with CHECK CONDITION status before the transfer count is exhausted only if an unrecoverable error is detected. If an unrecoverable data error occurred, the data in the block with the unrecoverable error may or may not be transferred to the application client depending on the setting of the transfer block (TB) bit (read operation only).
1	0	0	1	Invalid mode (DCR shall be set to zero if EER is one).[1]
1	0	1	0	Invalid mode (PER shall be set to one if DTE is one). [1]
1	0	1	1	Invalid mode (PER shall be set to one if DTE is one). [1]
1	1	0	0	The fewest possible retries and error correction are attempted to recover the data (EER equal one and DCR equal 0). The command terminates with CHECK CONDITION status before the transfer count is exhausted only if an unrecoverable error is detected. If an unrecoverable data error occurred, the data in the block with the unrecoverable error may or may not be transferred to the application client depending on the setting of the transfer block (TB) bit (read operation only). A CHECK CONDITION with a sense key of RECOVERED ERROR is reported at the completion of the command for any recoverable error that occurs (PER equal 1). The INFORMATION field in the sense data shall contain the logical block address of the last recovered error that occurred during the transfer.
1	1	0	1	Invalid mode (DCR shall be set to zero if EER is one). [1]
1	1	1	0	The fewest possible retries and error correction are attempted to recover the data (EER equal one and DCR equal 0). The command

				terminates with CHECK CONDITION status before the transfer count is exhausted if any error (recoverable or unrecoverable) is detected (DTE equal 1). The INFORMATION field in the sense data shall contain the logical block address of the block in error. If an unrecoverable data error occurs the data in the block with the error may or may not be transferred to the application client depending on the setting of the transfer block (TB) bit (read operation only).
1	1	1	1	Invalid mode (DCR shall be set to zero if EER is one). [1]
Note (1) If an invalid mode for the error recovery combination is sent by the application client the device server shall return CHECK CONDITION status and the sense key shall be set to ILLEGAL REQUEST with the additional sense code set to INVALID FIELD IN PARAMETER LIST				

...

The HEAD OFFSET COUNT field specifies in two's-complement notation an incremental offset position from the track center to the radial position the heads shall be moved. The effect of this field on write operations is unspecified. A HEAD OFFSET COUNT of zero indicates that no offset is specified. A positive value indicates moving in the direction of increasing logical block addresses. A negative value indicates moving in the direction of decreasing logical block addresses. Any value specified in this field does not preclude the device server from using positive or negative head offset during error recovery. However, after any error recovery is completed the device server shall return the head offset to the value specified in this field.

Note 34 - The degree of offset for each incremental value and the number of valid values are vendor-specific. The number of valid values should be equal for the positive and negative head offset counts.

The device server shall return CHECK CONDITION status and set the sense key to ILLEGAL REQUEST with the appropriate additional sense code for the condition if an unsupported head offset value is specified. The VALID bit shall be set to one and the INFORMATION field shall be set to the positive value of the maximum head offset count that is supported. The device server shall set the VALID bit to zero if the device server is unable to determine the maximum head offset count supported.

Note 35 - If the device server does not support this field, it returns a zero value in the MODE SENSE command).

[Editor's note: does the head offset field need to be expanded for long LBAs? We never resolved the issue of which of the head, cylinder, and sector fields needs to increase.]

...

The DATA STROBE OFFSET COUNT field specifies in two's-complement notation an incremental position to where the recovered data strobe shall be adjusted from its nominal setting. The effect of this field on write operations is unspecified. A value of zero indicates that no data strobe offset is specified. A positive value indicates movement in a positive direction as defined by the device server. A negative value indicates movement in the negative direction as defined by the device server. Any value specified in this field does not preclude the device server from using positive or negative data strobe offset during error recovery. However, after any error recovery is completed the device server shall return the data strobe offset to the value specified in this field.

Note 36 - The degree of offset for each incremental value and the number of valid values are vendor-specific. The number of valid values should be equal for the positive and negative data strobe offset counts.

The device server shall return CHECK CONDITION status and shall set the sense key to ILLEGAL REQUEST with the appropriate additional sense code for the condition if an unsupported data strobe offset count value is specified. The VALID bit shall be set to one and the INFORMATION field shall be set to the positive value of the maximum data strobe

offset count that is supported. The device server shall set the valid bit to zero if the device server is unable to determine the maximum data strobe offset supported.

Note 3 - If the device server does not support the DATA STROBE OFFSET COUNT field, it returns a zero value in the MODE SENSE command.

Suggested Changes to SSC-2

4.2.8.1 Error reporting

If any of the following conditions occur during the execution of a command or if a deferred error prevented the command from executing, the device server shall return CHECK CONDITION status. The appropriate sense key and additional sense code should be set. Table 1 illustrates some error conditions and the applicable sense keys. Table 1 does not provide an exhaustive enumeration of all conditions that may cause the CHECK CONDITION status.

Table 1 - Error conditions and sense keys

Condition	Sense key
Unsupported option requested	ILLEGAL REQUEST
Target reset or medium change since last command from this initiator	UNIT ATTENTION
Self diagnostic failed	HARDWARE ERROR
Unrecovered read error	MEDIUM ERROR HARDWARE ERROR
Recovered read or write error	RECOVERED ERROR
Overlength or other error that may be resolved by repeating the command	ABORTED COMMAND
Attempt a WRITE, READ, READ REVERSE, VERIFY, or RECOVER BUFFERED DATA command with the FIXED bit set to zero and variable block mode is not supported.	ILLEGAL REQUEST
Attempt a WRITE, READ, READ REVERSE, VERIFY, or RECOVER BUFFERED DATA command with the FIXED bit set to zero and requested block length is not supported.	ILLEGAL REQUEST
Attempt a WRITE, READ, READ REVERSE, VERIFY, or RECOVER BUFFERED DATA command with the FIXED bit set to one and MODE SENSE block length set to zero.	ILLEGAL REQUEST
Attempt to execute an erase, format, partition, set capacity, or write-type operation on write protected medium.	DATA PROTECT
Deferred write error.	MEDIUM ERROR VOLUME OVERFLOW HARDWARE ERROR

…

~~Refer to the READ(16) or READ(6) command (see 5.3 or 6.4) for a description of the FIXED bit. Refer to SPC-3 for a description of the sense data VALID bit and INFORMATION field contained in the REQUEST SENSE sense data. In addition, this standard describes the use of the INFORMATION field specific to the sequential-access device type.~~

SSC-2 devices shall support both the short and long sense data formats (see SPC-3). If the short sense data format is requested but the sense data contains an INFORMATION value too large for the short sense data format, the VALID bit shall be set to zero.

The read-write error recovery page (see 8.3.5) current values specify behavior when an unrecoverable read or write error is encountered. If this page is not implemented, the behavior is vendor-specific.

In the case of an unrecovered read error, if the FIXED bit is one, the sense data VALID bit shall be set to one and the INFORMATION field shall be set to the requested transfer length minus the actual number of blocks read (not including the unrecovered block). If the FIXED bit is zero, the sense data VALID bit shall be set to one and the INFORMATION field shall be set to the requested transfer length. Upon termination, the logical position shall be after the unrecovered block.

In the case of an unrecovered write error, if unbuffered mode is selected and the FIXED bit is set to one, the sense data VALID bit shall be set to one and the INFORMATION field shall be set to the requested transfer length minus the actual number of blocks written. If unbuffered mode is selected and the FIXED bit is set to zero, the INFORMATION field shall be set to the requested transfer length.

In the case of an unrecovered write error or a deferred write error, if buffered mode is selected and the FIXED bit is one, the sense data VALID bit shall be set to one and the INFORMATION field shall be set to the total number of blocks, filemarks, and setmarks not written (the number of blocks not transferred from the initiator for this command plus the number of blocks, filemarks, and setmarks remaining in the logical unit's buffer). If buffered mode is selected and the FIXED bit is zero, the INFORMATION field shall be set to the total number of bytes, filemarks, and setmarks not written (the number of bytes not transferred from the initiator for this command plus the number of ~~bytes, filemarks, and setmarks~~data bytes plus the number of filemarks plus the number of setmarks remaining in the logical unit's buffer). In both cases, the value in the INFORMATION field may exceed the transfer length.
[Editor's note: the bytes, filemarks, etc. change is from SSC-2 letter ballot resolution and should defer to the actual changes implemented. This proposal is not driving that change.]

The sense data INCORRECT LENGTH INDICATION (ILI) bit indicates that the requested logical block length did not match the logical block length of the data on the medium, or the logical block length of the data on the medium is too large for the device server to read.

The sense data FILEMARK bit indicates that the command read a filemark or setmark.

The sense data EOM bit indicates indicates that an end-of-medium condition (e.g., end-of-partition or beginning-of-partition) exists. This bit indicates that the unit is at or past the early-warning if the direction was forward, or that the command was not completed because beginning-of-partition was encountered if the direction was reverse.

Table xx summarizes use of the sense data fields.

Table xx - Sense data field usage

Field	SSC-2 usage	Reference
VALID bit and INFORMATION field	ERASE(16) READ(16) READ REVERSE(16) VERIFY(16) WRITE(16) WRITE FILEMARKS(16) ERASE(6) READ(6) READ REVERSE(6) SPACE(6) WRITE(6) WRITE FILEMARKS(6) RECOVER BUFFERED DATA Data compression mode page	
COMMAND-SPECIFIC INFORMATION field	None	
FILEMARK bit	READ(16) READ(6) RECOVER BUFFERED DATA SPACE(6)	
EOM bit	LOCATE(16) LOCATE(10) READ(16) READ(6) READ BLOCK LIMITS READ REVERSE(16) READ REVERSE(6) RECOVER BUFFERED DATA SPACE(6) WRITE(16) WRITE(6) WRITE FILEMARKS(16) WRITE FILEMARKS(6) Device configuration mode page	
ILI bit	READ(16) READ(6) READ REVERSE(16) READ REVERSE(6) RECOVER BUFFERED DATA Data compression mode page	

5.2 ERASE(16) command

5.2.1 ERASE(16) command introduction

…

If the logical unit encounters early-warning during an ERASE(16) command, and any buffered data, filemarks, or setmarks remain to be written, the device server action shall be as defined for the early-warning condition of the WRITE(16) command (see 5.6). If the LONG bit is zero, the erase operation shall terminate with CHECK CONDITION status and the sense data shall be set as defined for the WRITE(16) command. Any count of pending buffered erases shall not be reported as part of the value returned in the INFORMATION field or in the READ POSITION response data.

…

5.3 READ(16) command

5.3.1 READ(16) command introduction

…

NOTE 11 Since the residual information normally provided in the INFORMATION field of the sense data may not be available when the SILI bit is set, other methods for determining the actual block length should be used (e.g., including length information in the data block).

If the SILI bit is one and the FIXED bit is one, the device server shall terminate the command with CHECK CONDITION status and the sense key shall be set to ILLEGAL REQUEST with an additional sense code of INVALID FIELD IN CDB.

If the SILI bit is zero and an incorrect length block is read, CHECK CONDITION status shall be returned and the ILI and VALID bits shall be set to one in the sense data with an additional sense code of NO ADDITIONAL SENSE INFORMATION. Upon termination, the logical position shall be after the incorrect length block (end-of-partition side). If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of blocks read (not including the incorrect length block). If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length minus the actual block length. Logical units that do not support negative values shall set the INFORMATION field to zero if the overlength condition exists.

NOTE 12 In the above case with the FIXED bit of one, only the position of the incorrect-length logical block may be determined from the sense data. The actual length of the incorrect block is not reported. Other means may be used to determine its actual length (e.g., read it again with the fixed bit set to zero).

The LOGICAL BLOCK ADDRESS and PARTITION fields specify the position at which the READ(16) command shall start.

If the TRANSFER LENGTH field is not set to zero and the current logical position does not match the specified LOGICAL BLOCK ADDRESS and PARTITION fields, the device server shall locate to the specified logical block address and partition prior to performing the read operation. If the locate operation fails, the device server shall return CHECK CONDITION status and the additional sense code shall be set to LOCATE OPERATION FAILURE. The INFORMATION field in the sense data shall be set to the requested transfer length. Following a locate operation failure the logical position is undefined.

If the TRANSFER LENGTH field is set to zero, no data shall be transferred and the current logical position shall not be changed. This condition shall not be considered an error.

If the device server encounters a filemark during a READ(16) command, CHECK CONDITION status shall be returned and the FILEMARK and VALID bits shall be set to one in the sense data. The sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate, and the additional sense code shall be set to FILEMARK DETECTED. Upon termination, the logical position shall be after the filemark (end-of-partition side). If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of blocks read (not including the filemark). If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length.

If the device server encounters a setmark during a READ(16) command and the RSMK bit is set to one in the device configuration page (see 8.3.2), CHECK CONDITION status shall be returned and the FILEMARK and VALID bits shall be set to one in the sense data. The sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate, and the additional sense code shall be set to SETMARK DETECTED. Upon termination, the logical position shall be after the setmark (end-of-partition side). If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of blocks read (not including the setmark). If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length. The device server shall not return CHECK CONDITION when a setmark is encountered if the RSMK bit is set to zero or if this option is not supported.

If the device server encounters early-warning during a READ(16) command and the REW bit is set to one in the device configuration page (see 8.3.2), CHECK CONDITION status shall be returned upon completion of the current block. The sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate, and the additional sense code shall be set to END-OF-PARTITON/MEDIUM DETECTED. The EOM and VALID bits shall be set to one in the sense data. Upon termination, the logical position shall be after the last block transferred (end-of-partition side). If the FIXED bit is one, the INFORMATION field in the sense data shall be set to the requested transfer length minus the actual number of blocks read. If the FIXED bit is zero, the INFORMATION field in the sense data shall be set to the requested transfer length minus the actual block length. The device server shall not return CHECK CONDITION status when early-warning is encountered if the REW bit is zero or if the REW option is not supported.

NOTE 13 A REW bit of one is not recommended for most system applications since read data may be present after early-warning.

If the device server encounters end-of-data during a READ(16) command, CHECK CONDITION status shall be returned, the sense key shall be set to BLANK CHECK, and the VALID bit shall be set to one in the sense data. If end-of-data is encountered at or after early-warning, the EOM bit shall also be set to one. Upon termination, the logical position shall be immediately after the last recorded logical record, filemark, or setmark (end-of-partition side). If the FIXED bit is one, the INFORMATION field in the sense data shall be set to the requested transfer length minus the actual number of blocks read. If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length.

If the device server encounters end-of-partition during a READ(16) command, CHECK CONDITION status shall be returned, the sense key shall be set to MEDIUM ERROR, and the EOM and VALID bits shall be set to one in the sense data. The medium position following this condition is not defined. If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of blocks read. If the FIXED bit is zero, the INFORMATION field in the sense data shall be set to the requested transfer length.

NOTE 14 If a READ(16) command terminates with an error condition and no data transfer has occurred, the logical position of the medium is undefined. The application client should issue a READ POSITION(16) command to determine the logical position.

5.4 READ REVERSE(16) command
5.4.1 READ REVERSE(16) command introduction
…
The LOGICAL BLOCK ADDRESS and PARTITION fields specify the position at which the READ REVERSE(16) command shall start. If the TRANSFER LENGTH field is not set to zero and the current logical position does not match the specified LOGICAL BLOCK ADDRESS and PARTITION fields, the device server shall locate to the specified logical block address and partition prior to performing the read reverse operation. If the locate operation fails, the device server shall return CHECK CONDITION status and the additional sense code shall be set to LOCATE OPERATION FAILURE. The INFORMATION field in the sense data shall be set to the requested transfer length. Following a locate operation failure the logical position is undefined.

Filemarks, setmarks, incorrect length blocks, and unrecovered read errors are handled the same as in the READ(16) command, except that upon termination the logical position shall be before the filemark, setmark, incorrect length block, or unrecovered block (beginning-of-partition side).

If the device server encounters beginning-of-partition during a READ REVERSE(16) command, CHECK CONDITION status shall be returned and the EOM and VALID bits shall be set to one in the sense data. The sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate. If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of blocks transferred. If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length.

5.5 VERIFY(16) command
5.5.1 VERIFY(16) command introduction

…

The LOGICAL BLOCK ADDRESS and PARTITION fields specify the position where the VERIFY(16) command shall start. If the BYTCMP bit is set to one, the VERIFICATION LENGTH field is not set to zero, and the current logical position does not match the specified LOGICAL BLOCK ADDRESS and PARTITION fields, the device server shall locate to the specified logical block address and partition prior to performing the verify operation. If the locate operation fails, the device server shall return CHECK CONDITION status and the additional sense code shall be set to LOCATE OPERATION FAILURE. The INFORMATION field in the sense data shall be set to the requested verification length. Following a locate operation failure the logical position is undefined.

…

If the data does not compare (BYTCMP bit of one), the command shall terminate with CHECK CONDITION status, the sense data VALID bit shall be set to one the sense key shall be set to MISCOMPARE, and the additional sense code shall be set to MISCOMPARE DURING VERIFY OPERATION. If the FIXED bit is one, the INFORMATION field shall be set to the requested verification length minus the actual number of blocks successfully verified. If the FIXED bit is zero, the INFORMATION field shall be set to the requested verification length minus the actual number of bytes successfully verified. This number may be larger than the requested verification length if the error occurred on a previous VERIFY(16) command with an IMMED bit of one. Upon termination, the medium shall be positioned after the block containing the miscompare (end-of-partition side).

5.6 WRITE(16) command
5.6.1 WRITE(16) command introduction

…

The INFORMATION field shall be defined as follows:

A) If the device is operating in unbuffered mode (see 3.1.58) and the FIXED bit is set to one, the INFORMATION field shall be set to the requested transfer length minus the actual number of blocks written;

B) if the device is operating in unbuffered mode and the FIXED bit is set to zero, the INFORMATION field shall be set to the requested transfer length;

C) if the device is operating in buffered mode (see 3.1.8) and the FIXED bit is set to one, the INFORMATION field shall be set to the total number of blocks, filemarks, and setmarks not written (the number of blocks not transferred from the application client plus the number of blocks, filemarks, and setmarks remaining in the logical unit's buffer. The value in the INFORMATION field may exceed the transfer length; and

D) if the device is operating in buffered mode and the FIXED bit is set to zero, the INFORMATION field shall be set to the total number of bytes, filemarks, and setmarks not written (the number of bytes not transferred from the application client plus the number of bytes, filemarks, and setmarks remaining in the logical unit's buffer).

The logical unit should ensure that some additional data may be written to the medium (e.g., labels, filemarks, or setmarks) after the first early-warning indication has been returned to the application client (see 4.2.2).

If a WRITE(16) command is received while the logical unit is positioned between early-warning and end-of-partition, the device server shall return CHECK CONDITION status after attempting to perform the command. The EOM and VALID bits shall be set to one in the sense data. If all data that is to be written is successfully
transferred to the medium, the INFORMATION field in the sense data shall be set to zero. If any data that is to be written is not transferred to the medium prior to encountering end-of-partition, the sense key shall be set to VOLUME OVERFLOW and the INFORMATION field in the sense data shall be defined as follows:

A) If the FIXED bit is one, the INFORMATION field in the sense data shall be set to the requested transfer length minus the actual number of blocks written to the medium; or

B) if the FIXED bit is zero, the INFORMATION field in the sense data shall be set to the requested transfer length.

5.7 WRITE FILEMARKS(16) command
5.7.1 WRITE FILEMARKS(16) command introduction

…

The LOGICAL BLOCK ADDRESS and PARTITION fields specify the position where the WRITE FILEMARKS(16) command shall start. If the TRANSFER LENGTH field is not set to zero and the current logical position does not match the specified LOGICAL BLOCK ADDRESS and PARTITION fields, the device server shall locate to the specified logical block address and partition prior to performing the write filemarks operation. If the locate operation fails, the device server shall return CHECK CONDITION status and the additional sense code shall be set to LOCATE OPERATION FAILURE. The INFORMATION field in the sense data shall be set to the requested transfer length. Following a locate operation failure the logical position is undefined.

If the logical unit encounters early-warning during a WRITE FILEMARKS(16) command, an attempt to finish writing any buffered data, filemarks, or setmarks may be made, as determined by the current settings of the REW and SEW bits in the device configuration page (see 8.3.2). The command shall terminate with CHECK CONDITION status.

The additional sense code shall be set to END-OF-PARTITION/MEDIUM DETECTED, and the EOM and VALID bits shall be set to one in the sense data. If all buffered data, filemarks, and setmarks are successfully transferred to the medium, the sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate. If any buffered data, filemarks, or setmarks to be written are not transferred to the medium when early-warning is encountered, the sense key shall be set to VOLUME OVERFLOW.

The INFORMATION field shall be defined as follows:
A) If the device is operating in unbuffered mode (see 3.1.58) and the FIXED bit is set to one, the INFORMATION field shall be set to the requested transfer length minus the actual number of blocks written;
B) if the device is operating in unbuffered mode and the FIXED bit is set to zero, the INFORMATION field shall be set to the requested transfer length;
C) if the device is operating in buffered mode (see 3.1.8) and the FIXED bit is set to one, the INFORMATION field shall be set to the total number of blocks, filemarks, and setmarks not written (the number of blocks not transferred from the application client plus the number of blocks, filemarks, and setmarks remaining in the logical unit's buffer. The value in the INFORMATION field may exceed the transfer length; and
D) if the device is operating in buffered mode and the FIXED bit is set to zero, the INFORMATION field shall be set to the total number of bytes, filemarks, and setmarks not written (the number of bytes not transferred from buffer).

NOTE 20 The logical unit should ensure that some additional data may be written to the medium (e.g., labels, filemarks, or setmarks) after the first early-warning indication has been returned to the application client (see 4.2.2).

If a WRITE FILEMARKS(16) command is received while the logical unit is positioned between early-warning and end-of-partition, the device server shall return CHECK CONDITION status after attempting to perform the command. The EOM and VALID bits shall be set to one in the sense data. If all filemarks or setmarks to be written are successfully transferred to the medium, the INFORMATION field shall be set to zero. If any filemarks or setmarks to be written are not transferred to the medium prior to encountering end-of-partition, the sense key shall be set to VOLUME OVERFLOW and the INFORMATION field shall be set to the requested transfer length minus the actual number of filemarks or setmarks written to the medium.

6.2 ERASE(6) command
6.2.1 ERASE(6) command introduction

…

If the logical unit encounters early-warning during an ERASE(6) command, and any buffered data, filemarks, or setmarks remain to be written, the device server action shall be as defined for

the early-warning condition of the WRITE(6) command (see 6.8). If the LONG bit is zero, the erase operation shall terminate with CHECK CONDITION status and set the sense data as defined for the WRITE command. Any count of pending buffered erases shall not be reported as part of the value returned in the INFORMATION field or in the READ POSITION response data.

6.4 READ(6) command
6.4.1 READ(6) command introduction

…

NOTE 22 Since the residual information normally provided in the INFORMATION field of the sense data may not be available when the SILI bit is set, other methods for determining the actual block length should be used (e.g., including length information in the data block).

If the SILI bit is one and the FIXED bit is one, the device server shall terminate the command with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN CDB.

If the SILI bit is zero and an incorrect length block is read, CHECK CONDITION status shall be returned. The ILI and VALID bits shall be set to one in the sense data and the additional sense code shall be set to NO ADDITIONAL SENSE INFORMATION. Upon termination, the logical position shall be after the incorrect length block (end-of-partition side). If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of blocks read (not including the incorrect length block). If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length minus the actual block length. Logical units that do not support negative values shall set the INFORMATION field to zero if the overlength condition exists.
NOTE 23 In the above case with the FIXED bit of one, only the position of the incorrect-length logical block may be determined from the sense data. The actual length of the incorrect block is not reported. Other means may be used to determine its actual length (e.g., read it again with the fixed bit set to zero).
A TRANSFER LENGTH of zero specifies no data shall be transferred. This condition shall not be considered an error and the logical position shall not be changed.

If the device server encounters a filemark during a READ(6) command, CHECK CONDITION status shall be returned and the FILEMARK and VALID bits shall be set to one in the sense data. The sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate, and the additional sense code shall be set to FILEMARK DETECTED. Upon termination, the logical position shall be after the filemark (end-of-partition side). If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of blocks read (not including the filemark). If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length.

If the device server encounters a setmark during a READ(6) command and the RSMK bit is set to one in the device configuration page (see 8.3.2), CHECK CONDITION status shall be returned and the FILEMARK and VALID bits shall be set to one in the sense data. The sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate, and the additional sense code shall be set to SETMARK DETECTED. Upon termination, the logical position shall be after the setmark (end-of-partition side). If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of blocks read (not including the setmark). If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length. The device server shall not return CHECK CONDITION when a setmark is encountered if the RSMK bit is set to zero or if this option is not supported.

If the device server encounters early-warning during a READ(6) command and the REW bit is set to one in the device configuration page (see 8.3.2), CHECK CONDITION status shall be returned upon completion of the current block. The sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate, and the additional sense code shall be set to END-OF-PARTITON/MEDIUM DETECTED. The EOM and VALID bits shall be set to one in the sense data. Upon termination, the logical position shall be after the last block transferred (end-of-partition

side). If the FIXED bit is one, the INFORMATION field in the sense data shall be set to the requested transfer length minus the actual number of blocks read. If the FIXED bit is zero, the INFORMATION field in the sense data shall be set to the requested transfer length minus the actual block length. The device server shall not return CHECK CONDITION status when early-warning is encountered if the REW bit is zero or if the REW option is not supported.

NOTE 24 A REW bit of one is not recommended for most system applications since read data may be present after early-warning.

If the device server encounters end-of-data during a READ(6) command, CHECK CONDITION status shall be returned, the sense key shall be set to BLANK CHECK, and the VALID bit shall be set to one in the sense data. If end-of-data is encountered at or after early-warning, the EOM bit shall also be set to one. Upon termination, the logical position shall be immediately after the last recorded logical record, filemark, or setmark (end-of-partition side). If the FIXED bit is one, the INFORMATION field in the sense data shall be set to the requested transfer length minus the actual number of blocks read. If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length.

If the device server encounters end-of-partition during a READ(6) command, CHECK CONDITION status shall be returned, the sense key shall be set to MEDIUM ERROR, and the EOM and VALID bits shall be set to one in the sense data. The medium position following this condition is not defined. If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of blocks read. If the FIXED bit is zero, the INFORMATION field in the sense data shall be set to the requested transfer length.

6.5 READ REVERSE(6) command
6.5.1 READ REVERSE(6) command introduction
…
If the device server encounters beginning-of-partition during a READ REVERSE(6) command, CHECK CONDITION status shall be returned and the EOM and VALID bits shall be set to one in the sense data. The sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate. If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of blocks transferred. If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length.

6.6 SPACE(6) command
6.6.1 SPACE(6) command introduction
The SPACE(6) command (see table 24) provides a variety of positioning functions that are determined by the CODE and COUNT fields. Both forward and reverse positioning are provided, although some logical units may only support a subset of this command. Prior to performing the space operation, except as stated in the description of the count field, the logical unit shall ensure that all buffered data, filemarks, and setmarks have been transferred to the medium. If an application client requests an unsupported function, the command shall be terminated with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN CDB. The INFORMATION field value shall be equal to the magnitude of the count field minus the magnitude of the blocks, filemarks, or setmarks spaced over. A CHECK CONDITION caused by early termination of any SPACE(6) command shall not result in a negative INFORMATION field value.
…
If a filemark is encountered while spacing over blocks, the command shall be terminated. CHECK CONDITION status shall be returned, and the FILEMARK and VALID bits shall be set to one in the sense data. The sense key shall be set to NO SENSE and the additional sense code shall be set to FILEMARK DETECTED. The INFORMATION field shall be set to the requested count minus the actual number of blocks spaced over (not including the filemark). The logical position shall be on the end-of-partition side of the filemark if movement was in the forward direction and on the beginning-of-partition side of the filemark if movement was in the reverse direction.

If a setmark is encountered while spacing over blocks or filemarks and the RSMK bit is set to one in the device configuration page (see 8.3.2), the command shall be terminated, CHECK CONDITION status shall be returned, and the FILEMARK and VALID bits shall be set to one in the sense data. The sense key shall be set to NO SENSE and the additional sense code shall be set to SETMARK DETECTED. The INFORMATION field shall be set to the requested count minus the actual number of blocks or filemarks spaced over (not including the setmark). The logical position shall be on the end-of-partition side of the setmark if movement was in the forward direction and on the beginning-of-partition side of the setmark if movement was in the reverse direction. The device server shall not return CHECK CONDITION status when a setmark is encountered if the RSMK bit is set to zero or if this option is not supported.

If early-warning is encountered while spacing over blocks, filemarks, or setmarks and the REW bit is set to one in the device configuration page (see 8.3.2), CHECK CONDITION status shall be returned, the sense key shall be set to NO SENSE, and the EOM and VALID bits shall be set to one in the sense data. The additional sense code shall be set to END-OF-PARTITION/MEDIUM DETECTED. The INFORMATION field shall be set to the requested count minus the actual number of blocks, filemarks, or setmarks spaced over as defined by the CODE value. If the REW bit is zero or the option is not supported by the logical unit, the device server shall not report CHECK CONDITION status at the early-warning point.
NOTE 25 Setting the REW bit to one is not recommended for most system applications since data may be present after early-warning.

If end-of-data is encountered while spacing over blocks, filemarks, or setmarks, CHECK CONDITION status shall be returned, the sense key shall be set to BLANK CHECK, and the sense data VALID bit shall be set to one in the sense data. The additional sense code shall be set to END-OF-DATA DETECTED. The sense data EOM bit shall be set to one if end-of-data is encountered at or after early-warning. The INFORMATION field shall be set to the requested count minus the actual number of blocks, filemarks, or setmarks spaced over as defined by the CODE value. The medium shall be positioned such that a subsequent write operation would append to the last record, filemark, or setmark.

If the end-of-partition is encountered while spacing forward over blocks, filemarks, or setmarks, CHECK CONDITION status shall be returned, and the sense key shall be set to MEDIUM ERROR. The additional sense code shall be set to END-OF-PARTITION/MEDIUM DETECTED, and the sense data EOM and VALID bit shall be set to one. The INFORMATION field shall be set to the requested count minus the actual number of blocks, filemarks, or setmarks spaced over as defined by the CODE value.

If beginning-of-partition is encountered while spacing over blocks, filemarks, or setmarks in the reverse direction, the device server shall return CHECK CONDITION status and shall set the sense key to NO SENSE. The additional sense code shall be set to BEGINNING-OF-PARTITION/MEDIUM DETECTED. The sense data EOM and VALID bits shall be set to one, and the INFORMATION field set to the total number of blocks, filemarks, or setmarks not spaced over (the requested number of blocks, filemarks, or setmarks minus the actual number of blocks, filemarks, or setmarks spaced over). A successfully completed SPACE command shall not set EOM to one at beginning-of-partition.

…

6.7 VERIFY(6) command

6.7.1 VERIFY(6) command description

If the data does not compare (BYTCMP bit of one), the command shall terminate with CHECK CONDITION status, the sense data VALID bit shall be set to one the sense key shall be set to MISCOMPARE, and the additional sense code shall be set to MISCOMPARE DURING VERIFY OPERATION. If the FIXED bit is one, the INFORMATION field shall be set to the requested verification length minus the actual number of blocks successfully verified. If the FIXED bit is zero, the INFORMATION field shall be set to the requested verification length minus the actual number of bytes successfully verified. This number may be larger than the requested verification length if the

error occurred on a previous VERIFY(6) command with an IMMED bit of one. Upon termination, the medium shall be positioned after the block containing the miscompare (end-of-partition side).

6.8 WRITE(6) command
6.8.1 WRITE(6) command introduction

…

The INFORMATION field shall be defined as follows:

A) If the device is operating in unbuffered mode (see 3.1.58) and the FIXED bit is set to one, the INFORMATION field shall be set to the requested transfer length minus the actual number of blocks written;

B) if the device is operating in unbuffered mode and the FIXED bit is set to zero, the INFORMATION field shall be set to the requested transfer length;

C) if the device is operating in buffered mode (see 3.1.8) and the FIXED bit is set to one, the INFORMATION field shall be set to the total number of blocks, filemarks, and setmarks not written (the number of blocks not transferred from the application client plus the number of blocks, filemarks, and setmarks remaining in the logical unit's buffer. The value in the INFORMATION field may exceed the transfer length; and D) if the device is operating in buffered mode and the FIXED bit is set to zero, the INFORMATION field shall be set to the total number of bytes, filemarks, and setmarks not written (the number of bytes not transferred from the application client plus the number of bytes, filemarks, and setmarks remaining in the logical unit's buffer).

The logical unit should ensure that some additional data may be written to the medium (e.g., labels, filemarks, or setmarks) after the first early-warning indication has been returned to the application client (see 4.2.2).

If a WRITE(6) command is received while the logical unit is positioned between early-warning and end-of-partition, the device server shall return CHECK CONDITION status after attempting to perform the command. The EOM and VALID bits shall be set to one in the sense data. If all data that is to be written is successfully transferred to the medium, the INFORMATION field in the sense data shall be set to zero. If any data that is to be written is not transferred to the medium prior to encountering end-of-partition, the sense key shall be set to VOLUME OVERFLOW and the INFORMATION field in the sense data shall be defined as follows:

A) If the FIXED bit is one, the INFORMATION field in the sense data shall be set to the requested transfer length minus the actual number of blocks written to the medium; or

B) if the FIXED bit is zero, the INFORMATION field in the sense data shall be set to the requested transfer length.

NOTE 28 In some systems it is important to recognize an error if end-of-partition is encountered during execution of a WRITE command, without regard for whether all data that is to be written is successfully transferred to the medium. By its definition, the VOLUME OVERFLOW sense key may always validly be returned if end-of-partition is encountered while writing, and such usage is recommended. Reporting the MEDIUM ERROR sense key may cause confusion as to whether there was really defective medium encountered during execution of the last write command.

6.9 WRITE FILEMARKS(6) command
6.9.1 WRITE FILEMARKS(6) command introduction

…

The INFORMATION field shall be defined as follows:

A) If the device is operating in unbuffered mode (see 3.1.58), the INFORMATION field shall be set to the requested transfer length minus the actual number of filemarks or setmarks written;

B) if the device is operating in buffered mode (see 3.1.8) and the buffered data was written in variable block mode (see 6.8 or 5.6), the INFORMATION field shall be set to the total number of bytes, filemarks, and setmarks not written (the number of filemarks or setmarks not transferred from the application client plus the number of bytes, filemarks and setmarks remaining in the logical unit's buffer). It is possible for the value in the INFORMATION field to exceed the transfer length; or

C) if the device is operating in buffered mode and the buffered data was written in fixed block mode (see 6.8 or 5.6), the INFORMATION field shall be set to the total number of blocks, filemarks, and setmarks not written (the number filemarks or setmarks not transferred from the application

client plus the number of blocks, filemarks, and setmarks remaining in the logical unit's buffer). It is possible for the value in the INFORMATION field to exceed the transfer length.
NOTE 31 The logical unit should ensure that some additional data may be written to the medium (e.g., labels, filemarks, or setmarks) after the first early-warning indication has been returned to the application client (see 4.2.2).

If a WRITE FILEMARKS(6) command is received while the logical unit is positioned between early-warning and end-of-partition, the device server shall return CHECK CONDITION status after attempting to perform the command. The EOM and VALID bits shall be set to one in the sense data. If all filemarks or setmarks to be written are successfully transferred to the medium, the INFORMATION field shall be set to zero. If any filemarks or setmarks to be written are not transferred to the medium prior to encountering end-of-partition, the sense key shall be set to VOLUME OVERFLOW and the INFORMATION field shall be set to the requested transfer length minus the actual number of filemarks or setmarks written to the medium.

7.7 RECOVER BUFFERED DATA command
7.7.1 RECOVER BUFFERED DATA command introduction
…
If a buffered filemark is encountered during a RECOVER BUFFERED DATA command, CHECK CONDITION status shall be returned, the sense key shall be set to NO SENSE, and the FILEMARK and VALID bits shall be set to one in the sense data. Upon termination, the logical position shall be after the filemark. If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of blocks transferred (not including the filemark).

If a buffered setmark is encountered during a RECOVER BUFFERED DATA command and the RSMK bit is set to one in the device configuration page (see 8.3.2), CHECK CONDITION status shall be returned and the FILEMARK and VALID bits shall be set to one in the sense data. The sense key shall be set to NO SENSE and the additional sense code shall be set to SETMARK DETECTED. Upon termination, the logical position shall be after the setmark. If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of blocks transferred (not including the setmark). If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length. The device server shall not return CHECK CONDITION when a setmark is encountered if the RSMK bit is zero or if this option is not supported.

If an attempt is made to recover more logical blocks of data than are contained in the logical unit's buffer, CHECK CONDITION status shall be returned, the sense key shall be set to NO SENSE. The additional sense code shall be set to END-OF-DATA DETECTED, and the EOM and VALID bits shall be set to one in the sense data. If the FIXED bit is one, the INFORMATION field shall be set to the requested transfer length minus the actual number of blocks transferred.
If the FIXED bit is zero, the INFORMATION field shall be set to the requested transfer length.

8.3 Mode parameters
8.3.1 Data compression page
…
Upon detection of any of the boundary conditions described in table 59 that results in a CHECK CONDITION status, the additional sense code shall be set to either DECOMPRESSION EXCEPTION SHORT ALGORITHM ID OF NN (if the algorithm identifier is less than or equal to 255) or DECOMPRESSION EXCEPTION LONG ALGORITHM ID. The device shall, in both cases, set the DECOMPRESSION ALGORITHM field to the algorithm identifier of the compression algorithm used to process the encountered data. The logical position shall be on the EOP side of the encountered data, and the INFORMATION field in the sense data shall contain a count of the number of data blocks contained within the encountered data.

NOTE 48 When compressed data is encountered on the medium that the device is unable to decompress, the device should treat the data as a single variable-length record. In the sense data, the VALID bit, the ILI bit and the INFORMATION field should be set accordingly.