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**Subj: SPC-4 Remove restrictions on sense data valid bits**
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**Overview**

There is wording in the sense data descriptor format that requires certain validity bits to always be set to 1. This assumes that, whenever the associated descriptors are not needed, they are never returned. However this implementation requires more firmware effort than an implementation that simply returns all the descriptors (whether needed or not) and fills in the valid bits appropriately. This implementation is also easiest to translate to fixed descriptor format when required.

My goal is to remove the restrictive wording on the validity bit descriptions so that they are not required to always be set to 1.

## SPC-4 changes:

### 4.5.2 Descriptor format sense data

#### 4.5.2.1 Descriptor format sense data overview

The descriptor format sense data for response codes 72h (current errors) and 73h (deferred errors) is defined in table 25.

**Table 25 – Descriptor format sense data**

| Byte \ Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Resvd | RESPONSE CODE (72h or 73h) | | | | | | |
| 1 | Reserved | | | | SENSE KEY | | | |
| 2 | ADDITIONAL SENSE CODE | | | | | | | |
| 3 | ADDITIONAL SENSE CODE QUALIFIER | | | | | | | |
| 4 | (MSB) | | | | | | | |
| 6 | | | | | | | | (LSB) |
| 7 | ADDITIONAL SENSE LENGTH (n - 7) | | | | | | | |
| | Sense data descriptor(s) | | | | | | | |
| 8 | Sense data descriptor 0 (see table 26) | | | | | | | |
| | | | | | | | | |
| | : | | | | | | | |
| | : | | | | | | | |
| | Sense data descriptor x (see table 26) | | | | | | | |
| n | | | | | | | | |

The contents of the RESPONSE CODE field indicate the error type and format of the sense data (see 4.5.1). For descriptor format sense data, the RESPONSE CODE field shall be set to 72h or 73h.

The SENSE KEY, ADDITIONAL SENSE CODE and ADDITIONAL SENSE CODE QUALIFIER fields provide a hierarchy of information. The hierarchy provides a top-down approach for an application client to determine information relating to the error and exception conditions.

The SENSE KEY field indicates generic information describing an error or exception condition. The sense keys are defined in 4.5.6.

The ADDITIONAL SENSE CODE (ASC) field indicates further information related to the error or exception condition reported in the SENSE KEY field. Support of the additional sense codes not required by this standard is optional. A list of additional sense codes is in 4.5.6. If the device server does not have further information related to the error or exception condition, the additional sense code shall be set to zero.

The ADDITIONAL SENSE CODE QUALIFIER (ASCQ) field indicates detailed information related to the additional sense code. If the error or exception condition is reported by the device server, the value returned shall be as specified in 4.5.6. If the device server does not have detailed information related to the error or exception condition, the additional sense code qualifier shall be set to zero.

The ADDITIONAL SENSE LENGTH field indicates the number of additional sense bytes that follow. The additional sense length shall be less than or equal to 244 (i.e., limiting the total length of the sense data to 252 bytes). If the sense data is being returned as parameter data by a REQUEST SENSE command, then the relationship between the ADDITIONAL SENSE LENGTH field and the CDB ALLOCATION LENGTH field is defined in 4.3.5.6.

Sense data descriptors (see table 26) provide specific sense information. A given type of sense data descriptor ~~shall be included in the sense data only~~ may be excluded from the sense data when the information it contains is invalid.

**Table 26 – Sense data descriptor format**

| Byte \ Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | DESCRIPTOR TYPE | | | | | | | |
| 1 | ADDITIONAL LENGTH (n-1) | | | | | | | |
| 2 | Sense data descriptor specific | | | | | | | |
| n | | | | | | | | |

The DESCRIPTOR TYPE field (see table 27) identifies the type of sense data descriptor. No more than one sense data descriptor of each type shall be included in the descriptor format sense data.

**Table 27 – DESCRIPTOR TYPE field**

| Code | Description | Reference |
|---|---|---|
| 00h | Information | 4.5.2.2 |
| 01h | Command specific information | 4.5.2.3 |
| 02h | Sense key specific | 4.5.2.4 |
| 03h | Field replaceable unit | 4.5.2.5 |
| 04h | Stream commands | SSC-3 |
| 05h | Block commands | SBC-3 |
| 06h | OSD object identification | OSD |
| 07h | OSD response integrity check value | OSD |
| 08h | OSD attribute identification | OSD |
| 09h | ATA status return | SAT |
| 0Ah to 7Fh | Reserved | |
| 80h to FFh | Vendor specific | 4.5.2.6 |

The ADDITIONAL LENGTH field indicates the number of sense data descriptor specific bytes that follow in the sense data descriptor.

### 4.5.2.2 Information sense data descriptor

The information sense data descriptor (see table 28) provides information that is device-type or command specific and is defined in a command standard (see 3.1.27).

**Table 28 – Information sense data descriptor format**

| Bit / Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | DESCRIPTOR TYPE (00h) | | | | | | | |
| 1 | ADDITIONAL LENGTH (0Ah) | | | | | | | |
| 2 | VALID ~~(1b)~~ | Reserved | | | | | | |
| 3 | Reserved | | | | | | | |
| 4 | (MSB) | INFORMATION | | | | | | |
| 11 | | | | | | | | (LSB) |

The DESCRIPTOR TYPE and ADDITIONAL LENGTH fields are described in 4.5.2.1. For the information sense data descriptor, the DESCRIPTOR TYPE field shall be set to 00h and the ADDITIONAL LENGTH field shall be set to 0Ah.

~~The VALID bit shall be set to one.~~

~~NOTE 2 - In previous versions of this standard and in the fixed format sense data, the VALID bit indicates whether the contents of the INFORMATION field is valid as defined by a command standard. Since the contents of the INFORMATION field are valid whenever an information sense data descriptor is included in the sense data, the only legal value for the VALID bit is set to one.~~

A VALID bit set to zero indicates that the INFORMATION field is not defined in this standard or any other command standard (see 3.1.27). A VALID bit set to one indicates the INFORMATION field contains valid information as defined in this standard or a command standard.

The contents of the INFORMATION field are device-type or command specific and are defined in a command standard (see 3.1.27). When a four byte quantity is stored in the INFORMATION field, the first four bytes shall be zero.

### 4.5.2.3 Command-specific information sense data descriptor

The command-specific information sense data descriptor (see table 29) provides information that depends on the command on which the exception condition occurred.

**Table 29 – Command-specific Information sense data descriptor format**

| Bit / Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | DESCRIPTOR TYPE (01h) | | | | | | | |
| 1 | ADDITIONAL LENGTH (0Ah) | | | | | | | |
| 2 | Reserved | | | | | | | |
| 3 | Reserved | | | | | | | |
| 4 | COMMAND-SPECIFIC INFORMATION | | | | | | | |
| 11 | | | | | | | | |

The DESCRIPTOR TYPE and ADDITIONAL LENGTH fields are described in 4.5.2.1. For the command-specific information sense data descriptor, the DESCRIPTOR TYPE field shall be set to 01h and the ADDITIONAL LENGTH field shall be set to 0Ah.

The COMMAND-SPECIFIC INFORMATION field contains information that depends on the command on which the exception condition occurred. When a four byte quantity is stored in the COMMAND-SPECIFIC INFORMATION field, the first four bytes shall be zero.

Further meaning for the COMMAND-SPECIFIC INFORMATION field is defined within the command description in the appropriate command standard (e.g., see SBC-3 for the REASSIGN BLOCKS commands, or see 6.3 for the EXTENDED COPY command).

#### 4.5.2.4 Sense key specific sense data descriptor

##### 4.5.2.4.1 Sense key specific sense data descriptor introduction

The sense key specific sense data descriptor (see table 30) provides additional information about the exception condition. The format and content of the sense-key specific data depends on the value in the SENSE KEY field (see 4.5.2.1).

**Table 30 – Sense key specific sense data descriptor format**

| Bit / Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | DESCRIPTOR TYPE (02h) | | | | | | | |
| 1 | ADDITIONAL LENGTH (06h) | | | | | | | |
| 2 | Reserved | | | | | | | |
| 3 | Reserved | | | | | | | |
| 4 | SKSV~~(1b)~~ | SENSE KEY SPECIFIC | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| | Reserved | | | | | | | |

The DESCRIPTOR TYPE and ADDITIONAL LENGTH fields are described in 4.5.2.1. For the sense-key specific sense data descriptor, the DESCRIPTOR TYPE field shall be set to 01h and the ADDITIONAL LENGTH field shall be set to 06h.

~~The sense-key specific valid (SKSV) bit shall be set to one.~~

~~NOTE 3 - In previous versions of this standard and in the fixed format sense data, the SKSV bit indicates whether the contents of the SENSE KEY SPECIFIC field are valid as defined by a command standard. Since the contents of the SENSE KEY SPECIFIC field are valid whenever a sense-key specific sense data descriptor is included in the sense data, the only legal value for the SKSV bit is set to one.~~

A sense-key specific valid (SKSV) bit set to one indicates the SENSE KEY SPECIFIC field contains valid information as defined in this standard. An SKSV bit set to zero indicates that the SENSE KEY SPECIFIC field is not as defined by this standard.

The definition of the SENSE KEY SPECIFIC field (see table 31) is determined by the value of the SENSE KEY field (see 4.5.2.1).

**Table 31 – Sense key specific sense data descriptor definitions**

| Sense Key | Sense key specific field definition | Reference |
|---|---|---|
| ILLEGAL REQUEST | Field pointer | 4.5.2.4.2 |
| HARDWARE ERROR, MEDIUM ERROR, or RECOVERED ERROR | Actual retry count | 4.5.2.4.3 |
| NO SENSE or NOT READY | Progress indication | 4.5.2.4.4 |
| COPY ABORTED | Segment pointer | 4.5.2.4.5 |
| UNIT ATTENTION | Unit attention condition queue overflow | 4.5.2.4.6 |
| All other sense keys | ~~The sense key specific sense data descriptor shall not appear in the descriptor format sense data and the SKSV bit (see 4.5.3) shall be set to zero in the fixed format sense data~~ Reserved bytes | 4.5.2.4.7 |

#### 4.5.2.4.2 Field pointer sense key specific data

If the sense key is ILLEGAL REQUEST, then the SENSE KEY SPECIFIC field shall be as shown in table 32.

**Table 32 – Field pointer sense key specific data**

| Byte \ Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | SKSV~~(1b)~~ | C/D | Reserved | | BPV | BIT POINTER | | |
| 1 | FIELD POINTER | | | | | | | |
| 2 | | | | | | | | |

The SKSV bit is described in 4.5.2.4.1 ~~for descriptor format sense data and in 4.5.3 for fixed format sense data~~.

A command data (C/D) bit set to one indicates that the illegal parameter is in the CDB. A C/D bit set to 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 set to zero indicates that the value in the BIT POINTER field is not valid. A BPV bit set to 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 first bit (i.e., the 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 first byte (i.e., the left-most byte) of the field. If several consecutive bytes are reserved, each shall be treated as a single-byte field.

NOTE 4 - The bytes identified as being in error are not necessarily the bytes that need to be changed to correct the problem.

#### 4.5.2.4.3 Actual retry count sense key specific data

If the sense key is HARDWARE ERROR, MEDIUM ERROR, or RECOVERED ERROR, then the SENSE KEY SPECIFIC field shall be as shown in table 33.

**Table 33 – Actual retry count sense key specific data**

| Byte \ Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | SKSV~~(1b)~~ | Reserved | | | | | | |
| 1 | ACTUAL RETRY COUNT | | | | | | | |
| 2 | | | | | | | | |

The SKSV bit is described in 4.5.2.4.1 ~~for descriptor format sense data and in 4.5.3 for fixed format sense data~~.

The ACTUAL RETRY COUNT field returns vendor specific information on the number of retries of the recovery algorithm used in attempting to recover an error or exception condition.

NOTE 5 - This field should be computed in the same way as the retry count fields within the Read-Write Error Recovery mode page (see SBC-2, SSC-3, and MMC-4).

#### 4.5.2.4.4 Progress indication sense key specific data

If the sense key is NO SENSE or NOT READY, the SENSE KEY SPECIFIC field shall be as shown in table 34.

**Table 34 – Progress Indication sense key specific data**

| Byte \ Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | SKSV~~(1b)~~ | Reserved | | | | | | |
| 1 | PROGRESS INDICATION | | | | | | | |
| 2 | | | | | | | | |

The SKSV bit is described in 4.5.2.4.1 ~~for descriptor format sense data and in 4.5.3 for fixed format sense data~~.

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

NOTE 6 - The progress indication should be time related, however this is not an absolute requirement. (E.g., since 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.)

#### 4.5.2.4.5 Segment pointer sense key specific data

If the sense key is COPY ABORTED, the SENSE KEY SPECIFIC field shall be as shown in table 35.

**Table 35 – Segment pointer sense key specific data**

| Byte \ Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | SKSV~~(1b)~~ | Resvd | SD | Resvd | BPV | BIT POINTER | | |
| 1 | FIELD POINTER | | | | | | | |
| 2 | | | | | | | | |

The SKSV bit is described in 4.5.2.4.1 ~~for descriptor format sense data and in 4.5.3 for fixed format sense data~~.

The segment descriptor (SD) bit indicates whether the field pointer is relative to the start of the parameter list or to the start of a segment descriptor. An SD bit set to zero indicates that the field pointer is relative to the start of the parameter list. An SD bit set to 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 6.3.3).

A bit pointer valid (BPV) bit set to zero indicates that the value in the BIT POINTER field is not valid. A BPV bit set to 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.

If the parameter list is in excess of 65 528 bytes in length and SD is set to zero, the FIELD POINTER value may not fit in two bytes provided by the sense key specific sense data descriptor.

**4.5.2.4.6 Unit attention condition queue overflow sense key specific data**

If the sense key is UNIT ATTENTION, the SENSE KEY SPECIFIC field shall be as shown in table 36.

**Table 36 – Unit attention queue overflow sense key specific data**

| Bit / Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | SKSV~~(1b)~~ | Reserved | | | | | | OVERFLOW |
| 1 | | Reserved | | | | | | |
| 2 | | | | | | | | |

The SKSV bit is described in 4.5.2.4.1 ~~for descriptor format sense data and in 4.5.3 for fixed format sense data~~.

An OVERFLOW bit set to one indicates that the unit attention condition queue has overflowed. An OVERFLOW bit set to zero indicates that the unit attention condition queue has not overflowed.

**4.5.2.4.7 Other sense key specific data**

If the sense key is not one of the defined values in the Sense Key column of table 31, the SENSE KEY SPECIFIC field shall be as shown in table new1.

**Table new1 – Other sense key specific data**

| Bit / Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | SKSV | Reserved | | | | | | |
| 1 | | Reserved | | | | | | |
| 2 | | | | | | | | |

The SKSV bit is described in 4.5.2.4.1.

All other fields are reserved.

#### 4.5.2.5 Field replaceable unit sense data descriptor

The field replaceable unit sense data descriptor (see table 37) provides information about a component that has failed.

**Table 37 – Field replaceable unit sense data descriptor format**

| Byte \ Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | DESCRIPTOR TYPE (03h) | | | | | | | |
| 1 | ADDITIONAL LENGTH (02h) | | | | | | | |
| 2 | Reserved | | | | | | | |
| 3 | FIELD REPLACEABLE UNIT CODE | | | | | | | |

The DESCRIPTOR TYPE and ADDITIONAL LENGTH fields are described in 4.5.2.1. For the field replaceable unit sense data descriptor, the DESCRIPTOR TYPE field shall be set to 03h and the ADDITIONAL LENGTH field shall be set to 02h.

Non-zero values in the FIELD REPLACEABLE UNIT CODE field are used to identify a component that has failed. A value of zero in this field indicates that no specific component has been identified to have failed or that the data is not available. 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 VPD page (see 7.7.2), if supported by the device server.

#### 4.5.2.6 Vendor specific sense data descriptors

Vendor specific sense data descriptors (see table 38) contain vendor specific data that further defines the nature of the exception condition.

**Table 38 – Vendor specific sense data descriptor format**

| Byte \ Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | DESCRIPTOR TYPE (80h to FFh) | | | | | | | |
| 1 | ADDITIONAL LENGTH (n-1) | | | | | | | |
| 2 | Vendor specific | | | | | | | |
| n | | | | | | | | |

The DESCRIPTOR TYPE and ADDITIONAL LENGTH fields are described in 4.5.2.1. For the vendor specific sense data descriptor, the DESCRIPTOR TYPE field shall be set to a value between 80h and FFh, inclusive.

### 4.5.3 Fixed format sense data

The fixed format sense data for response codes 70h (current errors) and 71h (deferred errors) is defined in table 39.

**Table 39 – Fixed format sense data**

| Bit / Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | VALID | RESPONSE CODE (70h or 71h) | | | | | | |
| 1 | Obsolete | | | | | | | |
| 2 | FILEMARK | EOM | ILI | Resvd | SENSE KEY | | | |
| 3 | INFORMATION | | | | | | | |
| 6 | | | | | | | | |
| 7 | ADDITIONAL SENSE LENGTH (n-7) | | | | | | | |
| 8 | COMMAND-SPECIFIC INFORMATION | | | | | | | |
| 11 | | | | | | | | |
| 12 | ADDITIONAL SENSE CODE | | | | | | | |
| 13 | ADDITIONAL SENSE CODE QUALIFIER | | | | | | | |
| 14 | FIELD REPLACEABLE UNIT CODE | | | | | | | |
| 15 | SKSV | SENSE KEY SPECIFIC | | | | | | |
| 17 | | | | | | | | |
| 18 | Additional sense bytes | | | | | | | |
| n | | | | | | | | |

A VALID bit set to zero indicates that the INFORMATION field is not defined in this standard or any other command standard (see 3.1.27). A VALID bit set to one indicates the INFORMATION field contains valid information as defined in this standard or a command standard.

The contents of the RESPONSE CODE field indicate the error type and format of the sense data (see 4.5.1). For fixed format sense data, the RESPONSE CODE field shall be set to 70h or 71h.

The meaning of the FILEMARK bit is device-type or command specific (e.g., see the SSC-3 READ command and SPACE command for examples of FILEMARK bit usage) and the bit is defined in a command standard (see 3.1.27).

The meaning of the end-of-medium (EOM) bit is device-type or command specific (e.g., see the SSC-3 READ command, SPACE command, and WRITE command for examples of EOM bit usage) and the bit is defined in a command standard (see 3.1.27).

The meaning of the incorrect length indicator (ILI) bit is device-type or command specific (e.g., see the SBC-3 READ LONG command, SBC-3 WRITE LONG command, and SSC-3 READ command for examples of ILI bit usage) and the bit is defined in a command standard (see 3.1.27).

The SENSE KEY, ADDITIONAL SENSE CODE, and ADDITIONAL SENSE CODE QUALIFIER fields are described in 4.5.2.1.

The contents of the INFORMATION field are device-type or command specific and are defined in a command standard (see 3.1.27).

The ADDITIONAL SENSE LENGTH field indicates the number of additional sense bytes that follow. The additional sense length shall be less than or equal to 244 (i.e., limiting the total length of the sense data to 252 bytes). If the sense data is being returned as parameter data by a REQUEST

SENSE command, then the relationship between the ADDITIONAL SENSE LENGTH field and the CDB ALLOCATION LENGTH field is defined in 4.3.5.6.

The COMMAND-SPECIFIC INFORMATION field ~~contains information that depends on the command on which the exception condition occurred~~ is described in 4.5.2.3.

The FIELD REPLACEABLE UNIT CODE field is described in 4.5.2.5.

~~A~~ The sense-key specific valid (SKSV) bit ~~set to one indicates the SENSE KEY SPECIFIC field contains valid information as defined in this standard. An SKSV bit set to zero indicates that the SENSE KEY SPECIFIC field is not as defined by this standard.~~
and the SENSE KEY SPECIFIC field ~~is~~ are described in 4.5.2.4.

The additional sense bytes may contain vendor specific data that further defines the nature of the exception condition.

### 4.5.4 Current errors

[Remainder of this clause is unchanged.]