

To: T10 Technical Committee  
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Date: 18 July 2002  
Subject: T10/02-191r1 SES-2 New Invalid Operation Reason element

### **Revision History**

Revision 0 (28 June 2002) first revision

Revision 1 (18 July 2002) incorporated feedback from July CAP WG – don't make the element go first, let it join the others that follow the device elements

### **Related Documents**

ses2r00 - SCSI Enclosure Services - 2 revision 00

02-193r0 - SES-2 INVOP for Threshold In page

### **Overview**

It can be difficult for applicant software to determine why the INVOP bit is set in the Enclosure Status or Array Status (or Threshold In, if 02-193 is accepted) diagnostic pages.

### **Suggested Changes**

Define a new Invalid Operation Reason element containing fields indicating why the INVOP bit has been set.

#### **4.1.3 Access through non-enclosure services device**

An application client may also be able to address the enclosure services using some other peripheral device type as a transport for enclosure services information to and from the application client. Such peripheral devices have a vendor specific communications connection to the enclosure services process. The actual enclosure services device is not visible as a SCSI device or logical unit, but merely transports the standard enclosure services information through the addressed SCSI device. Such devices shall use the same SEND DIAGNOSTIC and RECEIVE DIAGNOSTIC RESULTS commands and page formats used by an enclosure services device, but otherwise support the device model specified by their peripheral device type value. SCSI device servers set the enclosure services bit (ENC SERV) in the standard INQUIRY data (see SPC-3) to indicate that they are capable of transporting enclosure services information if an enclosure services process is connected to the device. An application client determines that an enclosure services process is actually connected to the device by using the RECEIVE DIAGNOSTIC RESULTS command to request a Configuration diagnostic page. If the SCSI device is not able to communicate with an enclosure services process, a CHECK CONDITION status is returned and the sense data is set appropriately. The Enclosure Services Management mode page may be implemented by a SCSI device that allows access to the enclosure services process.

#### **4.4 Invalid field errors [as modified by 02-193]**

Any invalid fields included in the CDB or parameters of a SEND DIAGNOSTIC command and any invalid fields in the CDB of a RECEIVE DIAGNOSTIC RESULTS command shall be detected by the device server in an enclosure services device. An enclosure services device shall analyze these parameters before performing the requested operations and, if there is an error, the command shall be terminated with a CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall identify the location of the invalid fields, CDB, or parameter data.

The device server in a non-enclosure services device does not have the capability of analyzing the validity of the CDB and the parameters. Instead, the device server shall pass the parameters through to the enclosure services process without testing the validity of the parameters and shall return GOOD status. For errors in any diagnostic page other than the Threshold In diagnostic page, the Invalid Operation Requested bit (INVOP) (see 6.1.4) shall be set in the next Enclosure Status diagnostic page or Array Status diagnostic page returned to any initiator. For errors in the Threshold Out diagnostic page, the Invalid Operation Requested bit (INVOP) (see 6.1.8) shall be set in the next Threshold In diagnostic page returned to any initiator. [An Invalid Operation Reason](#) |

element (see 7.3.nn) may be included in the element list to indicate the reason for the error when returning a status page that has an INVOP bit (e.g., the Enclosure Status, Array Status, or Threshold In diagnostic page).

In a non-enclosure services device, the enclosure services process shall process a RECEIVE DIAGNOSTIC RESULTS command requesting an unsupported page code by returning no data. It shall process a SEND DIAGNOSTIC command requesting an unsupported page code by setting invop to one in the next Enclosure Status diagnostic page or Array Status diagnostic page returned to any initiator.

### 6.1.1 Configuration diagnostic page

The Configuration diagnostic page returns a list of elements in an enclosure. This page shall be implemented if the device supports enclosure services and does not use the Short Enclosure Status diagnostic page. The element list shall include all elements with defined element status or controls and may list any other elements in the enclosure. The Configuration diagnostic page provides enclosure descriptor information and parameters. The Configuration diagnostic page optionally provides descriptive text that applications clients may use to identify elements in more detail. The Configuration diagnostic page shall be read by the RECEIVE DIAGNOSTIC RESULTS command. If a PAGE CODE of 01h is transmitted using a SEND DIAGNOSTIC command, the command shall be treated as having an invalid field error (see 4.4).

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The TYPE DESCRIPTOR HEADER field indicates the element type being described, the number of such elements, and the length of an optional text describing the element type. The format of the TYPE DESCRIPTOR HEADER is shown in table 5. The elements of an enclosure shall be listed in the same order in ~~the Configuration diagnostic page, the type descriptor text of the Configuration diagnostic page, the Enclosure Status and Array Status diagnostic pages, the Enclosure Control and Array Control diagnostic pages, and the Threshold In and Threshold Out diagnostic pages;~~

- a) the Configuration diagnostic page;
- b) the type descriptor text of the Configuration diagnostic page;
- c) the Enclosure Status and Array Status diagnostic pages;
- d) the Enclosure Control and Array Control diagnostic pages; and
- e) the Threshold In and Threshold Out diagnostic pages.

Elements shall be listed in this order, regardless of SUB-ENCLOSURE IDENTIFIER:

- 1) All those elements defining SCSI devices; and
- 2) Elements of of other types.

~~All those elements defining SCSI devices shall be listed before elements of other types, regardless of SUB-ENCLOSURE IDENTIFIER.~~ Type descriptor headers for elements other than device elements may be listed in any order in the Configuration diagnostic page. The type descriptor text strings shall be placed after all type descriptor headers.

The TYPE DESCRIPTOR TEXT is an optional text string from zero to 255 bytes for each type descriptor header. The text string, if it has a length greater than zero, may contain any descriptive information about the element type that may be useful to an application client that is displaying the configuration of the enclosure. The TYPE DESCRIPTOR TEXT items shall be placed in the same order as the type descriptor headers, except that text items of 0 length shall be omitted.

Examples of information that may be included in the TYPE DESCRIPTOR TEXT field include the manufacturer's part number for a replacement element, a brief description of the element and its properties, or instructions about configuration limitations and redundancy requirements of the elements of that type.

The TYPE DESCRIPTOR TEXT uses the character encoding and language specified by the language element (see 7.2.16).

### 6.1.4 Enclosure Status diagnostic page [as modified by 02-193]

The Enclosure Status diagnostic page returns status information for each of the elements identified by the Configuration diagnostic page. In addition, an OVERALL STATUS field is provided to collect information about the collection of elements of the same type defined by each TYPE DESCRIPTOR HEADER. The information provides the status about many functions within the addressed enclosure.

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The INVOP, INFO, NON-CRIT, CRIT, and UNRECOV bits are mandatory. The bits may be read with an allocation length greater than one and may be examined by an enclosure polling procedure to determine if events have occurred that require reading the complete page. The bits are set independently and may be set in any combination. The bits may be set by either the enclosure services process or with the Enclosure Control diagnostic page.

The Invalid Operation Requested bit (INVOP) shall be set to one if an invalid field error (see 4.4) has occurred (e.g., an Enclosure Control diagnostic page or an Array Control diagnostic page with an invalid format has previously been transmitted to the enclosure services process and an application client has not already been informed of the error). For enclosure service devices, the INVOP bit shall be set one time in the first Enclosure Status diagnostic page or Array Status diagnostic page read by the same initiator that transmitted the invalid control page. If the application client was notified by a CHECK CONDITION when the SEND DIAGNOSTIC command transmitted the invalid control page, the INVOP bit shall not be set. Enclosure services processes that are accessed through another device type shall set the INVOP bit one time in the first Enclosure Status or Array Status diagnostic page read by any application client.

An Invalid Operation Reason element may be included in the element list. If INVOP is set to zero and an Invalid Operation Reason element (see 7.3.nn) is included, the Invalid Operation Reason element shall be ignored.

#### **6.1.8 Threshold In page [as modified by 02-193]**

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The GENERATION CODE shall have the same value as the GENERATION CODE in the Configuration diagnostic page, described in 6.1.2.

The Invalid Operation Requested bit (INVOP) shall be set if a Threshold Out diagnostic page with an invalid format has previously been transmitted to the enclosure services process and an application client has not already been informed of the error. For enclosure service devices, the INVOP bit shall be set one time in the first Threshold In diagnostic page read by the same initiator that transmitted the invalid control page. If the application client was notified by a CHECK CONDITION when the SEND DIAGNOSTIC command transmitted the invalid Threshold Out diagnostic page, the INVOP bit shall not be set. Enclosure services processes that are accessed through another device type shall set the INVOP bit one time in the first Threshold In page read by any application client.

An Invalid Operation Reason element may be included in the element list. If INVOP is set to zero and an Invalid Operation Reason element (see 7.3.nn) is included, the Invalid Operation Reason element shall be ignored.

The OVERALL THRESHOLD field for each element type has the same format as the corresponding ELEMENT THRESHOLD field. There is exactly one OVERALL THRESHOLD field for each TYPE DESCRIPTOR HEADER in the Configuration diagnostic page (see table 4). The OVERALL THRESHOLD optionally contains a summary of the threshold values for all of the elements of that type. The OVERALL THRESHOLD also may be used to contain the threshold values for those elements whose individual threshold values are not available, but that do have threshold values.

Following the OVERALL THRESHOLD field, there shall be one ELEMENT THRESHOLD field for each of the possible elements identified by the NUMBER OF POSSIBLE ELEMENTS field in the corresponding

TYPE DESCRIPTOR HEADER. Each ELEMENT THRESHOLD field optionally contains the actual threshold information for the element.

The OVERALL THRESHOLD field and the ELEMENT THRESHOLD field have the format specified in table 14.

The HIGH CRITICAL THRESHOLD field indicates the value at which the enclosure shall indicate a critical condition if a higher value is detected by the sensor element. A value of zero indicates that the sensor element does not test a high critical threshold.

The HIGH WARNING THRESHOLD field indicates the value at which the enclosure shall indicate a noncritical condition if the sensor element detects a value higher than the specified threshold value. A value of zero indicates that the sensor element does not test a high warning threshold.

The LOW WARNING THRESHOLD field indicates the value at which the enclosure shall indicate a noncritical condition if the sensor element detects a value lower than the specified threshold value. A value of zero indicates that the sensor element does not test a low warning threshold.

The LOW CRITICAL THRESHOLD field indicates the value at which the enclosure shall indicate a critical condition if the sensor element detects a value lower than the specified threshold value. A value of zero indicates that the sensor element does not test a low critical threshold.

The threshold values represent the values that the enclosure is using at the time the command is executed.

Each 8-bit threshold value shall have the definition specified by the text describing the corresponding element field. As an example, voltage sensor elements measure voltage in units of 10 millivolts. The threshold value is defined by 7.3.18 as a percentage of the nominal voltage in units of 0.5%. A HIGH CRITICAL THRESHOLD field value of 14 indicates that a critical condition shall be indicated when the voltage is 7% over the nominal maximum supply voltage, while a LOW WARNING THRESHOLD field value of 10 indicates that a noncritical condition shall be indicated when the voltage is 5% under the nominal minimum supply voltage.

**6.1.11 Array Status diagnostic page**

The optional Array Status diagnostic page returns the array elements for the devices resident in the enclosure.

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An Invalid Operation Reason element may be included in the element list. If INVOP is set to zero and an Invalid Operation Reason element (see 7.3.nn) is included, the Invalid Operation Reason element shall be ignored.

**7 Element definitions**

**7.1 Element definitions overview**

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Table 22 lists the elements and their ELEMENT TYPE codes. The table additionally indicates which elements accept the DISABLE bit (see 7.2.2) and which elements contain a value subject to comparison with a threshold.

**Table 23 – Element type codes**

| Type code | Type of element                             | DISABLE bit reference | Threshold       | Reference     |
|-----------|---|-----------------------|-----------------|---------------|
| ...       |   |                       |                 |               |
| 0Ah       | <u>Reserved</u><br><u>Invalid Operation</u> | <u>Reserved</u>       | <u>Reserved</u> | <u>7.2.nn</u> |

|     |               |                    |             |  |
|-----|---------------|--------------------|-------------|--|
|     | <u>Reason</u> | <u>Not defined</u> | <u>None</u> |  |
| ... |               |                    |             |  |

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**7.3 Field definitions for all element types**

**7.3.nn Invalid Operation Reason element**

An Invalid Operation Reason element is used to report information about why an INVOP bit is set to one. It is only meaningful in the pages which define INVOP bits (e.g., the Enclosure Status, Array Status, and Threshold In diagnostic pages).

The format of the CONTROL INFORMATION field for an Invalid Operation Reason element is shown in table xx.

**Table xx. Invalid Operation Reason element for control type diagnostic pages**

|          |                       |          |          |          |          |          |          |          |
|----------|-----------------------|----------|----------|----------|----------|----------|----------|----------|
|          | <u>7</u>              | <u>6</u> | <u>5</u> | <u>4</u> | <u>3</u> | <u>2</u> | <u>1</u> | <u>0</u> |
| <u>0</u> | <u>COMMON CONTROL</u> |          |          |          |          |          |          |          |
| <u>1</u> |                       |          |          |          |          |          |          |          |
| <u>2</u> | <u>Reserved</u>       |          |          |          |          |          |          |          |
| <u>3</u> |                       |          |          |          |          |          |          |          |

[Editor's note: none of the COMMON CONTROL bits apply, so this is just 3 reserved bytes for control pages.]

The format of the STATUS INFORMATION field for an Invalid Operation Reason element is defined in table xx.

**Table xx. Invalid Operation Reason element for status type diagnostic pages**

|          |                            |          |          |          |          |          |          |          |
|----------|----------------------------|----------|----------|----------|----------|----------|----------|----------|
|          | <u>7</u>                   | <u>6</u> | <u>5</u> | <u>4</u> | <u>3</u> | <u>2</u> | <u>1</u> | <u>0</u> |
| <u>0</u> | <u>COMMON STATUS</u>       |          |          |          |          |          |          |          |
| <u>1</u> | <u>INVOP TYPE</u>          |          |          |          |          |          |          |          |
| <u>2</u> | <u>INVOP TYPE specific</u> |          |          |          |          |          |          |          |
| <u>3</u> |                            |          |          |          |          |          |          |          |

[Editor's note: none of the COMMON STATUS bits apply.]

Table ww defines the INVOP TYPE field, which defines the format of the INVOP TYPE-specific bytes.

**Table ww. INVOP TYPE values**

| <u>INVOP TYPE value</u> | <u>Description</u>                       | <u>Reference</u> |
|-------------------------|--|------------------|
| <u>00b</u>              | <u>SEND DIAGNOSTIC page code error</u>   | <u>Table z00</u> |
| <u>01b</u>              | <u>SEND DIAGNOSTIC page format error</u> | <u>Table z01</u> |
| <u>10b</u>              | <u>Reserved</u>                          |                  |
| <u>11b</u>              | <u>Vendor-specific error</u>             | <u>Table z11</u> |

The format of the STATUS INFORMATION field when INVOP TYPE is 00b is defined in table z00.

**Table z00. Invalid Operation Reason element for status type diagnostic pages with INVOP TYPE of 00b**

|          | <u>7</u>                | <u>6</u> | <u>5</u>        | <u>4</u> | <u>3</u> | <u>2</u> | <u>1</u>                  | <u>0</u> |
|----------|-------------------------|----------|-----------------|----------|----------|----------|---------------------------|----------|
| <u>0</u> | <u>COMMON STATUS</u>    |          |                 |          |          |          |                           |          |
| <u>1</u> | <u>INVOP TYPE (00b)</u> |          | <u>Reserved</u> |          |          |          | <u>PAGE NOT SUPPORTED</u> |          |
| <u>2</u> | <u>Reserved</u>         |          |                 |          |          |          |                           |          |
| <u>3</u> |                         |          |                 |          |          |          |                           |          |

The PAGE NOT SUPPORTED bit indicates a SEND DIAGNOSTIC command requested a page not supported by the enclosure service process. This bit is only set to one when this element is returned by the Enclosure Status and the Array Status pages.

The format of the STATUS INFORMATION field when INVOP TYPE is 01b is defined in table z01.

**Table z01. Invalid Operation Reason element for status type diagnostic pages with INVOP TYPE of 01b**

|          | <u>7</u>                | <u>6</u> | <u>5</u>           | <u>4</u> | <u>3</u> | <u>2</u>          | <u>1</u> | <u>0</u>     |  |
|----------|-------------------------|----------|--------------------|----------|----------|-------------------|----------|--------------|--|
| <u>0</u> | <u>COMMON STATUS</u>    |          |                    |          |          |                   |          |              |  |
| <u>1</u> | <u>INVOP TYPE (01b)</u> |          | <u>Reserved</u>    |          |          | <u>BIT NUMBER</u> |          |              |  |
| <u>2</u> | <u>(MSB)</u>            |          | <u>BYTE OFFSET</u> |          |          |                   |          |              |  |
| <u>3</u> |                         |          |                    |          |          |                   |          | <u>(LSB)</u> |  |

The BIT NUMBER field contains the bit number of the most significant bit of the field responsible for the INVOP bit being set.

The BYTE OFFSET field contains the byte offset of the most significant byte of the field responsible for the INVOP bit being set.

The format of the STATUS INFORMATION field when INVOP TYPE is 11b is defined in table z11.

**Table z11. Invalid Operation Reason element for status type diagnostic pages with INVOP TYPE of 11b**

|          | <u>7</u>                | <u>6</u> | <u>5</u>     | <u>4</u> | <u>3</u> | <u>2</u> | <u>1</u> | <u>0</u>     |  |
|----------|-------------------------|----------|--------------|----------|----------|----------|----------|--------------|--|
| <u>0</u> | <u>COMMON STATUS</u>    |          |              |          |          |          |          |              |  |
| <u>1</u> | <u>INVOP TYPE (11b)</u> |          | <u>(MSB)</u> |          |          |          |          |              |  |
| <u>2</u> | <u>Vendor-specific</u>  |          |              |          |          |          |          |              |  |
| <u>3</u> |                         |          |              |          |          |          |          | <u>(LSB)</u> |  |

### A.3 Configuration diagnostic page using sub-enclosure identifiers

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The TYPE DESCRIPTOR HEADER field indicates the element type being described, the number of such elements, the sub-enclosure where the elements are located, and the length of an optional text describing the element type. The format of the TYPE DESCRIPTOR HEADER is shown in table 75. The elements of an enclosure shall be listed in the same order in ~~the Configuration diagnostic page, the type descriptor text of the Configuration diagnostic page, the enclosure and Array Status diagnostic pages, the enclosure and Array Control diagnostic pages, and the Threshold In and Threshold Out diagnostic pages;~~

a) the Configuration diagnostic page;

- b) the type descriptor text of the Configuration diagnostic page;
- c) the Enclosure Status and Array Status diagnostic pages;
- d) the Enclosure Control and Array Control diagnostic pages; and
- e) the Threshold In and Threshold Out diagnostic pages.

Elements shall be listed in this order, regardless of SUB-ENCLOSURE IDENTIFIER:

- 1) All those elements defining SCSI devices; and
- 2) Elements of of other types.

~~All those elements defining SCSI devices shall be listed before elements of other types, regardless of sub-enclosure identification.~~ The TYPE DESCRIPTOR HEADER fields for elements other than device elements may be listed in any order in the Configuration diagnostic page. The TYPE DESCRIPTOR TEXT fields are placed after all TYPE DESCRIPTOR HEADER fields.