

To: T10 Technical Committee  
From: Rob Elliott, HP (elliott@hp.com)  
Date: 8 December 2004  
Subject: 04-374r1 SES-2 Define a SAS Expander element

**Revision history**

Revision 0 (7 November 2004) First revision

Revision 1 (8 December 2004) Incorporated comments from November SAS and CAP WGs.

**Related documents**

ses2r09 - SCSI Enclosure Services - 2 revision 9

sas1r06 - Serial Attached SCSI - 1.1 revision 6

**Overview**

SAS expanders are not SCSI devices (although some might contain an embedded SCSI target port to provide access to an SES logical unit). This means that Device elements or Array Device elements are not really appropriate ways to represent them in SES. Without representation, though, software is unable to determine the enclosure in which each expander device (discovered with the SMP protocol) is located. If it determines that all the devices attached to an expander are in a certain enclosure, then it might assume that expander is also in that enclosure; however, that is not guaranteed (the expander could be outside in a separate box). The expander's embedded SES logical unit could be listed as a Device element (leading to its enclosure's identification) but not all expanders include SES logical units.

To determine which expanders are located in which enclosures, a new SAS Expander element is proposed. The Device Element Status diagnostic page is renamed the Additional Element Status diagnostic page and expanded to return information about SAS Expander elements in addition to returning that information about Device and Array Device elements.

In a dual-domain enclosure, the enclosure services process may or may not have access to information about expanders in the other domain, so elements for them may or may not be included. The RELATIVE ENCLOSURE SERVICE PROCESS IDENTIFIER and NUMBER OF ENCLOSURE SERVICE PROCESSES fields in the Configuration diagnostic page are the clues to decipher this and map the topology discovered via SMP to the information returned by the enclosure services process.

Additionally, a SAS Connector element is proposed to represent each connector (or specifically, which physically link in each connector) in the enclosure. The Additional Element Status diagnostic page descriptor for each SAS Expander element indicates the SAS Connector to which each phy is attached (if any), and the Device, Array Device, or SAS Expander element (if any) to which each phy is attached.

The following figure is an example of how the Configuration, Enclosure Status (elements), and Additional Element Status pages interact.

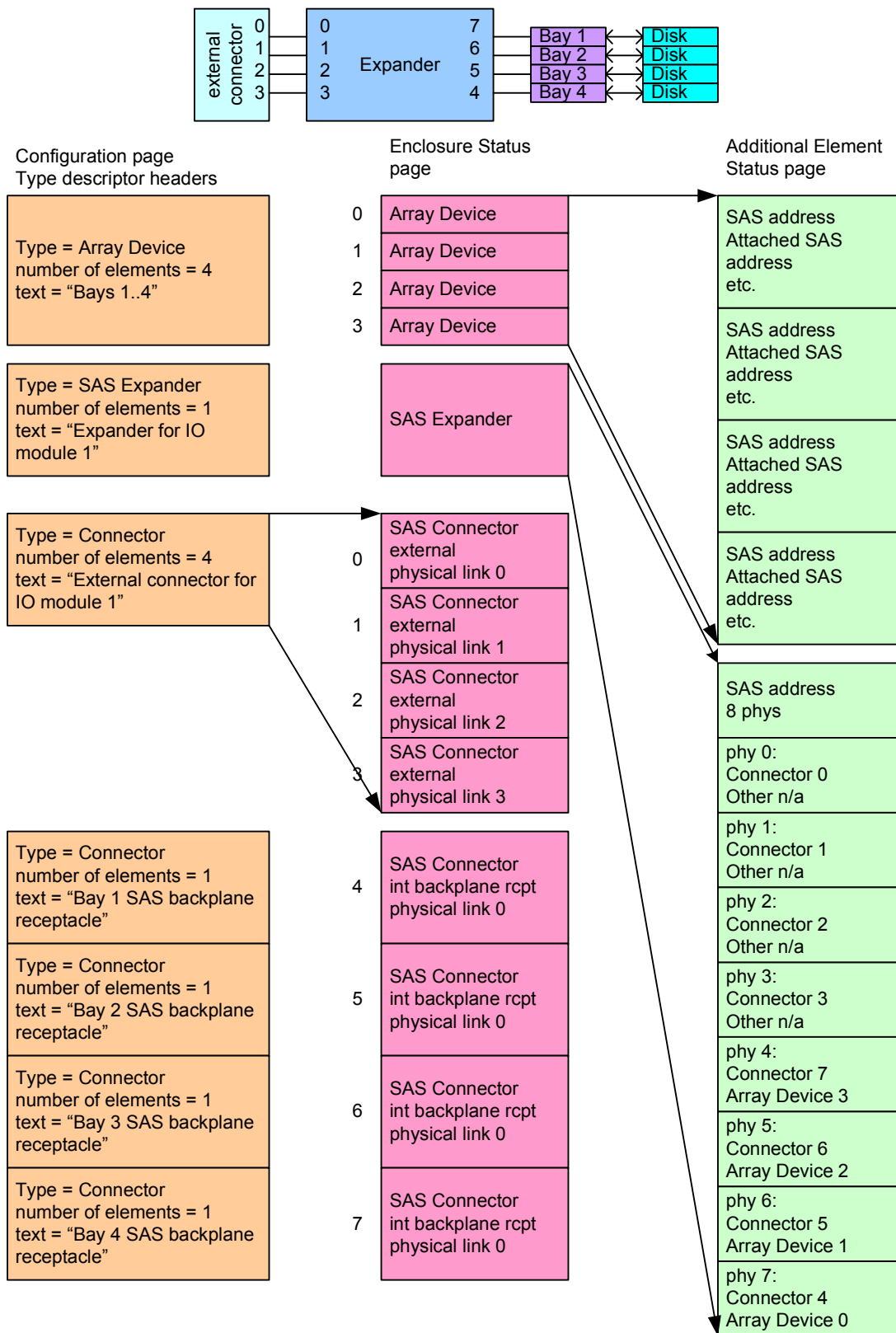


Figure 1 — Examples of diagnostic page contents

**Suggested changes**

### 6.1.13 **Device Additional** Element Status diagnostic page

#### 6.1.13.1 **Device Additional** Element Status diagnostic page overview

The optional **Device Additional** Element Status diagnostic page provides additional information about Device elements **and**, Array Device elements, **and SAS Expander elements**.

The **Device Additional** Status diagnostic page returns a device information descriptor for each of the Device elements **and**, Array Device elements, **and SAS Expander elements** that have been allowed for by the NUMBER OF POSSIBLE ELEMENTS field **in the corresponding type descriptor header** in the Configuration diagnostic page. The device information descriptors shall be in the same order as the ELEMENT STATUS fields in the Enclosure Status diagnostic page.

The **Device Additional** Status diagnostic page is read by the RECEIVE DIAGNOSTIC RESULTS command with a PCV bit set to one and a PAGE CODE field set to 0Ah. If the parameter list for a SEND DIAGNOSTIC command contains a PAGE CODE field set to 0Ah, the command shall be treated as having an invalid field error (see 4.5).

Table 1 describes the **Device Additional** Status diagnostic page.

**Table 1 — Additional Element Status diagnostic page**

Byte\Bit	7	6	5	4	3	2	1	0	
0	PAGE CODE (0Ah)								
1	Reserved								
2	(MSB)	PAGE LENGTH (n - 3)						(LSB)	
3									
4	(MSB)	GENERATION CODE						(LSB)	
7									
<b>Device Additional</b> Element Status descriptor list									
8	Zero or more <b>Device Additional</b> Element Status descriptors (see table 2)								
n									

The PAGE LENGTH field indicates the length in bytes of the diagnostic parameters that follow.

The format of the **Device Additional** Element Status descriptor is shown in table 2.

**Table 2 — Additional Element Status descriptor**

Byte\Bit	7	6	5	4	3	2	1	0
0	Reserved				PROTOCOL IDENTIFIER			
1	<b>DEVICE ADDITIONAL</b> ELEMENT STATUS DESCRIPTOR LENGTH (n - 1)							
2	Protocol-specific information							
n								

The PROTOCOL IDENTIFIER field is defined in SPC-3 and identifies the protocol of the device being described by the **Device Additional** Element Status descriptor.

The **DEVICE ADDITIONAL** ELEMENT STATUS DESCRIPTOR LENGTH field indicates the length in bytes of the protocol-specific information.

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Editor's Note 1: the length field limits each descriptor to 256 bytes

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6.1.13.2 Fibre Channel **Device Additional** Element Status descriptor

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6.1.13.3 Serial Attached SCSI **Device Additional** Element Status descriptor**6.1.13.3.1 Serial Attached SCSI Additional Element Status descriptor overview**

[Table 4 describes the Additional Element Status descriptor for Serial Attached SCSI devices and expander devices.](#)

Table 3 — SAS Additional Element Status descriptor

Byte\Bit	7	6	5	4	3	2	1	0
0	Reserved				PROTOCOL IDENTIFIER (6h)			
1	ADDITIONAL ELEMENT STATUS DESCRIPTOR LENGTH (n - 1)							
2	Descriptor-type specific							
3	DESCRIPTOR TYPE		Descriptor-type specific					
25	Descriptor-type specific							
n	Descriptor-type specific							

A [DESCRIPTOR TYPE](#) field set to zero indicates the descriptor describes a SAS device represented by a [Device element](#) or an [Array Device element](#) (see 6.1.13.3.2). A [DESCRIPTOR TYPE](#) field set to one indicates the descriptor describes a [expander device](#) represented by a [SAS Expander element](#) (see 6.1.13.3.3).

**6.1.13.3.2 SAS Additional Element Status descriptor for Device and Array Device elements**

Table 4 describes the [Device Additional](#) Status descriptor for ~~Serial Attached SCSI devices~~ Device elements and Array Device elements.

Table 4 — SAS Additional Element Status descriptor for Device and Array Device elements

Byte\Bit	7	6	5	4	3	2	1	0
0	Reserved				PROTOCOL IDENTIFIER (6h)			
1	<a href="#">DEVICE ADDITIONAL</a> ELEMENT STATUS DESCRIPTOR LENGTH (n - 1)							
2	NUMBER OFPHY DESCRIPTORS							
3	<a href="#">DESCRIPTOR TYPE (0b)</a>	Reserved						NOT ALL PHYS
Phy descriptor list								
4	Phy descriptor (see table 5) (first)							
31	...							
n - 27	Phy descriptor (see table 5) (last)							
n	Phy descriptor (see table 5) (last)							

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[Editor's Note 2: there is room for 8 phy descriptors](#)

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The [PROTOCOL IDENTIFIER](#) field set to 6h [and DESCRIPTOR TYPE bit set to to zero](#) indicate the descriptor is describing a Serial Attached SCSI (SAS) portsdevice.

The **DEVICE ADDITIONAL** ELEMENT STATUS DESCRIPTOR LENGTH field indicates the length in bytes of the rest of the **Device Additional** Status descriptor.

The NUMBER OF PHY DESCRIPTORS field indicates how many phy descriptors **follow** [are in the phy descriptor list](#).

A NOT ALL PHYS bit set to one indicates that all phys in the SAS device are not described. A NOT ALL PHYS bit set to zero indicates that all phys in the SAS device are described.

**NOTE 1** [The NOT ALL PHYS bit may be set to one for SAS devices with multiple ports, where the enclosure services process only has access to information about the phys in one of the ports \(e.g., in the same SAS domain as the enclosure services process\).](#)

Table 5 describes the phy descriptor.

**Table 5 — Phy descriptor**

Byte\Bit	7	6	5	4	3	2	1	0
0	Reserved	DEVICE TYPE			Reserved			
1	Reserved							
2	Reserved				SSP INITIATOR PORT	STP INITIATOR PORT	SMP INITIATOR PORT	Reserved
3	Reserved				SSP TARGET PORT	STP TARGET PORT	SMP TARGET PORT	Reserved
4	ATTACHED SAS ADDRESS							
11	SAS ADDRESS							
12	PHY IDENTIFIER							
20	Reserved							
21	Reserved							
27	Reserved							

The DEVICE TYPE field, SSP INITIATOR PORT bit, STP INITIATOR PORT bit, SMP INITIATOR PORT bit, SSP TARGET PORT bit, STP TARGET PORT bit, SMP TARGET PORT bit, SAS ADDRESS field, and PHY IDENTIFIER field contain the values of the fields in the IDENTIFY address frame transmitted by the phy (see SAS).

**NOTE 2** - The phy transmits these fields in the IDENTIFY address frame to the attached phy (usually an [expander phy in an](#) expander device). The enclosure [services](#) process may retrieve the values from the attached phy (e.g., an enclosure process built into an expander device has direct access [to the values received by the expander phy](#)).

The ATTACHED SAS ADDRESS field contains the SAS address of the attached phy (e.g., [the SAS address of the expander phy to which the SAS device is attached](#))(see SAS).

**NOTE 3** - All the fields are from the perspective of the SAS device associated with the Device element (e.g., the disk drive), not the device (e.g., the expander device) which receives the IDENTIFY address frame. The ATTACHED SAS ADDRESS fields [for multiple phys in the same SAS device](#) indicate if [a](#)the SAS device is attached to more than one SAS domain.

### **[6.1.13.3 SAS Additional Element Status descriptor for SAS Expander elements \[all new\]](#)**

[Table 6 describes the Additional Status descriptor for SAS Expander elements.](#)

**Table 6 — SAS Additional Element Status descriptor for SAS Expander elements**

Byte\Bit	7	6	5	4	3	2	1	0
0	Reserved				PROTOCOL IDENTIFIER (6h)			
1	ADDITIONAL ELEMENT STATUS DESCRIPTOR LENGTH (n - 1)							
2	NUMBER OF EXPANDER PHY DESCRIPTORS							
3	<a href="#">DESCRIPTOR TYPE (1b)</a>	Reserved						
4	SAS ADDRESS							
11								
Expander phy descriptor list								
12	Expander phy descriptor (see table 5) (first)							
	...							
n	Expander phy descriptor (see table 5) (last)							

[The PROTOCOL IDENTIFIER field set to 6h and DESCRIPTOR TYPE field set to one indicate the descriptor is describing a Serial Attached SCSI \(SAS\) expander device.](#)

[The DEVICE ELEMENT STATUS DESCRIPTOR LENGTH field indicates the length in bytes of the rest of the Additional Status descriptor.](#)

[The SAS ADDRESS field indicates the SAS address of the expander device \(see SAS\).](#)

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Editor's Note 3: there is room for 122 expander phy descriptors

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[Table 5 describes the expander phy descriptor.](#)

**Table 7 — Expander phy descriptor**

Byte\Bit	7	6	5	4	3	2	1	0
0	CONNECTOR ELEMENT INDEX							
1	OTHER ELEMENT INDEX							

[The CONNECTOR ELEMENT INDEX field indicates the index of a Connector element to which the expander phy is attached. If the expander phy is not attached to a connector represented by a Connector element, this field shall be set to FFh.](#)

[The OTHER ELEMENT INDEX field indicates the index of a Device element, Array Device element, or SAS Expander element to which the expander phy is attached. If the expander phy is not attached to one of those elements, this field shall be set to FFh.](#)

## 7.1 Element definitions overview

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Table 8 lists the elements and their ELEMENT TYPE codes, and indicates which elements accept the DISABLE bit (see 7.2.2) in their control field, and which elements contain a value subject to comparison with a threshold.

Table 8 — Element type codes

Type code	Type of element	DISABLE bit reference	Threshold	Reference
00h	Unspecified	not defined	none	7.3.1
01h	Device	not defined	none	7.3.2
02h	Power Supply	not defined	none	7.3.4
03h	Cooling	not defined	none	7.3.5
04h	Temperature Sensor	7.3.6	temperature	7.3.6
05h	Door Lock	not defined	none	7.3.7
06h	Audible Alarm	not defined	none	7.3.8
07h	Enclosure Services Controller Electronics	not defined	none	7.3.9
08h	SCC Controller Electronics	not defined	none	0.0.1
09h	Nonvolatile Cache	not defined	none	7.3.11
0Ah	Invalid Operation Reason	not defined	none	7.3.12
0Bh	Uninterruptible Power Supply	not defined	battery status	7.3.13
0Ch	Display	not defined	none	7.3.14
0Dh	Key Pad Entry	not defined	none	7.3.15
0Eh	Enclosure	not defined	none	7.3.16
0Fh	SCSI Port/Transceiver	not defined	none	7.3.17
10h	Language	not defined	none	7.3.18
11h	Communication Port	not defined	none	7.3.19
12h	Voltage Sensor	7.3.20	% voltage	7.3.20
13h	Current Sensor	7.3.21	% current	7.3.21
14h	SCSI Target Port	not defined	none	7.3.22
15h	SCSI Initiator Port	not defined	none	7.3.23
16h	Simple Subenclosure	not defined	none	7.3.24
17h	Array Device	not defined	none	7.3.3
<a href="#">18h</a>	<a href="#">SAS Expander</a>	<a href="#">not defined</a>	<a href="#">none</a>	<a href="#">7.3.xx</a>
<del>18h</del> <a href="#">19h</a> -7Fh	Reserved	reserved	reserved	
80h-FFh	Vendor-specific	vendor specific	vendor specific	

### 0.0.1 SAS Expander element [\[new\]](#)

The SAS Expander element represents a SAS expander device.

The format of the control field for a SAS Expander element is defined in table 9.

**Table 9 — SAS Expander element for control type diagnostic pages**

Byte\Bit	7	6	5	4	3	2	1	0
0	COMMON CONTROL							
1	RQST IDENT	Reserved						
2	Reserved							
3	Reserved							

The COMMON CONTROL field is specified in 7.2.2.

The RQST IDENT (request identify) bit is set to request that the element be identified by a visual indication. When the RQST IDENT bit is set to zero, the visual indication is not present.

The format of the status field for a SAS Expander element is defined in table 10.

**Table 10 — SAS Expander element for status type diagnostic pages**

Byte\Bit	7	6	5	4	3	2	1	0
0	COMMON STATUS							
1	IDENT	Reserved						
2	Reserved							
3	Reserved							

The COMMON STATUS field is specified in 7.2.3.

The IDENT (identify) bit is set to one to indicate that the RQST IDENT control bit has been set and that the element is providing a visual indication of its location. The IDENT bit is set to zero when the RQST IDENT control bit is set to zero or not implemented.

### 0.0.2 SAS Connector element [\[new\]](#)

The SAS Connector element represents a SAS connector or a portion of a SAS connector.

The format of the control field for a SAS Connector element is defined in table 11.

**Table 11 — SAS Connector element for control type diagnostic pages**

Byte\Bit	7	6	5	4	3	2	1	0
0	COMMON CONTROL							
1	RQST IDENT	Reserved						
2	Reserved							
3	Reserved							

The COMMON CONTROL field is specified in 7.2.2.

The RQST IDENT (request identify) bit is set to request that the element be identified by a visual indication. When the RQST IDENT bit is set to zero, the visual indication is not present.



The format of the status field for a SAS Connector element is defined in table 12.

**Table 12 — SAS Connector element for status type diagnostic pages**

Byte\Bit	7	6	5	4	3	2	1	0
0	COMMON STATUS							
1	IDENT	CONNECTOR TYPE						
2	CONNECTOR PHYSICAL LINK							
3	Reserved							

The COMMON STATUS field is specified in 7.2.3.

The IDENT (identify) bit is set to one to indicate that the RQST IDENT control bit has been set and that the element is providing a visual indication of its location. The IDENT bit is set to zero when the RQST IDENT control bit is set to zero or not implemented.

The CONNECTOR TYPE field indicates the type of connector and is defined in table 13.

**Table 13 — CONNECTOR TYPE field**

Code	Description	Maximum number of physical links (informative)
00h	No information	unknown
01h	SAS external receptacle (i.e., SFF-8470)	4
10h	SAS internal wide plug (i.e., SFF-8484)	4
20h	SAS backplane receptacle (i.e., SFF-8482)	2
21h	SATA-style host plug (i.e., ATA/ATAPI-7 V3)	1
22h	SAS plug (i.e., SFF-8484)	2
23h	SATA device plug (i.e., ATA/ATAPI-7 V3)	1
All others	Reserved	

The CONNECTOR PHYSICAL LINK field indicates the physical link in the connector represented by this element. A CONNECTOR PHYSICAL LINK field set to FFh indicates that the element represents the entire connector, not just one physical link in the connector. If a connector has only one physical link, the CONNECTOR PHYSICAL LINK field should be set to 01h rather than FFh.