

To: T10 Technical Committee
 From: Rob Elliott, HP (elliott@hp.com)
 Date: 12 April 2007
 Subject: 07-091r1 SAS-2 SMP function support for SNW-3 phy capabilities

Revision history

Revision 0 (28 February 2007) First revision (offshoot of 06-362r3).

Revision 1 (12 April 2007) Incorporated comments from March 2007 SAS physical WG - added mode page/log page support and SNW selection. Restructured the SNW-3 bit definitions into the traditional "byte\bit" table format rather than a single little-endian bitstream. Per request by Bob Sheffield (Intel), changed the PROGRAMMED PHY CAPABILITIES field from containing only the changeable bits that the application client has selected to containing the full set of bits (including START and PARITY) that are scheduled to be sent in the next SNW-3.

Related documents

sas2r08 - Serial Attached SCSI - 2 (SAS-2) revision 8

06-324/06-515 SAS-2 SAS-2 Modifications to speed negotiation (Steve Finch, ST Microelectronics and Amr Wassal, PMC-Sierra) - incorporated into sas2r08

06-363r3 SAS-2 SNW-3 bit definitions (Rob Elliott, HP) - incorporated into 06-324r7

Overview

Applications need to be able to access the SNW-3 phy capabilities bits.

1. Four fields are added to the SMP DISCOVER response for phys controlled by management device servers:

- a) incoming phy capabilities bits last received by the phy (including the START bit and the PARITY bit)
- b) outgoing phy capabilities bits last sent by the phy (including the START bit and the PARITY bit)
- c) outgoing phy capabilities bits that may be changed via PHY CONTROL (only bits 8-13, which specify G1-G3 with/without SSC)
- d) outgoing phy capabilities bits that will be sent by the phy in the next SNW-3. Includes any changes specified via PHY CONTROL (bits 8-13). The START bit is always one, and the PARITY bit is calculated by the management device server.

and one field to the SMP PHY CONTROL request:

- e) outgoing changeable phy capabilities bits (only bits 8-13 are honored).

2. Access to the phy capabilities bits for SSP end devices is added to the Protocol-Specific Phy Control And Discover mode page (only equivalents of the DISCOVER fields, not the PHY CONTROL field).

One approach (**option A**) requires adding a length field at the end of the SAS phy mode descriptor. If a SAS-1.1 application receives the SAS-2 mode page format, it will see the number of phy mode descriptors doesn't match the size of the mode page; it should interpret that as meaning there are additional fields at the end of the phy mode descriptor list. So, **option B** adds a SAS phy additional mode descriptor list at the end instead. If these are both deemed too risky, a new subpage could be defined to carry the additional fields. (At some point, software needs to tolerate growing mode pages, though.)

3. Access to the phy capabilities bits for SSP end devices is added to the Protocol-Specific Port log page (only equivalents of the DISCOVER fields, not the PHY CONTROL field).

Unlike the mode page, the SAS phy log descriptor already includes a length field, so extending the descriptor should be compatible with SAS-1.1 applications.

4. The SNW-3 bit definitions are restructured to follow usual SCSI conventions of byte\bit tables, rather than include one little-endian bit stream with bits numbered 0 through 31.

5. Control over which SNWs the phy will participate in is added in the SMP PHY CONTROL request.

Some notable combinations are:

- f) SNW-1=no, SNW-2=no, SNW-3=no: This would disable the phy, so is disallowed (000b means "don't change the current setting")

- g) SNW-1=no, SNW-2=no, SNW-3=yes: Useful if the system requires that SSC be enabled at all rates, or the physical link not be used at all
- h) SNW-1=yes, SNW-2=no, SNW-3=yes: If selected, the phy will only reach SNW-3 if the other phy does not participate in SNW-1.

6. Fields reporting the negotiated physical link rate and hardware muxing supported are added to the mode and log pages.

Suggested changes to SAS-2

6.7.4.2.3.3 SNW-3

SNW-3 allows the phys to exchange phy capabilities values indicating supported settings and other information.

If a phy supports SNW-3, then the phy:

- a) transmits a 32-bit phy capabilities value describing the capabilities of the phy; and
- b) receives a 32-bit phy capabilities value from the attached phy. If the attached phy does not support SNW-3, the phy capabilities bits are all set to zero (i.e., D.C. idle).

If a phy does not support SNW-3, then the phy:

- a) transmits D.C. idle; and
- b) ignores any SNW-3 phy capabilities bits received.

The first bit of the phy capabilities value is the START bit and shall be transmitted as a one. Each of the remaining 31 bits is a one or zero.

The transmitter shall:

- 1) transmit D.C. idle for an RCDT;
- 2) transmit 32 phy capabilities bits; and
- 3) transmit D.C. idle for the remainder of SNTT.

Table 1 defines the content of each phy capabilities bit.

Table 1 — SNW-3 phy capabilities bit

Value	Transmitted
One	COMWAKE (see 6.6)
Zero	D.C. idle

Figure 1 defines SNW-3, including:

- a) speed negotiation window time;
- b) speed negotiation window rate of 1,5 Gbps;
- c) rate change delay time (RCDT); and
- d) speed negotiation transmit time (SNTT).

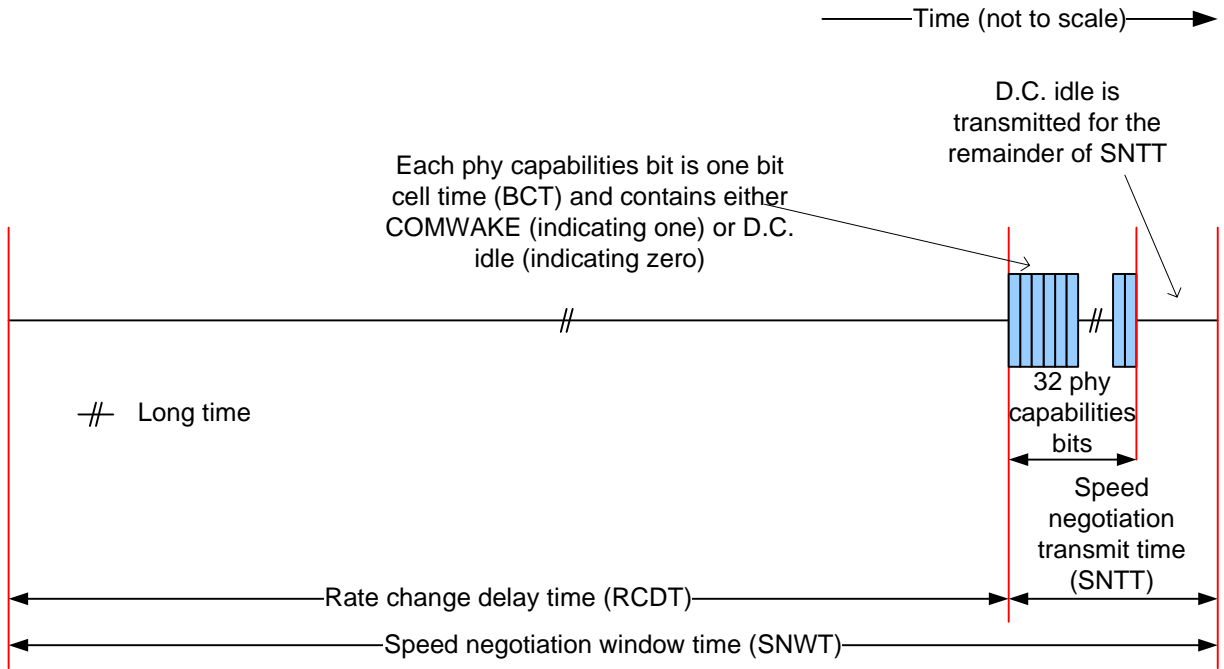


Figure 1 — SNW-3

The phy may enable or disable SSC (see 5.3.8) during SNW-3.

Table 84 defines the SNW-3 phy capabilities bits. For each bit defined as reserved, the phy shall transmit a zero (i.e., D.C. idle) and shall ignore the received value.

Table 84 — SNW-3 phy capabilities bits

Bit(s)	Description	Changeable ^a
Header		
0 (first bit)	START bit	no
1	TX SSC TYPE bit	no
2 to 3	Reserved	no
4 to 7	REQUESTED LOGICAL LINK RATE field bit 4 is the MSB; bit 7 is the LSB	no
Supported settings bits		
8	G1 WITHOUT SSC SUPPORTED bit	yes
9	G1 WITH SSC SUPPORTED bit	yes
10	G2 WITHOUT SSC SUPPORTED bit	yes
11	G2 WITH SSC SUPPORTED bit	yes
12	G3 WITHOUT SSC SUPPORTED bit	yes
13	G3 WITH SSC SUPPORTED bit	yes
14 to 30	Reserved	no
Trailer		
31 (last bit)	PARITY bit	no
^a In the "Changeable" column, phys controlled by a management device server with the SMP PHY CONTROL function (see 10.4.3.24) may set bits labeled "yes" to one in the SNW-3 PHY CAPABILITIES CHANGEABLE field and shall set bits labeled "no" to zero.		

Table 85 defines the SNW-3 phy capabilities. For each bit defined as reserved, the phy shall transmit a zero (i.e., D.C. idle) and shall ignore the received value.

Table 85 — SNW-3 phy capabilities

Byte/Bit	7	6	5	4	3	2	1	0
0	START (1b)	TX SSC TYPE	Reserved		REQUESTED LOGICAL LINK RATE			
1	G1 WITHOUT SSC	G1 WITH SSC	G2 WITHOUT SSC	G2 WITH SSC	G3 WITHOUT SSC	G3 WITH SSC	Reserved	
2	Reserved							
3	Reserved							PARITY

The SNW-3 phy capabilities bits are transmitted in the following order:

- 1) byte 0:
 - 1) byte 0 bit 7 (i.e., the START bit):
 - 2) ...; and
 - 3) byte 0 bit 0 (i.e., the LSB of the REQUESTED LOGICAL LINK RATE field):
- 2) byte 1:
 - 1) byte 1 bit 7:
 - 2) ...; and
 - 3) byte 1 bit 0:
- 3) byte 2:
 - 1) byte 2 bit 7:
 - 2) ...; and
 - 3) byte 2 bit 0:

and
- 4) byte 3:
 - 1) byte 3 bit 7:
 - 2) ...; and
 - 3) byte 3 bit 0 (i.e., the PARITY bit).

Table 86 defines the SNW-3 phy capabilities fields that phys may consider changeable.

Table 86 — SNW-3 phy capabilities changeable fields

<u>Field</u>	<u>May be changeable^b</u>
<u>START bit</u>	<u>no</u>
<u>TX SSC TYPE bit</u>	<u>no</u>
<u>Reserved</u>	<u>no</u>
<u>REQUESTED LOGICAL LINK RATE field</u>	<u>no</u>
<u>G1 WITHOUT SSC bit</u>	<u>yes</u>
<u>G1 WITH SSC bit</u>	<u>yes</u>
<u>G2 WITHOUT SSC bit</u>	<u>yes</u>
<u>G2 WITH SSC bit</u>	<u>yes</u>
<u>G3 WITHOUT SSC bit</u>	<u>yes</u>
<u>G3 WITH SSC bit</u>	<u>yes</u>
<u>Reserved</u>	<u>no</u>
<u>PARITY bit</u>	<u>no</u>
<p>^a <u>Phys controlled by a management device server indicate the fields that are changeable in the SMP DISCOVER response (see 10.4.3.5) CHANGEABLE PHY CAPABILITIES field.</u></p> <p>^b <u>Phys controlled by a management device server may accept bits labeled “yes” in the “may be changeable” column to be set to one in the SMP PHY CONTROL request (see 10.4.3.24) CHANGEABLE PHY CAPABILITIES field and shall require bits labeled “no” to be set to zero.</u></p>	

The START bit shall be set to one. The phy's receiver shall use this bit to establish the timing for the subsequent bits.

A TX SSC TYPE bit set to one indicates that the phy's transmitter uses center-spreading SSC when SSC is enabled. A TX SSC TYPE bit set to zero indicates that the phy's transmitter uses down-spreading SSC when SSC is enabled, or that the phy does not support SSC.

NOTE 1 - The phy receiver may use the TX SSC TYPE bit to optimize its CDR circuitry. This bit indicates the type of SSC used when attached to a SAS phy or an expander phy.

The REQUESTED LOGICAL LINK RATE field indicates if the phy supports multiplexing (see 6.10) and, if so, the logical link rate that the phy is requesting. If the phy is managed by an SMP target port, the field is based on the REQUESTED LOGICAL LINK RATE field in the SMP PHY CONTROL and DISCOVER functions. This field is independent of the supported settings bits (e.g., G3, G2, and G1 with or without SSC).

Table 87 defines the requested logical link rate based on the transmitted and received REQUESTED LOGICAL LINK RATE fields.

Table 87 — Requested logical link rate

Transmitted REQUESTED LOGICAL LINK RATE field	Received REQUESTED LOGICAL LINK RATE field	Requested logical link rate
0h (i.e., no multiplexing)	Any	Negotiated physical link rate
8h (i.e., 1,5 Gbps) ^a	8h (i.e., 1,5 Gbps)	1,5 Gbps
	9h (i.e., 3 Gbps)	
	Ah (i.e., 6 Gbps)	
	Bh - Fh (i.e., future rates)	
9h (i.e., 3 Gbps) ^a	8h (i.e., 1,5 Gbps)	1,5 Gbps
	9h (i.e., 3 Gbps)	3 Gbps
	Ah (i.e., 6 Gbps)	
	Bh - Fh (i.e., future rates)	
Ah (i.e., 6 Gbps) ^a	8h (i.e., 1,5 Gbps)	1,5 Gbps
	9h (i.e., 3 Gbps)	3 Gbps
	Ah (i.e., 6 Gbps)	6 Gbps
	Bh - Fh (i.e., future rates)	

^a A phy that transmits a value other than 0h allows multiplexing to be enabled.

Table 88 defines whether or not multiplexing is enabled and defines the negotiated logical link rate based on the requested logical link rate (see table 87) and the negotiated physical link rate (see 6.7.4.2.4).

Table 88 — Multiplexing negotiation

Requested logical link rate (see table 87)	Negotiated physical link rate	Multiplexing	Negotiated logical link rate
1,5 Gbps	1,5 Gbps	Disabled	1,5 Gbps
	3 Gbps	Enabled	1,5 Gbps
	6 Gbps		3 Gbps
3 Gbps	1,5 Gbps	Disabled	1,5 Gbps
	3 Gbps	Enabled	3 Gbps
	6 Gbps		3 Gbps
6 Gbps	1,5 Gbps	Disabled	1,5 Gbps
	3 Gbps		3 Gbps
	6 Gbps		6 Gbps
Negotiated physical link rate	1,5 Gbps	Disabled	1,5 Gbps
	3 Gbps		3 Gbps
	6 Gbps		6 Gbps

A G1 WITHOUT SSC **SUPPORTED** bit set to one indicates that the phy supports G1 (i.e., 1,5 Gbps) without SSC. A G1 WITHOUT SSC **SUPPORTED** bit set to zero indicates that the phy does not support G1 without SSC. If the phy supports SNW-1 and supports SNW-3, then the G1 WITHOUT SSC **SUPPORTED** bit shall be set to one.

A G1 WITH SSC **SUPPORTED** bit set to one indicates that the phy supports G1 (i.e., 1,5 Gbps) with SSC. A G1 WITH SSC **SUPPORTED** bit set to zero indicates that the phy does not support G1 with SSC.

A G2 WITHOUT SSC **SUPPORTED** bit set to one indicates that the phy supports G2 (i.e., 3 Gbps) without SSC. A G2 WITHOUT SSC **SUPPORTED** bit set to zero indicates that the phy does not support G2 without SSC. If the phy supports SNW-2 and supports SNW-3, then the G2 WITHOUT SSC **SUPPORTED** bit shall be set to one.

A G2 WITH SSC **SUPPORTED** bit set to one indicates that the phy supports G2 (i.e., 3 Gbps) with SSC. A G2 WITH SSC **SUPPORTED** bit set to zero indicates that the phy does not support G2 with SSC.

A G3 WITHOUT SSC **SUPPORTED** bit set to one indicates that the phy supports G3 (i.e., 6 Gbps) without SSC. A G3 G3 WITHOUT SSC **SUPPORTED** bit set to zero indicates that the phy does not support G3 without SSC.

A G3 WITH SSC **SUPPORTED** bit set to one indicates that the phy supports G3 (i.e., 6 Gbps) with SSC. A G3 WITH SSC **SUPPORTED** bit set to zero indicates that the phy does not support G3 with SSC.

The PARITY bit provides for error detection of the SNW-3 phy capabilities. The PARITY bit shall be set to one or zero such that the total number of SNW-3 phy capabilities bits that are set to one is even, including the START bit and the PARITY bit. If the PARITY bit received is incorrect based upon the received bits, then the parity is bad and the phy shall consider it a phy reset problem (see 6.7.4.2.4).

Table 89 lists some example SNW-3 phy capabilities values.

Table 89 — Example SNW-3 phy capabilities values

Code ^a	Description
80540000h	Down-spreading SSC G1, G2, and G3 with SSC supported
80FC0001h	Down-spreading SSC G1, G2, and G3 with and without SSC supported
80A80000h	G1, G2, and G3 without SSC supported
C0FC0000h	Center-spreading SSC G1, G2, and G3 with and without SSC supported
C9FC0000h	Center-spreading SSC Requested 3 Gbps logical link rate G1, G2, and G3 with and without SSC supported
C8F00001h	Center-spreading SSC Requested 1,5 Gbps logical link rate G1 and G2 with and without SSC supported
^a Expressed as a 32-bit value with byte 0 bit 7 (i.e., the START bit) as the MSB and byte 3 bit 0 as the LSB (i.e., the PARITY bit).	

10.4.3.5 DISCOVER function

The DISCOVER function returns information about the specified phy. This SMP function provides information from the IDENTIFY address frame received by the phy and additional phy-specific information. This SMP function shall be implemented by all management device servers.

NOTE 2 - The DISCOVER LIST function (see 10.4.3.12) returns information about one or more phys.

...

Table 236 defines the response format.

Table 236 — DISCOVER response (part 1 of 3)

Byte\Bit	7	6	5	4	3	2	1	0
0	SMP FRAME TYPE (41h)							
1	FUNCTION (10h)							
2	FUNCTION RESULT							
3	RESPONSE LENGTH (17h)							
4	(MSB)	EXPANDER CHANGE COUNT						(LSB)
5								
6	Reserved							
8								
9	PHY IDENTIFIER							
10	Reserved							
11								
12	Reserved	ATTACHED DEVICE TYPE				Reserved		

Table 236 — DISCOVER response (part 2 of 3)

Byte\Bit	7	6	5	4	3	2	1	0
13	Reserved				NEGOTIATED PHYSICAL LINK RATE			
14	Reserved				ATTACHED SSP INITIATOR	ATTACHED STP INITIATOR	ATTACHED SMP INITIATOR	ATTACHED SATA HOST
15	ATTACHED SATA PORT SELECTOR	Reserved			ATTACHED SSP TARGET	ATTACHED STP TARGET	ATTACHED SMP TARGET	ATTACHED SATA DEVICE
16	SAS ADDRESS							
23	SAS ADDRESS							
24	ATTACHED SAS ADDRESS							
31	ATTACHED SAS ADDRESS							
32	ATTACHED PHY IDENTIFIER							
33	Reserved					ATTACHED INSIDE ZPSDS PERSISTENT	ATTACHED REQUESTED INSIDE ZPSDS	ATTACHED BREAK_REPLY CAPABLE
34	Reserved							
39	Reserved							
40	PROGRAMMED MINIMUM PHYSICAL LINK RATE				HARDWARE MINIMUM PHYSICAL LINK RATE			
41	PROGRAMMED MAXIMUM PHYSICAL LINK RATE				HARDWARE MAXIMUM PHYSICAL LINK RATE			
42	PHY CHANGE COUNT							
43	VIRTUAL PHY	Reserved			PARTIAL PATHWAY TIMEOUT VALUE			
44	Reserved				ROUTING ATTRIBUTE			
45	Reserved	CONNECTOR TYPE						
46	CONNECTOR ELEMENT INDEX							
47	CONNECTOR PHYSICAL LINK							
48	Reserved							
49	Reserved							
50	Vendor specific							
51	Vendor specific							
52	ATTACHED DEVICE NAME							
59	ATTACHED DEVICE NAME							
60	Reserved	REQUESTED INSIDE ZPSDS CHANGED BY EXPANDER	INSIDE ZPSDS PERSISTENT	REQUESTED INSIDE ZPSDS	ZONE ADDRESS RESOLVED	ZONE GROUP PERSISTENT	INSIDE ZPSDS	ZONING ENABLED

Table 236 — DISCOVER response (part 3 of 3)

Byte\Bit	7	6	5	4	3	2	1	0	
61	Reserved								
62	Reserved								
63	ZONE GROUP								
64	SELF-CONFIGURATION STATUS								
65	SELF-CONFIGURATION LEVELS COMPLETED								
66	Reserved								
67	Reserved								
68	SELF-CONFIGURATION SAS ADDRESS								
75	SELF-CONFIGURATION SAS ADDRESS								
76	Reserved								
94	Reserved								
76	CHANGEABLE PHY CAPABILITIES								
79	CHANGEABLE PHY CAPABILITIES								
80	NEXT PHY CAPABILITIES								
83	NEXT PHY CAPABILITIES								
84	PHY CAPABILITIES								
87	PHY CAPABILITIES								
88	ATTACHED PHY CAPABILITIES								
91	ATTACHED PHY CAPABILITIES								
92	Reserved					Reserved SNW SUPPORTED			
93	Reserved								
94	Reserved				NEGOTIATED PHYSICAL LINK RATE				
95	Reserved							HARDWARE MUXING SUPPORTED	
96	(MSB)	CRC							
99								(LSB)	

The SMP FRAME TYPE field shall be set to 41h.

The FUNCTION field shall be set to 10h.

The FUNCTION RESULT field is defined in 10.4.3.2.

The RESPONSE LENGTH field shall be set to 17h. For compatibility with previous versions of this standard, a RESPONSE LENGTH field set to 00h indicates that there are 12 dwords before the CRC field.

...

The SELF-CONFIGURATION SAS ADDRESS field indicates the SAS address of the SMP target port to which the self-configuring expander device established a connection or attempted to establish a connection using the specified phy and resulted in the status indicated by the SELF-CONFIGURATION STATUS field.

The CHANGEABLE PHY CAPABILITIES field indicates the SNW-3 phy capabilities bits (see table 84 in 6.7.4.2.3.3) that are changeable with the SMP PHY CONTROL function (see 10.4.3.18). A bit set to one indicates the bit is changeable. A bit set to zero indicates the bit is not changeable. Table 84 in 6.7.4.2.3.3 defines which bits may be changeable. A changeable multi-bit field is indicated with each bit in the field set to one, even if all possible values of the field are not supported.

The NEXT PHY CAPABILITIES field indicates the SNW-3 phy capabilities bits that will be transmitted in the next link reset sequence containing SNW-3. This field reflects any changes specified with the SMP PHY CONTROL function (see 10.4.3.18).

Editor's Note 1: This field could report either the application's chosen changeable bit settings, or the full set of bits headed out the wire (including START and PARITY). Per Bob Sheffield's request, this revision proposes the latter.

The PHY CAPABILITIES field indicates the outgoing SNW-3 phy capabilities bits transmitted in the last link reset sequence. If the last link reset sequence did not include SNW-3 or was a SATA link reset sequence, the PHY CAPABILITIES field shall be set to zero.

The ATTACHED PHY CAPABILITIES field indicates the incoming SNW-3 phy capabilities bits received in the last SNW-3. If the last link reset sequence did not include SNW-3 or was a SATA link reset sequence, the ATTACHED PHY CAPABILITIES field shall be set to zero.

The CRC field is defined in 10.4.3.2.

10.4.3.18 PHY CONTROL function

The PHY CONTROL function requests actions by the specified phy. This SMP function may be implemented by any management device server. In zoning expander devices, if zoning is enabled then this function shall only be processed from SMP initiator ports that have access to zone group 2 or the zone group of the specified phy (see 4.9.3.2).

Table 289 defines the request format.

Table 289 — PHY CONTROL request (part 1 of 2)

Byte\Bit	7	6	5	4	3	2	1	0	
0	SMP FRAME TYPE (40h)								
1	FUNCTION (91h)								
2	Reserved								
3	REQUEST LENGTH (09h 0Bh)								
4	(MSB)	EXPECTED EXPANDER CHANGE COUNT							
5								(LSB)	

Table 289 — PHY CONTROL request (part 2 of 2)

Byte/Bit	7	6	5	4	3	2	1	0
6	Reserved							
8	Reserved							
9	PHY IDENTIFIER							
10	PHY OPERATION							
11	Reserved					Reserved UPDATE PHY CAPABILITIES		UPDATE PARTIAL PATHWAY TIMEOUT VALUE
12	Reserved							
31	Reserved							
32	PROGRAMMED MINIMUM PHYSICAL LINK RATE				Reserved			
33	PROGRAMMED MAXIMUM PHYSICAL LINK RATE				Reserved			
34	Reserved							
35	Reserved							
36	Reserved				PARTIAL PATHWAY TIMEOUT VALUE			
37	Reserved							
39	Reserved							
40	Reserved				SNW SUPPORTED			
41	Reserved							
43	Reserved							
44	PHY CAPABILITIES							
47	PHY CAPABILITIES							
40 48	(MSB)							
				CRC				
43 51	(LSB)							

The SMP FRAME TYPE field shall be set to 40h.

The FUNCTION field shall be set to 91h.

The REQUEST LENGTH field shall be set to ~~09h~~[0Bh](#). For compatibility with previous versions of this standard, a REQUEST LENGTH field set to 00h specifies that there are 9 dwords before the CRC field.

The EXPECTED EXPANDER CHANGE COUNT field is defined in the SMP CONFIGURE GENERAL request (see 10.4.3.14).

The PHY IDENTIFIER field specifies the phy (see 4.2.7) to which the SMP PHY CONTROL request applies.

...

An UPDATE PARTIAL PATHWAY TIMEOUT VALUE bit set to one specifies that the PARTIAL PATHWAY TIMEOUT VALUE field shall be honored. An UPDATE PARTIAL PATHWAY TIMEOUT VALUE bit set to zero specifies that the PARTIAL PATHWAY TIMEOUT VALUE field shall be ignored.

[An UPDATE SNW SUPPORTED bit set to one specifies that the SNW SUPPORTED field shall be honored. An UPDATE SNW SUPPORTED bit set to zero specifies that the SNW SUPPORTED field shall be ignored.](#)

[An UPDATE PHY CAPABILITIES bit set to one specifies that the PHY CAPABILITIES field shall be honored. An UPDATE PHY CAPABILITIES bit set to zero specifies that the PHY CAPABILITIES field shall be ignored.](#)

The PROGRAMMED MINIMUM PHYSICAL LINK RATE field specifies the minimum physical link rate the phy shall support during a link reset sequence (see 4.4.1). Table 290 defines the values for this field. [This value is reported in the DISCOVER response \(see 10.4.3.5\).](#) If this field is changed along with a phy operation of LINK RESET or HARD RESET, that phy operation shall utilize the new value for this field. This value is reported in the DISCOVER response (see 10.4.3.5).

The PROGRAMMED MAXIMUM PHYSICAL LINK RATE field specifies the maximum physical link rates the phy shall support during a link reset sequence (see 4.4.1). Table 290 defines the values for this field. [This value is reported in the DISCOVER response \(see 10.4.3.5\).](#) If this field is changed along with a phy operation of LINK RESET or HARD RESET, that phy operation shall utilize the new value for this field. This value is reported in the DISCOVER response (see 10.4.3.5).

Table 290 — PROGRAMMED MINIMUM PHYSICAL LINK RATE **and** PROGRAMMED MAXIMUM PHYSICAL LINK RATE **fields**

Code	Description
0h	Do not change current value
1h -7h	Reserved
8h	1,5 Gbps
9h	3 Gbps
Ah	6 Gbps
Bh - Fh	Reserved for future physical link rates

If the PROGRAMMED MINIMUM PHYSICAL LINK RATE field or the PROGRAMMED MAXIMUM PHYSICAL LINK RATE field is set to an unsupported or reserved value, or the PROGRAMMED MINIMUM PHYSICAL LINK RATE field and PROGRAMMED MAXIMUM PHYSICAL LINK RATE field are set to an invalid combination of values (e.g., the minimum is greater than the maximum), the management device server shall not change either of their values and may return a function result of SMP FUNCTION FAILED in the response frame. If it returns a function result of SMP FUNCTION FAILED, it shall not perform the requested phy operation.

The PARTIAL PATHWAY TIMEOUT VALUE field specifies the amount of time in microseconds the expander phy shall wait after receiving an Arbitrating (Blocked On Partial) confirmation from the ECM before requesting that the ECM resolve pathway blockage (see 7.12.4.5). A PARTIAL PATHWAY TIMEOUT VALUE field value of zero (i.e., 0 μ s) specifies that partial pathway resolution shall be requested by the expander phy immediately upon reception of an Arbitrating (Blocked On Partial) confirmation from the ECM. The PARTIAL PATHWAY TIMEOUT VALUE field is only honored when the UPDATE PARTIAL PATHWAY TIMEOUT VALUE bit is set to one. This value is reported in the DISCOVER response (see 10.4.3.5).

[Table 291](#) defines the SNW SUPPORTED field.

Table 291 — SNW SUPPORTED field

<u>Code</u>	<u>SNWs in which the phy participates</u>
000b	No change to current SNW supported list
001b	SNW-1 only
010b	SNW-2 only
011b	SNW-1 and SNW-2
100b	SNW-3 only
101b	SNW-1 and SNW-3 ^a
110b	SNW-2 and SNW-3
111b	SNW-1, SNW-2, and SNW-3
^a The value 101b is not recommended. If SNW-1 succeeds and SNW-2 fails, SNW-3 is never attempted. SNW-3 is only attempted if the other phy does not support SNW-1.	

The PHY CAPABILITIES field specifies the outgoing changeable SNW-3 phy capabilities that the phy shall use in every subsequent link reset sequence containing an SNW-3. If this field is changed along with a phy operation of LINK RESET or HARD RESET, that phy operation shall utilize the new value for this field. This value is used to determine the value of the DISCOVER response (see 10.4.3.5) NEXT PHY CAPABILITIES field.

If the PHY CAPABILITIES field is honored and:

- a) [the phy does not support the value \(e.g., a non-changeable bit is set to one, or a multi-bit field is set to an unsupported value\);](#)
- b) [the lowest physical link rate does not match the physical link rate specified by the PROGRAMMED MINIMUM PHYSICAL LINK RATE field; or](#)
- c) [the highest physical link rate does not match the physical link rate specified by the PROGRAMMED MAXIMUM PHYSICAL LINK RATE field,](#)

or the PHY CAPABILITIES field is ignored and:

- d) [the lowest physical link rate in the DISCOVER response NEXT PHY CAPABILITIES field \(see 10.4.3.5\) does not match the physical link rate specified by the PROGRAMMED MINIMUM PHYSICAL LINK RATE field; or](#)
- e) [the highest physical link rate in the DISCOVER response NEXT PHY CAPABILITIES field \(see 10.4.3.5\) does not match the physical link rate specified by the PROGRAMMED MAXIMUM PHYSICAL LINK RATE field,](#)

[then the management device server shall:](#)

- a) [not change the SNW-3 phy capabilities;](#)
- b) [return a function result of SMP FUNCTION FAILED in the response frame; and](#)
- c) [not perform the requested phy operation.](#)

The CRC field is defined in 10.4.3.1.

Table 291 defines the response format.

Table 292 — PHY CONTROL response

Byte\Bit	7	6	5	4	3	2	1	0
0	SMP FRAME TYPE (41h)							
1	FUNCTION (91h)							
2	FUNCTION RESULT							
3	RESPONSE LENGTH (00h)							
4	(MSB)	CRC						(LSB)
7								

The SMP FRAME TYPE field shall be set to 41h.

The FUNCTION field shall be set to 91h.

The FUNCTION RESULT field is defined in 10.4.3.2.

The RESPONSE LENGTH field shall be set to 00h.

The CRC field is defined in 10.4.3.2.

[\[option A - expand the SAS phy mode descriptor\]](#)

10.2.7.4 Phy Control And Discover mode page

The Phy Control And Discover mode page contains parameters that affect SSP target phy operation. If the mode page is implemented by one logical unit in a SCSI target device, it shall be implemented by all logical units in the SCSI target device that support the MODE SELECT or MODE SENSE commands.

The mode page policy (see SPC-4) for this mode page shall be shared. Parameters in this mode page shall affect only the referenced phy.

Table 293 defines the format of this mode page.

Table 293 — Phy Control And Discover mode page

Byte\Bit	7	6	5	4	3	2	1	0
0	PS	SPF (1b)	PAGE CODE (19h)					
1	SUBPAGE CODE (01h)							
2	(MSB)	PAGE LENGTH (n - 3)						(LSB)
3								
4	Reserved							
5	Reserved				PROTOCOL IDENTIFIER (6h)			
6	Reserved							
7	NUMBER OF PHYS							
SAS phy mode descriptor list								
8	SAS phy mode descriptor (first)(see table 294)							
55								
...	...							
n - 47	SAS phy mode descriptor (last)(see table 294)							
n								

The PARAMETERS SAVEABLE (PS) bit is defined in SPC-4.

The SUBPAGE FORMAT (SPF) bit shall be set to one to access this mode page.

The PAGE CODE field shall be set to 19h.

The SUBPAGE CODE field shall be set to 01h.

The PAGE LENGTH field shall be set to the number of bytes in the page after the PAGE LENGTH field (i.e., 4 + (the value of the NUMBER OF PHYS field) × (the length in bytes of the SAS phy mode descriptor)).

The PROTOCOL IDENTIFIER field shall be set to 6h indicating this is a SAS SSP specific mode page.

The NUMBER OF PHYS field contains the number of phys in the SAS target device and indicates the number of SAS phy mode descriptors that follow. This field shall not be changeable with the MODE SELECT command.

The SAS phy mode descriptor list contains a SAS phy mode descriptor for each phy in the SAS target device, not just the SAS target port, starting with the lowest numbered phy and ending with the highest numbered phy.

Table 294 defines the SAS phy mode descriptor.

Table 294 — SAS phy mode descriptor (part 1 of 2)

Byte\Bit	7	6	5	4	3	2	1	0
0	Reserved							
1	PHY IDENTIFIER							
2	Reserved							
3	Reserved							
4	Reserved	ATTACHED DEVICE TYPE			ATTACHED REASON			
5	REASON				NEGOTIATED LOGICAL LINK RATE			
6	Reserved				ATTACHED SSP INITIATOR PORT	ATTACHED STP INITIATOR PORT	ATTACHED SMP INITIATOR PORT	Reserved
7	Reserved				ATTACHED SSP TARGET PORT	ATTACHED STP TARGET PORT	ATTACHED SMP TARGET PORT	Reserved
8	SAS ADDRESS							
15	SAS ADDRESS							
16	ATTACHED SAS ADDRESS							
23	ATTACHED SAS ADDRESS							
24	ATTACHED PHY IDENTIFIER							
25	Reserved							
31	Reserved							
32	PROGRAMMED MINIMUM PHYSICAL LINK RATE				HARDWARE MINIMUM PHYSICAL LINK RATE			
33	PROGRAMMED MAXIMUM PHYSICAL LINK RATE				HARDWARE MAXIMUM PHYSICAL LINK RATE			
34	Reserved							
41	Reserved							
42	Vendor specific							
43	Vendor specific							
44	Reserved							
46	Reserved							
47	<p style="text-align: center;">Reserved ADDITIONAL DESCRIPTOR LENGTH (14h)</p>							

I

Table 294 — SAS phy mode descriptor (part 2 of 2)

Byte\Bit	7	6	5	4	3	2	1	0
48	CHANGEABLE PHY CAPABILITIES							
51								
52	NEXT PHY CAPABILITIES							
55								
56	PHY CAPABILITIES							
59								
60	ATTACHED PHY CAPABILITIES							
63								
64	Reserved				SNW SUPPORTED			
65	Reserved							
66	Reserved				NEGOTIATED PHYSICAL LINK RATE			
67	Reserved							HARDWARE MUXING SUPPORTED

The PROGRAMMED MINIMUM PHYSICAL LINK RATE field and PROGRAMMED MAXIMUM PHYSICAL LINK RATE field are defined in the SMP PHY CONTROL function (see 10.4.3.18).

[The ADDITIONAL DESCRIPTOR LENGTH field contains the length in bytes that follow in the descriptor and shall be set to 14h.](#)

The fields in the SAS phy mode descriptor not defined in this subclause are defined in the SMP DISCOVER response (see 10.4.3.5). These fields shall not be changeable with the MODE SELECT command.

[\[end of option A\]](#)

[\[option B - add another list at the end - a SAS phy additional mode descriptor list\]](#)

10.2.7.4 Phy Control And Discover mode page

The Phy Control And Discover mode page contains parameters that affect SSP target phy operation. If the mode page is implemented by one logical unit in a SCSI target device, it shall be implemented by all logical units in the SCSI target device that support the MODE SELECT or MODE SENSE commands.

The mode page policy (see SPC-4) for this mode page shall be shared. Parameters in this mode page shall affect only the referenced phy.

Table 293 defines the format of this mode page.

Table 293 — Phy Control And Discover mode page

Byte\Bit	7	6	5	4	3	2	1	0
0	PS	SPF (1b)	PAGE CODE (19h)					
1	SUBPAGE CODE (01h)							
2	(MSB)	PAGE LENGTH (n - 3)						(LSB)
3								
4	Reserved							
5	Reserved				PROTOCOL IDENTIFIER (6h)			
6	Reserved							
7	NUMBER OF PHYS							
SAS phy mode descriptor list								
8	SAS phy mode descriptor (first)(see table 294)							
55								
...	...							
n - 47	SAS phy mode descriptor (last)(see table 294)							
n								
<u>SAS phy additional mode descriptor list</u>								
<u>8</u>	<u>SAS phy additional mode descriptor (first)(see table 295)</u>							
<u>55</u>								
<u>...</u>	<u>...</u>							
<u>n - 47</u>	<u>SAS phy additional mode descriptor (last)(see table 295)</u>							
<u>n</u>								

The PARAMETERS SAVEABLE (PS) bit is defined in SPC-4.

The SUBPAGE FORMAT (SPF) bit shall be set to one to access this mode page.

The PAGE CODE field shall be set to 19h.

The SUBPAGE CODE field shall be set to 01h.

The PAGE LENGTH field shall be set to the number of bytes in the page after the PAGE LENGTH field (i.e., 4 + (the value of the NUMBER OF PHYS field) × (the length in bytes of the SAS phy mode descriptor)).

The PROTOCOL IDENTIFIER field shall be set to 6h indicating this is a SAS SSP specific mode page.

The NUMBER OF PHYS field contains the number of phys in the SAS target device and indicates the number of SAS phy mode descriptors [and SAS phy additional mode descriptors](#) that follow. This field shall not be changeable with the MODE SELECT command.

The SAS phy mode descriptor list contains a SAS phy mode descriptor for each phy in the SAS target device, not just the SAS target port, starting with the lowest numbered phy and ending with the highest numbered phy.

Table 294 defines the SAS phy mode descriptor.

Table 294 — SAS phy mode descriptor (part 1 of 2)

Byte\Bit	7	6	5	4	3	2	1	0
0	Reserved							
1	PHY IDENTIFIER							
2	Reserved							
3	Reserved							
4	Reserved	ATTACHED DEVICE TYPE			ATTACHED REASON			
5	REASON				NEGOTIATED LOGICAL LINK RATE			
6	Reserved				ATTACHED SSP INITIATOR PORT	ATTACHED STP INITIATOR PORT	ATTACHED SMP INITIATOR PORT	Reserved
7	Reserved				ATTACHED SSP TARGET PORT	ATTACHED STP TARGET PORT	ATTACHED SMP TARGET PORT	Reserved
8	SAS ADDRESS							
15	SAS ADDRESS							
16	ATTACHED SAS ADDRESS							
23	ATTACHED SAS ADDRESS							
24	ATTACHED PHY IDENTIFIER							
25	Reserved							
31	Reserved							
32	PROGRAMMED MINIMUM PHYSICAL LINK RATE				HARDWARE MINIMUM PHYSICAL LINK RATE			
33	PROGRAMMED MAXIMUM PHYSICAL LINK RATE				HARDWARE MAXIMUM PHYSICAL LINK RATE			
34	Reserved							
41	Reserved							
42	Vendor specific							
43	Vendor specific							
44	Reserved							
46	Reserved							

Table 294 — SAS phy mode descriptor (part 2 of 2)

Byte\Bit	7	6	5	4	3	2	1	0
47	Reserved <u>ADDITIONAL DESCRIPTOR LENGTH (14h)</u>							
<u>48</u>	<u>CHANGEABLE PHY CAPABILITIES</u>							
<u>51</u>	<u>CHANGEABLE PHY CAPABILITIES</u>							
<u>52</u>	<u>NEXT PHY CAPABILITIES</u>							
<u>55</u>	<u>NEXT PHY CAPABILITIES</u>							
<u>56</u>	<u>PHY CAPABILITIES</u>							
<u>59</u>	<u>PHY CAPABILITIES</u>							
<u>60</u>	<u>ATTACHED PHY CAPABILITIES</u>							
<u>63</u>	<u>ATTACHED PHY CAPABILITIES</u>							
<u>64</u>	<u>Reserved</u>				<u>SNW SUPPORTED</u>			
<u>65</u>	<u>Reserved</u>							
<u>66</u>	<u>Reserved</u>				<u>NEGOTIATED PHYSICAL LINK RATE</u>			
<u>67</u>	<u>Reserved</u>							<u>HARDWARE MUXING SUPPORTED</u>

The PROGRAMMED MINIMUM PHYSICAL LINK RATE field and PROGRAMMED MAXIMUM PHYSICAL LINK RATE field are defined in the SMP PHY CONTROL function (see 10.4.3.18).

The fields in the SAS phy mode descriptor not defined in this subclause are defined in the SMP DISCOVER response (see 10.4.3.5). These fields shall not be changeable with the MODE SELECT command.

Table 294 defines the SAS phy additional mode descriptor.

Table 295 — SAS phy mode additional descriptor (part 1 of 2)

Byte\Bit	7	6	5	4	3	2	1	0
0	Reserved							
2	Reserved							
3	<u>ADDITIONAL DESCRIPTOR LENGTH (14h)</u>							
<u>4</u>	<u>CHANGEABLE PHY CAPABILITIES</u>							
<u>7</u>	<u>CHANGEABLE PHY CAPABILITIES</u>							
<u>8</u>	<u>NEXT PHY CAPABILITIES</u>							
<u>11</u>	<u>NEXT PHY CAPABILITIES</u>							
<u>12</u>	<u>PHY CAPABILITIES</u>							
<u>15</u>	<u>PHY CAPABILITIES</u>							

Table 295 — SAS phy mode additional descriptor (part 2 of 2)

Byte\Bit	7	6	5	4	3	2	1	0
16	ATTACHED PHY CAPABILITIES							
19								
20	Reserved				SNW SUPPORTED			
21	Reserved							
22	Reserved				NEGOTIATED PHYSICAL LINK RATE			
23	Reserved							HARDWARE MUXING SUPPORTED

The [ADDITIONAL DESCRIPTOR LENGTH](#) field contains the length in bytes that follow in the descriptor and shall be set to 14h.

The fields in the SAS phy additional mode descriptor not defined in this subclause are defined in the [SMP DISCOVER](#) response (see 10.4.3.5). These fields shall not be changeable with the [MODE SELECT](#) command.

[\[end of option B\]](#)

10.2.8.1 Protocol-Specific Port log page

The Protocol-Specific Port log page for SAS SSP defined in table 205 is used to return phy event information concerning the SAS target device’s phy(s).

Table 205 — Protocol-Specific Port log page for SAS SSP

Byte\Bit	7	6	5	4	3	2	1	0
0	DS	SPF (0b)	PAGE CODE (18h)					
1	SUBPAGE CODE (00h)							
2	(MSB)	PAGE LENGTH (m - 3)						
3								(LSB)
Protocol-specific port log parameter list								
4	Protocol-specific port log parameter (first)(see table 206)							
...	...							
m	Protocol-specific port log parameter (last)(see table 206)							

The DISABLE SAVE (DS) bit is defined in SPC-4.

The SUBPAGE FORMAT (SPF) bit shall be set to zero for access to this log page.

The PAGE CODE field shall be set to 18h.

The SUBPAGE CODE field shall be set to 00h.

The PAGE LENGTH field shall be set to the number of bytes in the log page after the PAGE LENGTH field.

Table 206 defines the format for the Protocol-Specific Port log parameter for SAS. The SAS log parameter is a list parameter (i.e., not a data counter) and only has cumulative (i.e., not threshold) values (see SPC-4).

Table 206 — Protocol-Specific Port log parameter for SAS

Byte\Bit	7	6	5	4	3	2	1	0
0	(MSB) _____							
1	PARAMETER CODE (relative target port identifier)						_____ (LSB)	
2	Parameter control byte							
	DU	Obsolete	TSD	ETC	TMC		FORMAT AND LINKING	
3	PARAMETER LENGTH (y - 3)							
4	Reserved				PROTOCOL IDENTIFIER (6h)			
5	Reserved							
6	Reserved							
7	NUMBER OF PHYS							
SAS phy log descriptor list								
8	SAS phy log descriptor (first)(see table 208)							
8 + m	SAS phy log descriptor (first)(see table 208)							
...	...							
y - m	SAS phy log descriptor (last)(see table 208)							
y	SAS phy log descriptor (last)(see table 208)							

The PARAMETER CODE field contains the relative target port identifier (see SPC-4) of the SSP target port that the log parameter describes.

Table 207 defines the values of the fields in the parameter control byte for the log parameter.

Table 207 — Parameter control byte in the Protocol-Specific Port log parameter for SAS

Field	Value for LOG SENSE	Value for LOG SELECT	Description
DU	0	0 or 1	The DU bit is not defined for list parameters, so shall be set to zero when read with the LOG SENSE command and shall be ignored when written with the LOG SELECT command.
TSD	0	0 or 1	The device server shall support implicitly saving the log parameter at vendor specific intervals.
ETC	0	0 or 1	The ETC bit is not defined for list parameters, so shall be set to zero when read with the LOG SENSE command and shall be ignored when written with the LOG SELECT command.
TMC	00b	any	The TMC field is not defined for list parameters, so shall be set to 00b when read with the LOG SENSE command and shall be ignored when written with the LOG SELECT command.
FORMAT AND LINKING	11b	11b	The log parameter is a binary format list parameter.

The PARAMETER LENGTH field is set to the number of bytes in the log parameter that follow the PARAMETER LENGTH field.

The PROTOCOL IDENTIFIER field is set to 6h.

The NUMBER OF PHYS field contains the number of phys in the SAS target port (not in the entire SAS target device) and indicates the number of SAS phy log descriptors that follow.

The SAS phy log descriptor list contains SAS phy log descriptors.

Table 208 defines the SAS phy log descriptor.

Table 208 — SAS phy log descriptor (part 1 of 3)

Byte\Bit	7	6	5	4	3	2	1	0	
0	Reserved								
1	PHY IDENTIFIER								
2	Reserved								
3	SAS PHY LOG DESCRIPTOR LENGTH ($m + 20 - 3$)								
4	Reserved	ATTACHED DEVICE TYPE			ATTACHED REASON				
5	REASON				NEGOTIATED LOGICAL LINK RATE				
6	Reserved				ATTACHED SSP INITIATOR PORT	ATTACHED STP INITIATOR PORT	ATTACHED SMP INITIATOR PORT	Reserved	

Table 208 — SAS phy log descriptor (part 2 of 3)

Byte\Bit	7	6	5	4	3	2	1	0
7	Reserved				ATTACHED SSP TARGET PORT	ATTACHED STP TARGET PORT	ATTACHED SMP TARGET PORT	Reserved
8	SAS ADDRESS							
15	ATTACHED SAS ADDRESS							
23	ATTACHED PHY IDENTIFIER							
24	Reserved							
25	Reserved							
31	Reserved							
32	(MSB)	INVALID DWORD COUNT						(LSB)
35	RUNNING DISPARITY ERROR COUNT							
36	(MSB)	LOSS OF DWORD SYNCHRONIZATION						(LSB)
39	PHY RESET PROBLEM							
40	(MSB)	PHY RESET PROBLEM						(LSB)
43	Reserved							
44	(MSB)	NUMBER OF PHY EVENT DESCRIPTORS						(LSB)
47	Reserved							
48	Reserved							
50	Reserved							
51	NUMBER OF PHY EVENT DESCRIPTORS							
Phy event descriptor list								
52	Phy event descriptor (first)(see table 254 in 10.4.3.11)							
63	Phy event descriptor (first)(see table 254 in 10.4.3.11)							
...	...							
m - 11	Phy event descriptor (last)(see table 254 in 10.4.3.11)							
m	Phy event descriptor (last)(see table 254 in 10.4.3.11)							
m + 1	CHANGEABLE PHY CAPABILITIES							
m + 4	CHANGEABLE PHY CAPABILITIES							

Table 208 — SAS phy log descriptor (part 3 of 3)

Byte\Bit	7	6	5	4	3	2	1	0
m + 5	NEXT PHY CAPABILITIES							
m + 8	PHY CAPABILITIES							
m + 9	ATTACHED PHY CAPABILITIES							
m + 12	Reserved							
m + 13	Reserved							
m + 16	Reserved				SNW SUPPORTED			
m + 17	Reserved							
m + 18	Reserved				NEGOTIATED PHYSICAL LINK RATE			
m + 19	Reserved							
m + 20	Reserved							HARDWARE MUXING SUPPORTED

The SAS PHY LOG DESCRIPTOR LENGTH field indicates the number of bytes that follow in the SAS phy log descriptor. A SAS PHY LOG DESCRIPTOR LENGTH field set to zero indicates there are 44 additional bytes.

NOTE 3 - Logical units compliant with SAS and SAS-1.1 only support a 48 byte SAS phy log descriptor.

The INVALID DWORD COUNT field, RUNNING DISPARITY ERROR COUNT field, LOSS OF DWORD SYNCHRONIZATION field, and PHY RESET PROBLEM COUNT field are each defined in the SMP REPORT PHY ERROR LOG response (see 10.4.3.8).

For the INVALID DWORD COUNT field, RUNNING DISPARITY ERROR COUNT field, LOSS OF DWORD SYNCHRONIZATION COUNT field, and PHY RESET PROBLEM COUNT field, the phy may maintain any size counter but should maintain a 32-bit counter. If it reaches its maximum value, the counter shall stop and the device server shall set the field to FFFFFFFFh in the SAS phy log descriptor.

The number of phy event descriptors field indicates how many phy event descriptors follow.

Each phy event descriptor follows the format defined for the SMP REPORT PHY EVENT INFORMATION function in table 254 (see 10.4.3.11).

The fields in the SAS phy log descriptor not defined in this subclause are defined in the SMP DISCOVER response (see 10.4.3.5). These fields shall not be changeable with the LOG SELECT command.