

To: T10 Technical Committee
 From: Rob Elliott, HP (elliott@hp.com)
 Date: 8 August 2006
 Subject: 06-363r1 SAS-2 SNW-3 bit definitions

Revision history

Revision 0 (2 August 2006) First revision

Revision 1 (8 August 2006) Incorporated comments from 3 August 2006 SAS physical WG teleconference.
 Added DISCOVER and PHY CONTROL changes.

Related documents

sas2r05a - Serial Attached SCSI - 2 (SAS-2) revision 5a
 05-397 SAS-2 Start-up training sequence (Harvey Newman, Infineon)
 06-263 SAS-2 Spread-spectrum clocking (Rob Elliott, HP)
 06-295 SAS-2 Speed negotiation (Amr Wassal and Robert Watson, PMC-Sierra)
 06-354 SAS-2 Startup training sequence proposal (Steve Finch, ST Microelectronics)
 06-355 SAS-2 SNW-3 Definition (Amr Wassal and Robert Watson, PMC-Sierra)

Overview

06-355 defines a new format for the G3 speed negotiation window (renamed SNW-3) that exchanges phy capability information using OOB signals, similar to Ethernet's Fast Link Pulse (FLP) based Link Code Word (base page)'s TECHNOLOGY ABILITY field. The format of that information needs to be defined.

Unlike the legacy G1 and G2 SNWs, SNW-3 is capable of negotiating spread spectrum clocking (SSC) or not for each physical link rate (including G1 and G2). Also, phys compliant with future physical link rates (e.g., 12 Gbps) will use SNW-3 to negotiate those future rates, rather than tacking on additional SNWs.

Suggested changes

[\[to be placed in the SNW-3 description area; all new; change marks not shown\]](#)

The phy shall negotiate to the highest commonly supported settings based on the outgoing and incoming SNW-3 information. For bits defined as reserved, the phy shall transmit zeros in the outgoing SNW-3 information and shall ignore the bits in the incoming SNW-3 information. Table 1 defines the priority of the SNW-3 supported settings.

Table 1 — Negotiation priority of SNW-3 supported settings

| Priority | Supported setting |
|----------|-------------------|
| Highest | G3 with SSC |
| ... | G3 without SSC |
| ... | G2 with SSC |
| ... | G2 without SSC |
| ... | G1 with SSC |
| Lowest | G1 without SSC |

If a phy reset problem occurs (i.e., the phy does not successfully negotiate the highest commonly supported setting in the final SNW), if the next link reset sequence include a SNW-3, the phy shall disable the highest commonly supported setting and any higher priority settings and set the DEGRADED bit to one (e.g., if a phy supports G1, G2, G3 without SSC, and G3 with SSC, and it fails to negotiate G3 without SSC in the final SNW, it shall disable G3 without SSC and G3 with SSC during the next link reset sequence).

Table 2 defines the SNW-3 information.

Table 2 — SNW-3 information

| Bit(s) | Description |
|--------------------|---------------------------|
| Header | |
| 0 | START bit |
| 1 | DEGRADED bit |
| 2 | TX SSC TYPE bit |
| 3 to 7 | Reserved |
| Supported settings | |
| 8 | G1 WITH SSC SUPPORTED bit |
| 9 | G1 SUPPORTED bit |
| 10 | G2 WITH SSC SUPPORTED bit |
| 11 | G2 SUPPORTED bit |
| 12 | G3 WITH SSC SUPPORTED bit |
| 13 | G3 SUPPORTED bit |
| 14 to 63 | Reserved |
| Trailer | |
| 64 to 71 | CRC field |

Editor's Note 1: could start the Supported settings bits later (bit 16 or 32) to leave more room for non-programmable bits/fields at the front.

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 DEGRADED bit set to one indicates that the phy is performing a link reset sequence after encountering a phy reset problem. A DEGRADED bit set to zero indicates that the phy is not performing a link reset sequence after encountering a phy reset problem.

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; if a phy supports center-spreading when attached to a SAS phy or an expander phy and down-spreading when attached to a SATA phy, it sets the TX SSC TYPE bit to one.

The G<GENERATION NUMBER> WITH SSC SUPPORTED bits and G<GENERATION NUMBER> WITH SSC SUPPORTED bits indicate the physical link rates and SSC options the phy is attempting to negotiate.

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 G1 SUPPORTED bit set to one indicates that the phy supports G1 without SSC. A G1 SUPPORTED bit set to zero indicates that the phy does not support G1 without SSC.

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 G2 SUPPORTED bit set to one indicates that the phy supports G2 with SSC. A G2 SUPPORTED bit set to zero indicates that the phy does not support G2 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.

A G3 SUPPORTED bit set to one indicates that the phy supports G3 with SSC. A G3 SUPPORTED bit set to zero indicates that the phy does not support G3 without SSC.

The CRC field contains an 8-bit CRC of the SNW-3 information. If the CRC field is incorrect, the phy shall retry the link reset sequence with the same SNW-3 information values one time. If the CRC field is incorrect a second time, the phy shall consider it a phy reset problem.

Editor's Note 2: CRC-8 polynomials that are popular include: $x^8 + x^2 + x + 1$ (ATM), $x^8 + x^7 + x^3 + x^2 + 1$ (CCITT), and $x^8 + x^7 + x^6 + x^4 + x^2 + 1$. Could also just use a parity bit, or no check value at all (if detection of these bits is expected to be reliable).

[\[Change marks resume\]](#)

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 101 defines the request format.

Table 101 — DISCOVER request

| Byte/Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|----------|----------------------|-----|---|---|---|---|-------|-------------------------|--|
| 0 | SMP FRAME TYPE (40h) | | | | | | | | |
| 1 | FUNCTION (10h) | | | | | | | | |
| 2 | Reserved | | | | | | | | |
| 3 | REQUEST LENGTH (02h) | | | | | | | | |
| 4 | Reserved | | | | | | | | |
| 7 | Reserved | | | | | | | | |
| 8 | Reserved | | | | | | | IGNORE ZONE GROUP | |
| 9 | PHY IDENTIFIER | | | | | | | | |
| 10 | Reserved | | | | | | | | |
| 11 | Reserved | | | | | | | | |
| 12 | (MSB) | CRC | | | | | | | |
| 15 | | | | | | | (LSB) | | |

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

The FUNCTION field shall be set to 10h.

The REQUEST LENGTH field shall be set to 02h. For compatibility with previous versions of this standard, a REQUEST LENGTH field set to 00h specifies that there are 2 dwords before the CRC field.

An IGNORE ZONE GROUP bit set to one specifies that the management device server shall return information about the specified phy (i.e., the phy specified by the PHY IDENTIFIER field) regardless of the zone permission table.

An IGNORE ZONE GROUP bit set to zero specifies that the management device server shall:

- a) if the SMP initiator port has access to the specified phy based on the zone permission table, return the requested information; and
- b) if the SMP initiator port does not have access to the specified phy, return a function result of PHY VACANT in the response frame.

If the management device server is not in a zoning expander device with zoning enabled, it shall ignore the IGNORE ZONE GROUP bit.

The PHY IDENTIFIER field specifies the phy (see 4.2.7) for which the information is being requested.

The CRC field is defined in 10.4.3.1.

Table 102 defines the response format.

Table 102 — 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 (12h 40h) | | | | | | | |
| 4 | (MSB) EXPANDER CHANGE COUNT (LSB) | | | | | | | |
| 5 | | | | | | | | |
| 6 | Reserved | | | | | | | |
| 8 | | | | | | | | |
| 9 | PHY IDENTIFIER | | | | | | | |
| 10 | Reserved | | | | | | | |
| 11 | | | | | | | | |
| 12 | Reserved | ATTACHED DEVICE TYPE | | | Reserved | | | |
| 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 | | | | | | | | |
| 24 | ATTACHED SAS ADDRESS | | | | | | | |
| 31 | | | | | | | | |
| 32 | ATTACHED PHY IDENTIFIER | | | | | | | |
| 33 | Reserved | | | | ATTACHED INSIDE ZPSDS PERSISTENT | ATTACHED REQUESTED INSIDE ZPSDS | ATTACHED BREAK_REPLY CAPABLE | |
| 34 | Reserved | | | | | | | |
| 39 | | | | | | | | |
| 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 | | | | | | |

Table 102 — DISCOVER response (part 2 of 3)

| Byte\Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------------------|-------------------------------------|---|-------------------------------|------------------------------|-----------------------------|-----------------------------|-----------------|--------------------------|
| 46 | CONNECTOR ELEMENT INDEX | | | | | | | |
| 47 | CONNECTOR PHYSICAL LINK | | | | | | | |
| 48 | Reserved | | | | | | | |
| 49 | Reserved | | | | | | | |
| 50 | Vendor specific | | | | | | | |
| 51 | Reserved | | | | | | | |
| 52 | ATTACHED DEVICE NAME | | | | | | | |
| 59 | Reserved | | | | | | | |
| 60 | Reserved | REQUESTED INSIDE ZPSDS CHANGED BY EXPANDER | INSIDE ZPSDS PERSISTENT | REQUESTED INSIDE ZPSDS | ZONE ADDRESS RESOLVED | ZONE GROUP PERSISTENT | INSIDE ZPSDS | ZONING ENABLED |
| 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 | Reserved | | | | | | | |
| 76 | Reserved | | | | | | | |
| 77 | (bit 8) | HARDWARE SNW-3 INFORMATION SUPPORTED | | | | | | (bit 15) |
| 83 | (bit 56) | PROGRAMMED SNW-3 INFORMATION SUPPORTED | | | | | | (bit 63) |
| 84 | Reserved | | | | | | | |
| 85 | (bit 8) | SNW-3 INFORMATION | | | | | | (bit 15) |
| 91 | (bit 56) | SNW-3 INFORMATION | | | | | | (bit 63) |
| 92 | (bit 0) | SNW-3 INFORMATION | | | | | | (bit 7) |
| 100 | (bit 64) | SNW-3 INFORMATION | | | | | | (bit 71) |
| 101 | Reserved | | | | | | | |
| 103 | Reserved | | | | | | | |

Table 102 — DISCOVER response (part 3 of 3)

| Byte\Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|--------------------------|-----------------------------------|---|---|---|---|---|---|-----------------|
| <u>104</u> | <u>(bit 0)</u> | | | | | | | <u>(bit 7)</u> |
| | <u>ATTACHED SNW-3 INFORMATION</u> | | | | | | | |
| <u>112</u> | <u>(bit 64)</u> | | | | | | | <u>(bit 71)</u> |
| <u>113</u> | <u>Reserved</u> | | | | | | | |
| <u>115</u> | | | | | | | | |
| 76 <u>116</u> | <u>(MSB)</u> | | | | | | | |
| | <u>CRC</u> | | | | | | | |
| 77 <u>119</u> | | | | | | | | <u>(LSB)</u> |

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 ~~42h~~40h. 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 EXPANDER CHANGE COUNT field is defined in the SMP REPORT GENERAL response (see 10.4.3.3).

The PHY IDENTIFIER field indicates the phy for which physical configuration link information is being returned.

The ATTACHED DEVICE TYPE field indicates the DEVICE TYPE value received during the link reset sequence and is defined in table 103.

Table 103 — ATTACHED DEVICE TYPE field

| Code | Description |
|------------|--|
| 000b | No device attached |
| 001b | End device |
| 010b | Expander device |
| 011b | Expander device compliant with a previous version of this standard |
| All others | Reserved |

The ATTACHED DEVICE TYPE field shall only be set to a value other than 000b after:

- a) the identification sequence is complete if a SAS device or expander device is attached; or
- b) the initial Register - Device to Host FIS has been received if a SATA phy is attached.

The NEGOTIATED PHYSICAL LINK RATE field is defined in table 104 and indicates the physical link rate negotiated during the link reset sequence or other conditions of the phy. The negotiated physical link rate may be less than the programmed minimum physical link rate or greater than the programmed maximum physical link rate if the programmed physical link rates have been changed since the last link reset sequence.

Table 104 — NEGOTIATED PHYSICAL LINK RATE field

| Code | Name | Description |
|--|--------------------|--|
| 0h | UNKNOWN | Phy is enabled; unknown physical link rate. ^a |
| 1h | DISABLED | Phy is disabled. |
| 2h | PHY_RESET_PROBLEM | Phy is enabled; the phy obtained dword synchronization for at least one physical link rate during the SAS speed negotiation sequence (see 6.7.4.2), but the SAS speed negotiation sequence failed (i.e., the last speed negotiation window, using a physical link rate expected to succeed, failed). These failures may be logged in the SMP REPORT PHY ERROR LOG function (see 10.4.3.7), the SMP REPORT PHY EVENT INFORMATION function (see 10.4.3.10), and/or the Protocol-Specific Port log page (see 10.2.8.1). |
| 3h | SPINUP_HOLD | Phy is enabled; detected a SATA device and entered the SATA spinup hold state. The SMP PHY CONTROL function (see 10.4.3.18) phy operations of LINK RESET and HARD RESET may be used to release the phy. This field shall be updated to this value at SATA spinup hold time (see 6.8.7 and 6.10)(i.e., after the COMSAS Detect Timeout timer expires during the SATA OOB sequence) if SATA spinup hold is supported. |
| 4h | PORT_SELECTOR | Phy is enabled; detected a SATA port selector. The physical link rate has not been negotiated since the last time the phy's SP state machine entered the SP0:OOB_COMINIT state. The SATA spinup hold state has not been entered since the last time the phy's SP state machine entered the SP0:OOB_COMINIT state. The value in this field may change to 3h, 8h, or 9h if attached to the active phy of the SATA port selector. Presence of a SATA port selector is indicated by the ATTACHED SATA PORT SELECTOR bit. |
| 5h | RESET_IN_PROGRESS | Phy is enabled; the expander phy is performing an SMP PHY CONTROL function (see 10.4.3.18) phy operation of LINK RESET or HARD RESET. The value in this field shall change when this field is updated to any other value. This value shall only be returned if the specified phy contained a value of 8h or 9h in this field when an SMP PHY CONTROL function phy operation of LINK RESET or HARD RESET phy operation is processed. |
| 8h | G1 | Phy is enabled; 1,5 Gbps physical link rate. This field shall be updated to this value after the speed negotiation sequence completes. |
| 9h | G2 | Phy is enabled; 3,0 Gbps physical link rate. This field shall be updated to this value after the speed negotiation sequence completes. |
| Ah | G3 | Phy is enabled; 6 Gbps physical link rate. This field shall be updated to this value after the speed negotiation sequence completes. |
| All others | Reserved. | |
| ^a This code may be used by an application client in its local data structures to indicate an unknown negotiated physical link rate (e.g., before the discover process has queried the phy). | | |

Table 105 describes the ATTACHED SATA PORT SELECTOR bit and the ATTACHED SATA DEVICE bit.

Table 105 — ATTACHED SATA PORT SELECTOR and ATTACHED SATA DEVICE bits

| ATTACHED SATA PORT SELECTOR bit value ^{a b} | ATTACHED SATA DEVICE bit value ^{c d} | Description |
|---|---|--|
| 0 | 0 | Neither a SATA port selector nor a SATA device is attached and ready on the selected phy. |
| 0 | 1 | The attached phy is a SATA device phy. No SATA port selector is present (i.e., the SP state machine did not detect COMWAKE in response to the initial COMINIT, but sequenced through the normal (non-SATA port selector) SATA device OOB sequence). |
| 1 | 0 | The attached phy is a SATA port selector host phy, and either: a) the attached phy is the inactive host phy, or b) the attached phy is the active host phy and a SATA device is either not present or not ready behind the SATA port selector (i.e., the SP state machine detected COMWAKE while waiting for COMINIT). |
| 1 | 1 | The attached phy is a SATA port selector's active host phy and a SATA device is present behind the SATA port selector (i.e., the SP state machine detected COMWAKE while waiting for COMINIT, timed out waiting for COMSAS, and exchanged COMWAKE with an attached SATA device). |
| <p>^a The ATTACHED SATA PORT SELECTOR bit is invalid if the NEGOTIATED PHYSICAL LINK RATE field is set to UNKNOWN (i.e., 0h), DISABLED (i.e., 1h), or RESET_IN_PROGRESS (i.e., 5h).</p> <p>^b Whenever the ATTACHED SATA PORT SELECTOR bit changes, the phy shall originate a Broadcast (Change)(see 7.11).</p> <p>^c For the purposes of the ATTACHED SATA DEVICE bit, the SATA port selector is not considered a SATA device.</p> <p>^d The ATTACHED SATA DEVICE bit shall be updated at SATA spin-up hold time (see 6.8.7 and 6.10).</p> | | |

An ATTACHED SATA HOST bit set to one indicates a SATA host port is attached. An ATTACHED SATA HOST bit set to zero indicates a SATA host port is not attached.

NOTE 3 - Support for SATA hosts is outside the scope of this standard.

If a SAS phy reset sequence occurs (see 6.7.4)(i.e., one or more of the ATTACHED SSP INITIATOR PORT bit, ATTACHED STP INITIATOR PORT bit, the ATTACHED SMP INITIATOR PORT bit, the ATTACHED SSP TARGET PORT bit, the ATTACHED STP TARGET PORT bit, and/or the ATTACHED SMP TARGET PORT bit is set to one), then the ATTACHED SATA PORT SELECTOR bit, the ATTACHED SATA DEVICE bit, and the ATTACHED SATA HOST bit shall each be set to zero.

The ATTACHED SSP INITIATOR PORT bit indicates the value of the SSP INITIATOR PORT field received in the IDENTIFY address frame (see 7.8.2) during the identification sequence.

The ATTACHED STP INITIATOR PORT bit indicates the value of the STP INITIATOR PORT field received in the IDENTIFY address frame (see 7.8.2) during the identification sequence.

The ATTACHED SMP INITIATOR PORT bit indicates the value of the SMP INITIATOR PORT field received in the IDENTIFY address frame (see 7.8.2) during the identification sequence.

The ATTACHED SSP TARGET PORT bit indicates the value of the SSP TARGET PORT field received in the IDENTIFY address frame (see 7.8.2) during the identification sequence.

The ATTACHED STP TARGET PORT bit indicates the value of the STP TARGET PORT field received in the IDENTIFY address frame (see 7.8.2) during the identification sequence.

The ATTACHED SMP TARGET PORT bit indicates the value of the SMP TARGET PORT field received in the IDENTIFY address frame (see 7.8.2) during the identification sequence.

The ATTACHED SSP INITIATOR PORT bit, ATTACHED STP INITIATOR PORT bit, ATTACHED SMP INITIATOR PORT bit, ATTACHED SSP TARGET PORT bit, ATTACHED STP TARGET PORT bit, and ATTACHED SMP TARGET PORT bit shall be updated at the end of the identification sequence.

If a SATA phy reset sequence occurs (see 6.7.3)(i.e., the ATTACHED SATA PORT SELECTOR bit is set to one, the ATTACHED SATA DEVICE bit is set to one, or the ATTACHED SATA HOST bit is set to one), then the ATTACHED SSP INITIATOR PORT bit, ATTACHED STP INITIATOR PORT bit, ATTACHED SMP INITIATOR PORT bit, ATTACHED SSP TARGET PORT bit, ATTACHED STP TARGET PORT bit, and ATTACHED SMP TARGET PORT bit shall each be set to zero.

The SAS ADDRESS field contains the value of the SAS ADDRESS field transmitted in the IDENTIFY address frame during the identification sequence. If the phy is an expander phy, the SAS ADDRESS field contains the SAS address of the expander device (see 4.2.4). If the phy is a SAS phy, the SAS ADDRESS field contains the SAS address of the SAS port (see 4.2.6).

The ATTACHED SAS ADDRESS field contains the value of the SAS ADDRESS field received in the IDENTIFY address frame during the identification sequence. If the attached port is an expander port, the ATTACHED SAS ADDRESS field contains the SAS address of the attached expander device (see 4.2.4). If the attached port is a SAS port, the ATTACHED SAS ADDRESS field contains SAS address of the attached SAS port (see 4.2.6). If the attached port is a SATA device port, the ATTACHED SAS ADDRESS field contains the SAS address of the STP/SATA bridge (see 4.6.2).

The ATTACHED SAS ADDRESS field shall be updated:

- a) after the identification sequence completes, if a SAS phy or expander phy is attached; or
- b) after the COMSAS Detect Timeout timer expires (see 6.8.3.9), if a SATA phy is attached.

An STP initiator port should not make a connection request to the attached SAS address until the ATTACHED DEVICE TYPE field is set to a value other than 000b.

The ATTACHED PHY IDENTIFIER field contains a phy identifier for the attached phy:

- a) If the attached phy is a SAS phy or an expander phy, the ATTACHED PHY IDENTIFIER field contains the value of the PHY IDENTIFIER field received in the IDENTIFY address frame during the identification sequence:
 - A) If the attached phy is a SAS phy, the ATTACHED PHY IDENTIFIER field contains the phy identifier of the attached SAS phy in the attached SAS device;
 - B) If the attached phy is an expander phy, the ATTACHED PHY IDENTIFIER field contains the phy identifier (see 4.2.7) of the attached expander phy in the attached expander device; and
- b) If the attached phy is a SATA device phy, the ATTACHED PHY IDENTIFIER field contains 00h;
- c) If the attached phy is a SATA port selector phy and the expander device is able to determine the port of the SATA port selector to which it is attached, the ATTACHED PHY IDENTIFIER field contains 00h or 01h; and
- d) If the attached phy is a SATA port selector phy and the expander device is not able to determine the port of the SATA port selector to which it is attached, the ATTACHED PHY IDENTIFIER field contains 00h.

The ATTACHED PHY IDENTIFIER field shall be updated:

- a) after the identification sequence completes, if a SAS phy or expander phy is attached; or
- b) after the COMSAS Detect Timeout timer expires (see 6.8.3.9), if a SATA phy is attached.

The ATTACHED INSIDE ZPSDS PERSISTENT bit indicates the value of the INSIDE ZPSDS PERSISTENT bit received in the IDENTIFY address frame (see 7.8.2) from the attached phy during the identification sequence.

The ATTACHED REQUESTED INSIDE ZPSDS bit indicates the value of the REQUESTED INSIDE ZPSDS bit received in the IDENTIFY address frame (see 7.8.2) from the attached phy during the identification sequence.

The ATTACHED BREAK_REPLY CAPABLE bit indicates the value of the BREAK_REPLY CAPABLE bit received in the IDENTIFY address frame (see 7.8.2) during the identification sequence. If a phy reset sequence occurs (see 6.7) then the ATTACHED BREAK_REPLY CAPABLE bit shall be set to zero.

The PROGRAMMED MINIMUM PHYSICAL LINK RATE field indicates the minimum physical link rate set by the PHY CONTROL function (see 10.4.3.18). The values are defined in table 106. The default value shall be the value of the HARDWARE MINIMUM PHYSICAL LINK RATE field.

The HARDWARE MINIMUM PHYSICAL LINK RATE field indicates the minimum physical link rate supported by the phy. The values are defined in table 107.

The PROGRAMMED MAXIMUM PHYSICAL LINK RATE field indicates the maximum physical link rate set by the PHY CONTROL function (see 10.4.3.18). The values are defined in table 106. The default value shall be the value of the HARDWARE MAXIMUM PHYSICAL LINK RATE field.

Table 106 — PROGRAMMED MINIMUM PHYSICAL LINK RATE **and** PROGRAMMED MAXIMUM PHYSICAL LINK **rate fields**

| Code | Description |
|------------|------------------|
| 0h | Not programmable |
| 8h | 1,5 Gbps |
| 9h | 3,0 Gbps |
| Ah | 6 Gbps |
| All others | Reserved |

The HARDWARE MAXIMUM PHYSICAL LINK RATE field indicates the maximum physical link rate supported by the phy. The values are defined in table 107.

Table 107 — HARDWARE MINIMUM PHYSICAL LINK RATE **and** HARDWARE MAXIMUM PHYSICAL LINK RATE **fields**

| Code | Description |
|------------|-------------|
| 8h | 1,5 Gbps |
| 9h | 3,0 Gbps |
| Ah | 6 Gbps |
| All others | Reserved |

The PHY CHANGE COUNT field counts the number of Broadcast (Change)s originated by an expander phy. Expander devices shall support this field. Other device types shall not support this field. This field shall be set to zero at power on. The expander device shall increment this field at least once when it originates a Broadcast (Change) for any reason described in 7.11 from the specified expander phy and shall not increment this field when forwarding a Broadcast (Change).

After incrementing the PHY CHANGE COUNT field, the expander device is not required to increment the PHY CHANGE COUNT field again unless a DISCOVER response is transmitted. The PHY CHANGE COUNT field shall wrap to zero after the maximum value (i.e., FFh) has been reached.

NOTE 4 - Application clients that use the PHY CHANGE COUNT field should read it often enough to ensure that it does not increment a multiple of 256 times between reading the field.

A VIRTUAL PHY bit set to one indicates the phy is part of an internal port and the attached device is contained within the expander device. A VIRTUAL PHY bit set to zero indicates the phy is a physical phy and the attached device is not contained within the expander device.

The PARTIAL PATHWAY TIMEOUT VALUE field indicates the partial pathway timeout value in microseconds (see 7.12.4.4) set by the PHY CONTROL function (see 10.4.3.18).

NOTE 5 - The recommended default value for PARTIAL PATHWAY TIMEOUT VALUE is 7 μ s.

The ROUTING ATTRIBUTE field indicates the routing attribute supported by the phy (see 4.6.7.1) and is defined in table 108.

Table 108 — ROUTING ATTRIBUTE field

| Code | Name | Description |
|------------|-------------------------------|--|
| 0h | Direct routing attribute | Direct routing method for attached end devices. Attached expander devices are not supported on this phy. |
| 1h | Subtractive routing attribute | Either: a) subtractive routing method for attached expander devices; or b) direct routing method for attached end devices. |
| 2h | Table routing attribute | Either: a) table routing method for attached expander devices; or b) direct routing method for attached end devices. |
| All others | Reserved | |

The ROUTING ATTRIBUTE field shall not change based on the attached device type.

The CONNECTOR TYPE field indicates the type of connector used to access the phy, as reported by the enclosure services process for the enclosure (see the SAS Connector element in SES-2). A CONNECTOR TYPE field set to 00h indicates no connector information is available and that the CONNECTOR ELEMENT INDEX field and the CONNECTOR PHYSICAL LINK fields are invalid and shall be ignored.

The CONNECTOR ELEMENT INDEX indicates the element index of the SAS Connector element representing the connector used to access the phy, as reported by the enclosure services process for the enclosure (see the SAS Connector element in SES-2).

The CONNECTOR PHYSICAL LINK field indicates the physical link in the connector used to access the phy, as reported by the enclosure services process for the enclosure (see the SAS Connector element in SES-2).

The ATTACHED DEVICE NAME field contains the value of the the device name field received in the IDENTIFY address frame during the identification sequence. If the attached port is an expander port or a SAS port, the ATTACHED DEVICE NAME field contains the device name of the attached expander device or SAS device (see 4.2.4). If the attached port is a SATA device port, the ATTACHED DEVICE NAME field contains 00000000 00000000h.

The ATTACHED DEVICE NAME field shall be updated:

- a) after the identification sequence completes, if a SAS phy or expander phy is attached; or
- b) after the COMSAS Detect Timeout timer expires (see 6.8.3.9), if a SATA phy is attached.

A REQUESTED INSIDE ZPSDS CHANGED BY EXPANDER bit set to one indicates that the zoning expander device set the REQUESTED INSIDE ZPSDS bit to zero in the zone phy information at the completion of the last link reset sequence. A REQUESTED INSIDE ZPSDS CHANGED BY EXPANDER bit set to zero indicates that the zoning expander device did not set the REQUESTED INSIDE ZPSDS bit to zero in the zone phy information at the completion of the last link reset sequence.

NOTE 6 - The zone manager may use the REQUESTED INSIDE ZPSDS CHANGED BY EXPANDER bit to determine why the REQUESTED INSIDE ZPSDS bit has changed in the DISCOVER response from the value to which it last set the bit.

The INSIDE ZPSDS PERSISTENT bit contains the value of the INSIDE ZPSDS PERSISTENT bit in the zone phy information (see 4.9.3.1).

The REQUESTED INSIDE ZPSDS bit contains the value of the REQUESTED INSIDE ZPSDS bit in the zone phy information (see 4.9.3.1).

The ZONE ADDRESS RESOLVED bit contains the value of the ZONE ADDRESS RESOLVED bit in the zone phy information (see 4.9.3.1).

The ZONE GROUP PERSISTENT bit contains the value of the ZONE GROUP PERSISTENT bit in the zone phy information (see 4.9.3.1).

The INSIDE ZPSDS bit contains the value of the INSIDE ZPSDS bit in the zone phy information (see 4.9.3.1).

A ZONING ENABLED bit set to one indicates that zoning is enabled in the expander device. A ZONING ENABLED bit set to zero indicates that zoning is disabled in the expander device.

The ZONE GROUP field contains the value of the ZONE GROUP field in the zone phy information (see 4.9.3.1). Zone group values between 128 and 255, inclusive, are reserved.

The SELF-CONFIGURATION STATUS field indicates the status of a self-configuring expander device pertaining to the specified phy and is defined in table 109.

Table 109 — SELF-CONFIGURATION STATUS field

| Code | Description |
|-----------|---|
| 00h | No status available |
| 01h - FFh | As defined for the STATUS TYPE field in the self-configuration status descriptor in the REPORT SELF-CONFIGURATION STATUS response (see table 218 in 10.4.3.6) |

The SELF-CONFIGURATION LEVELS COMPLETED field indicates the number of levels of expander devices beyond the expander port containing the specified phy for which the self-configuring expander device's management application client has completed the discover process and is defined in table 110.

Table 110 — SELF-CONFIGURATION LEVELS COMPLETED field

| Code | Description |
|------|---|
| 00h | The management application client: a) has not begun the discover process through the expander port containing the specified phy; or b) has not completed the discover process through the expander port containing the specified phy. |
| 01h | The management application client has completed discovery of the expander device attached to the expander port containing the specified phy (i.e., level 1). |
| 02h | The management application client has completed discovery of the expander devices attached to the expander device attached to the expander port containing the specified phy (i.e., level 2). |
| ... | ... |
| FFh | The management application client has completed discovery of the expander devices attached at level 255. |

NOTE 7 - The self-configuration levels completed field does not reflect the level of externally configurable expander devices that the configuration subprocess updates to enable the discover process to proceed to higher levels.

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 HARDWARE SNW-3 INFORMATION SUPPORTED field indicates the SNW-3 information bits supported by the phy.](#)

Editor's Note 3: If a multi-bit field is ever added, return all 1s in its bit positions

The PROGRAMMED SNW-3 INFORMATION SUPPORTED field indicates the SNW-3 information set by the PHY CONTROL function (see 10.4.3.18). The default value shall be the value of the HARDWARE SNW-3 INFORMATION SUPPORTED field.

NOTE 8 - The HARDWARE SNW-3 INFORMATION SUPPORTED field and PROGRAMMED SNW-3 INFORMATION SUPPORTED field do not include SNW-3 information bits 0 through 7 and 64 through 71.

The SNW-3 INFORMATION field indicates the outgoing SNW-3 information transmitted in the last link reset sequence. If the last link reset sequence did not include an SNW-3 or was a SATA link reset sequence, the SNW-3 INFORMATION field shall be set to zero.

The ATTACHED SNW-3 INFORMATION field indicates the incoming SNW-3 information received in the last SNW-3. If the last link reset sequence did not include an SNW-3 or was a SATA link reset sequence, the ATTACHED SNW-3 INFORMATION 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 251 defines the request format.

Table 251 — 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 (09h0Bh) | | | | | | | | |
| 4 | (MSB) | EXPECTED EXPANDER CHANGE COUNT | | | | | | | |
| 5 | | | | | | | | (LSB) | |
| 6 | Reserved | | | | | | | | |
| 8 | Reserved | | | | | | | | |
| 9 | PHY IDENTIFIER | | | | | | | | |
| 10 | PHY OPERATION | | | | | | | | |
| 11 | Reserved | | | | | | | UPDATE PARTIAL PATHWAY TIMEOUT VALUE | |
| 12 | Reserved | | | | | | | | |
| 31 | Reserved | | | | | | | | |
| 32 | PROGRAMMED MINIMUM PHYSICAL LINK RATE | | | | Reserved | | | | |

Table 251 — PHY CONTROL request [\(part 2 of 2\)](#)

| Byte\Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----------|---------------------------------------|--|---|---|-------------------------------|---|---|--------------------------|
| 33 | PROGRAMMED MAXIMUM PHYSICAL LINK RATE | | | | Reserved | | | |
| 34 | Reserved | | | | | | | |
| 35 | Reserved | | | | | | | |
| 36 | Reserved | | | | PARTIAL PATHWAY TIMEOUT VALUE | | | |
| 37 | Reserved | | | | | | | |
| 39 | Reserved | | | | | | | |
| 40 | (bit 8) | PROGRAMMED SNW-3 INFORMATION SUPPORTED | | | | | | (bit 15) |
| 46 | (bit 56) | | | | | | | (bit 63) |
| 47 | Reserved | | | | | | | |
| 4048 | (MSB) | CRC | | | | | | |
| 4351 | | | | | | | | (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.

Table 252 defines the PHY OPERATION field.

Table 252 — PHY OPERATION field (part 1 of 2)

| Code | Operation | Description |
|------|-------------------|---|
| 00h | NOP | No operation. |
| 01h | LINK RESET | <p>If the specified phy is not a virtual phy, perform a link reset sequence (see 4.4) on the specified phy and enable the specified phy. If the specified phy is a virtual phy, perform an internal reset and enable the specified phy. See 7.11 for Broadcast (Change) requirements related to this phy operation in an expander device.</p> <p>Any affiliation (see 7.17.5) shall continue to be present. The phy shall bypass the SATA spinup hold state, if implemented (see 6.8.3.9).</p> <p>The management device server shall return the PHY CONTROL response without waiting for the LINK RESET phy operation to complete.</p> <p>While the LINK RESET phy operation is in progress, the management device server sets the NEGOTIATED PHYSICAL LINK RATE field to RESET_IN_PROGRESS in the SMP DISCOVER response (see 10.4.3.5) and the SMP DISCOVER LIST response (see 10.4.3.12).</p> |
| 02h | HARD RESET | <p>If the specified phy is not a virtual phy, perform a link reset sequence (see 4.4) on the specified phy and enable the specified phy. If the attached phy is a SAS phy or an expander phy, the link reset sequence shall include a hard reset sequence (see 4.4.2). If the attached phy is a SATA phy, the phy shall bypass the SATA spinup hold state. See 7.11 for Broadcast (Change) requirements related to this phy operation in an expander device.</p> <p>If the specified phy is a virtual phy, perform an internal reset and enable the specified phy.</p> <p>Any affiliation (see 7.17.5) shall be cleared.</p> <p>The management device server shall return the PHY CONTROL response without waiting for the HARD RESET phy operation to complete.</p> <p>While the HARD RESET phy operation is in progress, the management device server sets the NEGOTIATED PHYSICAL LINK RATE field to RESET_IN_PROGRESS in the SMP DISCOVER response (see 10.4.3.5) and the SMP DISCOVER LIST response (see 10.4.3.12).</p> |
| 03h | DISABLE | Disable the specified phy (i.e., stop transmitting valid dwords and receiving dwords on the specified phy). The LINK RESET and HARD RESET operations may be used to enable the phy. See 7.11 for Broadcast (Change) requirements related to this phy operation in an expander device. |
| 04h | Reserved | |
| 05h | CLEAR ERROR LOG | Clear the error log counters reported in the REPORT PHY ERROR LOG function (see 10.4.3.7) for the specified phy. |
| 06h | CLEAR AFFILIATION | Clear an affiliation (see 7.17.5) from the STP initiator port with the same SAS address as the SMP initiator port that opened this SMP connection. If there is no such affiliation, the management device server shall return a function result of SMP FUNCTION FAILED in the response frame. |

Table 252 — PHY OPERATION field (part 2 of 2)

| Code | Operation | Description |
|---------------|--|---|
| 07h | TRANSMIT SATA PORT SELECTION SIGNAL | <p>This function shall only be supported by phys in an expander device.</p> <p>If the expander phy incorporates an STP/SATA bridge and supports SATA port selectors, the phy shall transmit the SATA port selection signal (see 6.6) which causes the SATA port selector to select the attached phy as the active host phy and make its other host phy inactive. See 7.11 for Broadcast (Change) requirements related to this phy operation in an expander device.</p> <p>Any affiliation (see 7.17.5) shall be cleared.</p> <p>If the expander phy does not support SATA port selectors, then the management device server shall return a function result of PHY DOES NOT SUPPORT SATA.</p> <p>If the expander phy supports SATA port selectors but is attached to a SAS phy or an expander phy, the management device server shall return a function result of SMP FUNCTION FAILED.</p> |
| 08h | CLEAR STP I_T NEXUS LOSS | The STP I_T NEXUS LOSS OCCURRED bit in the REPORT PHY SATA function (see 10.4.3.8) shall be set to zero. |
| All others | Reserved | |

If the PHY IDENTIFIER field specifies the phy which is being used for the SMP connection and a phy operation of LINK RESET, HARD RESET, or DISABLE is requested, the management device server shall not perform the requested operation and shall return a function result of SMP FUNCTION FAILED in the response frame.

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.

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 253 defines the values for this field. If the value does not agree with the PROGRAMMED SNW-3 INFORMATION SUPPORTED field, the management device server shall not change the current SNW-3 information, shall return a function result of SMP FUNCTION FAILED in the response frame, and shall not perform the requested phy operation. 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 253 defines the values for this field. If the value does not agree with the PROGRAMMED SNW-3 INFORMATION SUPPORTED field, the management device server shall not change the current SNW-3 information, shall return a function result of SMP FUNCTION FAILED in the

[response frame, and shall not perform the requested phy operation. 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 253 — PROGRAMMED MINIMUM PHYSICAL LINK RATE **and** PROGRAMMED MAXIMUM PHYSICAL LINK RATE **fields**

| Code | Description |
|------------|-----------------------------|
| 0h | Do not change current value |
| 8h | 1,5 Gbps |
| 9h | 3,0 Gbps |
| All others | Reserved |

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 μs) 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).

[The PROGRAMMED SNW-3 INFORMATION SUPPORTED field specifies the outgoing SNW-3 information the phy shall use in every subsequent link reset sequence containing an SNW-3. If the phy does not support the value or the value does not agree with the PROGRAMMED MINIMUM PHYSICAL LINK RATE field and the PROGRAMMED MAXIMUM PHYSICAL LINK RATE field, the management device server shall not change the current SNW-3 information, shall return a function result of SMP FUNCTION FAILED in the response frame, and shall not perform the requested phy operation. This value is reported in the DISCOVER response \(see 10.4.3.5\).](#)

[NOTE 9 - The PROGRAMMED SNW-3 INFORMATION SUPPORTED field does not include SNW-3 information bits 0 through 7 and 64 through 71.](#)

The CRC field is defined in 10.4.3.1.

Table 254 defines the response format.

Table 254 — 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 | | | | | | | |
| 7 | | | | | | | | (LSB) | |

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.