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To: T10 SAS Protocol Working Group
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Subject: [SAS-2.1 / SPL](#), Low power transceiver options, phy states

1 Related documents

SAS-2r14 - Serial Attached SCSI - 2, revision 14d
 T10/08-015r4, SAS: Add low power transceiver options
[T10/08-249r2, SAS 2.1 / SPL+: Link Layer Power Management](#)

2 Introduction

This proposal is a first pass at adding what is required in proposal 08-015 for the phy layer state diagrams to include the low power transceiver options of partial and slumber conditions for SAS.

[Revision 1 of this proposal removes all link layer state elements, as those are now described in 08-249. These deletions are not shown in this revision.](#)

[Revision 2 of this proposal includes resolution to the comments received since revision 1 was posted.](#)

3 Proposal

[The following are the proposed changes based on the heading numbers in SAS-2r14d:](#)

6.7.1 Phy reset sequences overview

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A phy shall originate a phy reset sequence after:

- a) power on;
- b) hard reset (i.e., receiving a HARD_RESET primitive sequence before an IDENTIFY address frame) (see 4.4.2);
- c) management application layer request (see 6.8.1);
- d) losing dword synchronization and not attempting to re-acquire dword synchronization (see 6.8.4.9 and 6.8.5.8);
- e) Receive Identify Timeout timer expires (see 7.10); ~~or~~
- f) for expander phys, after a hot-plug timeout (see 6.7.5); or
- g) [when a SAS phy is exiting a low power state \(see 6.8.5\); and](#)
 - A) [a hot-plug timeout occurs; or](#)
 - B) [the SNLT timer expires.](#)

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In Table 93 — Phy reset sequence timing specifications, change the wording in the “comments” column as follows:

The time after which:

- a) an expander phy shall retry an unsuccessful phy reset sequence;
- b) a SAS initiator phy should retry an unsuccessful phy reset sequence (see 6.7.5); or
- c) a SAS phy exiting a low power state (see 6.8.5.2.2) shall begin a phy reset sequence (see 6.7) if the phy does not receive a COMWAKE Completed message.

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6.7.4.2.2 SAS speed negotiation sequence timing specifications

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In Table 95 — SAS speed negotiation sequence timing specifications, change the wording in the “comments” column for the “Speed negotiation lock time” row to be as follows:

- a) The maximum time for a phy to reply with ALIGN (1) during SNW-1, SNW-2, and Final-SNW; or
- b) The maximum time for a phy to reply with an ALIGN (0) or ALIGN (1) when exiting a SAS phy power management state.

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6.8.1 SP state machine overview

The SP state machine controls the phy reset sequence. This state machine consists of ~~three~~four sets of states:

- c) OOB sequence (OOB) states;
- d) SAS speed negotiation (SAS) states; ~~;~~
- e) SATA host emulation (SATA) states; and
- f) SAS phy power management (PS) states.

This state machine consists of the following states

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- ad) SP29:SAS_Train (see 6.8.4.12); ~~and~~
- ae) SP30:SAS_TrainingDone (see 6.8.4.13); ~~;~~
- af) SP31:SAS PS Phy Low Power state (see 6.8.5.2);
- ag) SP32:SAS PS ALIGN0 state (see 6.8.5.3); and
- ah) SP33:SAS PS ALIGN1 state (see 6.8.5.4).

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If the phy supports SAS phy power management, then this state machine shall maintain a SASPhyPwrMgmt state machine variable to determine the current power condition of the phy.

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6.8.3.1 OOB sequence states overview

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In figure 157 – SP (phy layer) state machine - OOB sequences states, add a transition arrow from all SAS phy power management states to the SP0:OOB_COMINIT state.

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6.8.3.2 SP0:OOB_COMINIT state**6.8.3.2.1 State description**

This state is the initial state for this state machine.

Upon entry into this state, the phy shall:

- a) set the COMWAKE_Received state machine variable to zero;
- b) [set the SASPhyPwrMgmt state machine variable to Active;](#)
- c) send a Stop DWS message to the SP_DWS state machine;
- d) send a Phy Layer Not Ready confirmation to the link layer;
- e) set the ATTACHED SATA DEVICE bit to zero in the SMP DISCOVER response (see 10.4.3.10);
- f) if this state was entered due to power on, then set the ATTACHED SATA PORT SELECTOR bit to zero in the SMP DISCOVER response (see 10.4.3.10); and
- g) if this state was not entered because of a Disable Phy request, then send a Transmit COMINIT.

message to the SP transmitter.

6.8.4.1 SAS speed negotiation states overview

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[In figure 158 – SP \(phy layer\) state machine - SAS speed negotiation states, add](#)

- a) [a Phy Power Management request to the SP15:SAS_PHY_Ready state;](#)
- b) [a transition arrow from the SP15:SAS_PHY_Ready state to the SP31:SAS_PS_Phy_Low_Power state; and](#)
- c) [a transition arrow from the SP33:SAS_PS_ALIGN1 state to the SP15:SAS_PHY_Ready state.](#)

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6.8.4.2 SP8:SAS_Start state**6.8.4.2.1 State description**

This is the ~~initial~~ state ~~for~~ [in which](#) the SAS speed negotiation sequence [begins](#).

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6.8.4.9 SP15:SAS_Phy_Ready state**6.8.4.9.1 State description**

This state waits for:

- a) a COMINIT Detected message;
- b) a DWS Lost message; ~~or~~
- c) a DWS Reset message; ~~or~~
- d) [a Phy Power Management request.](#)

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[6.8.3.4.9.3 Transition SP15:SAS_Phy_Ready to SP31:SAS_PS_Phy_Low_Power](#)

[This transition shall occur after this state receives a Phy Power Management \(Partial\) request or a Phy Power Management \(Slumber\) request.](#)

[If this transition is the result of this state receiving a Phy Power Management \(Partial\) request, then the transition shall include a Partial argument.](#)

[If this transition is the result of this state receiving a Phy Power Management \(Slumber\) request, then the transition shall include a Slumber argument.](#)

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6.8.5 SAS phy power management states

[Editor's note: this is a new clause with a new figure.]

6.8.5.1 SAS phy power management states overview

Figure a shows the SAS phy power management states. These states are entered when a phy enters a low power condition (i.e., the SAS partial low power condition or the SAS slumber low power condition) and process the actions that return a phy from a low power condition to participating in an operational logical link. These states are indicated by state names with a prefix of SAS PS.

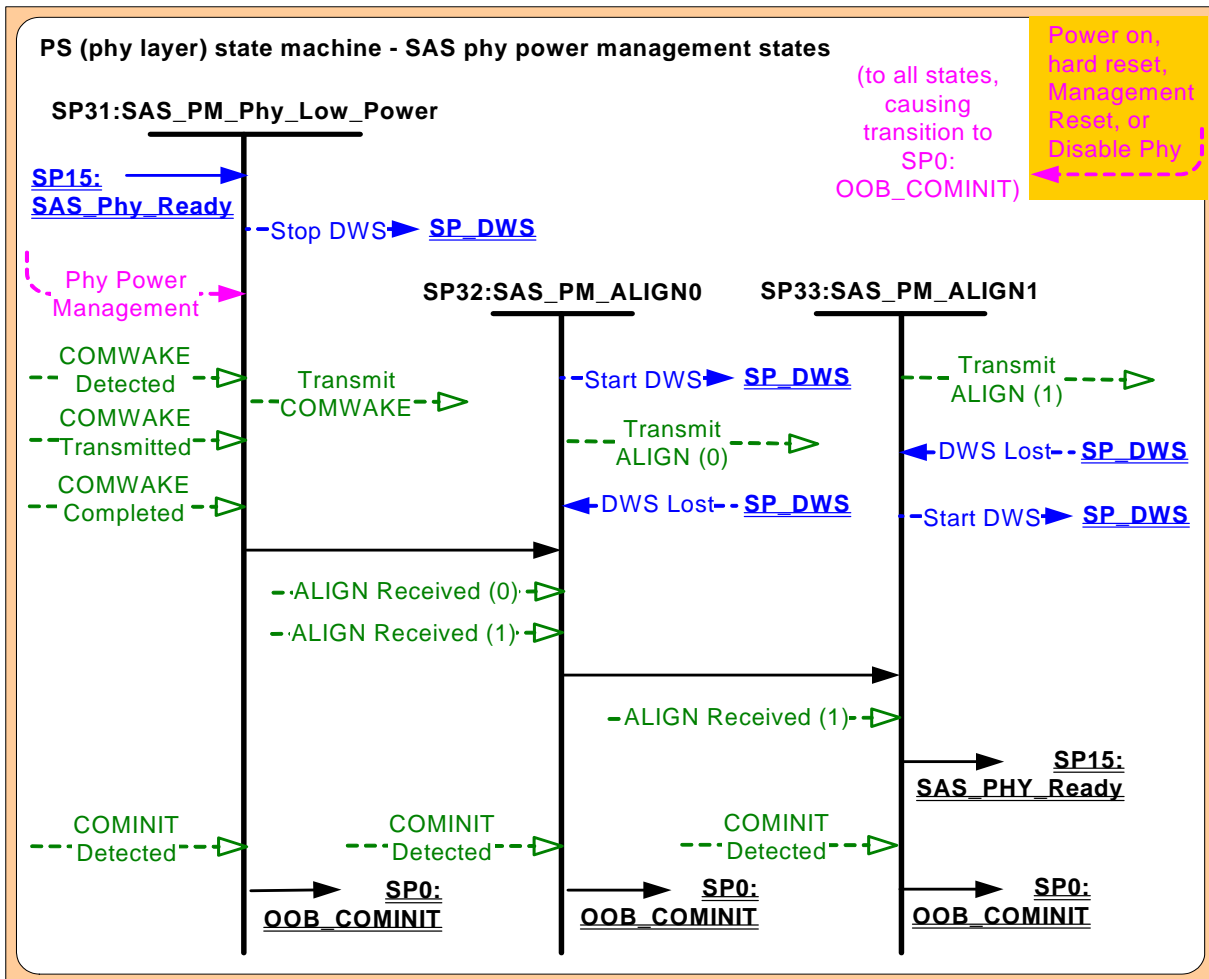


Figure a — PS (phy layer) state machine - SAS phy power management states

6.8.5.2 SP31:SAS PS Phy Low Power state

6.8.5.2.1 State description

Upon entry into this state, this state shall send a Stop DWS message.

If this state is entered with a Partial argument, then:

- a) the phy shall enter in the Partial power condition (see [add a cross reference to a clause where this is defined in 08-015]); and
- b) the state shall set the SASPhyPwrMgmt state machine variable to Partial.

If this state is entered with a Slumber argument, then:

- a) the phy shall enter in the Slumber power condition (see [add a cross reference to a clause where this is defined in 08-015]); and
- b) the state shall set the SASPhyPwrMgmt state machine variable to Slumber.

Editor's note: I think these should be called "power conditions" as opposed to "power states" to minimize confusion in the state diagrams and descriptions.]

If this state receives a Phy Power Management (Exit) request or a COMWAKE Detected message, then this state shall send a Transmit COMWAKE message.

6.8.5.2.2 Transition SP31:SAS PS Phy Low Power to SP0:OOB COMINIT

This transition shall occur if:

- a) this state:
 - A) receives a COMWAKE Transmitted message; and
 - B) does not receive a COMWAKE Completed message within a hot-plug timeout (see table 93 in 6.7.1);
- or
- b) this state receives a COMINIT Detected message.

6.8.5.2.3 Transition SP31:SAS PS Phy Low Power to SP32:SAS PS ALIGN0

This transition shall occur after this state:

- a) receives a COMWAKE Transmitted message; and
- b) receives a COMWAKE Completed message.

6.8.5.3 SP32:SAS PS ALIGN0 state

6.8.5.3.1 State description

Upon entry into this state, the phy shall:

- 1) initialize and start the SNLT timer;
- 2) send a Set Physical Link Rate message to the SP transmitter and to the SP receiver and send a Set SSC message to the SP transmitter with the arguments set to those determined from the last speed negotiation window;
- 3) if applicable, restore any vendor-unique information for the SP receiver determined from the previous Train-SNW speed negotiation window with the arguments set to the same values as those for the previous entry into the SP28:SAS TrainSetup state (see 6.8.4.11);
- 4) send a Start DWS message; and
- 5) repeatedly send Transmit ALIGN (0) messages.

Each time this state receives a DWS Lost message, this state may send a Start DWS message to re-acquire dword synchronization without running a new link reset sequence.

6.8.5.3.2 Transition SP32:SAS PS ALIGN0 state to SP0:OOB COMINIT

This transition shall occur after this state:

- a) receives a DWS Lost message, if this state does not send a Start DWS message;
- b) receives a COMINIT Detected message; or
- c) does not receive an ALIGN Received (0) message or an ALIGN Received (1) message before the SNLT timer expires.

6.8.5.3.3 Transition SP32:SAS PS ALIGN0 to SP33:SAS PS ALIGN1

This transition shall occur:

- a) if this state receives an ALIGN Received (0) message or an ALIGN Received (1) message before the SNLT timer expires; and
- b) after this state has sent at least three Transmit ALIGN (0) messages.

6.8.5.4 SP33:SAS PS ALIGN1 state

6.8.5.4.1 State description

Upon entry into this state, the phy shall:

- 1) initialize and start the SNLT timer; and
- 2) repeatedly send Transmit ALIGN (1) messages.

Each time this state receives a DWS Lost message, this state may send a Start DWS message to re-acquire dword synchronization without running a new link reset sequence.

6.8.5.4.2 Transition SP33:SAS PS ALIGN1 state to SP0:OOB COMINIT

This transition shall occur after this state:

- a) receives a DWS Lost message, if this state does not send a Start DWS message;
- b) receives a COMINIT Detected message; or
- c) does not receive an ALIGN Received (1) message before the SNLT timer expires.

6.8.5.4.3 Transition SP33:SAS PS ALIGN1 state to SP15:SAS PHY Ready

This transition shall occur:

- a) if this state receives an ALIGN Received (1) message before the SNLT timer expires;
- b) after this state has sent at least three Transmit ALIGN (1) messages; and
- c) after this state sets the SASPhyPwrMgmt state machine variable to Active.

NOTE 1 - Receipt of the ALIGN Receive (1) message indicates that the connected phy has been able to achieve dword synchronization with the previously negotiated settings.

NOTE 2 - After the transition, the SP15:SAS PHY Ready state sends a Phy Layer Ready (SAS) confirmation after establishing multiplexing, if multiplexing is enabled.

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