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To: T10 SAS Protocol Working Group  
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Subject: SAS-2.1 / SPL, Low power transceiver options, phy ~~and link~~ states

## 1 Related documents

SAS-2r14 - Serial Attached SCSI - 2, revision 14 [d](#)  
 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 08-015r4 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.](#)

## 3 Proposal

The following are the proposed changes to the SP state machine.

### 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:

- a) OOB sequence (OOB) states;
- b) SAS speed negotiation (SAS) states; ~~and~~ [and](#)
- c) SATA host emulation (SATA) states; and
- d) [SAS phy power management \(PM\) 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\\_PM\\_Phy\\_Low\\_Power state \(see 6.8.5.2\);](#)
- [ag\) SP32:SAS\\_PM\\_ALIGN0 state \(see 6.8.5.3\).; and](#)
- [ah\) SP33:SAS\\_PM\\_ALIGN1 state \(see 6.8.5.4\).](#)

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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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**6.8.4.1 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 PM Phy Low Power state; and
- c) a transition arrow from the SP33:SAS PM ALIGN1 state to the SP15:SAS PHY Ready state.

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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;
- d) a Phy Power Management request.

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**6.8.3.4.9.3 Transition SP15:SAS Phy Ready to SP31:SAS PM Phy Low Power**

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

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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 PM.

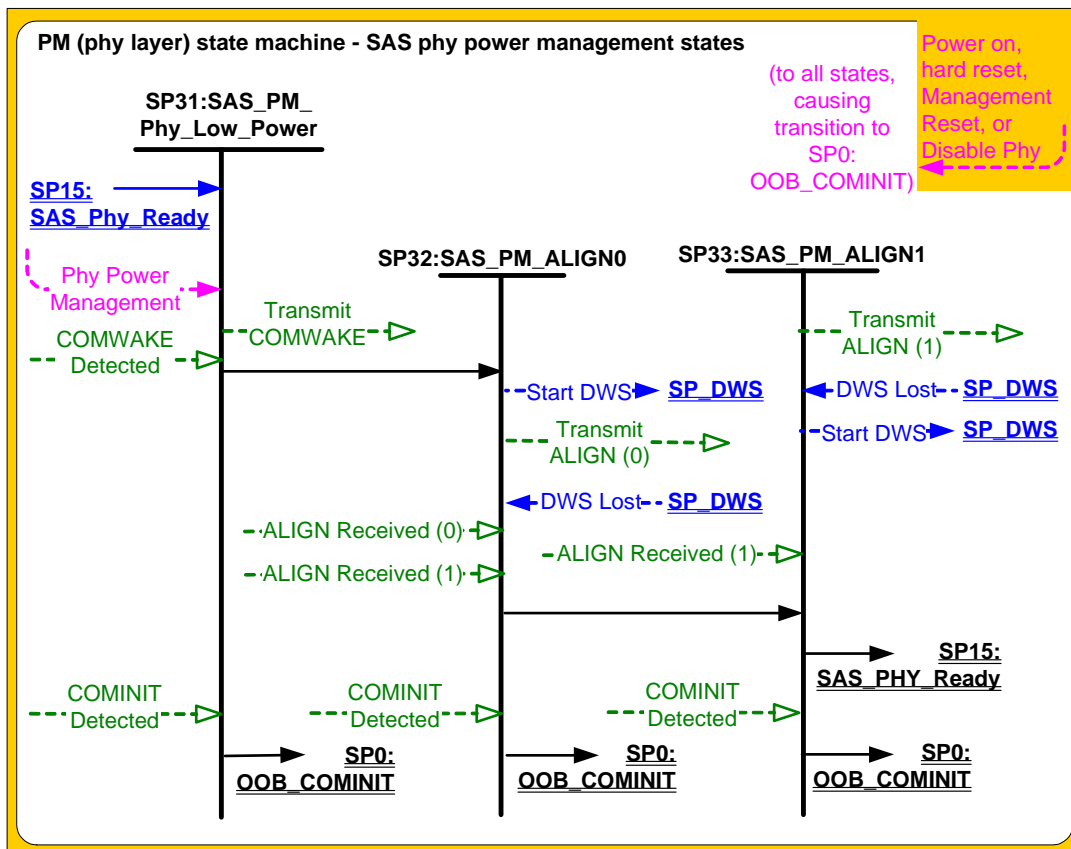


Figure a — PM (phy layer) state machine - SAS phy power management states

6.8.5.2 SP31:SAS PM Phy Low Power state

6.8.4.2.1 State description

This is the initial state for the SAS phy power management states. In this state the phy is either in the SAS partial low power condition or the SAS slumber low power condition.

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

6.8.4.2.2 Transition SP31:SAS PM Recovery Start to SP0:OOB\_COMINIT

This transition shall occur if:

- a) this state:
  - A) receives a Phy Power Management (Exit) request;
  - B) sends a Transmit COMWAKE message; and
  - C) does not receive a COMWAKE Detected message within a COMWAKE timeout;
 or
- b) this state receive a COMINIT Detected message.

6.8.4.2.2 Transition SP31:SAS PM Recovery Start to SP32:SAS PM ALIGN0

This transition shall occur after this state:

- a) receives a Phy Power Management (Exit) request and sends a Transmit COMWAKE message; or
- b) receives a COMWAKE Detected message.

### **6.8.5.3 SP32:SAS PM ALIGN0 state**

#### **6.8.5.3.1 State description**

Upon entry into this state, the phy shall:

- a) initialize and start the SNLT timer;
- b) send a Start DWS message; and
- c) 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.

If this state does not send a Start DWS message after receiving a a DWS Lost message, then this state shall set the ResetStatus state machine variable to UNKNOWN.

#### **6.8.5.3.2 Transition SP32:SAS PM 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; or
- b) this state receive a COMINIT Detected message.

#### **6.8.5.3.3 Transition SP32:SAS PM ALIGN0 to SP33:SAS PM ALIGN1**

This transition shall occur if this state receives an ALIGN Received (0) message or an ALIGN Received (1) message before the SNLT timer expires.

### **6.8.5.4 SP33:SAS PM ALIGN1 state**

#### **6.8.5.4.1 State description**

Upon entry into this state, the phy shall 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.

If this state does not send a Start DWS message after receiving a a DWS Lost message, then this state shall set the ResetStatus state machine variable to UNKNOWN.

#### **6.8.5.4.2 Transition SP33:SAS PM 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; or
- b) this state receive a COMINIT Detected message.

#### **6.8.5.4.3 Transition SP33:SAS PM ALIGN1 state to SP15:SAS PHY Ready**

This transition shall occur if this state receives an ALIGN Received (1) message before the SNLT timer expires.

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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