

To: T10 SAS Protocol Working Group

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Subject: SAS 2: Changes for the NEGOTIATED PHYSICAL LINK RATE

Revision History

Revision 0 - Initial draft (November 1, 2006)

Related Documents

sas2r06 - Serial Attached SCSI - 2 Draft revision 06

Overview

At the meeting in Nashua, the group briefly discussed how the negotiated physical link rate could be clarified against the SP state machine. This proposal attempts to base the negotiated physical link rate field to specific SP states. There was some discussion on which states should be persistent until something else more informative occurs. The following are my intentions and assumptions relative to the proposed changes.

- a) UNKNOWN happens at any power-on or hard reset, and non-Management reset requests excluding SPINUP_HOLD condition.
- b) DISABLED only happens as a result of the Disable Phy request.
- c) PHY_RESET_PROBLEM only happens when the final SAS (not SATA) speed negotiation fails. This would persist until a power-on, hard reset, Disable Phy, Management Reset request, or upon detecting the device is no longer present.
- d) SPINUP_HOLD only happens when reaching the SP26: SATA_SpinupHold state, and remains at that value until cleared by a power-on, hard reset, DisablePhy, or Management reset request.
- e) PORT_SELECTOR is set when receiving the COMWAKE after sending the COMINIT. Since the ATTACHED SATA PORT SELECTOR bit is persistent across phy reset sequences, this value does not need to be persistent. It can be set back to UNKNOWN when hot plug timer expires. This means when attached to inactive port of the port selector, the field will toggle between UNKNOWN and PORT_SELECTOR every hot plug time. The PHY_RESET_PROBLEM, SPINUP_HOLD, and UNSUPPORTED_PHY_ATTACHED conditions have precedence over this value.
- f) RESET_IN_PROGRESS is set when a Management Reset request happens after the phy has already achieved a G1 or G2 value, or a new Management Reset request happens while already in the RESET_IN_PROGRESS condition.
- g) G1 or G2 is set whenever reaching the SP22:SATA_PHY_Ready SP state, or reaching the SP12:SAS_AwaitSNW SP state.
- h) UNSUPPORTED_PHY_ATTACHED is a new proposed value, which indicates when a device is attached, but the phy was not able to negotiate to a common supported rate. This value would persist until a power-on, hard reset, Disable Phy, Management Reset request, or upon detecting the device is no longer present.

Proposed Changes

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.

This state machine waits for receipt of a COMINIT Transmitted message and/or a COMINIT Detected message.

Upon entry into this state, this state shall:

- a) set the COMWAKE_Received state machine variable to zero;

- b) send a Stop DWS message to the SP_DWS state machine;
- c) send a Phy Layer Not Ready confirmation to the link layer; and
- d) set the ATTACHED SATA DEVICE bit to zero in the SMP DISCOVER response (see 10.4.3.7) and the SMP DISCOVER LIST response (see 10.4.3.13.3).

If this state was entered due to power on, the phy shall set the ATTACHED SATA PORT SELECTOR bit to zero in the SMP DISCOVER response (see 10.4.3.7) and the SMP DISCOVER LIST response (see 10.4.3.13.3).

Editor's Note 1: The phrase "in the SMP DISCOVER response (see 10.4.3.7) and the SMP DISCOVER LIST response (see 10.4.3.13.3)" would need to be added in quite a number of places... anywhere the NEGOTIATED PHYSICAL LINK RATE is checked or set (same as was done for the ATTACHED SATA PORT SELECTOR bit). Should this be done using some global state machine variables here, that the SMP section refers to instead, or some other method?

If this state was not entered because of a Disable Phy request, this state shall send a Transmit COMINIT message to the SP transmitter upon entry into this state.

Upon entry into this state, if this state was entered because of a Disable Phy request, this state shall:

- a) ignore COMINIT Detected messages until this state is re-entered due to a power on, hard reset, or Management Reset request; and
- b) set the NEGOTIATED PHYSICAL LINK RATE field to UNKNOWN.

Upon entry into this state, if this state was entered due to power on or hard reset, this state shall set the NEGOTIATED PHYSICAL LINK RATE field to UNKNOWN.

Upon entry into this state, if this state was entered because of a Management Reset request, then this state shall:

- a) if the NEGOTIATED PHYSICAL LINK RATE field is not set to RESET_IN_PROGRESS, G1, or G2, set the NEGOTIATED PHYSICAL LINK RATE field to UNKNOWN; and
- b) if the NEGOTIATED PHYSICAL LINK RATE field is set to RESET_IN_PROGRESS, G1, or G2, set the NEGOTIATED PHYSICAL LINK RATE field to RESET_IN_PROGRESS.

Upon entry into this state, if this state was not entered due to a power on, hard reset, Disable Phy, or Management Reset request, then this state shall:

- a) if the NEGOTIATED PHYSICAL LINK RATE field is not set to PHY_RESET_PROBLEM, SPINUP_HOLD, or UNSUPPORTED_PHY_ATTACHED, set the NEGOTIATED PHYSICAL LINK RATE field to UNKNOWN; and
- b) if the NEGOTIATED PHYSICAL LINK RATE field is set to PHY_RESET_PROBLEM, SPINUP_HOLD, or UNSUPPORTED_PHY_ATTACHED, not change the NEGOTIATED PHYSICAL LINK RATE field.

If the phy supports SATA port selectors and this state receives a COMWAKE Detected message, this state shall:

- a) if the NEGOTIATED PHYSICAL LINK RATE field is not set to PHY_RESET_PROBLEM, SPINUP_HOLD, or UNSUPPORTED_PHY_ATTACHED, set the NEGOTIATED PHYSICAL LINK RATE field to PORT_SELECTOR.
- b) set the COMWAKE_Received state machine variable to one; and
- c) if the ATTACHED SATA PORT SELECTOR bit is set to zero in the SMP DISCOVER response (see 10.4.3.7) and the SMP DISCOVER LIST response (see 10.4.3.13.3):
 - A) set the ATTACHED SATA PORT SELECTOR bit to one in the SMP DISCOVER response and the SMP DISCOVER LIST response; and
 - B) send a SATA Port Selector Change confirmation to the link layer.

6.8.3.2.2 Transition SP0:OOB_COMINIT to SP1:OOB_AwaitCOMX

This transition shall occur if this state receives a COMINIT Transmitted message and has not received a COMINIT Detected message.

6.8.3.2.3 Transition SP0:OOB_COMINIT to SP3:OOB_AwaitCOMINIT_Sent

This transition shall occur if this state receives a COMINIT Detected message and has not received a COMINIT Transmitted message.

6.8.3.2.4 Transition SP0:OOB_COMINIT to SP4:OOB_COMSAS

This transition shall occur if this state receives both a COMINIT Transmitted message and a COMINIT Detected message.

6.8.3.3 SP1:OOB_AwaitCOMX state

6.8.3.3.1 State description

Upon entry into this state, the Hot-Plug Timeout timer shall be initialized and started if this phy is:

- a) an expander phy; or
- b) an initiator phy or target phy implementing the Hot-Plug Timeout timer.

If the phy supports SATA port selectors and this state receives a COMWAKE Detected message, this state shall:

- a) if the NEGOTIATED PHYSICAL LINK RATE field is not set to PHY_RESET_PROBLEM, SPINUP_HOLD, or UNSUPPORTED_PHY_ATTACHED, set the NEGOTIATED PHYSICAL LINK RATE field to PORT_SELECTOR;
- b) set the COMWAKE_Received state machine variable to one; and
- c) if the ATTACHED SATA PORT SELECTOR bit is set to zero in the SMP DISCOVER response (see 10.4.3.7) and the SMP DISCOVER LIST response (see 10.4.3.13.3):
 - A) set the ATTACHED SATA PORT SELECTOR bit to one in the SMP DISCOVER response and the SMP DISCOVER LIST response; and
 - B) send a SATA Port Selector Change confirmation to the link layer.

6.8.3.3.2 Transition SP1:OOB_AwaitCOMX to SP0:OOB_COMINIT

This transition shall occur if the Hot-Plug Timeout timer expires.

If the COMWAKE_Received state machine variable is set to zero and the ATTACHED SATA PORT SELECTOR bit is set to one in the SMP DISCOVER response (see 10.4.3.7) and the SMP DISCOVER LIST response (see 10.4.3.13.3), the state machine shall, before the transition:

- a) set the ATTACHED SATA PORT SELECTOR bit to zero in the SMP DISCOVER response and the SMP DISCOVER LIST response; and
- b) send a SATA Port Selector Change confirmation to the link layer.

Before the transition, if this state was entered from SP0:OOB_COMINIT, and the COMWAKE_Received state machine variable is set to zero, then this state shall set the NEGOTIATED PHYSICAL LINK RATE field to UNKNOWN.

6.8.3.3.3 Transition SP1:OOB_AwaitCOMX to SP4:OOB_COMSAS

This transition shall occur after receiving either a COMINIT Detected message or a COMSAS Detected message. If COMSAS Detected was received, this transition shall include a COMSAS Detected argument.

If the ATTACHED SATA PORT SELECTOR bit is set to one in the SMP DISCOVER response (see 10.4.3.7) and the SMP DISCOVER LIST response (see 10.4.3.13.3), the state machine shall, before the transition:

- a) set the ATTACHED SATA PORT SELECTOR bit to zero in the SMP DISCOVER response and the SMP DISCOVER LIST response; and
- b) send a SATA Port Selector Change confirmation to the link layer.

6.8.3.4 SP2:OOB_NoCOMSASTimeout state

6.8.3.4.1 State description

Upon entry into this state, the Hot-Plug Timeout timer shall be initialized and started if this phy is:

- a) this phy is an expander phy; or
- b) this phy is an initiator phy or target phy implementing the Hot-Plug Timeout timer.

6.8.3.4.2 Transition SP2:OOB_NoCOMSASTimeout to SP0:OOB_COMINIT

This transition shall occur if the Hot-Plug Timeout timer expires.

6.8.3.4.3 Transition SP2:OOB_NoCOMSASTimeout to SP4:OOB_COMSAS

This transition shall occur after receiving a COMINIT Detected message.

6.8.3.5 SP3:OOB_AwaitCOMINIT_Sent state

6.8.3.5.1 State description

This state waits for a COMINIT Transmitted message.

If the phy supports SATA port selectors, the ATTACHED SATA PORT SELECTOR bit is set to zero in the SMP DISCOVER response (see 10.4.3.7) and the SMP DISCOVER LIST response (see 10.4.3.13.3), and this state receives a COMWAKE Detected message, this state shall:

- a) [if the NEGOTIATED PHYSICAL LINK RATE field is not set to PHY_RESET_PROBLEM, SPINUP_HOLD, or UNSUPPORTED_PHY_ATTACHED, set the NEGOTIATED PHYSICAL LINK RATE field to PORT_SELECTOR.](#)
- b) set the ATTACHED SATA PORT SELECTOR bit to one in the SMP DISCOVER response and the SMP DISCOVER LIST response; and
- c) send a SATA Port Selector Change confirmation to the link layer.

6.8.3.5.2 Transition SP3:OOB_AwaitCOMINIT_Sent to SP4:OOB_COMSAS

This transition shall occur after receiving a COMINIT Transmitted message.

6.8.3.6 SP4:OOB_COMSAS state

6.8.3.6.1 State description

Upon entry into this state, this state shall send a Transmit COMSAS message to the SP transmitter.

This state waits for receipt of a COMSAS Transmitted message and/or a COMSAS Detected message.

If the phy supports SATA port selectors, the ATTACHED SATA PORT SELECTOR bit is set to zero in the SMP DISCOVER response (see 10.4.3.7) and the SMP DISCOVER LIST response (see 10.4.3.13.3), and this state receives a COMWAKE Detected message, this state shall:

- a) [if the NEGOTIATED PHYSICAL LINK RATE field is not set to PHY_RESET_PROBLEM, SPINUP_HOLD, or UNSUPPORTED_PHY_ATTACHED, set the NEGOTIATED PHYSICAL LINK RATE field to PORT_SELECTOR.](#)
- b) set the ATTACHED SATA PORT SELECTOR bit to one in the SMP DISCOVER response and the SMP DISCOVER LIST response; and
- c) send a SATA Port Selector Change confirmation to the link layer.

6.8.3.6.2 Transition SP4:OOB_COMSAS to SP5:OOB_AwaitCOMSAS_Sent

This transition shall occur if this state receives a COMSAS Detected message or this state was entered with a COMSAS Detected argument, and this state has not received a COMSAS Transmitted message.

If the ATTACHED SATA PORT SELECTOR bit is set to one in the SMP DISCOVER response (see 10.4.3.7) and the SMP DISCOVER LIST response (see 10.4.3.13.3), the state machine shall set the ATTACHED SATA PORT

SELECTOR bit to zero in the SMP DISCOVER response and the SMP DISCOVER LIST response and send a SATA Port Selector Change confirmation to the link layer before the transition.

6.8.3.6.3 Transition SP4:OOB_COMSAS to SP6:OOB_AwaitNoCOMSAS

This transition shall occur if this state receives both a COMSAS Transmitted message and a COMSAS Detected message.

If the ATTACHED SATA PORT SELECTOR bit is set to one in the SMP DISCOVER response (see 10.4.3.7) and the SMP DISCOVER LIST response (see 10.4.3.13.3), the state machine shall set the ATTACHED SATA PORT SELECTOR bit to zero in the SMP DISCOVER response and the SMP DISCOVER LIST response and send a SATA Port Selector Change confirmation to the link layer before the transition.

6.8.3.6.4 Transition SP4:OOB_COMSAS to SP7:OOB_AwaitCOMSAS

This transition shall occur if this state receives a COMSAS Transmitted message and has not received a COMSAS Detected message.

6.8.3.7 SP5:OOB_AwaitCOMSAS_Sent state

6.8.3.7.1 State description

This state waits for receipt of a COMSAS Transmitted message.

6.8.3.7.2 Transition SP5:OOB_AwaitCOMSAS_Sent to SP6:OOB_AwaitNoCOMSAS

This transition shall occur after receiving a COMSAS Transmitted message.

If this state received a COMSAS Completed message, it shall include a COMSAS Completed argument with the transition.

6.8.3.8 SP6:OOB_AwaitNoCOMSAS state

6.8.3.8.1 State description

This state machine waits for a COMSAS Completed message, which indicates that COMSAS has been completely received.

6.8.3.8.2 Transition SP6:OOB_AwaitNoCOMSAS to SP0:OOB_COMINIT

This transition shall occur after receiving a COMINIT Detected message.

6.8.3.8.3 Transition SP6:OOB_AwaitNoCOMSAS to SP8:SAS_Start

This transition shall occur after receiving a COMSAS Completed message, or shall occur if a COMSAS Completed argument was received in the transition.

6.8.3.9 SP7:OOB_AwaitCOMSAS state

6.8.3.9.1 State description

Upon entry into this state the COMSAS Detect Timeout timer shall be initialized and started.

6.8.3.9.2 Transition SP7:OOB_AwaitCOMSAS to SP2:OOB_NoCOMSASTimeout

This transition shall occur if the phy does not support SATA and the COMSAS Detect Timeout timer expires. The state machine shall set the MgmtReset state machine variable to zero before the transition.

6.8.3.9.3 Transition SP7:OOB_AwaitCOMSAS to SP6:OOB_AwaitNoCOMSAS

This transition shall occur after receiving a COMSAS Detected message.

The state machine shall set the MgmtReset state machine variable to zero before the transition.

The state machine shall set the ATTACHED SATA PORT SELECTOR bit to zero in the SMP DISCOVER response (see 10.4.3.7) and the SMP DISCOVER LIST response (see 10.4.3.13.3). If the ATTACHED SATA PORT SELECTOR bit in the SMP DISCOVER response and the SMP DISCOVER LIST response was set to one prior to this transition, the state machine shall send a SATA Port Selector Change confirmation to the link layer before the transition.

6.8.3.9.4 Transition SP7:OOB_AwaitCOMSAS to SP16:SATA_COMWAKE

This transition shall occur if:

- a) the phy supports SATA;
- b) the COMSAS Detect Timeout timer expires; and
 - A) the MgmtReset state machine variable is set to one; or
 - B) the phy does not implement SATA spinup hold.

The state machine shall set the MgmtReset state machine variable to zero before the transition.

The state machine shall set the ATTACHED SATA DEVICE bit to one in the SMP DISCOVER response (see 10.4.3.7) and the SMP DISCOVER LIST response (see 10.4.3.13.3) before the transition.

6.8.3.9.5 Transition SP7:OOB_AwaitCOMSAS to SP26:SATA_SpinupHold

This transition shall occur if:

- a) the phy supports SATA;
- b) the COMSAS Detect Timeout timer expires;
- c) the phy implements SATA spinup hold; and
- d) the MgmtReset state machine variable is set to zero.

The state machine shall set the ATTACHED SATA DEVICE bit to one in the SMP DISCOVER response (see 10.4.3.7) and the SMP DISCOVER LIST response (see 10.4.3.13.3) before the transition.

6.8.4 SAS speed negotiation states

6.8.4.1 SAS speed negotiation states overview

Figure 131 shows the SAS speed negotiation states, in which the phy has detected that it is attached to a SAS phy or expander phy rather than a SATA phy, and performs the SAS speed negotiation sequence. These states are indicated by state names with a prefix of SAS.

<figure deleted>

Figure 131 — SP (phy layer) state machine - SAS speed negotiation states

6.8.4.2 SP8:SAS_Start state

6.8.4.2.1 State description

This is the initial state for the SAS speed negotiation sequence.

Upon entry into this state, this state shall:

- a) initialize and start the RCDT timer;
- b) send a Set Rate message to the SP transmitter with the argument set to:
 - A) 1.5 Gbps, if the transition into this state was from the SP6:OOB_AwaitNoCOMSAS state (i.e., if this is the first speed negotiation window); or
 - B) the value of the SAS Speed Negotiation Window Rate argument.

During this state D.C. idle shall be transmitted.

6.8.4.2.2 Transition SP8:SAS_Start to SP0:OOB_COMINIT

This transition shall occur after receiving a COMINIT Detected message.

6.8.4.2.3 Transition SP8:SAS_Start to SP9:SAS_RateNotSupported

This transition shall occur after the RCDT timer expires if the current speed negotiation window rate is not supported.

6.8.4.2.4 Transition SP8:SAS_Start to SP10:SAS_AwaitALIGN

This transition shall occur after the RCDT timer expires if the current speed negotiation window rate is supported.

6.8.4.3 SP9:SAS_RateNotSupported state**6.8.4.3.1 State description**

Upon entry into this state the SNTT timer shall be initialized and started.

During this state D.C. idle shall be transmitted.

6.8.4.3.2 Transition SP9:SAS_RateNotSupported to SP14:SAS_Fail

This transition shall occur after the SNTT timer expires.

6.8.4.4 SP10:SAS_AwaitALIGN state**6.8.4.4.1 State description**

Upon entry into this state, the SNTT timer and SNLT timer shall be initialized and started and this state shall repeatedly send Transmit ALIGN (0) messages to the SP transmitter.

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

Upon entry into this state, this state shall send a Start DWS message to the SP_DWS state machine.

6.8.4.4.2 Transition SP10:SAS_AwaitALIGN to SP0:OOB_COMINIT

This transition shall occur after receiving a DWS Lost message if this state does not send a Start DWS message, or after receiving a COMINIT Detected message.

6.8.4.4.3 Transition SP10:SAS_AwaitALIGN to SP11:SAS_AwaitALIGN1

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

6.8.4.4.4 Transition SP10:SAS_AwaitALIGN to SP12:SAS_AwaitSNW

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

6.8.4.4.5 Transition SP10:SAS_AwaitALIGN to SP14:SAS_Fail

This transition shall occur if the SNTT timer expires.

6.8.4.5 SP11:SAS_AwaitALIGN1 state**6.8.4.5.1 State description**

This state shall repeatedly send Transmit ALIGN (1) messages to the SP transmitter.

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

6.8.4.5.2 Transition SP11:SAS_AwaitALIGN1 to SP0:OOB_COMINIT

This transition shall occur after receiving a DWS Lost message if this state does not send a Start DWS message, or after receiving a COMINIT Detected message.

6.8.4.5.3 Transition SP11:SAS_AwaitALIGN1 to SP12:SAS_AwaitSNW

This transition shall occur if this state receives an ALIGN Received (1) message before the SNLT timer expires. This indicates that the other phy has been able to achieve dword synchronization in the current speed negotiation window.

6.8.4.5.4 Transition SP11:SAS_AwaitALIGN1 to SP14:SAS_Fail

This transition shall occur if the SNTT timer expires. This indicates that the other phy has not been able to achieve dword synchronization in the current speed negotiation window.

6.8.4.6 SP12:SAS_AwaitSNW state

6.8.4.6.1 State description

This state shall repeatedly send Transmit ALIGN (1) messages to the SP transmitter.

If this is the final speed negotiation window, this state shall:

- a) send a Start SL_IR Receiver confirmation to the link layer; and
- b) set the NEGOTIATED PHYSICAL LINK RATE field to the value of the SAS Speed Negotiation Window Rate (i.e. G1 or G2).

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

This state waits for the SNTT timer to expire or for a Stop SNTT request.

6.8.4.6.2 Transition SP12:SAS_AwaitSNW to SP0:OOB_COMINIT

This transition shall occur after receiving a DWS Lost message if this state does not send a Start DWS message, or after receiving a COMINIT Detected message.

6.8.4.6.3 Transition SP12:SAS_AwaitSNW to SP13:SAS_Pass

This transition shall occur after the SNTT timer expires or after receiving a Stop SNTT request.

6.8.4.7 SP13:SAS_Pass state

6.8.4.7.1 State description

This state determines if:

- a) another SAS speed negotiation window is required; or
- b) the SAS speed negotiation sequence is complete.

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

6.8.4.7.2 Transition SP13:SAS_Pass to SP0:OOB_COMINIT

This transition shall occur after receiving a DWS Lost message if this state does not send a Start DWS message, or after receiving a COMINIT Detected message.

6.8.4.7.3 Transition SP13:SAS_Pass to SP8:SAS_Start

This transition shall occur if this is not the final speed negotiation window.

This transition shall include a SAS Speed Negotiation Window Rate argument with the transition set to the next higher speed negotiation window rate.

6.8.4.7.4 Transition SP13:SAS_Pass to SP15:SAS_PHY_Ready

This transition shall occur if this is the final speed negotiation window.

6.8.4.8 SP14:SAS_Fail state

6.8.4.8.1 State description

This state determines if:

- a) another SAS speed negotiation window is required; or
- b) the SAS speed negotiation sequence is complete.

6.8.4.8.2 Transition SP14:SAS_Fail to SP1:OOB_AwaitCOMX

This transition shall occur if:

- a) the current speed negotiation window is the maximum SAS speed negotiation window and the previous speed negotiation window was not successful; or
- b) the current speed negotiation window is the final SAS speed negotiation window.

Before the transition, this state shall:

- a) if the current speed negotiation window is the maximum SAS speed negotiation window and the previous speed negotiation window was not successful, set the NEGOTIATED PHYSICAL LINK RATE field to UNSUPPORTED_PHY_ATTACHED; and
- b) if the the current speed negotiation window is the final SAS speed negotiation window, set the NEGOTIATED PHYSICAL LINK RATE field to PHY_RESET_PROBLEM.

6.8.4.8.3 Transition SP14:SAS_Fail to SP8:SAS_Start

If the previous SAS speed negotiation window was successful, this transition shall occur and shall include:

- a) a SAS Speed Negotiation Window Rate argument set to the previous speed negotiation window rate; and
- b) a Final SAS Speed Negotiation Window argument.

If the previous SAS speed negotiation window failed and the current speed negotiation window is not the maximum SAS speed negotiation window, this transition shall occur and shall include a SAS Speed Negotiation Window Rate argument set to the next higher speed negotiation window rate.

6.8.4.9 SP15:SAS_PHY_Ready state

6.8.4.9.1 State description

This state waits for a COMINIT Detected message, a DWS Lost message, or a DWS Reset message.

While in this state dwords from the link layer are transmitted at the negotiated physical link rate at the rate established in the previous speed negotiation window.

Upon entry into this state, this state shall send a Phy Layer Ready (SAS) confirmation to the link layer to indicate that the physical link has been brought up successfully in SAS mode.

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

6.8.4.9.2 Transition SP15:SAS_PHY_Ready to SP0:OOB_COMINIT

This transition shall occur after:

- a) receiving a DWS Lost message, if this state does not send a Start DWS message;
- b) receiving a DWS Lost message followed by a COMINIT Detected message, if this state does not send a Start DWS message; or
- c) receiving a DWS Reset message.

This transition may but should not occur after receiving a COMINIT Detected message before receiving a DWS Lost message, or after receiving a COMINIT Detected message after sending a Start DWS message (i.e., the SP state machine should ignore COMINIT Detected messages unless the SP_DWS state machine has indicated loss of dword synchronization).

6.8.5 SATA host emulation states

6.8.5.1 SATA host emulation states overview

Figure 132 shows the SATA host emulation states, in which the phy has detected that it is attached to a SATA phy and behaves as if it were a SATA host phy, initiating the SATA speed negotiation sequence. These states are indicated by state names with a prefix of SATA.

The power management states defined in this standard are for SAS initiator phys that support SATA; expander devices that support SATA do not support power management in this standard.

<figure deleted>

Figure 132 — SP (phy layer) state machine - SATA host emulation states

6.8.5.2 SP16:SATA_COMWAKE state

6.8.5.2.1 State description

This state shall send a Transmit COMWAKE message to the SP transmitter and wait for a COMWAKE Transmitted message.

6.8.5.2.2 Transition SP16:SATA_COMWAKE to SP17:SATA_AwaitCOMWAKE

This transition shall occur after receiving a COMWAKE Transmitted message.

6.8.5.3 SP17:SATA_AwaitCOMWAKE state

6.8.5.3.1 State description

This state waits for COMWAKE to be received.

6.8.5.3.2 Transition SP17:SATA_AwaitCOMWAKE to SP0:OOB_COMINIT

This transition shall occur after receiving a COMINIT Detected message.

6.8.5.3.3 Transition SP17:SATA_AwaitCOMWAKE to SP18:SATA_AwaitNoCOMWAKE

This transition shall occur after receiving a COMWAKE Detected message.

6.8.5.4 SP18:SATA_AwaitNoCOMWAKE state

6.8.5.4.1 State description

This state waits for a COMWAKE Completed message.

6.8.5.4.2 Transition SP18:SATA_AwaitNoCOMWAKE to SP0:OOB_COMINIT

This transition shall occur after receiving a COMINIT Detected message.

6.8.5.4.3 Transition SP18:SATA_AwaitNoCOMWAKE to SP19:SATA_AwaitALIGN

This transition shall occur after receiving a COMWAKE Completed message.

6.8.5.5 SP19:SATA_AwaitALIGN state

6.8.5.5.1 State description

Upon entry into this state, this state shall send a Start DWS message to the SP_DWS state machine.

This state shall:

- a) repeatedly send Transmit D10.2 messages to the SP transmitter;
- b) initialize and start the Await ALIGN Timeout timer; and
- c) wait for an ALIGN Received (0) message to be received or for the Await ALIGN Timeout timer to expire.

The phy shall start transmitting D10.2 characters no later than a COMWAKE response time (see 6.7.2.2) after entry into this state.

6.8.5.5.2 Transition SP19:SATA_AwaitALIGN to SP0:OOB_COMINIT

This transition shall occur if the Await ALIGN Timeout timer expires or after receiving a DWS Lost message, or after receiving a COMINIT Detected message.

Before the transition, if the Await ALIGN Timeout timer expires, this state shall set the NEGOTIATED PHYSICAL LINK RATE field to UNSUPPORTED_PHY_ATTACHED.

6.8.5.5.3 Transition SP19:SATA_AwaitALIGN to SP20:SATA_AdjustSpeed

This transition shall occur if this state receives an ALIGN Received (0) message before the Await ALIGN Timeout timer expires. The ALIGN Received (0) message indicates an ALIGN (0) was received at any of the physical link rates supported by this phy.

6.8.5.6 SP20:SATA_AdjustSpeed state

6.8.5.6.1 State description

This state waits for the SP transmitter to adjust to the same physical link rate of the ALIGNs that were detected by the receiver circuitry.

This state shall:

- 1) send a Set Rate message to the SP transmitter; and
- 2) repeatedly send Transmit D10.2 messages to the SP transmitter.

6.8.5.6.2 Transition SP20:SATA_AdjustSpeed to SP0:OOB_COMINIT

This transition shall occur after receiving a DWS Lost message, or after receiving a COMINIT Detected message.

6.8.5.6.3 Transition SP20:SATA_AdjustSpeed to SP21:SATA_TransmitALIGN

This transition shall occur after receiving a Transmitter Ready message.

6.8.5.7 SP21:SATA_TransmitALIGN state

6.8.5.7.1 State description

This state shall repeatedly send Transmit ALIGN (0) messages to the SP transmitter.

6.8.5.7.2 Transition SP21:SATA_TransmitALIGN to SP0:OOB_COMINIT

This transition shall occur after receiving a DWS Lost message, or after receiving a COMINIT Detected message.

6.8.5.7.3 Transition SP21:SATA_TransmitALIGN to SP22:SATA_PHY_Ready

This transition shall occur after receiving three consecutive Dword Received messages containing primitives other than ALIGN (0).

6.8.5.8 SP22:SATA_PHY_Ready state

6.8.5.8.1 State description

While in this state dwords from the link layer are transmitted at the negotiated physical link rate at the rate established in the previous speed negotiation window.

Upon entry into this state, this state shall:

- a) if the SP transmitter is transmitting at 1.5Gbps, set the NEGOTIATED PHYSICAL LINK RATE field to G1; or
- b) if the SP transmitter is transmitting at 3.0Gbps, set the NEGOTIATED PHYSICAL LINK RATE field to G2.

This state shall send a Phy Layer Ready (SATA) confirmation to the link layer to indicate that the physical link has been brought up successfully in SATA mode.

This state waits for a COMINIT Detected message, a DWS Lost message, or a DWS Reset message.

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

6.8.5.8.2 Transition SP22:SATA_PHY_Ready to SP0:OOB_COMINIT

This transition shall occur after:

- a) receiving a DWS Lost message, if this state does not send a Start DWS message;
- a) receiving a DWS Lost message followed by a COMINIT Detected message, if this state does not send a Start DWS message; or
- b) receiving a DWS Reset message.

This transition may but should not occur after receiving a COMINIT Detected message before receiving a DWS Lost message, or after receiving a COMINIT Detected message after sending a Start DWS message (i.e., the SP state machine should ignore COMINIT Detected messages unless the SP_DWS state machine has indicated loss of dword synchronization).

6.8.5.8.3 Transition SP22:SATA_PHY_Ready to SP23:SATA_PM_Partial

This transition shall occur after receiving an Enter Partial request.

6.8.5.8.4 Transition SP22:SATA_PHY_Ready to SP24:SATA_PM_Slumber

This transition shall occur after receiving an Enter Slumber request.

6.8.5.9 SP23:SATA_PM_Partial state

6.8.5.9.1 State description

This state waits for a COMWAKE Detected message or an Exit Partial request.

6.8.5.9.2 Transition SP23:SATA_PM_Partial to SP0:OOB_COMINIT

This transition shall occur after receiving a COMINIT Detected message.

6.8.5.9.3 Transition SP23:SATA_PM_Partial to SP16:SATA_COMWAKE

This transition shall occur after receiving a Exit Partial request.

6.8.5.9.4 Transition SP23:SATA_PM_Partial to SP18:SATA_AwaitNoCOMWAKE

This transition shall occur after receiving a COMWAKE Detected message.

6.8.5.10 SP24:SATA_PM_Slumber state

6.8.5.10.1 State description

This state waits for a COMWAKE Detected message or an Exit Slumber request.

6.8.5.10.2 Transition SP24:SATA_PM_Slumber to SP0:OOB_COMINIT

This transition shall occur after receiving a COMINIT Detected message.

6.8.5.10.3 Transition SP24:SATA_PM_Slumber to SP16:SATA_COMWAKE

This transition shall occur after receiving a Exit Slumber request.

6.8.5.10.4 Transition SP24:SATA_PM_Slumber to SP18:SATA_AwaitNoCOMWAKE

This transition shall occur after receiving a COMWAKE Detected message.

6.8.6 SATA port selector state

6.8.6.1 State description

Figure 133 shows the SP25:SATA_PortSel state. This state controls transmission of the SATA port selection signal when a specified phy processes a Transmit SATA Port Selection Signal request.

<figure deleted>

Figure 133 — SP (phy layer) state machine – SATA port selector state

Upon entry into this state, the phy shall:

- a) [set the NEGOTIATED PHYSICAL LINK RATE field to UNKNOWN;](#)
- b) end a Transmit SATA Port Selection Signal message to the SP transmitter;
- c) set the ATTACHED SATA PORT SELECTOR bit to zero in the SMP DISCOVER response (see 10.4.3.7) and the SMP DISCOVER LIST response (see 10.4.3.13.3); and
- d) set the ATTACHED SATA DEVICE bit to zero in the SMP DISCOVER response and the SMP DISCOVER LIST response.

6.8.6.2 Transition SP25:SATA_PortSel to SP1:OOB_AwaitCOMX

This transition shall occur after receiving a SATA Port Selection Signal Transmitted message.

6.8.7 SATA spinup hold state

6.8.7.1 State description

[Upon entry into this state, this state shall set the NEGOTIATED PHYSICAL LINK RATE field to SPINUP_HOLD.](#)

Figure 134 shows the SP26:SATA_SpinupHold state.

<figure deleted>

Figure 134 — SP (phy layer) state machine - SATA spinup hold state

If this state machine is in an expander phy, this state shall send a SATA Spinup Hold confirmation to the link layer.

6.8.7.2 Transition SP26:SATA_SpinupHold to SP0:OOB_COMINIT

This transition shall occur if this state receives a COMINIT Detected message.

Table 225 — 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 10.4.3.8), the SMP REPORT PHY EVENT INFORMATION function (see 10.4.3.11), 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 10.4.3.24) 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 10.4.3.24) 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.
6h	<u>UNSUPPORTED PHY ATTACHED</u>	<u>Phy is enabled; the phy detected a SAS or SATA device, but the phys do not agree on a commonly supported physical link rate (e.g., one phy is 3 Gbps only and the other is 1,5 Gbps only).</u>
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 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).		

