

To: T10 Technical Committee
From: Rob Elliott, HP (elliott@hp.com)
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Subject: 08-011r0 SAS-2 XL Forward Dword correction

Revision history

Revision 0 (6 December 2007) First revision

Related documents

sas2r13 - Serial Attached SCSI - 2 (SAS-2) revision 13

Overview

In the XL state machine, the XL3:Open_Confirm_Wait state (which is entered after sending an OPEN to the ECR; the state waits for a reply) is supposed to send a Forward Dword request to the ECR for each dword received on the phy. This is already reflected in all the example figures in annex J and the fact that the XL6 state (in the other expander phy) is prepared to receive Forward Dword indications.

As noted by Tim Hogleund (LSI), a statement about expanding and collapsing STP primitive sequences in XL6 is not applicable, as only idle dwords are flowing at that time; this statement is deleted.

Suggested changes

7.15 XL (link layer for expander logical phys) state machine

7.15.1 XL state machine overview

The XL state machine controls the flow of dwords on the logical link and establishes and maintains connections with another XL state machine as facilitated by the expander function (e.g., the ECM and ECR).

This state machine consists of the following states:

- a) XL0:Idle (see 7.15.3)(initial state);
- b) XL1:Request_Path (see 7.15.4);
- c) XL2:Request_Open (see 7.15.5);
- d) XL3:Open_Confirm_Wait (see 7.15.6);
- e) XL4:Open_Reject (see 7.15.7);
- f) XL5:Forward_Open (see 7.15.8);
- g) XL6:Open_Response_Wait (see 7.15.9);
- h) XL7:Connected (see 7.15.10);
- i) XL8:Close_Wait (see 7.15.11);
- j) XL9:Break (see 7.15.12); and
- k) XL10:Break_Wait (see 7.15.13).

The XL state machine shall start in the XL0:Idle state. The XL state machine shall transition to the XL0:Idle state from any other state after receiving an Enable Disable SAS Link (Disable) message from the SL_IR state machines (see 7.9.4).

The XL state machine receives the following messages from the SL_IR state machines:

- a) Enable Disable SAS Link (Enable); and
- b) Enable Disable SAS Link (Disable).

Any message received by a state that is not referred to in the description of that state shall be ignored.

The XL state machine shall maintain the timers listed in table 1.

Table 1 — XL timers

Timer	Initial value
Partial Pathway Timeout timer	Partial pathway timeout value (see 7.12.4.4)
Break Timeout timer	1 ms

Figure 1 shows several states in the XL state machine.

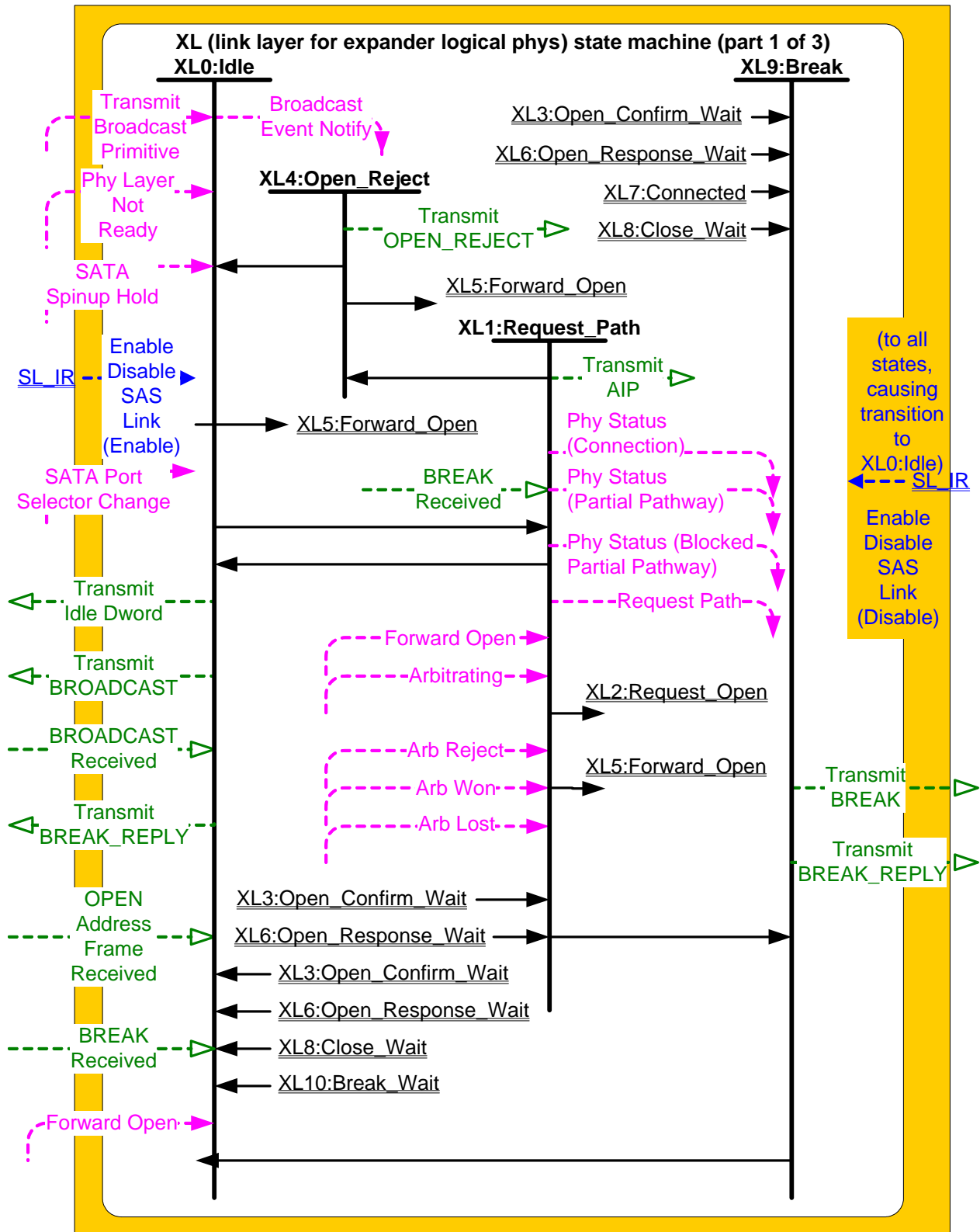


Figure 1 — XL (link layer for expander logical phys) state machine (part 1) [\[no change\]](#)

Figure 2 shows additional states in the XL state machine.

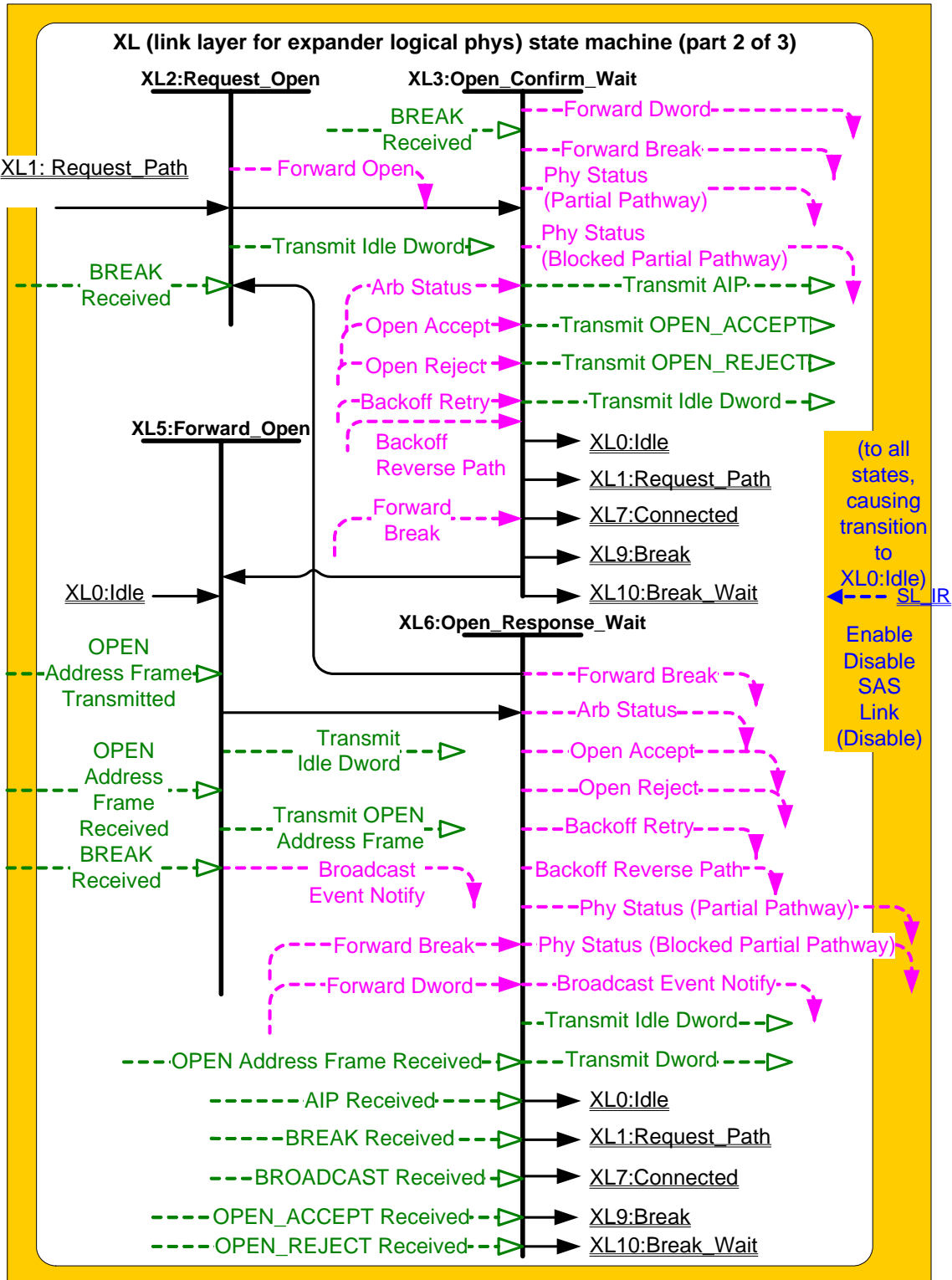


Figure 2 — XL (link layer for expander logical phys) state machine (part 2) **[modified]**

Figure 3 shows additional states in the XL state machine.

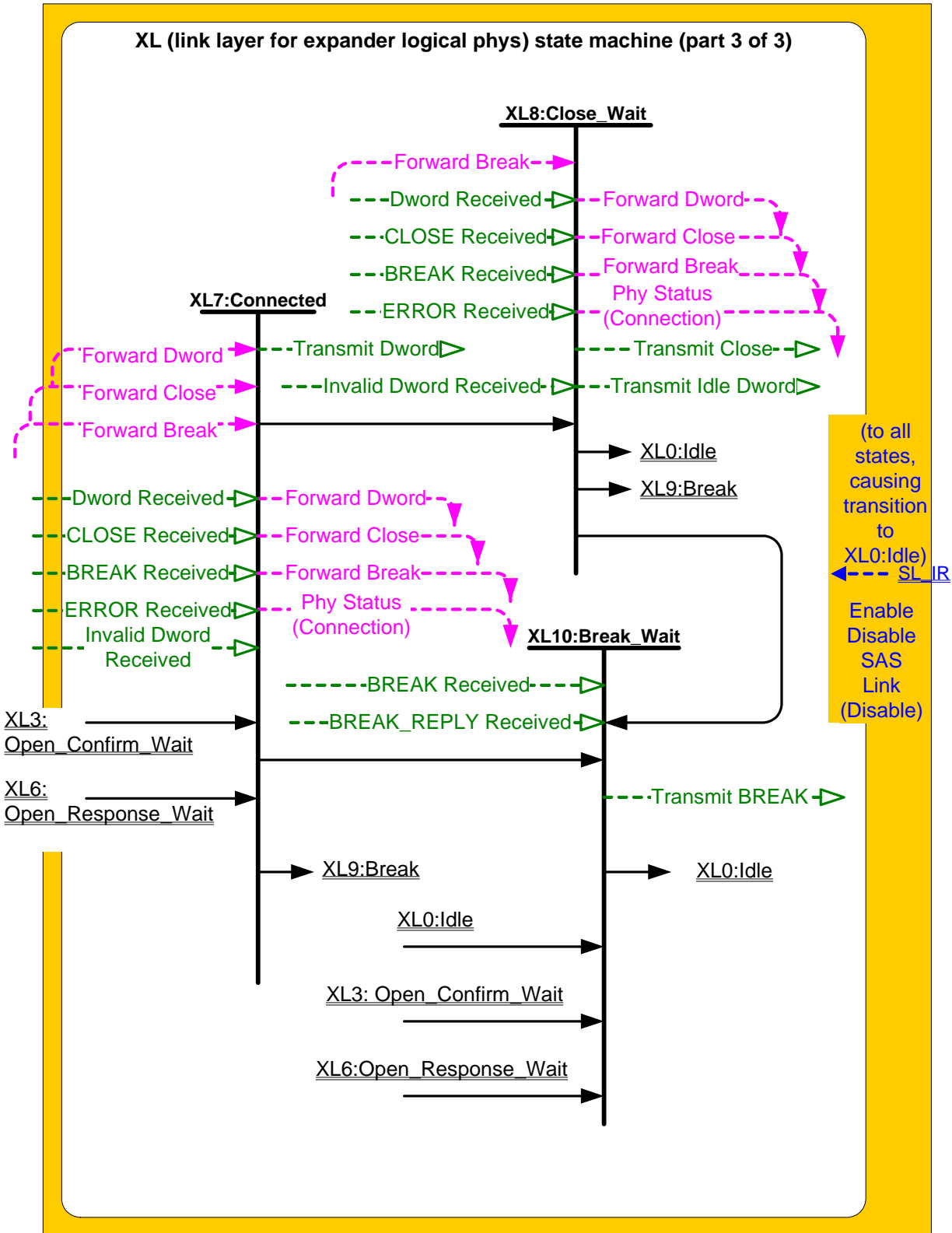


Figure 3 — XL (link layer for expander logical phys) state machine (part 3) [no change]

7.15.2 XL transmitter and receiver

The XL transmitter receives the following messages from the XL state machine specifying primitive sequences, frames, and dwords to transmit:

- a) Transmit Idle Dword;
- b) Transmit AIP with an argument indicating the specific type (e.g., Transmit AIP (Normal));
- c) Transmit BREAK;
- d) Transmit BREAK_REPLY;
- e) Transmit BROADCAST with an argument indicating the specific type (e.g., Transmit BROADCAST (Change));
- f) Transmit CLOSE with an argument indicating the specific type (e.g., Transmit CLOSE (Normal));
- g) Transmit OPEN_ACCEPT;
- h) Transmit OPEN_REJECT, with an argument indicating the specific type (e.g., Transmit OPEN_REJECT (No Destination));
- i) Transmit OPEN Address Frame; and
- j) Transmit Dword.

The XL transmitter sends the following messages to the XL state machine based on dwords that have been transmitted:

- a) OPEN Address Frame Transmitted.

The XL transmitter shall ensure physical link rate tolerance management requirements are met (see 7.3) while originating dwords.

The XL transmitter shall ensure physical link rate tolerance management requirements are met while forwarding dwords (i.e., during a connection) by inserting or deleting as many deletable primitives as required to match the transmit and receive connection rates (see 7.3.2).

The XL transmitter shall ensure physical link rate tolerance management requirements are met (see 7.3) during and after switching from forwarding dwords to originating dwords, including, for example:

- a) when transmitting BREAK;
- b) when transmitting BREAK_REPLY;
- c) when transmitting CLOSE;
- d) when transmitting an idle dword after closing a connection (i.e., after receiving BREAK, BREAK_REPLY, or CLOSE);
- e) while transmitting a SATA frame to a SAS logical link during an STP connection, when transmitting the first SATA_HOLD in response to detection of SATA_HOLD; and
- f) while receiving dwords of a SATA frame from a SAS logical link during an STP connection, when transmitting SATA_HOLD.

NOTE 1 - The XL transmitter may always insert a deletable primitive before transmitting a BREAK, BREAK_REPLY, CLOSE, or SATA_HOLD to meet physical link rate tolerance management requirements.

The XL transmitter shall insert a deletable primitive before switching from originating dwords to forwarding dwords, including, for example:

- a) when transmitting OPEN_ACCEPT;
- b) when transmitting the last idle dword before a connection is established (i.e., after receiving OPEN_ACCEPT);
- c) while transmitting a SATA frame to a SAS logical link during an STP connection, when transmitting the last dword from the STP flow control buffer in response to release of SATA_HOLD;
- d) while transmitting a SATA frame to a SAS logical link during an STP connection, when transmitting the last SATA_HOLD in response to release of SATA_HOLD (e.g., if the STP flow control buffer is empty); and
- e) while receiving dwords of a SATA frame from a SAS logical link during an STP connection, when transmitting the last SATA_HOLD.

NOTE 2 - This ensures that physical link rate tolerance management requirements are met, even if the forwarded dword stream does not include a deletable primitive until the last possible dword.

The XL transmitter shall ensure rate matching requirements are met during a connection (see 7.13).

When there is no outstanding message specifying a dword to transmit, the XL transmitter shall transmit idle dwords.

The XL receiver sends the following messages to the XL state machine indicating primitive sequences, frames, and dwords received from the SP_DWS receiver (see 6.9.2):

- a) AIP Received with an argument indicating the specific type (e.g., AIP Received (Normal));
- b) BREAK Received;
- c) BREAK_REPLY Received;
- d) BROADCAST Received;
- e) CLOSE Received;
- f) OPEN_ACCEPT Received;
- g) OPEN_REJECT Received;
- h) OPEN Address Frame Received;
- i) Dword Received with an argument indicating the data dword or primitive received; and
- j) Invalid Dword Received.

The XL receiver shall ignore all other dwords.

While receiving an address frame, if the XL receiver receives an invalid dword or ERROR, then the XL receiver shall:

- a) ignore the invalid dword or ERROR; or
- b) discard the address frame.

The XL transmitter relationship to other transmitters is defined in 4.3.2. The XL receiver relationship to other receivers is defined in 4.3.3.

7.15.3 XL0:Idle state

7.15.3.1 State description

This state is the initial state and is the state that is used when there is no connection pending or established.

If a Phy Layer Not Ready confirmation is received, this state shall send a Broadcast Event Notify (Phy Not Ready) request to the BPP.

If a SATA Spinup Hold confirmation is received, this state shall send a Broadcast Event Notify (SATA Spinup Hold) request to the BPP.

If an Enable Disable SAS Link (Enable) message is received, this state shall send a Broadcast Event Notify (Identification Sequence Complete) request to the BPP.

If a SATA Port Selector Change confirmation is received, this state shall send a Broadcast Event Notify (SATA Port Selector Change) request to the BPP.

If a BROADCAST Received message is received, this state shall send a Broadcast Event Notify request to the BPP with the argument indicating the specific BROADCAST primitive received (e.g., Change Received).

If a Transmit Broadcast indication is received, this state shall send a Transmit BROADCAST message to the XL transmitter with an argument specifying the specific type from the Transmit Broadcast indication. Otherwise, this state shall request idle dwords be transmitted by repeatedly sending Transmit Idle Dword messages to the XL transmitter.

If a BREAK Received message is received and the BREAK_REPLY method of responding to received BREAK primitive sequences is enabled (see 7.12.5), then this state shall send a Transmit BREAK_REPLY message to the XL transmitter.

7.15.3.2 Transition XL0:Idle to XL1:Request_Path

This transition shall occur if:

- a) an Enable Disable SAS Link (Enable) message has been received;

- b) a Forward Open indication is not being received; and
- c) an OPEN Address Frame Received message is received.

This state shall include an OPEN Address Frame Received argument with the transition.

7.15.3.3 Transition XL0:Idle to XL5:Forward_Open

This transition shall occur if:

- a) an Enable Disable SAS Link (Enable) message has been received; and
- b) a Forward Open indication is received.

This transition shall include a set of arguments containing the arguments received in the Forward Open indication.

If an OPEN Address Frame Received message is received, this state shall include an OPEN Address Frame Received argument with the transition.

7.15.4 XL1:Request_Path state

7.15.4.1 State description

This state is used to arbitrate for connection resources and to specify the destination of the connection.

If an Arbitrating (Normal) confirmation is received, this state shall repeatedly send Transmit AIP (Normal) and Transmit Idle Dword messages to the XL transmitter in accordance with AIP transmission rules (see 7.12.4.3).

If an Arbitrating (Waiting On Partial) or Arbitrating (Blocked On Partial) confirmation is received, this state shall repeatedly send Transmit AIP (Waiting On Partial) and Transmit Idle Dword messages to the XL transmitter in accordance with AIP transmission rules (see 7.12.4.3).

If an Arbitrating (Waiting On Partial) confirmation is received, this state shall repeatedly send a Phy Status (Partial Pathway) response to the ECM.

If an Arbitrating (Blocked On Partial) confirmation is received, this state shall repeatedly send a Phy Status (Blocked Partial Pathway) response to the ECM.

If an Arbitrating (Waiting On Connection) confirmation is received, this state shall repeatedly send Transmit AIP (Waiting On Connection) and Transmit Idle Dword messages to the XL transmitter in accordance with AIP transmission rules (see 7.12.4.3).

If an Arbitrating (Waiting On Connection) confirmation is received, this state shall repeatedly send a Phy Status (Connection) response to the ECM.

If this state is entered from the XL6:Open_Response_Wait state, the Retry Priority Status argument shall be set to IGNORE AWT. If this state is entered from any other state, the Retry Priority Status argument shall be set to NORMAL.

Upon entry into this state, this state shall send a Request Path request to the ECM with the following arguments:

- a) initiator port bit;
- b) protocol;
- c) connection rate;
- d) initiator connection tag;
- e) destination SAS address;
- f) source SAS address;
- g) pathway blocked count;
- h) arbitration wait time; and
- i) retry priority status.

This state maintains the Partial Pathway Timeout timer.

If the Partial Pathway Timeout timer is not already running, the Partial Pathway Timeout timer shall be initialized and started when an Arbitrating (Blocked On Partial) confirmation is received.

If the Partial Pathway Timeout timer is already running, the Partial Pathway Timeout timer shall continue to run if an Arbitrating (Blocked On Partial) confirmation is received.

The Partial Pathway Timeout timer shall be stopped when one of the following confirmations is received:

- a) Arbitrating (Waiting On Partial); or
- b) Arbitrating (Waiting On Connection).

If the Partial Pathway Timeout timer expires, this state shall send a Partial Pathway Timeout Timer Expired request to the ECM.

7.15.4.2 Transition XL1:Request_Path to XL0:Idle

This transition shall occur if:

- a) a BREAK Received message has not been received; and
- b) an Arb Lost confirmation is received.

7.15.4.3 Transition XL1:Request_Path to XL2:Request_Open

This transition shall occur if:

- a) a BREAK Received message has not been received; and
- b) an Arb Won confirmation is received.

7.15.4.4 Transition XL1:Request_Path to XL4:Open_Reject

This transition shall occur if:

- a) a BREAK Received message has not been received; and
- b) an Arb Reject confirmation is received.

This transition shall include an Arb Reject argument corresponding to the Arb Reject confirmation.

7.15.4.5 Transition XL1:Request_Path to XL5:Forward_Open

This transition shall occur if a Forward Open indication is received and none of the following confirmations have been received:

- a) Arbitrating (Normal);
- b) Arbitrating (Waiting On Partial);
- c) Arbitrating (Blocked On Partial);
- d) Arbitrating (Waiting On Connection);
- e) Arb Won;
- f) Arb Lost;
- g) Arb Reject (No Destination);
- h) Arb Reject (Bad Destination);
- i) Arb Reject (Connection Rate Not Supported);
- j) Arb Reject (Zone Violation);
- k) Arb Reject (Pathway Blocked); or
- l) Arb Reject (Retry).

This transition shall include:

- a) an OPEN Address Frame Received argument containing the arguments received in the Forward Open indication; and
- b) a BREAK Received argument if a BREAK Received message was received.

7.15.4.6 Transition XL1:Request_Path to XL9:Break

This transition shall occur after receiving a BREAK Received message if a Forward Open indication has not been received.

7.15.5 XL2:Request_Open state

7.15.5.1 State description

This state is used to forward an OPEN address frame through the ECR to a destination phy.

This state shall request idle dwords be transmitted by repeatedly sending Transmit Idle Dword messages to the XL transmitter.

Upon entry into this state, this state shall send a Forward Open request to the ECR, received by the destination phy as a Forward Open indication (see 7.15.5.2). The arguments to the Forward Open request are:

- a) initiator port bit;
- b) protocol;
- c) features;
- d) connection rate;
- e) initiator connection tag;
- f) destination SAS address;
- g) source SAS address;
- h) source zone group;
- i) pathway blocked count;
- j) arbitration wait time; and
- k) more compatible features.

7.15.5.2 Transition XL2:Request_Open to XL3:Open_Confirm_Wait

This transition shall occur after sending a Forward Open request to the ECR.

If a BREAK Received message is received, this state shall include a BREAK Received argument with the transition.

7.15.6 XL3:Open_Confirm_Wait state

7.15.6.1 State description

This state waits for confirmation ~~tefor~~ an OPEN address frame sent on a destination phy.

This state shall send the following messages to the XL transmitter:

- a) Transmit AIP (Normal) when an Arb Status (Normal) confirmation is received;
- b) Transmit AIP (Waiting On Partial) when an Arb Status (Waiting On Partial) confirmation is received;
- c) Transmit AIP (Waiting On Connection) when an Arb Status (Waiting On Connection) confirmation is received;
- d) Transmit AIP (Waiting On Device) when an Arb Status (Waiting On Device) confirmation is received;
- e) Transmit OPEN_ACCEPT when an Open Accept confirmation is received (see 7.15.6.5);
- f) Transmit OPEN_REJECT when an Open Reject confirmation is received with the argument from the Open Reject confirmation, after releasing path resources (see 7.15.6.2); or
- g) request idle dwords be transmitted by repeatedly sending Transmit Idle Dword messages when none of the previous conditions are present.

If a Backoff Retry confirmation is received, this state shall release path resources.

If a BREAK Received message is received or a BREAK Received argument is included in the transition into this state, this state shall send a Forward Break request to the ECR (see 7.15.6.6).

This state shall repeatedly send a Phy Status (Partial Pathway) response to the ECM until an Arb Status (Waiting On Partial) confirmation is received. After an Arb Status (Waiting on Partial) confirmation is received, this state shall repeatedly send a Phy Status (Blocked Partial Pathway) response to the ECM.

If a Dword Received message is received containing a valid dword except a BREAK primitive, this state shall send a Forward Dword request to the ECR containing that dword.

If:

- a) an Invalid Dword Received message is received; and
- b) the expander logical phy is forwarding to an expander logical phy attached to a SAS logical link,

the expander logical phy shall:

- a) send an ERROR primitive with the Forward Dword request instead of the invalid dword; or
- b) delete the invalid dword.

If:

- a) an ERROR primitive is received with the Dword Received message or an Invalid Dword Received message is received; and
- b) the expander logical phy is forwarding to an expander phy attached to a SATA physical link,

the expander logical phy shall:

- a) send a SATA_ERROR with the Forward Dword request instead of the invalid dword or ERROR primitive; or
- b) delete the ERROR primitive or invalid dword.

7.15.6.2 Transition XL3:Open_Confirm_Wait to XL0:Idle

This transition shall occur after sending a Transmit OPEN_REJECT message to the XL transmitter if:

- a) a BREAK Received message has not been received; and
- b) a BREAK Received argument was not included in the transition into this state.

7.15.6.3 Transition XL3:Open_Confirm_Wait to XL1:Request_Path

This transition shall occur after receiving a Backoff Retry confirmation, after releasing path resources if:

- a) a BREAK Received message has not been received; and
- b) a BREAK Received argument was not included in the transition into this state.

7.15.6.4 Transition XL3:Open_Confirm_Wait to XL5:Forward_Open

This transition shall occur after receiving a Backoff Reverse Path confirmation if:

- a) a BREAK Received message has not been received; and
- b) a BREAK Received argument was not included in the transition into this state.

The transition shall include the Backoff Reverse Path arguments (i.e., the OPEN address frame).

7.15.6.5 Transition XL3:Open_Confirm_Wait to XL7:Connected

This transition shall occur after sending a Transmit OPEN_ACCEPT message to the XL transmitter if:

- a) a BREAK Received message has not been received; and
- b) a BREAK Received argument was not included in the transition into this state.

7.15.6.6 Transition XL3:Open_Confirm_Wait to XL9:Break

This transition shall occur after sending a Forward Break request to the ECR.

7.15.6.7 Transition XL3:Open_Confirm_Wait to XL10:Break_Wait

This transition shall occur after receiving a Forward Break indication if:

- a) a BREAK Received message has not been received; and
- b) a BREAK Received argument was not included in the transition into this state.

7.15.7 XL4:Open_Reject state**7.15.7.1 State description**

This state is used to reject a connection request.

This state shall send one of the following messages to the XL transmitter (see 7.15.7.2):

- a) a Transmit OPEN_REJECT (No Destination) message when an Arb Reject (No Destination) argument is received with the transition into this state;
- b) a Transmit OPEN_REJECT (Bad Destination) message when an Arb Reject (Bad Destination) argument is received with the transition into this state;
- c) a Transmit OPEN_REJECT (Connection Rate Not Supported) message when an Arb Reject (Connection Rate Not Supported) argument is received with the transition into this state;
- d) a Transmit OPEN_REJECT (Zone Violation) message when an Arb Reject (Zone Violation) argument is received with the transition into this state;
- e) a Transmit OPEN_REJECT (Pathway Blocked) message when an Arb Reject (Pathway Blocked) argument is received with the transition into this state; or
- f) a Transmit OPEN_REJECT (Retry) message when an Arb Reject (Retry) argument is received with the transition into this state.
- g)

7.15.7.2 Transition XL4:Open_Reject to XL0:Idle

This transition shall occur after sending a Transmit OPEN_REJECT message to the XL transmitter.

7.15.7.3 Transition XL4:Open_Reject to XL5:Forward_Open

This transition shall occur if a Forward Open indication is received. This transition shall include an OPEN Address Frame Received argument containing the arguments received in the Forward Open indication.

7.15.8 XL5:Forward_Open state**7.15.8.1 State description**

This state is used to transmit an OPEN address frame passed with the transition into this state.

If a BROADCAST Received message is received, this state shall send a Broadcast Event Notify request to the BPP with the argument indicating the specific BROADCAST primitive received (e.g., Change Received).

Upon entry into this state, this state shall send a Transmit OPEN Address Frame message to the XL transmitter with the fields set to the values specified with the transition into this state.

This state shall request idle dwords be transmitted by repeatedly sending Transmit Idle Dword messages to the XL transmitter.

7.15.8.2 Transition XL5:Forward_Open to XL6:Open_Response_Wait

This transition shall occur after receiving an OPEN Address Frame Transmitted message.

If an OPEN Address Frame Received message or argument is received, this state shall include an OPEN Address Frame Received argument with the transition.

If a BREAK Received message or argument is received, this state shall include a BREAK Received argument with the transition.

7.15.9 XL6:Open_Response_Wait state**7.15.9.1 State description**

This state waits for a response to a transmitted OPEN address frame and determines the appropriate action to take based on the response.

This state shall either:

- a) request idle dwords be transmitted by repeatedly sending Transmit Idle Dword messages to the XL transmitter, honoring ALIGN insertion rules for rate matching and physical link rate tolerance management; or
- b) send Transmit Dword messages to the XL transmitter to transmit all dwords received with Forward Dword indications. ~~During an STP connection, the expander device may expand or contract a repeated or continued primitive sequence (see 7.2.4).~~

If a BROADCAST Received message is received before an AIP Received message is received this state shall send a Broadcast Event Notify request to the BPP with the argument indicating the specific BROADCAST primitive received (e.g., Broadcasts).

This state shall send the following responses to the ECR, which are received by the source phy as confirmations:

- a) an Open Accept response when an OPEN_ACCEPT Received message is received (see 7.15.9.5);
- b) an Open Reject response when an OPEN_REJECT Received message is received, after releasing any path resources (see 7.15.9.2);
- c) a Backoff Retry response, after releasing path resources (see 7.15.9.3), when:
 - A) an AIP Received message has not been received;
 - B) an OPEN Address Frame Received message is received or an OPEN Address Frame Received argument is included in the transition into this state containing a higher priority OPEN address frame according to the arbitration fairness comparison (see 7.12.3); and
 - C) the destination SAS address and connection rate of the received OPEN address frame are not equal to the source SAS address and connection rate of the transmitted OPEN address frame;
- d) a Backoff Retry response, after releasing path resources (see 7.15.9.3), when:
 - A) an AIP Received message has been received;
 - B) an OPEN Address Frame Received message is received or an OPEN Address Frame Received argument is included in the transition into this state; and
 - C) the destination SAS address and connection rate of the received OPEN address frame are not equal to the source SAS address and connection rate of the transmitted OPEN address frame;
- e) a Backoff Reverse Path response (see 7.15.9.4) when:
 - A) an AIP Received message has not been received,
 - B) an OPEN Address Frame Received message is received or an OPEN Address Frame Received argument is included in the transition into this state containing a higher priority OPEN address frame according to the arbitration fairness comparison (see 7.12.3); and
 - C) the destination SAS address and connection rate of the received OPEN address frame are equal to the source SAS address and connection rate of the transmitted OPEN address frame;

and
- f) a Backoff Reverse Path response (see 7.15.9.4) when:
 - A) an AIP Received message has been received;
 - B) an OPEN Address Frame Received message is received or an OPEN Address Frame Received argument is included in the transition into this state; and
 - C) the destination SAS address and connection rate of the received OPEN address frame are equal to the source SAS address and connection rate of the transmitted OPEN address frame.

A Backoff Reverse Path response shall include the contents of the OPEN Address Frame Received message or argument.

This state shall send the following responses to the ECR, which are received by the source phy as confirmations:

- a) an Arb Status (Waiting On Device) response upon entry into this state;
- b) an Arb Status (Normal) response when an AIP Received (Normal) message is received;
- c) an Arb Status (Waiting On Partial) response when an AIP Received (Waiting On Partial) message is received;
- d) an Arb Status (Waiting On Connection) response when an AIP Received (Waiting On Connection) message is received; and

- e) an Arb Status (Waiting On Device) response when an AIP Received (Waiting On Device) message is received.

If a BREAK Received message is received or a BREAK Received argument is included in the transition into this state, this state shall send a Forward Break request to the ECR (see 7.15.9.6).

This state shall repeatedly send a Phy Status (Partial Pathway) response to the ECM until an AIP Received (Waiting On Partial) message is received. After an AIP Received (Waiting On Partial) message is received, this state shall repeatedly send a Phy Status (Blocked Partial Pathway) response to the ECM.

7.15.9.2 Transition XL6:Open_Response_Wait to XL0:Idle

This transition shall occur after sending an Open Reject response to the ECR.

7.15.9.3 Transition XL6:Open_Response_Wait to XL1:Request_Path

This transition shall occur after sending a Backoff Retry response to the ECR.

7.15.9.4 Transition XL6:Open_Response_Wait to XL2:Request_Open

This transition shall occur after sending a Backoff Reverse Path response to the ECR.

7.15.9.5 Transition XL6:Open_Response_Wait to XL7:Connected

This transition shall occur after sending an Open Accept response to the ECR.

7.15.9.6 Transition XL6:Open_Response_Wait to XL9:Break

This transition shall occur after sending a Forward Break response to the ECR.

7.15.9.7 Transition XL6:Open_Response_Wait to XL10:Break_Wait

This transition shall occur after receiving a Forward Break indication if:

- a) a BREAK Received message has not been received; and
- b) a BREAK Received argument was not included in the transition into this state.

7.15.10 XL7:Connected state

7.15.10.1 State description

This state provides a full-duplex circuit between two phys within an expander device.

This state shall send Transmit Dword messages to the XL transmitter to transmit all dwords received with Forward Dword indications. During an STP connection, the expander device may expand or contract a repeated or continued primitive sequence (see 7.2.4).

If this state has not sent a Forward Close request to the ECR, this state shall send Forward Dword requests to the ECR containing each valid dword except BREAK and CLOSE primitives received with Dword Received messages. During an STP connection, the expander device may expand or contract a repeated or continued primitive sequence (see 7.2.4).

If:

- a) an Invalid Dword Received message is received; and
- b) the expander phy is forwarding to an expander logical phy attached to a SAS logical link,

the expander logical phy shall:

- a) send an ERROR primitive with the Forward Dword request instead of the invalid dword; or
- b) delete the invalid dword.

If:

- a) an ERROR primitive is received with the Dword Received message or an Invalid Dword Received message is received; and

- b) the expander phy is forwarding to an expander logical phy attached to a SATA phy,

the expander logical phy shall:

- a) send a SATA_ERROR with the Forward Dword request instead of the invalid dword or ERROR primitive; or
- b) delete the ERROR primitive or invalid dword.

If a CLOSE Received message is received, this state shall send a Forward Close request to the ECR with the argument from the CLOSE Received message.

If a BREAK Received message is received, this state shall send a Forward Break request to the ECR (see 7.15.10.3).

This state shall repeatedly send a Phy Status (Connection) response to the ECM.

7.15.10.2 Transition XL7:Connected to XL8:Close_Wait

This transition shall occur after receiving a Forward Close indication if a BREAK Received message has not been received.

7.15.10.3 Transition XL7:Connected to XL9:Break

This transition shall occur after sending a Forward Break request to the ECR.

7.15.10.4 Transition XL7:Connected to XL10:Break_Wait

This transition shall occur after receiving a Forward Break indication if a BREAK Received message has not been received.

7.15.11 XL8:Close_Wait state

7.15.11.1 State description

This state closes a connection and releases path resources.

Upon entry into this state, this state shall send a Transmit CLOSE message to the XL transmitter with the argument from the Forward Close indication, then shall request idle dwords be transmitted by repeatedly sending Transmit Idle Dword messages to the XL transmitter.

NOTE 3 - Possible livelock scenarios occur if the BREAK_REPLY method of responding to received BREAK primitive sequences is disabled and a phy transmits BREAK to break a connection (e.g., if its Close Timeout timer expires). Phys should respond to CLOSE faster than 1 ms to reduce susceptibility to this problem.

If a Dword Received message is received containing a valid dword except a BREAK or CLOSE primitive, this state shall send a Forward Dword request to the ECR containing that dword. During an STP connection, the expander device may expand or contract a repeated or continued primitive sequence (see 7.2.4).

If:

- a) an Invalid Dword Received message is received; and
- b) the expander logical phy is forwarding to an expander logical phy attached to a SAS logical link,

the expander logical phy shall:

- a) send an ERROR primitive with the Forward Dword request instead of the invalid dword; or
- b) delete the invalid dword.

If:

- a) an ERROR primitive is received with the Dword Received message or an Invalid Dword Received message is received; and
- b) the expander logical phy is forwarding to an expander phy attached to a SATA physical link,

the expander logical phy shall:

- a) send a SATA_ERROR with the Forward Dword request instead of the invalid dword or ERROR primitive; or
- b) delete the ERROR primitive or invalid dword.

If a CLOSE Received message is received, this state shall release path resources and send a Forward Close request to the ECR with the argument from the CLOSE Received message (see 7.15.11.2).

If a BREAK Received message is received, this state shall send a Forward Break request to the ECR (see 7.15.11.3).

This state shall repeatedly send a Phy Status (Connection) response to the ECM.

7.15.11.2 Transition XL8:Close_Wait to XL0:Idle

This transition shall occur after sending a Forward Close request to the ECR.

7.15.11.3 Transition XL8:Close_Wait to XL9:Break

This transition shall occur after sending a Forward Break request to the ECR.

7.15.11.4 Transition XL8:Close_Wait to XL10:Break_Wait

This transition shall occur after receiving a Forward Break indication if a BREAK Received message has not been received.

7.15.12 XL9:Break state

7.15.12.1 State description

This state closes the connection if there is one and releases all path resources associated with the connection.

This state shall send a Transmit BREAK message to the XL transmitter (see 7.15.12.2).

This state shall:

- a) send a Transmit BREAK_REPLY message to the XL transmitter if the BREAK_REPLY method of responding to received BREAK primitive sequences is enabled (see 7.12.5); and
- b) send a Transmit BREAK message to the XL transmitter if the BREAK_REPLY method of responding to received BREAK primitive sequences is disabled (see 7.12.5).

7.15.12.2 Transition XL9:Break to XL0:Idle

This transition shall occur after sending a Transmit BREAK message or a Transmit BREAK_REPLY message to the XL transmitter.

7.15.13 XL10:Break_Wait state

7.15.13.1 State description

This state closes the connection if there is one and releases path resources associated with the connection.

Upon entry into this state, this state shall:

- 1) send a Transmit BREAK message to the XL transmitter; and
- 2) initialize and start the Break Timeout timer.

If a BREAK Received message is received and the BREAK_REPLY method of responding to received BREAK primitive sequences is enabled (see 7.12.5), then this state shall send a Transmit BREAK_REPLY message to the XL transmitter.

7.15.13.2 Transition XL10:Break_Wait to XL0:Idle

This transition shall occur after:

- a) a BREAK_REPLY Received message is received if the BREAK_REPLY method of responding to received BREAK primitive sequences is enabled (see 7.12.5);
- b) a BREAK Received message is received if the BREAK_REPLY method of responding to received BREAK primitive sequences is disabled (see 7.12.5); or
- c) the Break Timeout timer expires.