

To: T10 Technical Committee  
From: Rob Elliott, HP (elliott@hp.com)  
Date: 30 October 2006  
Subject: 06-322r2 SAS-2 Response to abandon-class OPEN\_REJECT

### **Revision history**

Revision 0 (7 July 2006) First revision

Revision 1 (11 August 2006) Incorporated comments from July SAS protocol WG - made some corrections and added some new rules concerning OPEN\_REJECT (CONNECTION RATE NOT SUPPORTED) handling for STP/SATA bridges.

Revision 2 (30 October 2006) Incorporated comments from Vicky Duerk, Intel, and the September SAS protocol WG.

### **Related documents**

sas2r04a - Serial Attached SCSI - 2 (SAS-2) revision 4a  
Serial ATA 2.5 (not publicly available; see [www.sata-io.org](http://www.sata-io.org) for details)

### **Overview**

1. If an STP target port receives an abandon-class OPEN\_REJECT such as OPEN\_REJECT (PROTOCOL NOT SUPPORTED), it needs to stop trying to open that initiator port and abort any outstanding commands from that STP initiator port. If the STP target port is in an STP/SATA bridge (in an expander), the way it aborts those commands is by performing a link reset sequence on the phy attached to the SATA device. If an STP initiator port receives an abandon-class OPEN\_REJECT, it needs to consider all commands to that target as completed with an error.

This is the same as if an I\_T nexus loss occurs, so the I\_T nexus loss definition is expanded to including receiving an abandon-class OPEN\_REJECT.

2. OPEN\_REJECT (CONNECTION RATE NOT SUPPORTED) presents additional problems. It is labeled as abandon-class, but the request is not really abandoned unless it requested a 1.5 Gbps connection rate; if it was higher than that, then it is reattempted with a lower connection rate. This is clarified throughout. The rules for both SSP and STP target ports are adjusted to avoid infinite retries at connection rates that are not working.

3. "SATA rate matching."

If a SATA physical link is faster than the SAS connection rate (which could be the cause of an OPEN\_REJECT (CONNECTION RATE NOT SUPPORTED), then the STP/SATA bridge is going to be overrun by the incoming data from the SATA drive.

The existing rule that the SATA physical link rate shall be set the same as the highest possible connection rate on the potential pathways to the STP initiator port doesn't help the error case and doesn't help if multiple initiators are present with different physical link rates. This rule is proposed to be constrained to single-initiator cases or eliminated altogether (assuming "SATA rate matching" described below works).

The only defense the STP/SATA bridge can offer is to send SATA\_HOLD; each time it releases SATA\_HOLD for n dwords, up to 21+n more incoming dwords are unleashed. SATA 1.0/1.0a HT and DT state machines originally stated that HOLD was not allowed in either direction for non-Data FISes (e.g., register, DMA Setup, Set Device Bits, PIO Setup) but SATA 2.5 seems to have dropped that restriction. So, SATA\_HOLD seems like a viable solution. Although this will create extra HOLD/HOLDA turnarounds on the SATA physical link, it is only consuming bandwidth that is not achievable

The STP/SATA bridge still must handle incoming primitives without losing any important information.

The outgoing direction (SAS to SATA) is easier; the STP/SATA bridge just rate matches, using either ALIGN (0) (but they must be transmitted in pairs) or SATA\_HOLD.

### **Suggested changes**

**3.1.32 connection rate:** The effective rate of dwords through the pathway between a SAS initiator phy and a SAS target phy, established through the connection request.

**3.1.88 I\_T nexus:** A nexus that exists between a [SAS initiator port and a SAS target port, or a nexus that exists between a SCSI initiator port and a SCSI target port](#). See SAM-4.

**3.1.89 I\_T nexus loss:** A condition where a SAS port determines that another SAS port is no longer available. See 4.5.

**3.1.127 nexus:** A relationship between a [SAS initiator port and a SAS target port, or a relationship between a SCSI initiator port and a SCSI target port](#) that may extend to a logical unit and a task. See SAM-4.

**3.1.137 pathway blocked count:** The number of times the port has retried this connection request due to receiving OPEN\_REJECT (PATHWAY BLOCKED), [OPEN\\_REJECT \(RESERVED STOP 0\)](#), or [OPEN\\_REJECT \(RESERVED STOP 1\)](#).

#### 4.1.11 Connections

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The connection rate is the effective rate of dwords through the pathway between a SAS initiator phy and a SAS target phy, established through the connection request. Every phy shall support a 1,5 Gbps connection rate regardless of its physical link rate.

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### 4.5 I\_T nexus loss

When a SAS port receives OPEN\_REJECT (NO DESTINATION), OPEN\_REJECT (PATHWAY BLOCKED), [OPEN\\_REJECT \(RESERVED INITIALIZE 0\)](#), [OPEN\\_REJECT \(RESERVED INITIALIZE 1\)](#), [OPEN\\_REJECT \(RESERVED STOP 0\)](#), [OPEN\\_REJECT \(RESERVED STOP 1\)](#), or an open connection timeout occurs in response to a connection request, it shall retry the connection request until:

- a) the connection is established;
- b) for SSP target ports, the time indicated by the I\_T NEXUS LOSS field in the Protocol-Specific Port mode page expires; or
- c) the I\_T nexus loss timer, if any, expires (see 8.2.2.1, 10.2.7.2, and 10.4.3.14).

[An I\\_T nexus loss occurs in a SAS port when:](#)

- a) [the I\\_T nexus loss timer expires; or](#)
- b) [the SAS port receives an abandon-class OPEN\\_REJECT \(see table 90 in 7.2.5.12\).](#)

I\_T nexus loss is handled by the port layer state machines (see 8.2.2.3). In some cases, the I\_T nexus loss timer is overridden for connection requests through self-configuring expander devices as described in 4.7.1.

If ~~the I\_T nexus loss timer expires~~ [an I\\_T nexus loss occurs](#) in an SSP port, then the port shall send a Nexus Loss event notification to the SCSI application layer (see 10.2.5) and the SCSI device shall perform the actions defined for I\_T nexus loss in SAM-3.

If ~~the I\_T nexus loss timer expires~~ [an I\\_T nexus loss occurs](#) in an STP initiator port, then the [STP initiator port shall send a Transport Event Notification \(Nexus Loss, \[Device\]\) indication to the port/ATA application client \(i.e., create a nexus loss event\)\(see ATA8-AAM\)](#). The ATA application client shall consider any commands for the lost STP target port to be completed with an error. ~~This serves as a nexus loss event (see ATA8-AAM).~~

If ~~the I\_T nexus loss timer expires~~ [an I\\_T nexus loss occurs](#) in an STP target port, then the ~~port~~ [the ATA device server shall abort any/all outstanding commands for the lost STP initiator port](#). If the STP target port is in an STP/SATA bridge, the STP/SATA bridge shall originate a link reset sequence to the SATA device [so the ATA device server in the SATA device aborts all outstanding commands](#).

~~If the I\_T nexus loss timer expires in an SMP initiator port, then the port shall stop attempting to establish connections to the lost SMP target port.~~

If ~~the I\_T nexus loss timer expires~~ [an I\\_T nexus loss occurs](#) in an initiator port, then a management application client [shall consider the lost target port to be unavailable and stop attempting to establish connections to the lost STP target port](#). It should cause a link reset sequence on the phy(s) attached to the lost target port (e.g, if directly attached, the phys in the initiator port; if attached via expander device(s), the phys in the expander device closest to and attached to the target port).

#### 4.6.4 Expander connection router (ECR)

The ECR routes messages between pairs of expander phys as configured by the ECM. Enough routing resources shall be provided to support at least one connection.

When forwarding dwords during a connection from a source phy with a higher physical link rate to a destination phy with a lower physical link rate, rate matching (see 7.13) ensures the dwords are at a connection rate equal to or less than the lower physical link rate. However, the ECR may be requested to forward more dwords than the destination phy is able to accept if:

- a) an invalid dword occurs during an ALIGN or NOTIFY;
- b) an invalid dword occurs during a CLOSE; or
- c) multiple invalid dwords occur during a BREAK.

The ECR may discard dwords if needed and count them as receive elasticity buffer overflows (see 4.11).

When forwarding dwords from a SATA physical link with a higher physical link rate to a SAS physical link with a lower physical link rate, the SATA host port in the STP/SATA bridge shall throttle incoming FISes with SATA\_HOLD (see 7.17.3).

NOTE 1 - If SATA\_HOLD is deasserted for n dwords, the SATA device may send (21+n) more data dwords.

NOTE 2 - SATA\_HOLD does not affect primitives (see ATA/ATAPI-7 V3). The STP/SATA bridge may expand or contract repeated and continued primitives without changing their functional meaning.

When forwarding dwords from a SAS physical link with a lower physical link rate to a SATA physical link with a higher physical link rate, the SATA host port in the STP/SATA bridge shall perform a process similar to rate matching (see 7.13) by inserting ALIGN (0) and/or SATA\_HOLD on the SATA physical link whenever it underflows.

NOTE 3 - SATA requires that ALIGN (0) be sent in pairs (see ATA/ATAPI-7 V3).

#### 4.8.3 Route table optimization

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If the management application client supports route table optimization, then the management application client should provide a vendor-specific method for initiating a check of the resulting expander route tables.

The check should be performed under the following situations:

- a) when an ~~OPEN\_REJECT (NO DESTINATION) is received for a connection request to a SAS address-~~  
I\_T nexus loss occurs for a destination port that is expected to be ~~accepted~~present;
- b) when a discover process has been completed;
- c) when another SMP initiator port is discovered in the SAS domain; or
- d) when a self-configuring expander device is discovered in the SAS domain.

Table 1 — PHY EVENT INFORMATION SOURCE field

Code	Name	Type <sup>a</sup>	Description
...	...	...	...
21h	Transmitted <a href="#">abandon-class</a> OPEN_REJECT <del>abandon</del> count	WC	Number of times the phy received an OPEN address frame and transmitted an abandon-class OPEN_REJECT (see 7.2.5.12). In expander devices, forwarded OPEN_REJECTs shall not be counted.
22h	Received <a href="#">abandon-class</a> OPEN_REJECT <del>abandon</del> count	WC	Number of times the phy originated an OPEN address frame and received an abandon-class OPEN_REJECT (see 7.2.5.12). In expander devices, OPEN_REJECTs in response to forwarded OPEN address frames shall not be counted.
23h	Transmitted <a href="#">retry-class</a> OPEN_REJECT <del>retry</del> count	WC	Number of times the phy received an OPEN address frame and transmitted a retry-class OPEN_REJECT (see 7.2.5.12). In expander devices, forwarded OPEN_REJECTs shall not be counted.
24h	Received <a href="#">retry-class</a> OPEN_REJECT <del>retry</del> count	WC	Number of times the phy originated an OPEN address frame and received a retry-class OPEN_REJECT (see 7.2.5.12). In expander devices, OPEN_REJECTs in response to forwarded OPEN address frames shall not be counted.
<sup>a</sup> The Type column indicates the source type: <ul style="list-style-type: none"> <li>a) WC = wrapping counter</li> <li>b) PVD = peak value detector</li> <li>c) N/A = not applicable</li> </ul> <sup>b</sup> This standard also defines a saturating counter that counts this event (see 10.2.8.1 and 10.4.3.7).			

### 7.2.5.12 OPEN\_REJECT

OPEN\_REJECT specifies that a connection request has been rejected and specifies the reason for the rejection. The result of some OPEN\_REJECTs is to abandon (i.e., not retry) the connection request and the result of other OPEN\_REJECTs is to retry the connection request.

All of the OPEN\_REJECT versions defined in table 2 shall result in the originating port abandoning the connection request.

Table 2 — [Abandon-class OPEN\\_REJECT](#) ~~abandon~~-primitives

Primitive	Originator	Description
OPEN_REJECT (BAD DESTINATION)	Expander phy	A connection request arrives through an expander phy using the direct routing or table routing method and the expander device determines the connection request would have to be routed to the same expander port as the expander port through which the connection request arrived (e.g., the destination SAS address equals the source SAS address), and the expander device has not chosen to return OPEN_REJECT (NO DESTINATION) (see 7.12.4.3 and 7.12.4.4).
OPEN_REJECT (CONNECTION RATE NOT SUPPORTED)	Any phy	The requested connection rate is not supported on some physical link on the pathway between the source phy and destination phy. When a SAS initiator phy is directly attached to a SAS target phy, the requested connection rate is not supported by the destination phy.  <a href="#">If the connection rate is 1.5 Gbps, this is considered an abandon-class OPEN_REJECT.</a>  <a href="#">If the connection rate is greater than 1.5 Gbps, the connection request may be modified and reattempted as described in 7.12.2.27.12.2.3.</a>
OPEN_REJECT (PROTOCOL NOT SUPPORTED)	Destination phy	Phy with destination SAS address exists but the destination phy does not support the requested initiator/target role, protocol, initiator connection tag, or features (i.e., the values in the INITIATOR PORT bit, the PROTOCOL field, the INITIATOR CONNECTION TAG field, and/or the FEATURES field in the OPEN address frame are not supported).
OPEN_REJECT (RESERVED ABANDON 1)	Unknown	Reserved. Process the same as OPEN_REJECT (WRONG DESTINATION).
OPEN_REJECT (RESERVED ABANDON 2)		
OPEN_REJECT (RESERVED ABANDON 3)		
OPEN_REJECT (STP RESOURCES BUSY)	Destination phy	STP target port with destination SAS address exists but the STP target port has an affiliation with another STP initiator port or all of the available task file registers have been allocated to other STP initiator ports (see 7.17.5). Process the same as OPEN_REJECT (WRONG DESTINATION) for non-STP connection requests.
OPEN_REJECT (WRONG DESTINATION)	Destination phy	The destination SAS address does not match the SAS address of the SAS port to which the connection request was delivered.
OPEN_REJECT (ZONE VIOLATION)	Zoning expander phy	The connection request is from a zone group that does not have permission to access the zone group that contains the destination phy.

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Editor's Note 1: move ZONE VIOLATION to the bottom of the table to keep sorted. Re-sort all references to it throughout the standard.

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All of the OPEN\_REJECT versions defined in table 3 shall result in the originating port retrying the connection request.

**Table 3 — Retry-class OPEN\_REJECT ~~retry~~ primitives**

Primitive	Originator	Description
OPEN_REJECT (NO DESTINATION) <sup>a</sup>	Expander phy	Either: a) No such destination phy; b) the expander device determines the connection request would have to be routed to the same expander port as the expander port through which the connection request arrived (e.g., the destination SAS address equals the source SAS address) and the expander device has not chosen to return OPEN_REJECT (BAD DESTINATION) (see 7.12.4.3 and 7.12.4.4); or c) the SAS address is valid for an STP target port in an STP/SATA bridge, but the initial Register - Device to Host FIS has not been successfully received (see 10.4.3.8).
OPEN_REJECT (PATHWAY BLOCKED) <sup>b</sup>	Expander phy	An expander device determined the pathway was blocked by higher priority connection requests.
OPEN_REJECT (RESERVED CONTINUE 0) <sup>c</sup>	Unknown	Reserved. Process the same as OPEN_REJECT (RETRY).
OPEN_REJECT (RESERVED CONTINUE 1) <sup>c</sup>		
OPEN_REJECT (RESERVED INITIALIZE 0) <sup>a</sup>	Unknown	Reserved. Process the same as OPEN_REJECT (NO DESTINATION).
OPEN_REJECT (RESERVED INITIALIZE 1) <sup>a</sup>		
OPEN_REJECT (RESERVED STOP 0) <sup>b</sup>	Unknown	Reserved. Process the same as OPEN_REJECT (PATHWAY BLOCKED).
OPEN_REJECT (RESERVED STOP 1) <sup>b</sup>		
OPEN_REJECT (RETRY) <sup>c</sup>	Destination phy	Phy with destination SAS address exists but is not able to accept connections.
<sup>a</sup> If the I_T Nexus Loss timer is already running, it continues running; if it is not already running, it is initialized and started. Stop retrying the connection request if the I_T Nexus Loss timer expires. <sup>b</sup> If the I_T Nexus Loss timer is already running, it continues running. Stop retrying the connection request if the I_T Nexus Loss timer expires. <sup>c</sup> If the I_T Nexus Loss timer (see 8.2.2) is already running, it is stopped.		

NOTE 4 - Some SAS phys compliant with earlier versions of this standard also transmit OPEN\_REJECT (RETRY) if they receive an OPEN address frame while their SL\_CC state machines are in the SL\_CC5:BreakWait state (see 7.14.4.7).

When a SAS phy detects more than one reason to transmit an OPEN\_REJECT, the SL\_CC state machine determines the priority in the SL\_CC2:Selected state (see 7.14.4.4).

When an expander phy detects more than one reason to transmit an OPEN\_REJECT, the ECM determines the priority (see 7.12.4).

See 7.12 for details on connection requests.

**7.8.3 OPEN address frame**

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The CONNECTION RATE field specifies the connection rate (see 4.1.11) being requested between the source and destination, and is defined in table 112.

**Table 112 — CONNECTION RATE field**

Code	Description
8h	1,5 Gbps
9h	3 Gbps
<a href="#">Ah</a>	<a href="#">6 Gbps</a>
<a href="#">Bh - Fh</a>	<a href="#">Reserved for future connection rates</a>
All others	Reserved

~~When requesting a connection to a SAS target port, a SAS initiator port shall set the CONNECTION RATE field to a value supported by at least one potential pathway.~~

~~When requesting an SSP connection to an SSP initiator port, an SSP target port shall set the CONNECTION RATE field to the connection rate in effect when the command was received unless it has received an OPEN\_REJECT (CONNECTION RATE NOT SUPPORTED). See 7.12.2.27.12.2.3 for details on handling OPEN\_REJECT (CONNECTION RATE NOT SUPPORTED).~~

A SAS initiator port shall set the CONNECTION RATE field using one of the following:

- a) use the highest supported connection rate supported by a potential pathway as determined during the discover process (e.g., based on the logical link rates of each logical link reported in the SMP DISCOVER responses); or

NOTE 5 - If the connection request results in OPEN\_REJECT (CONNECTION RATE NOT SUPPORTED), the discover process information is no longer current and should be run again.

- b) start with the logical link rate of the logical phy. Each time a connection request with a connection rate greater than 1,5 Gbps results in OPEN\_REJECT (CONNECTION RATE NOT SUPPORTED), reattempt the connection request with the next highest connection rate (e.g., on a 6 Gbps logical phy, first attempt 6 Gbps, then 3 Gbps, then 1,5 Gbps).

A SAS target port shall remember the last known good connection rate established with each initiator port (covering both incoming and outgoing connection requests).

An SSP target port shall remember the connection rate in effect when it receives a command or task management function. An SSP target port shall set the CONNECTION RATE field to the lower of:

- a) the last known good connection rate; and
- b) for the first frame the SSP target port intends to transmit in the connection, the connection rate in effect when the command or task management function was received.

The ~~SASSP~~ target port should send frames in a connection to the ~~SASSP~~ initiator port regardless of whether the saved connection rate for that command or task management function matches the current connection rate; the ~~SASSP~~ target port should not close the connection just to reopen the connection at the saved connection rate.

An STP target port shall set the CONNECTION RATE field to the last known good connection rate.

**Option 1A:**

If a SAS target port receives an OPEN\_REJECT (CONNECTION RATE NOT SUPPORTED) for a connection request, it shall set the last known good connection rate to 1.5 Gbps and reattempt the connection request.

**Option 1B:**

If a SAS target port receives an OPEN\_REJECT (CONNECTION RATE NOT SUPPORTED) for a connection request with a connection rate greater than 1.5 Gbps, it shall set the last known good connection rate to the next highest connection rate (e.g., drop from 6 Gbps to 3 Gbps, or from 3 Gbps to 1.5 Gbps) and reattempt the connection request.

~~When requesting an STP connection to an STP initiator port, an STP target port shall set the CONNECTION\_RATE field to the last value received in a connection request from the STP initiator port unless the STP target port has received an OPEN\_REJECT (CONNECTION RATE NOT SUPPORTED).~~

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The PATHWAY BLOCKED COUNT field specifies the number of times the port has retried this connection request due to receiving OPEN\_REJECT (PATHWAY BLOCKED), OPEN\_REJECT (RESERVED STOP 0), or OPEN\_REJECT (RESERVED STOP 1). The port shall not increment the PATHWAY BLOCKED COUNT value past Fh. If the port changes connection requests, it shall use a PATHWAY BLOCKED COUNT ~~off~~field set to 00h.

## 7.12.2 Opening a connection

### 7.12.2.1 Connection request

The OPEN address frame (see 7.8.3) is used to open a connection from a source port to a destination port using one source phy and one destination phy.

To make a connection request, the source port shall transmit an OPEN address frame through an available phy. The source phy shall transmit idle dwords after the OPEN address frame until it receives a response or aborts the connection request with BREAK.

After transmitting an OPEN address frame, the source phy shall initialize and start a 1 ms Open Timeout timer. Whenever an AIP is received, the source phy shall reinitialize and restart the Open Timeout timer. Source phys are not required to enforce a limit on the number of AIPs received before aborting the connection request. When any connection response is received, the source phy shall reinitialize the Open Timeout timer. If the Open Timeout timer expires before a connection response is received, the source phy shall transmit BREAK to abort the connection request (see 7.12.6).

The OPEN address frame flows through expander devices onto intermediate physical links. If an expander device on the pathway is unable to forward the connection request, it returns OPEN\_REJECT (see 7.12.4). If the OPEN address frame reaches the destination, it returns either OPEN\_ACCEPT or OPEN\_REJECT unless the OPEN address frame passed an OPEN address frame from the destination with higher arbitration priority (see 7.12.3). Rate matching shall be used on any physical links in the pathway with negotiated physical link rates that are faster than the requested connection rate (see 7.13).



**7.12.2.2 Results of a connection request**

After a phy transmits an OPEN address frame, it shall expect one or more of the results listed in table 113.

**Table 113 — Connection Results of a connection request**

Result	Description
Receive AIP	Arbitration in progress. When an expander device is trying to open a connection to the selected destination port, it returns an AIP to the source phy. The source phy shall reinitialize and restart its Open Timeout timer each time it receives an AIP. AIP is sent by an expander device while it is internally arbitrating for access to an expander port.
Receive OPEN_ACCEPT	Connection request accepted. OPEN_ACCEPT is transmitted by the destination phy.
Receive OPEN_REJECT	Connection request rejected. OPEN_REJECT is transmitted by the destination phy or by an expander device in the partial pathway. The different versions are described in 7.2.5.12. See 4.5 for I_T nexus loss handling. <a href="#">See 7.8.3 for handling of OPEN_REJECT (CONNECTION RATE NOT SUPPORTED) for connection rates greater than 1.5 Gbps.</a>
Receive OPEN address frame	If AIP has been previously detected, this indicates an overriding connection request.  If AIP has not yet been detected, this indicates two connection requests crossing on the physical link. Arbitration fairness determines which one wins (see 7.12.3).
Receive BREAK	The destination phy or an expander device in the partial pathway may reply with BREAK indicating the connection is not being established.
Open Timeout timer expires	The source phy shall abort the connection request by transmitting BREAK (see 7.12.6). See 4.5 for I_T nexus loss handling.

~~After an OPEN\_REJECT (CONNECTION RATE NOT SUPPORTED) has been received by a SAS target port, the SAS target device shall set the connection rate for future requests for that I\_T\_L\_Q nexus to:~~

- ~~a) the last value received in a connection request from the SAS initiator port;~~
- ~~b) 1,5-Gbps; or~~
- ~~c) the connection rate in effect when the command was received.~~

**7.13 Rate matching**

Each successful connection request contains the connection rate (see 4.1.11) of the pathway.

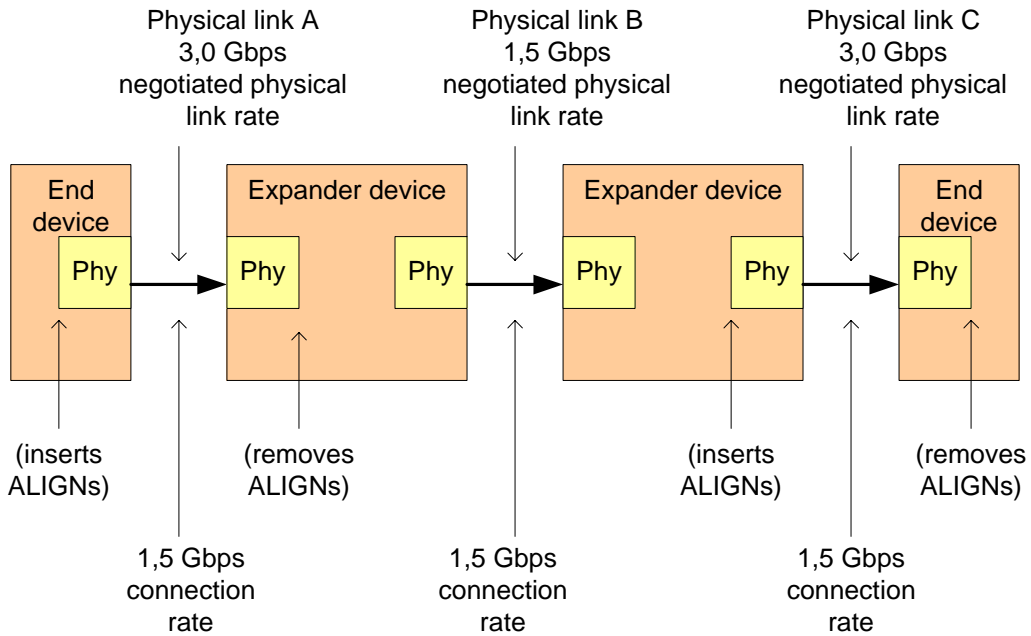
Each phy in the pathway shall insert ALIGNs and/or NOTIFYs between dwords if its physical link rate is faster than the connection rate as described in table 114.

**Table 114 — Rate matching ALIGN and/or NOTIFY insertion requirements**

Physical link rate	Connection rate	Requirement
1,5 Gbps	1,5 Gbps	None
3,0 Gbps	1,5 Gbps	One ALIGN or NOTIFY within every 2 dwords that are not clock skew management ALIGNs or NOTIFYs (i.e., every overlapping window of 2 dwords)(e.g., a repeating pattern of an ALIGN or NOTIFY followed by a dword or a repeating pattern of a dword followed by an ALIGN or NOTIFY)
	3,0 Gbps	None

ALIGNs and NOTIFYs inserted for rate matching are in addition to ALIGNs and NOTIFYs inserted for clock skew management (see 7.3) and STP initiator phy throttling (see 7.17.2). See Annex H for a summary of their combined requirements.

Figure 1 shows an example of rate matching between a 3,0 Gbps source phy and a 3,0 Gbps destination phy, with an intermediate 1,5 Gbps physical link in between them.



Sample dwords on physical links (from left to right) during a 1,5 Gbps connection:

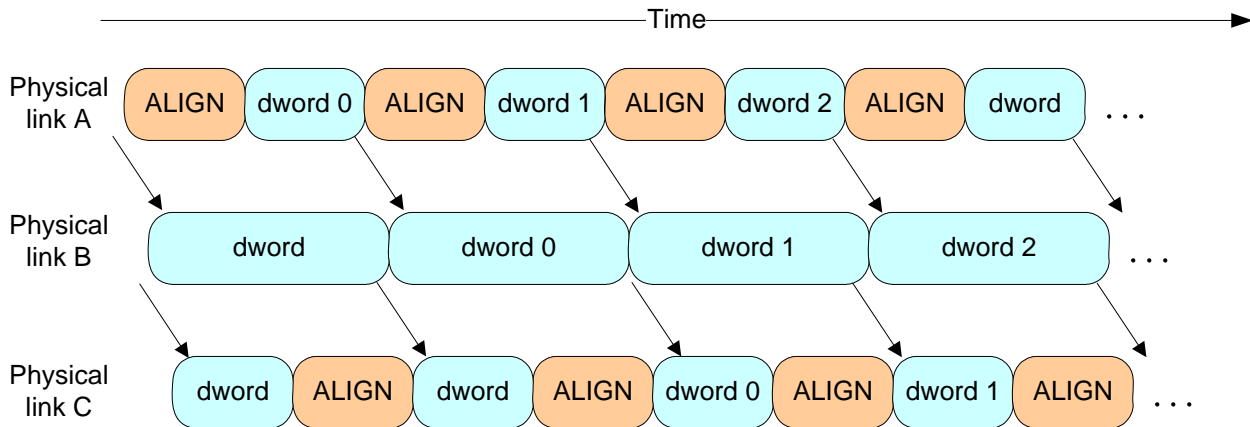


Figure 1 — Rate matching example

A phy shall start rate matching at the selected connection rate starting with the first dword that is not an ALIGN or NOTIFY inserted for clock skew management following:

- a) transmitting the EOAF for an OPEN address frame; or
- b) transmitting an OPEN\_ACCEPT.

The source phy transmits idle dwords including ALIGNs and NOTIFYs at the selected connection rate while waiting for the connection response. This enables each expander device to start forwarding dwords from the source phy to the destination phy after forwarding an OPEN\_ACCEPT.

A phy shall stop inserting ALIGNs and/or NOTIFYs for rate matching after:

- a) transmitting the first dword in a CLOSE;
- b) transmitting the first dword in a BREAK;
- c) transmitting the first dword in a BREAK\_REPLY;
- d) receiving an OPEN\_REJECT for a connection request; or
- e) losing arbitration to a received OPEN address frame.

**Option 2A:**

If an expander phy attached to a SATA phy is using a physical link rate greater than the maximum connection rate supported by the pathway from an STP initiator port, [and there is only one STP initiator port using that SATA device \(i.e., there are not multiple active STP initiator ports\)](#), a management application client should use the SMP PHY CONTROL function (see 10.4.3.18) to set the PROGRAMMED MAXIMUM PHYSICAL LINK RATE field of the expander phy to the maximum connection rate supported by the [potential pathways](#) from that STP initiator port [and request a phy operation of LINK RESET to make the new physical link rate take effect](#).

**Option 2B:**

~~If an expander phy attached to a SATA phy is using a physical link rate greater than the maximum connection rate supported by the pathway from an STP initiator port, a management application client should use the SMP PHY CONTROL function (see 10.4.3.18) to set the PROGRAMMED MAXIMUM PHYSICAL LINK RATE field of the expander phy to the maximum connection rate supported by the pathway from that STP initiator port.~~

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Editor's Note 2: This rule does not work if multiple initiators with different link rates are present, so it must at least be constrained to the single-initiator case. With SAS-2 expanders implementing SATA rate matching (using SATA\_HOLD), it may be best to drop this rule altogether. The programmed minimum/maximum link rate fields might themselves be obsolete, letting the expander chose the best rate by itself.

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**7.16.1 Opening an SSP connection**

An SSP phy that accepts an OPEN address frame shall transmit at least one RRDY in that connection within 1 ms of transmitting an OPEN\_ACCEPT. If the SSP phy is not able to grant credit, it shall respond with OPEN\_REJECT (RETRY) and not accept the connection request.

**7.17.6 Opening an STP connection**

If no STP connection exists when the SATA host port in an STP/SATA bridge receives a SATA\_X\_RDY from the attached SATA device, the STP target port in the STP/SATA bridge shall establish an STP connection to the appropriate STP initiator port before it transmits a SATA\_R\_RDY to the SATA device.

Wide STP initiator ports shall not request more than one connection at a time to an STP target port. Wide STP target ports shall not request more than one connection at a time to an STP initiator port.

While a wide STP target port is waiting for a response to a connection request or has established a connection to an STP initiator port, it shall:

- a) reject incoming connection requests from that STP initiator port with OPEN\_REJECT (RETRY); and
- b) if affiliations are supported, reject incoming connection requests from other STP initiator ports with OPEN\_REJECT (STP RESOURCES BUSY).

While a wide STP initiator port is waiting for a response to a connection request to an STP target port, it shall not reject an incoming connection request from that STP target port because of its outgoing connection request. It may reject incoming connection requests for other reasons (see 7.2.5.12).

If a wide STP initiator port receives an incoming connection request from an STP target port while it has a connection established with that STP target port, it shall reject the request with OPEN\_REJECT (RETRY).

The first dword that an STP phy sends inside an STP connection after OPEN\_ACCEPT that is not an ALIGN or NOTIFY shall be an STP primitive (e.g., SATA\_SYNC).

**7.18.3 Opening an SMP connection**

An SMP target port shall not attempt to establish an SMP connection.

**8.2.2.2.1 PL\_OC1:Idle state description**

...

If an I\_T Nexus Loss timer expires for a destination SAS address, this state shall perform the following:

- a) delete the I\_T Nexus Loss timer for the SAS address;
- b) send a Transmission Status (I\_T Nexus Loss) confirmation for each pending Tx Frame message for the SAS address; and
- c) discard each pending Tx Frame message for the SAS address and any corresponding pending Tx Open messages.

If the port is an STP target port or an STP initiator port, the port shall handle all pending commands as described in 4.5.

#### 8.2.2.3.4 PL\_OC2:Overall\_Control state unable to establish a connection

...

If this state receives an Unable To Connect (Connection Rate Not Supported), Unable To Connect (Protocol Not Supported), Unable To Connect (Zone Violation), Unable To Connect (Reserved Abandon 1), Unable To Connect (Reserved Abandon 2), Unable To Connect (Reserved Abandon 3), or Unable To Connect (STP Resources Busy) message and an I\_T Nexus Loss timer is running for the SAS address, then this state shall:

- a) stop the I\_T Nexus Loss timer, if the timer has been running; and
- b) initialize the I\_T Nexus Loss timer.

This state shall discard the pending Tx Frame message for which the Transmission Status confirmation was sent.

#### 10.2.7.2.2 Protocol-Specific Port mode page - short format

...

The I\_T NEXUS LOSS TIME field contains the time that the SSP target port shall retry connection requests to an SSP initiator port that are rejected with [certain](#) responses indicating [that](#) the SSP initiator port may no longer be present (see 8.2.2) before recognizing an I\_T nexus loss (see 4.5). Table 179 defines the values of the I\_T NEXUS LOSS TIME field. If this mode page is not implemented, the I\_T nexus loss time is vendor specific. This value is enforced by the port layer (see 8.2.2).