To: T10 Technical Committee
From: Rob Elliott, HP (elliott@hp.com)
Date: 12 April 2007
Subject: 07-119r1 SAS-2 Far-end retimed loopback phy test function

Revision history
Revision 0 (9 March 2007) First revision
Revision 1 (12 April 2007) Incorporated comments from March 2007 SAS physical WG: removed analog
      loopback mode. Per a request from Mark Evans (Western Digital), added an optional PHY TEST
      FUNCTION address frame to invoke phy test functions in a simpler manner than the SEND
      DIAGNOSTIC command or the SMP PHY TEST FUNCTION function; this could be used for initiators.

Related documents
sas2r08 - Serial Attached SCSI - 2 (SAS-2) revision 8
02-218r0 SAS Remove far-end retimed loopback (Jim Coomes, Seagate) - accepted into sas-r00b
Serial ATA 2.6 (from the Serial ATA International Organization - http://www.sata-io.org)
PCI Express Base Specification Revision 2.0 (PCI SIG - http://www.pcisig.org)

Overview
1. Many phy designs implement far-end loopback (receiver -> transmitter) phy test modes, where the phy
retransmits everything it receives. As with test patterns, there should be a common mechanism for entering
these test modes.

Other high-speed serial interface standards define standard ways to enter loopback modes.

The Serial ATA specification defines two far-end loopback modes and defines enabling them via the BIST
Activate FIS: far-end retimed (required) and far-end analog (optional). In far-end retimed mode:

   a) the tester must send valid 8b10b characters
   b) the tester must send two ALIGNs every 256 dwords (normal SATA rule)
   c) the phy may consume up to two ALIGNs every 256 dwords (preventing elasticity buffer overflow)
   d) the phy may add a single ALIGN (on elasticity buffer underflow) as long as it is directly preceded or
      followed by a tester ALIGN(s) that was not consumed
   e) the phy may add two ALIGNs back-to-back at any time
   f) the tester may send a burst of four ALIGNs to guarantee it gets at least two ALIGNs back, regardless
      of physical link rate tolerance differences.
   g) the phy may change disparity
   h) exit on receiving COMRESET/COMINIT

The PCI Express specification defines a Loopback mode "for test and fault isolation use."

   a) entry is via two consecutive TS1 Ordered Sets with the Enable Loopback bit set to one.
   b) phy's link rate is selected via TS1/TS2 bits
   c) phy's deemphasis level is selected via TS1/TS2 bits
   d) tester must go to electrical idle for 1 ms if changing speeds
   e) phy must go to electrical idle for 2 ms if changing speeds
   f) tester must send enough TS1s for the phy to lock before sending test patterns
   g) tester must send valid 8b10b symbols (characters)
   h) the phy must preserve disparity
   i) the phy may drop SKP symbols (the equivalent to SAS deletable primitives) if needed
   j) the phy may add SKP symbols adjacent to tester SKP symbols if needed (same disparity)
   k) the phy must preserve 10-bit data (even invalid 10 bit patterns)
   l) exit on receipt of four consecutive EIOS (Electrical Idle Ordered Set) patterns
   m) at 2.5 GT/sec, exit on electrical idle for 128 usec (this is all analogous to the SAS/SATA COMINIT
      signal).

SAS-1 original included far-end retimed loopback, but it was removed in SAS revision 1b - it didn't seem worth
the effort to resolve the details. Many SAS phy designs do implement this feature, however, with
vendor-specific mechanisms.

SAS-2 should define standardized controls using the Protocol-Specific diagnostic page and the SMP PHY TEST function for far-end retimed loopback mode.

2. The SCSI Protocol-Specific diagnostic page and the SMP PHY TEST FUNCTION function are not well-suited for sending initiators into test modes, since initiators don't often implement SSP and/or SMP target ports. A PHY TEST FUNCTION address frame is proposed for this purpose, similar to the SATA BIST Activate frame. Its contents are nearly identical to the SMP PHY TEST FUNCTION request frame, just lacking the ability to specify the phy identifer. It works on any phy, not just in initiators.

The address frame sends the phy that receives it into the test mode; the diagnostic page and SMP function cannot send that phy into the test mode, it can only send other phys into the test mode.

Suggested changes to SAS-2

4.10 Phy test functions

4.10.1 Phy test functions overview

The optional Protocol-Specific diagnostic page for SAS (see 10.2.9.1) provides methods for an application client to enable and disable a phy test function (e.g., transmission of the CJTPAT) for a selected phy in a SAS target device with an SSP target port. The optional SMP PHY TEST FUNCTION function (see 10.4.3.25) provides similar methods for expander devices and SAS target devices with SMP target ports.

Phy test functions (e.g., transmission of test patterns) are used for phy and interconnect characterization and diagnosis. The phy may be attached to test equipment while performing a phy test function. The following optional mechanisms are defined for invoking phy test functions:

   a)   the PHY TEST FUNCTION address frame (see 7.9.4) to invoke a phy test function in a SAS phy or an expander phy;
   b)   the Protocol-Specific diagnostic page for SAS (see 10.2.9.1) to invoke a phy test function in a selected phy in a SAS target device with an SSP target port; and
   c)   the SMP PHY TEST FUNCTION function (see 10.4.3.25) to invoke a phy test function in a SAS phy or an expander phy contolled by a management device server.

   Editor's Note 1: TRAIN_DONE (or whatever is added) might be useful for the diagnostic page and SMP function invoked tests as well. It announces that the test mode is beginning.

Each phy test function is optional.

The application client sends a SEND DIAGNOSTIC command with the Protocol-Specific diagnostic page or an SMP PHY TEST FUNCTION function specifying the phy in the SAS target device that is to perform the phy test function and the phy test function to be performed. If the phy test function requires a specific phy test pattern and/or phy test pattern physical link rate, then it also specifies the phy test pattern and phy test pattern physical link rate are also specified.

The SEND DIAGNOSTIC command may be sent through any SSP target port to any logical unit in the SAS target device that contains the phy that is to perform the phy test function.

The phy test function begins at the following times:

   a)   For the SEND DIAGNOSTIC command, the phy shall begin the specified phy test function after the SSP target port receives an ACK for the RESPONSE frame transmitted in response to the SEND DIAGNOSTIC command that requested the phy test function.;
   b)   For the SMP PHY TEST FUNCTION function, the phy shall begin the specified phy test function after the SMP target port transmits the SMP response frame.; and
   c)   for the PHY TEST FUNCTION address frame, the phy shall begin the specified phy test function after transmitting TRAIN_DONE.

Editor's Note 2: With the SMP and the diagnostic page, the function cannot be invoked on the phy that receives the function or page. They can only trigger the tests on other phys.

Once a SAS phy has begun performing a phy test function, ~~it shall ignore its receiver~~the link layer receivers (i.e., the SL_IR receiver, SL receiver, SSP receiver, STP receiver, and SMP receiver) shall ignore incoming dwords.

To stop a SAS phy from performing a phy test function, an application client sends a SEND DIAGNOSTIC command or an SMP PHY TEST FUNCTION function to a SAS phy in the SAS target device that is not performing a phy test function requesting a phy test function of 00h (i.e., STOP). If no such phy is available, the phy test function only stops on power loss or, for the far-end retimed loopback phy test function, on power loss or COMINIT.

Editor's Note 3: Having the TRANSMIT_PATTERN phy test function also stop on COMINIT would be more consistent

4.10.2 Far-end retimed loopback phy test function

A phy performing the far-end retimed loopback phy test function is considerd to be in the far-end retimed loopback phy test mode.

When transmitting to a phy in the far-end retimed loopback phy test mode, the test equipment:

a)   shall transmit valid 8b10b characters and D.C. idle;
b)   shall transmit deletable primitives according to 7.3;
c)   shall not transmit COMINIT pattern until it wants to exit the far-end retimed loopback phy test function.

Upon entry into the far-end retimed loopback phy test function, the phy shall transmit TRAIN_DONE.

Editor's Note 4: TRAIN_DONE might not be the best choice. A new primitive could be defined.

While performing the far-end retimed loopback phy test function, the phy:

a)   shall perform clock recovery, synchronizing the received signal to its transmit clock, and perform dword synchronization;
b)   should delete each deletable primitive that it receives;
c)   shall either delete invalid dwords or convert them into ERROR primitives;
d)   shall retransmit each dword that is not a deleteable primitive;
e)   shall transmit a deletable primitive whenever it underflows (i.e., whenever the transmitter is ready to transmit a dword but the receiver has not provided another dword to transmit); and
f)   shall transmit dwords using valid disparity based on the transmitted dword stream.

   NOTE 1 - Only valid 8b10b characters are looped back.

While in the far-end retimed loopback phy test mode, the phy shall operate its OOB signal detector to detect COMINIT.

The phy shall remain in the far-end retimed loopback phy test mode until:

a)   the phy test function is stopped via another phy with the SEND DIAGNOSTIC command Protocol-Specific diagnostic page for SAS (see 10.2.9.1) or the SMP PHY TEST FUNCTION function with the PHY TEST FUNCTION field set to 00h (i.e., STOP);
b)   the phy receives a COMINIT; or
c)   power off.

NOTE 2 - If the test equipment is changed after putting the phy into the far-end retimed loopback phy test mode, the receiver in the phy may not be able to reattain dword synchronization.

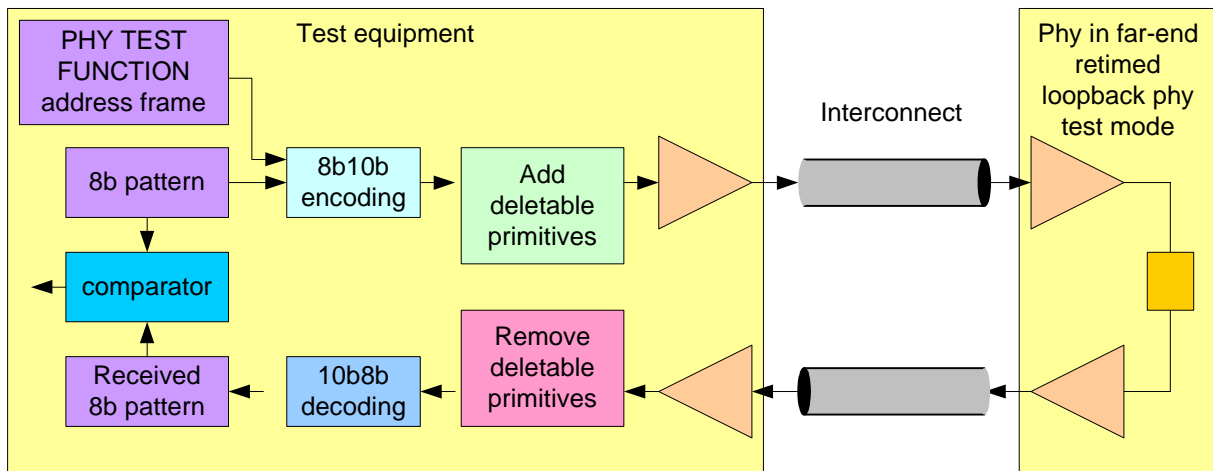Editor's Note 5: PCI Express mentions that sending training sequences again is a good idea. We could mention that here

Figure 1 shows the far-end retimed loopback phy test mode.
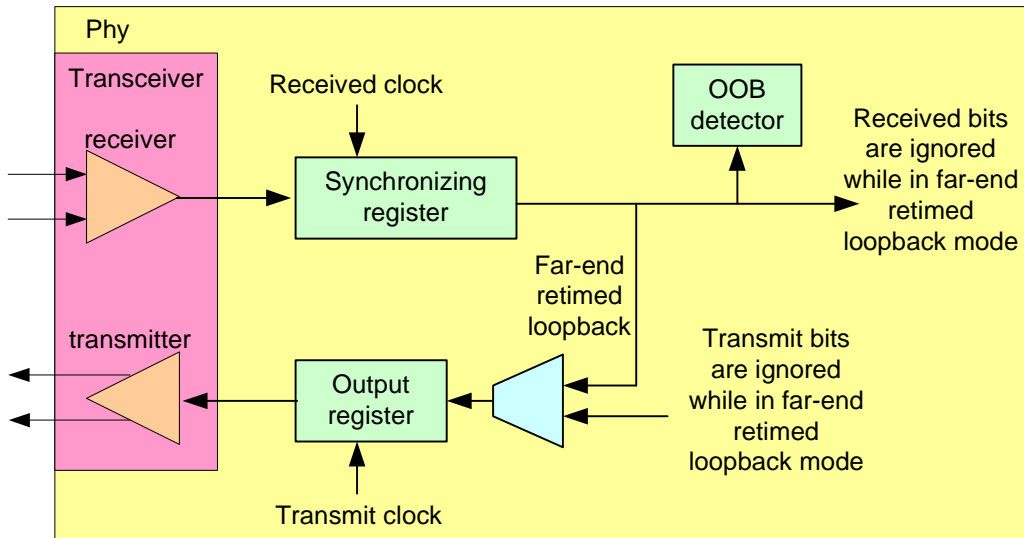
Figure 1 — Far-end retimed loopback phy test mode

Figure 1 shows usage of the far-end retimed loopback test mode.

Figure 2 — Far-end retimed loopback phy test mode usage

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.

Upon entry into this state, the phy shall:

   a)   if multiplexing is enabled (see table 86 in 6.7.4.2.3.3), send a Transmit MUX Sequence message to the SP transmitter;

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   b) 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;
   c) if the SP transmitter is transmitting at 1.5 Gbps, set the ResetStatus state machine variable to G1;
   d) if the SP transmitter is transmitting at 3 Gbps, set the ResetStatus state machine variable to G2; and
   e) if the SP transmitter is transmitting at 6 Gbps, set the ResetStatus state machine variable to G3.

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.

If multiplexing is disabled, 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.

> NOTE 3 - If multiplexing is enabled and this state receives a DWS Lost message, this state does not send a
> Start DWS message and the state machine transitions to SP0:OOB_COMINIT.

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).

6.8.4.9.3 Transition SP15:SAS_PHY_Ready to SPxx:Far_End_Retimed_Loopback

This transition shall occur after receiving a Start Far End Retimed Loopback request (e.g., from the SMP PHY
TEST FUNCTION function requesting a phy test function of FAR_END_RETIMED_LOOPBACK in an
expander device).

6.8.4.9.4 Transition SP15:SAS_PHY_Ready to SPxy:Transmit_Pattern

This transition shall occur after receiving a Start Transmit Pattern request (e.g., from the SMP PHY TEST
FUNCTION function requesting a phy test function of TRANSMIT_PATTERN in an expander device).

> Editor's Note 6: Add two new states to the state diagram

6.8.4.9 SPxx:Far_End_Retimed_Loopback state

6.8.4.9.1 State description

During this state, the phy is in the far end retimed loopback mode (see 4.10).

This state waits for a COMINIT Detected message or a Stop Phy Test Function request.

6.8.4.9.2 Transition SPxx:Far_End_Retimed_Loopback to SP0:OOB_COMINIT

This transition shall occur after:

   a) receiving a COMINIT Detected message; or
   b) receiving a Stop Phy Test Function request.

Before the transition, this state shall set the ResetStatus state machine variable to UNKNOWN.

Editor's Note 7: We will not document how the application layer decides to send a Stop Phy Test Function request to SP.

6.8.4.9 SPxy:Transmit_Pattern state

6.8.4.9.1 State description

During this state, the phy performs the transmit pattern phy test function (see 4.10).

This state waits for a Stop Phy Test Function request.

### 6.8.4.9.2 Transition SPxy:Transmit_Pattern to SP0:OOB_COMINIT

This transition shall occur after receiving a Stop Phy Test Function request.

Before the transition, this state shall set the ResetStatus state machine variable to UNKNOWN.

Editor's Note 8: Transmit Pattern could be done at the link layer (provided all the patterns are link layer compliant), but since Far-End Retimed Loopback needs to be at the phy layer, it is simpler to keep them together.

7.8 Address frames

7.8.1 Address frames overview

Address frames are used for the identification sequence and for connection requests.

Address frames are preceded by SOAF and followed by EOAF as shows in figure 158.
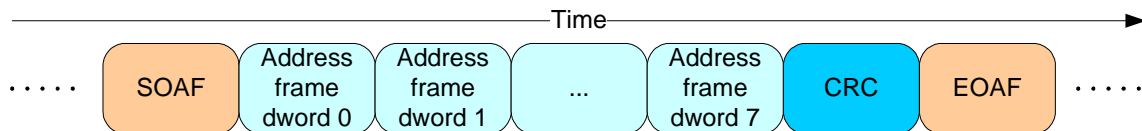
Figure 158 — Address frame transmission

Address frames shall only be sent outside connections. Address frames shall not be terminated early. All data dwords in an address frame shall be scrambled.

Table 114 defines the address frame format.

Table 114 — Address frame format

Byte\Bit	7	6	5	4	3	2	1	0
0					ADDRESS FRAME TYPE			
1				Frame type dependent bytes				
27								
28	(MSB)							
				CRC				
31								(LSB)

The ADDRESS FRAME TYPE field indicates the type of address frame and is defined in table 115. This field determines the definition of the frame type dependent bytes.

Table 115 — ADDRESS FRAME TYPE **field**

Code	Address frame type	Description
0h	IDENTIFY	Identification sequence
1h	OPEN	Connection request
2h	PHY TEST FUNCTION	Phy test function
All others	Reserved	

The CRC field contains a CRC value (see 7.5) that is computed over the entire address frame prior to the CRC field.

Address frames with unknown address frame types, incorrect lengths, or CRC errors shall be ignored by the recipient.

7.8.2 IDENTIFY address frame

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7.8.3 OPEN address frame

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7.8.4 PHY TEST FUNCTION address frame

Table 116 defines the PHY TEST FUNCTION address frame, which is used to request that a phy perform a phy test function (see 4.x).

Table 116 — PHY TEST FUNCTION address frame format

Byte\Bit	7	6	5	4	3	2	1	0
0	Reserved				ADDRESS FRAME TYPE (2h)			
1	Reserved							
9								
10	PHY TEST FUNCTION							
11	PHY TEST PATTERN							
12	Reserved							
14								
15	Reserved				PHY TEST PATTERN PHYSICAL LINK RATE			
16	Reserved							
18								
19	PHY TEST PATTERN DWORDS CONTROL							
20	PHY TEST PATTERN DWORDS							
27								
28	(MSB)							
31	CRC							(LSB)

The ADDRESS FRAME TYPE field shall be set to 2h.

All fields not defined in this subclause are defined in the SMP PHY TEST FUNCTION (see 10.x.x.x).

The CRC field is defined in 7.8.1.

7.8.5 SL_RA (receive ~~OPEN~~ address frame) state machine

The SL_RA state machine's function is to receive address frames and determine if the received address frame is an OPEN address frame and whether or not it was received successfully. This state machine consists of one state.

This state machine receives SOAFs, dwords of an OPEN address frames, and EOAFs.

This state machine shall ignore all messages except SOAF Received, Data Dword Received, and EOAF Received.

If this state machine receives a subsequent SOAF Received message after receiving an SOAF Received message but before receiving an EOAF Received message, then this state machine shall discard the Data Dword Received messages received before the subsequent SOAF Received message.

If this state machine receives more than eight Data Dword Received messages after an SOAF Received message and before an EOAF Received message, then this state machine shall discard the address frame.

If this state machine receives an Invalid Dword Received message or an ERROR Received message after an SOAF Received message and before an EOAF Received message, then this state machine shall:

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

After receiving an EOAF Received message, this state machine shall check if the address frame is a valid OPEN address frame.

This state machine shall accept an address frame if:

a) the ADDRESS FRAME TYPE field is set to ~~Open~~1h (i.e., OPEN) or 2h (i.e., PHY TEST FUNCTION);
b) the number of data dwords between the SOAF and EOAF is 8; and
c) the CRC field contains a good CRC.

Otherwise, this state machine shall discard the address frame.

If the address frame is ~~not discarded~~an OPEN address frame then this state machine shall send a OPEN Address Frame Received message to the SL_CC0:Idle state and the SL_CC1:ArbSel state with an argument that contains all the data dwords received in the OPEN address frame.

If the address frame is a PHY TEST FUNCTION address frame then this state machine shall send a Phy Test Function Received confirmation to the application layer.

> Editor's Note 9: We will not document how the application layer parses the address frame contents and decides to send a Start Far End Retimed Loopback request or Start Transmit Pattern request to SP.

10.2.9 SCSI diagnostic parameters

10.2.9.1 Protocol-Specific diagnostic page

The Protocol-Specific diagnostic page for SAS provides a method for an application client to enable and disable phy test functions (see 4.10) for selected phys. The diagnostic page format is specified in SPC-4.

The Protocol-Specific diagnostic page is transmitted using the SEND DIAGNOSTIC command. If the device server receives a RECEIVE DIAGNOSTIC RESULTS command with the PAGE CODE field set to 3Fh, it shall terminate the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and

the additional sense code set to INVALID FIELD IN PARAMETER LIST. Table 117 defines the Protocol-Specific diagnostic page for SAS.

Table 117 — Protocol-Specific diagnostic page for SAS

Byte\Bit	7	6	5	4	3	2	1	0
0	PAGE CODE (3Fh)							
1	Reserved				PROTOCOL IDENTIFIER (6h)			
2	(MSB)	PAGE LENGTH (001Ch)						
3								(LSB)
4	PHY IDENTIFIER							
5	PHY TEST FUNCTION							
6	PHY TEST PATTERN							
7	Reserved				PHY TEST PATTERN PHYSICAL LINK RATE			
8	Reserved							
10								
11	PHY TEST PATTERN DWORDS CONTROL							
12	PHY TEST PATTERN DWORDS							
19								
20	Reserved							
31								

The PAGE CODE field shall be set to 3Fh.

The PROTOCOL IDENTIFIER field shall be set to 6h indicating this is a SAS SSP specific diagnostic page.

The PAGE LENGTH field shall be set to the number of bytes in the diagnostic page after the PAGE LENGTH field (i.e., 001Ch)

The PHY IDENTIFIER field specifies the phy identifier (see 4.2.7) of the phy that is to perform or to stop performing a phy test function (i.e., the selected phy). If the PHY IDENTIFIER field specifies a phy that does not exist, then the device server shall terminate the SEND DIAGNOSTIC command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN PARAMETER LIST.

The PHY TEST FUNCTION field specifies the phy test function to be performed and is defined in table 118. If the PHY TEST FUNCTION field specifies a phy test function that is not supported, then the device server shall terminate the SEND DIAGNOSTIC command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN PARAMETER LIST.

Table 118 — PHY TEST FUNCTION **field**

Code	Name	Description
00h	STOP	If the selected phy is performing a phy test function, then the selected phy shall stop performing the phy test function and originate a link reset sequence. If the selected phy is not performing a phy test function, then this function has no effect on the selected phy. [a]
01h	TRANSMIT_PATTERN	If the selected phy is not performing a phy test function, the selected phy shall be set to transmit the phy test pattern specified by the PHY TEST PATTERN field at the physical link rate specified by the PHY TEST PATTERN PHYSICAL LINK RATE field and set to ignore its receiver. If the selected phy receives data while transmitting the pattern, then the selected phy shall ignore the received data. If the selected phy is performing a phy test function, the device server shall terminate the SEND DIAGNOSTIC command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to PHY TEST FUNCTION IN PROGRESS. [a]
02h	FAR_END_RETIMED_LOOPBACK	If the selected phy is not performing a phy test function and is operating at a valid physical link rate (i.e., G1, G2, or G3), the selected phy shall be set to the far-end retimed loopback mode (see 4.10). If the selected phy is performing a phy test function or is not operating at a valid physical link rate, the device server shall terminate the SEND DIAGNOSTIC command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to PHY TEST FUNCTION IN PROGRESS. [a]
~~02h~~03h - EFh	Reserved	
F0h - FFh	Vendor specific	
[a] If there is no SSP target port available to receive a SEND DIAGNOSTIC command to stop a phy from performing a phy test function, then a power on may be required to cause the phy to stop performing the function and originate a phy reset sequence.		

If the PHY TEST FUNCTION field is set to TRANSMIT_PATTERN (i.e., 01h), then the PHY TEST PATTERN field specifies the phy test pattern to be transmitted as defined by table 212. If the PHY TEST PATTERN field specifies a phy test pattern that is not supported by the specified SAS phy, then the device server shall terminate the SEND DIAGNOSTIC command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN PARAMETER LIST.

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10.4.3.25 PHY TEST FUNCTION function

The PHY TEST FUNCTION function requests actions by the specified phy. This SMP function may be implemented by any management device server. In zoning expander devices, if zoning is enabled then this

function shall only be processed from SMP initiator ports that have access to zone group 2 or the zone group of the specified phy (see 4.9.3.2).

Table 119 defines the request format.

Table 119 — PHY TEST FUNCTION request

Byte\Bit	7	6	5	4	3	2	1	0
0	SMP FRAME TYPE (40h)							
1	FUNCTION (92h)							
2	Reserved							
3	REQUEST LENGTH (09h)							
4	(MSB)			EXPECTED EXPANDER CHANGE COUNT				
5								(LSB)
6				Reserved				
8								
9	PHY IDENTIFIER							
10	PHY TEST FUNCTION							
11	PHY TEST PATTERN							
12				Reserved				
14								
15	Reserved				PHY TEST PATTERN PHYSICAL LINK RATE			
16				Reserved				
18								
19	PHY TEST PATTERN DWORDS CONTROL							
20				PHY TEST PATTERN DWORDS				
27								
28				Reserved				
39								
40	(MSB)			CRC				
43								(LSB)

The SMP FRAME TYPE field shall be set to 40h.

The FUNCTION field shall be set to 92h.

The REQUEST LENGTH field shall be set to 09h. For compatibility with previous versions of this standard, a REQUEST LENGTH field set to 00h specifies that there are 9 dwords before the CRC field.

The EXPECTED EXPANDER CHANGE COUNT field is defined in the SMP CONFIGURE GENERAL request (see 10.4.3.15).

The PHY IDENTIFIER field specifies the phy (see 4.2.7) to which the SMP PHY TEST PATTERN request applies.

If the PHY IDENTIFIER field specifies the phy which is being used for the SMP connection, the management device server shall not perform the requested operation and shall return a function result of SMP FUNCTION FAILED in the response frame.

The PHY TEST FUNCTION field specifies the phy test function to be performed, and is defined in table 120. If the PHY TEST FUNCTION field specifies a phy test function that is not supported by the phy, the management device server shall return a function result of UNKNOWN PHY TEST FUNCTION in the response frame.

Table 120 — PHY TEST FUNCTION **field**

Code	Name	Description
00h	STOP	If the selected phy is performing a phy test function, then the selected phy shall stop performing the phy test function and originate a link reset sequence. If the selected phy is not performing a phy test function, then this function has no effect on the selected phy.
01h	TRANSMIT_ PATTERN	If the selected phy is not performing a phy test function, the selected phy shall be set to transmit the phy test pattern specified by the PHY TEST PATTERN field at the physical link rate specified by the PHY TEST PATTERN PHYSICAL LINK RATE field and set to ignore its receiver. If the selected phy receives data while transmitting the pattern, then the selected phy shall ignore the received data. If the selected phy is performing a phy test function, the management device server shall return a function result of PHY TEST FUNCTION IN PROGRESS in the response frame.
02h	FAR_END_ RETIMED_ LOOPBACK	If the selected phy is not performing a phy test function, the selected phy shall be set to the far-end retimed loopback mode (see 4.10). If the selected phy is performing a phy test function, the device server shall return a function result of PHY TEST FUNCTION IN PROGRESS in the response frame.
~~02h~~03h - EFh	Reserved	
F0h - FFh	Vendor specific	

If the PHY TEST FUNCTION field is set to 01h, the PHY TEST PATTERN field specifies the phy test pattern to be performed, and is the same as that defined in table 212 for the Protocol-Specific diagnostic page (see 10.2.9.1). The phy test pattern shall be sent at the physical link rate specified by the PHY TEST PATTERN PHYSICAL LINK RATE field.

The PHY TEST PATTERN PHYSICAL LINK RATE field specifies the physical link rate at which the phy test function, if any, shall be performed. Table 121 defines the values for this field.

Table 121 — PHY TEST PATTERN PHYSICAL LINK RATE **field**

Code	Description
0h - 7h	Reserved
8h	1,5 Gbps
9h	3 Gbps
Ah	6 Gbps
Bh - Fh	Reserved for future physical link rates

The PHY TEST PATTERN DWORDS CONTROL field and the PHY TEST PATTERN DWORDS field are as defined in table 212 for the Protocol-Specific diagnostic page (see 10.2.9.1).

The CRC field is defined in 10.4.3.1.

Table 122 defines the response format.

Table 122 — PHY TEST FUNCTION response

Byte\Bit	7	6	5	4	3	2	1	0
0	SMP FRAME TYPE (41h)							
1	FUNCTION (92h)							
2	FUNCTION RESULT							
3	RESPONSE LENGTH (00h)							
4	(MSB)							
7				CRC				(LSB)

The SMP FRAME TYPE field shall be set to 41h.

The FUNCTION field shall be set to 92h.

The FUNCTION RESULT field is defined in 10.4.3.2.

The RESPONSE LENGTH field shall be set to 00h.

The CRC field is defined in 10.4.3.2.