To: T10 Technical Committee
From: Rob Elliott, HP (elliott@hp.com)
Date: 14 January 2008
Subject: 07-479r2 SAS-2 Phy test pattern transmitter controls

Revision history
Revision 0 (2 November 2007) First revision
Revision 1 (12 November 2007) Incorporated comments from November SAS protocol WG
Revision 2 (14 January 2008) Incorporated comments from January SAS protocol WG

Related documents
sas2r12 - Serial Attached SCSI - 2 (SAS-2) revision 12
07-119 SAS-2 Far-end retimed loopback phy test function (Rob Elliott, HP)
07-480 SAS-2 More phy test patterns - TRAIN, TRAIN_DONE, and idle dwords (Rob Elliott, HP)

Overview
This proposal adds fields to the Protocol-Specific diagnostic page and the SMP PHY TEST PATTERN request to specify the transmitter settings with which the phy transmits test patterns:

     a)   SAS or SATA levels. Phys in initiators and expanders often have different settings for SAS vs. SATA operation; this specifies which settings to use.
     b)   SSC modulation type: none, center-spreading, or down-spreading. End devices won't support center-spreading; expander devices supporting SATA must support all three.

The phy does not go through the link reset sequence to learn what these settings should be, so the method triggering the test function needs to provide that information.

This proposal also adds a sentence clarifying that a phy test function might mess up settings on other phys. The specific case triggering this is a device with a common SSC clock architecture, where one phy was running normally with no SSC when another phy is asked to enter the phy test function with SSC enabled. Rather than reject the request (e.g. with a new additional sense code PHY TEST FUNCTION UNAVAILABLE), the WG preferred to process the request and disrupt the first phy if needed.

Suggested changes to SAS-2

0.1 Phy test functions

The optional Protocol-Specific diagnostic page for SAS (see 10.2.9.2) provide 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 10.4.3.28) provides similar methods for expander devices and SAS target devices with SMP target ports.

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.

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.

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. 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.

The phy test function on one phy may affect the previously negotiated settings on other phys (e.g., in a device with a common SSC clock, the SSC modulation type may change from none to down-spreading even on phys that negotiated no SSC).

Once a SAS phy has begun performing a phy test function, it shall ignore its receiver. 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.

10.2 SCSI application layer

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 203 defines the Protocol-Specific diagnostic page for SAS.

Table 203 — 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)							
3	PAGE LENGTH (001Ch)							(LSB)
4	PHY IDENTIFIER							
5	PHY TEST FUNCTION							
6	PHY TEST PATTERN							
7	Reserved	~~Reserved~~ PHY TEST PATTERN SATA	~~Reserved~~ PHY TEST PATTERN SSC		PHY TEST PATTERN PHYSICAL LINK RATE			
8 10	Reserved							
11	PHY TEST PATTERN DWORDS CONTROL							
12 19	PHY TEST PATTERN DWORDS							
20 31	Reserved							

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 204. 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 204 — 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 - 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 205. 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.

Table 205 — PHY TEST PATTERN **field**

Code	Name	Description
00h	Reserved	
01h	JTPAT	The selected phy shall continuously transmit the JTPAT for RD+ and RD- (see A.1).
02h	CJTPAT	The selected phy shall continuously transmit the CJTPAT (see A.2).
03h - 0Fh	Reserved	
40h	TWO_DWORDS	The selected phy shall continuously transmit the dwords specified by the PHY TEST PATTERN DWORDS CONTROL field and the PHY TEST PATTERN DWORDS field without scrambling. This pattern is only for use for characterization of the transmitter device and the passive interconnect. Phys are not required to support all patterns that may be specified.
41h - EFh	Reserved	
F0h - FFh	Vendor specific	

A PHY TEST PATTERN SATA bit set to one specifies that the phy shall transmit the phy test pattern as a SATA phy. A PHY TEST PATTERN SATA bit set to zero specifies that the phy shall transmit the phy test pattern as a SAS phy. If the PHY TEST PATTERN SATA bit is set to one and the phy does not support SATA, 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 PATTERN SSC field specifies the SSC modulation type (see 5.3.8.1) with which the phy test pattern shall be transmitted and is defined in table 206. If the SSC modulation type specified by the PHY TEST PATTERN SSC field is not supported (e.g., if the phy is a SAS phy, then it only supports no SSC and down-spreading SSC), 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 206 — PHY TEST PATTERN SSC **field**

Code	Description
00b	No SSC
01b	Center-spreading SSC [a]
10b	Down-spreading SSC
11b	Reserved
[a] If the PHY TEST PATTERN SATA bit is set to one, 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 PATTERN PHYSICAL LINK RATE field specifies the physical link rate at which the phy test pattern shall be transmitted and is defined in table 207. If the physical link rate specified by the PHY TEST PATTERN PHYSICAL LINK RATE field is less than the hardware minimum physical link rate or greater than the hardware maximum physical link rate, 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 207 — 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

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10.4 Management application layer

10.4.3.27 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 306 defines the request format.

Table 306 — 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	~~Reserved~~ PHY TEST PATTERN SATA	~~Reserved~~ PHY TEST PATTERN SSC	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 307. 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.

<p align="center">**Table 307 —** PHY TEST FUNCTION **field**</p>

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 - EFh	Reserved	
F0h - FFh	Vendor specific	

If the PHY TEST FUNCTION field is set to 01h (i.e., TRANSMIT_PATTERN), the PHY TEST PATTERN field specifies the phy test pattern to be performed, and is the same as that defined in table 205 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 SATA bit is as defined in the Protocol-Specific diagnostic page (see 10.2.9.1).

The PHY TEST PATTERN SSC field is as defined in table 206 for the Protocol-Specific diagnostic page (see 10.2.9.1).

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 308 defines the values for this field.

Table 308 — 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 205 for the Protocol-Specific diagnostic page (see 10.2.9.1).

The CRC field is defined in 10.4.3.1.

Table 309 defines the response format.

Table 309 — 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.