To: T10 Technical Committee
From: Rob Elliott, HP (elliott@hp.com)
Date: 2 November 2007
Subject: 07-480r0 SAS-2 More phy test patterns - TRAIN, TRAIN_DONE, and idle dwords

Revision history
Revision 0 (2 November 2007) First revision

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)
07-479 SAS-2 Phy test pattern transceiver controls (Rob Elliott, HP)

Overview

This proposal adds some phy test patterns to the Protocol-Specific diagnostic page (which are also inherited by the SMP PHY TEST PATTERN request):

a) TRAIN and TRAIN_DONE. These are helpful to analyze phy performance during the speed negotiation sequence without actually performing the link reset sequence (no interactive exchanging of OOB signals, no time limits, etc.)
b) idle dwords. This is the default pattern that appears on idle physical links. Making it a test pattern allows it to be started without actually performing the link reset sequence.

Suggested changes to SAS-2

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)	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 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]
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 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 - ~~3Fh~~0Fh	Reserved	
10h	TRAIN	The selected phy shall continuously transmit the TRAIN pattern (see 6.7.4.2.3.4).
11h	TRAIN_DONE	The selected phy shall continuously transmit the TRAIN_DONE pattern (see 6.7.4.2.3.4).
12h	IDLE	The selected phy shall continuously transmit idle dwords (see 7.4).
13h - 3Fh	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	

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 206. 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 206 — 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 PHY TEST PATTERN DWORDS field are only used if the PHY TEST PATTERN field is set to TWO_DWORDS (see table 205).

The PHY TEST PATTERN DWORDS CONTROL field defined in table 207 controls whether the bytes in the PHY TEST PATTERN DWORDS field are sent as control characters or data characters.

Table 207 — PHY TEST PATTERN DWORDS CONTROL field

Code	Description
00h	Each byte in the PHY TEST PATTERN DWORDS field shall be sent as a data character (i.e., Dxx.y)(see 6.3.3) without scrambling.
08h	The fifth byte in the PHY TEST PATTERN DWORDS field shall be sent as a control character (i.e., Kxx.y)(see 6.3.3); each other byte shall be sent as a data character without scrambling.
80h	The first byte in the PHY TEST PATTERN DWORDS field shall be sent as a control character; each other byte shall be sent as a data character without scrambling.
88h	The first and fifth bytes in the PHY TEST PATTERN DWORDS field shall each be sent as a control character; each other byte shall be sent as a data character without scrambling.
All others	Reserved

The PHY TEST PATTERN DWORDS field contains the two dwords that are sent during a TWO_DWORDS test pattern. Whether each byte in the dwords is sent as a control character or a data character is specified by the PHY TEST PATTERN DWORDS CONTROL field. A byte specifying a control character shall only specify a control character which is used in this standard (see table 75 in 6.3) and is supported by the phy (i.e., all phys support K28.5 (i.e., BCh), but only phys supporting STP support K28.3 (i.e., 7Ch) or K28.6 (i.e., DCh)).

The device server shall terminate a SEND DIAGNOSTIC command specifying any unsupported combination 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 208 lists some examples of TWO_DWORDS phy test patterns.

Table 208 — TWO_DWORDS phy test pattern examples

PHY TEST PATTERN DWORDS CONTROL field	PHY TEST PATTERN DWORDS field	Description
00h	4A4A4A4A 4A4A4A4Ah	D10.2 characters (see table 73 in 6.3.3). This high-frequency pattern contains 01b repeating and has the highest possible frequency. This pattern may be used for measuring skew and rise/fall times (see table 59 in 5.3.6.2, table 60 in 5.3.6.3, and table 62 in 5.3.7.2).
00h	B5B5B5B5 B5B5B5B5h	D21.5 characters (see table 73 in 6.3.3). This high-frequency pattern contains 10b repeating and has the highest possible frequency. This pattern may be used for measuring skew and rise/fall times (see table 59 in 5.3.6.2, table 60 in 5.3.6.3, and table 62 in 5.3.7.2).
00h	78787878 78787878h	D24.3 characters (see table 73 in 6.3.3). This mid-frequency pattern contains 0011b or 1100b repeating (depending on starting disparity) and has half the highest possible frequency.
00h	D926D926 D926D926h	Pairs of D25.6 and D6.1 characters (see table 73 in 6.3.3). This mid-frequency pattern contains 1001b repeating and has half the highest possible frequency.
00h	7E7E7E7E 7E7E7E7Eh	D30.3 characters (see table 73 in 6.3.3). This low-frequency pattern contains four bits of one polarity, three bits of the other polarity, and three bits of the first polarity (e.g., 1111000111b), followed by the inverse (e.g., 0000111000b).
00h	EBF4EBF4 EBF4EBF4h	Pairs of these D11.7 and D20.7 characters (see table 73 in 6.3.3). This pattern contains a single bit of one polarity after five bits of the other polarity (i.e., 0000010b and 1111101b). This pattern may be used as a lone bit pattern for measuring jitter in external cables (see table 52 in 5.2.6).
88h	BC4A4A7B BC4A4A7Bh	ALIGN (0) primitives (see table 102 in 7.2.3). This pattern appears during OOB bursts (see 6.6), the SATA speed negotiation sequence (see 6.7.2.2), and the SAS speed negotiation sequence (see 6.7.4.2).
88h	BC070707 BC070707h	ALIGN (1) primitives (see table 102 in 7.2.3). This pattern appears during the SAS speed negotiation sequences (see 6.7.4.2).
80h	BC4A4A7B 4A787E7Eh	Pairs of an ALIGN (0) primitive (see table 102 in 7.2.3) and a dword containing D10.2, D24.3, D30.3, and D30.3 characters (see table 73 in 6.3.3).

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)							
5	EXPECTED EXPANDER CHANGE COUNT							(LSB)
6								
8	Reserved							
9	PHY IDENTIFIER							
10	PHY TEST FUNCTION							
11	PHY TEST PATTERN							
12								
14	Reserved							
15	Reserved							PHY TEST PATTERN PHYSICAL LINK RATE
16								
18	Reserved							
19	PHY TEST PATTERN DWORDS CONTROL							
20								
27	PHY TEST PATTERN DWORDS							
28								
39	Reserved							
40	(MSB)							
43	CRC							(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.

Table 307 — 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 - 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 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)	CRC						
7								(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.