To: T10 Technical Committee
From: Rob Elliott, HP (elliott@hp.com)
Date: 11 November 2005
Subject: 04-222r6 SAS-2 More phy test patterns

Revision history

Revision 0 (8 July 2004) First revision, proposing a mode page to generate an arbitrary 8 character pattern.

Revision 1 (29 October 2004) Changed to be based on the diagnostic page defined by 04-181r2 and included in sas1r06. Limited the pattern to 4 characters (one dword). Add PRBS-7 predefined pattern.

Revision 2 (11 November 2004) Incorporated comments from November Physical WG meeting - removed PRBS-7 and expanded pattern to 2 dwords.

Revision 3 (26 February 2005) Incorporated comments from January Protocol/Physical WG meeting - restored “test pattern” names since that is what everyone says, made wording clearer that devices may reject objectionable patterns.

Revision 4 (11 September 2005) Incorporated comments from March Protocol WG meeting - add text that that the TWO_DWORD patterns are sent without scrambling.

Revision 5 (20 September 2005) Incorporated comments from September Protocol WG meeting - only allow PHY TEST PATTERN DWORDS CONTROL field values of 00h, 08h, 80h, and 88h.

Revision 6 (11 November 2005) Incorporated comments from November Protocol WG meeting - only allow PHY TEST PATTERN DWORDS field specifying control characeters to specify K28.5, K28.3, or K28.6.

Related documents

04-181r2 SAS-1.1 Phy Test Functions diagnostic page (Mark Evans, Maxtor) (incorporated into sas1r06)
sas1r10 - Serial Attached SCSI 1.1 revision 10

Overview

Phy test patterns other than JTPAT and CJTPAT are desired. Rather than define specific patterns, a generic way to specify a repeating pair of dwords (composed of any combination of data and control characters) is proposed. This is like a feature available in Serial ATA’s BIST FIS.

Suggested changes

4.8 Phy test functions

The optional Protocol-Specific diagnostic page for SAS (see 10.2.9.1) 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 10.4.3.11) 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.

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.

10.2.9 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 4.8) for selected phys. The diagnostic page format is specified in SPC-3.

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 ILLEGAL FIELD IN PARAMETER LIST. Table 1 defines the Protocol-Specific diagnostic page for SAS.

Table 1 — 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								
~~8~~20	Reserved							
31								

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 2. 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 2 — 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 ~~selected~~ phy from performing a phy test function, then a power on may be required to cause the ~~selected~~ phy to stop performing the function and originate a phy reset sequence.

If the PHY TEST FUNCTION field is set to TRANSMIT_PATTERN, then the PHY TEST PATTERN field specifies the phy test pattern to be transmitted as defined by table 3. 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 3 — 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). ~~If the selected phy receives data while transmitting the pattern, then the selected phy shall ignore the received data.~~
02h	CJTPAT	The selected phy shall continuously transmit the CJTPAT (see A.2). ~~If the selected phy receives data while transmitting the pattern, then the selected phy shall ignore the received data.~~
03h - ~~FFh~~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 4. 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 4 — PHY TEST PATTERN PHYSICAL LINK RATE **field**

Code	Description
0h - 7h	Reserved
8h	1,5 Gbps
9h	3,0 Gbps
Ah - Fh	Reserved

The PHY TEST PATTERN DWORDS CONTROL field and PHY TEST PATTERN DWORDS field and are only used if the PHY TEST PATTERN field is set to TWO_DWORDS (see table 3).

The PHY TEST PATTERN DWORDS CONTROL field defined in table 5 controls whether the bytes in the PHY TEST PATTERN DWORDS field are sent as control characters or data characters.

Table 5 — 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 56 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 6 lists some examples of TWO_DWORDS phy test patterns.

Table 6 — 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 38 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 32 in 5.3.7.2, table 33 in 5.3.7.3, and table 35 in 5.3.8.2).
00h	B5B5B5B5 B5B5B5B5h	D21.5 characters (see table 38 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 32 in 5.3.7.2, table 33 in 5.3.7.3, and table 35 in 5.3.8.2).
00h	78787878 78787878h	D24.3 characters (see table 38 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 38 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 38 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 38 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 28 in 5.2.6).
88h	BC4A4A7B BC4A4A7Bh	ALIGN (0) primitives (see table 57 in 7.2.3). This pattern appears during OOB bursts (see 6.4), the SATA speed negotiation sequence (see 6.7.2.4), and the SAS speed negotiation sequence (see 6.7.4.2).
88h	BC4A4A7B BC4A4A7Bh	ALIGN (1) primitives (see table 57 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 57 in 7.2.3) and a dword containing D10.2, D24.3, D30.3, and D30.3 characters (see table 38 in 6.3.3).