To: T10 Technical Committee
From: Rob Elliott, HP (elliott@hp.com) and Steve Fairchild, HP (steve.fairchild@hp.com)
Date: 29 October 2004
Subject: 04-222r1 SAS-1.1 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.

Related documents
04-181r2 SAS-1.1 Phy Test Functions diagnostic page (Mark Evans, Maxtor)
sas1r06 - Serial Attached SCSI 1.1 revision 6

Overview
Additional phy test patterns are desired. Rather than define specific patterns, a generic way to specify a repeating dword (composed of any combination of data and control characters) is proposed.

Note that Serial ATA's BIST FIS and revision 0 of this proposal provides the ability to specify two dwords that are repeated. This revision only suggests one dword.

Additionally, a 7-stage pseudorandom bit sequence (PRBS-7) is proposed, matching a simple pattern available from most pattern generators.

Suggested changes

10.2.8 SCSI diagnostic parameters

10.2.8.1 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 4.7) 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	PHY TEST PATTERN DWORD CONTROL				PHY TEST PATTERN PHYSICAL LINK RATE			
8	PHY TEST PATTERN DWORD							
11								
~~8~~12	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	Description
00h	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	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.

Editor's Note 1: The additional sense code returned if phy test function 01h is selected while a phy test function (including 01h) is already running needs to be assigned by SPC-3.

If the PHY TEST FUNCTION field is set to 01h, then the PHY TEST PATTERN field specifies the phy test pattern to be transmitted.

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 defines the PHY TEST PATTERN field.

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	DWORD	The selected phy shall continuously transmit the dword specified by the PHY TEST PATTERN DWORD CONTROL field and the PHY TEST PATTERN DWORD field. See table x for DWORD test pattern examples. Patterns may be specified which do not appear during normal operation.
04h	PRBS-7	The selected phy shall continuously transmit a 128-bit pseudorandom bit sequence (PRBS-7) based on the output of a linear feedback shift register implemented with the following polynomial: $G(x) = x^7 + x^6 + 1$ The value of the linear feedback shift register shall be initialized to FFh. This pattern contains 10-bit sequences that are not valid characters and thus does not appear during normal operation.
~~03h~~ 05h - FFh	Reserved	
F0h - FFh	Vendor specific	

Table xx lists some DWORD phy test pattern examples.

Table 4 — DWORD phy test pattern examples [new]

PHY TEST PATTERN DWORD CONTROL field	PHY TEST PATTERN DWORD field	Description
0h	4A4A4A4Ah	D10.2 characters (see table 38 in 6.3.3). This is a repeating 01b pattern, which is the highest frequency pattern.
0h	78787878h	D24.3 characters (see table 38 in 6.3.3). This is a repeating 0011b pattern, which has half the highest frequency.
Fh	BCBCBCBCh	K28.5 characters (see table 39 in 6.3.3). This pattern does not appear during normal operation.
8h	BC4A4A7Bh	ALIGN (0) dwords (see table 57 in 7.2.3).
0h	EBF4EBF4h	Pairs of these characters: D11.7 followed by D20.7 (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).

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 5. 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 5 — 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 DWORD CONTROL field and PHY TEST PATTERN DWORD field are only used if the PHY TEST PATTERN field is set to DWORD. Each bit in the PHY TEST PATTERN DWORD CONTROL field corresponds to a byte in the PHY TEST PATTERN DWORD field. Byte 7 bit 7 of the diagnostic page corresponds to byte 8, byte 7 bit 6 corresponds to byte 9, byte 7 bit 5 corresponds to byte 10, and byte 7 bit 4 corresponds to byte 11. A bit set to one specifies that the corresponding byte in the PHY TEST PATTERN DWORD field shall be sent as a control character (Kxx.y). A bit set to zero specifies that the corresponding byte in the PHY TEST PATTERN DWORD field shall be sent as a data character (Dxx.y).