To: T10 Technical Committee
From: Steven Fairchild, HP (steve.Fairchild@hp.com)
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Subject: SAS Transceiver Control mode page

The purpose for this proposal is to define a mechanism for allowing an application to adjust the transceiver parameters of a SAS target device supporting SSP and the SCSI command set. This will facilitate qualification efforts to evaluate signal compliance.

The transceiver adjustment method is based on an initiator sending a MODE SELECT with the Protocol-Specific Port Mode Page and a sub-page code of Transceiver Control. The definition of the Transceiver Control sub-page and the resulting behavior is described below.

Since the mode pages are not accessible until after the target has been started, the default parameters are used until the target completes startup and the target firmware has an opportunity to load the information contained on the SAS Transceiver Control mode page. To ensure a "glitch free" transition to the transceiver settings defined on the mode page, the target should initiate a link reset sequence and apply the settings prior to beginning speed negotiation.

Implementation decisions make the definition and interaction of driver pre-emphasis or de-emphasis with respect to the driver strength a complex algorithm. To simplify the target requirements, there is no intention to end up with a common definition. If a specific transceiver setting results in the transceiver exceeding the SAS specification, then a check condition shall occur and an error return of invalid parameter shall be returned.

1 Protocol-Specific Port Mode Page – Transceiver Control Sub-Page (??h)

The Transceiver Control sub-page of the Protocol-Specific Port Mode page is used to adjust the transceiver parameters of a phy. The transceiver parameters may only be adjusted temporarily using the contents of this mode page and can not be saved. The Transceiver Control sub-page is not returned as part of a MODE SENSE request to return all pages it must specifically be requested. The Transceiver Control Page fields are described below.

Table 1: Transceiver Control Sub-Page (??h)

Bit / Byte	7	6	5	4	3	2	1	0
0	**PS**	**SPF (1b)**	**Page Code 19h**					
1	Sub-Page Code (??h)							
2-3	Page Length							
4-6	Reserved							
7	Number of Phys							
8-10	Reserved							
11	Transceiver Control for Phy Length							
12	Transceiver Control for Phy 0							
	…							
	Transceiver Control for Phy N (N = Number of Phys – 1)							

1.1 PS, Parameters Savable

The parameters savable field as defined in SPC-3.

1.2 SPF

The SPF field shall be set to one to access the long format mode pages.

1.3 Page Code

The value in the Page Code field is a constant defining the Protocol-Specific Port Mode Page. Shall be set to 19h.

1.4 Page Length

The value in the Page Length field is a constant defining the length of the Transceiver Control Page excluding the Page 19h header bytes. The value shall be established based on the following equation:

Page Length = (4 + (Number of Phys * Transceiver Control for Phy Length))

This value is not changeable.

1.5 Number of Phys

The value in the Number of Phys field is a constant defining the number of phys available on this device. The phys are numbered from 0 to N, where N is the value of this field minus one. This value is not changeable.

1.6 Transceiver Control for Phy Length

The value in the Transceiver Control for Phy Length field is a constant defining the length of each Transceiver Control for Phy X field.

1.7 Transceiver Control for Phy X

The value in the Transceiver Control for Phy X field defines the transceiver control parameters for each available phy. Some elements of the field are changeable and none are savable. See the definition in Table 2.

Table 2: Transceiver Control for Phy X

Bit / Byte	7	6	5	4	3	2	1	0
0	Minimum Controllable Link Rate Supported							
1	Maximum Controllable Link Rate Supported							
2	Reserved							
3	Transceiver Control for Link Rate Length							
	Transceiver Control for Link Rate, 1.5 Gb/s							
	Transceiver Control for Link Rate, 3.0 Gb/s							
	Reserved							

1.7.1 Minimum Controllable Link Rate Supported

The value in the Minimum Controllable Link Rate Supported field contains the minimum controllable link rate supported for this phy. The supported values for this field are shown in Table 3. The value in this field shall be less than or equal to the value in the Maximum Controllable Link Rate Supported field. This field is not changeable.

Table 3: Controllable Link Rates

Value	Definition
0x00	Phy exists, but does not support Transceiver Control controls
0x01 – 0x07	Reserved
0x08	Phy supports Transceiver Control controls for 1,5 Gb/s
0x09	Phy supports Transceiver Control controls for 3,0 Gb/s
0x0A – 0xFF	Reserved

1.7.2 Maximum Controllable Link Rate Supported

The value in the Minimum Controllable Link Rate Supported field contains the maximum controllable link rate supported for this phy. The supported values for this field are shown in Table 3. This field is not changeable.

1.7.3 Transceiver Control for Link Rate Length

The value in the Transceiver Control for Link Rate Length field is a constant defining the length of each Transceiver Control for Link Rate, X field.

1.7.4 Transceiver Control for Link Rate, X

The value in the Transceiver Control for Link Rate X field defines the transceiver control parameters for each available link rate of a phy. Some elements of the field are changeable and none are savable. See the definition in Table 4.

Table 4: Transceiver Control for Link Rate X

Bit / Byte	7	6	5	4	3	2	1	0
0	Driver Strength Control							
1	Driver Emphasis Control							
2	Driver Slew Rate Control							
3 – 7	Reserved							
8	Receiver Threshold Control							
9	Receiver Equalization Gain Control							
10 – 11	Reserved							
12	**Reserved**			**DTS**	**DAG**	**Reserved**		**ATC**
13	**Reserved**						**Emphasis**	
14 – 15	Reserved							

1.7.4.1 Driver Strength Control

The value in the Driver Strength Control field contains the step offset from the default setting that the transceiver shall use to establish the transceiver driver voltage. The field value should be treated as a 2's-complement signed value that can range from –128 to +127. If the step requested is out of range of the transceiver capability a check condition shall occur and an error return of invalid parameter shall be returned. The values are shown in Table 5. The field is changeable.

Table 5: Driver Strength Control

Value	Definition
0	Use nominal or default value for the driver voltage
0x01 – 0x7F (1 to 127)	Increase the driver voltage by the number of programmable steps specified.
0xFF – 0x80 (-1 to -128)	Decrease the driver voltage by the number of programmable steps specified.
0x9B – 0x80	Reserved

1.7.4.2 Driver Emphasis Control

The value in the Driver Emphasis Control field contains the step offset from the default setting that the transceiver shall use to establish the transceiver driver pre-emphasis/de-emphasis. The field value should be treated as a 2's-complement signed value that can range from –128 to +127. If the step requested is out of range of the transceiver capability a check condition shall occur and an error return of invalid parameter shall be returned. The values are shown in Table 6. The field is changeable.

Note: If the target implements emphasis as a pre-emphasis added to the driver strength then the positive value should be used to increase emphasis. If the target implements emphasis as a de-emphasis subtracting from the driver strength, then the positive values should be used to increase emphasis, but decrease driver strength.

Table 6: Driver Emphasis Control

Value	Definition
0	Use nominal or default value for the driver pre-emphasis or de-emphasis
0x01 – 0x7F (1 to 127)	Increase the driver emphasis by the number of programmable steps specified.
0xFF – 0x80 (-1 to -128)	Decrease the driver emphasis by the number of programmable steps specified.
0x9B – 0x80	Reserved

1.7.4.3 Receiver Threshold Control

The value in the Receiver Threshold Control field contains the step offset from the default setting that the transceiver shall use to establish the receiver threshold. The field value should be treated as a 2's-complement signed value that can range from –128 to +127. If the step requested is out of range of the transceiver capability a check condition shall occur and an error return of invalid parameter shall be returned. The values are shown in Table 7. The field is changeable.

Table 7: Receiver Threshold Control

Value	Definition
0	Use nominal or default value for the receiver threshold
0x01 – 0x7F (1 to 127)	Increase the receiver threshold by the number of programmable steps specified.
0xFF – 0x80 (-1 to -128)	Decrease the receiver threshold by the number of programmable steps specified.
0x9B – 0x80	Reserved

1.7.4.4 Receiver Equalizer Gain Control

The value in the Receiver Equalizer Gain Control field contains the step offset from the default setting that the transceiver shall use to establish the receiver equalizer gain. The field value should be treated as a 2's-complement signed value that can range from –128 to +127. If the step requested is out of range of the transceiver capability a check condition shall occur and an error return of invalid parameter shall be returned. The values are shown in Table 7. The field is changeable.

Table 8: Receiver Equalizer Gain Control

Value	Definition
0	Use nominal or default value for the receiver equalizer gain
0x01 – 0x7F (1 to 127)	Increase the receiver equalizer gain by the number of programmable steps specified.
0xFF – 0x80 (-1 to -128)	Decrease the receiver equalizer gain by the number of programmable steps specified.
0x9B – 0x80	Reserved

1.7.4.5 Activate Transceiver Controls (ATC)

The value in the ATC field is the activation control for the Transceiver Control page. If ATC is set to 0 then the fields on the Transceiver Control page are updated, but no further action is initiated. If ATC is set to 1, then the fields on the Transceiver Control page are updated and the specified adjustments to the transceivers of each phy is performed. The field is changeable.

1.7.4.6 Disable ALIGN Generation (DAG)

The value in the DAG field is the control for the ALIGN primitive generation by the phy. If DAG is set to 0 then the phy will insert the necessary ALIGN primitives as defined in the SAS specification. If DAG is set to 1, then the ALIGN primitive insertion is suppressed. If ALIGN generation cannot be suppressed with this field a check condition shall occur and an error return of invalid parameter shall be returned. The field is changeable.

1.7.4.7 Disable Transmitter Scrambling (DTS)

The value in the DTS field is the control for the transmitter data scrambling by the phy. If DTS is set to 0 then the phy will transmit data scrambled as defined in the SAS specification. If DTS is set to 1, then the transmitter data scrambling is disabled. If transmitter data scrambling cannot be suppressed with this field a check condition shall occur and an error return of invalid parameter shall be returned. The field is changeable.

1.7.4.8 Emphasis

The value in the Emphasis field is used to specify whether the driver will enable Emphasis. The values are shown in Table 9. If the driver Emphasis cannot be controlled, then a check condition shall occur and an error return of invalid parameter shall be returned. The field is changeable.

Table 9: Pre-emphasis

Value	Description
00b	Use the nominal or default setting for emphasis.
01b	Disable driver emphasis.
10b	Enable driver emphasis at a nominal value.
11b	Reserved (use the default setting for emphasis)