



To: T10 Technical Committee  
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Subject: SAS Pattern Generation Mode Page

The purpose for this proposal is to define a mechanism for enabling the transmitter of a SAS target device supporting SSP and SCSI command set to enter a pattern generation mode. The pattern generation may use a predefined or a user defined data pattern.

This proposal is related to, and dependent on, two other SAS proposals that enhance the ability to test and verify signal integrity margins during the system manufacturer's disk drive qualifications cycle. The related proposals define a mechanism to change or adjust the transmit signaling characteristics; that, combined with the ability to generate various signaling data patterns, provides a comprehensive signal source for drive and interconnect qualification. The related proposals are:

- SAS Signal Class Proposal
- SAS Transceiver Control Mode Page Proposal

The activation method is based on an initiator sending a MODE SELECT Protocol-Specific Port Mode Page and a sub-page code of Pattern Generation sub-page. The definition of the Pattern Generation sub-page and the resulting behavior is described below.

When pattern generation for the designated link rate is specified in a MODE SELECT operation, the target shall respond with a completion status for the command, close the open connection and allow the link to go idle. Once in an idle state, the transmitter shall begin and continue transmitting the specified pattern until the target device is powered off.

The Pattern Generation sub-page is not reported as part of a MODE SENSE to return all pages and must be specifically requested.



# 1 Protocol-Specific Port Mode Page – Pattern Generation Sub-Page ( ??h)

The Pattern Generation sub-page of the Protocol-Specific Port Mode page is used to place the transmitter of a phy in a pattern generation mode that is used for doing signal compliance testing. On a target with multiple phys, the parameters for setting up and controlling the generation of the test pattern are replicated. Enabling the pattern generation mode can be done to one or more of the target phys with a MODE SELECT operation. The Pattern Generation sub-page is not returned as part of a MODE SENSE request to return all pages it must specifically be requested.

Table 1: Pattern Generation 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	Pattern Generation Parameters Length							
12	Pattern Generation Parameters for Phy 0							
	...							
	Pattern Generation Parameters 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 Pattern Generation Page excluding the Page 19h header bytes. The value shall be set based on the following equation:

$$\text{Page Length} = (4 + (\text{Number of Phys} * \text{Pattern Generation Parameters Length}))$$

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 Pattern Generation Parameters Length

The value in the Pattern Generation Parameters Length field is a constant defining the length of each Pattern Generation Parameters for Phy X field.

## 1.7 Pattern Generation for Phy

This field defines the Pattern Generation parameters for each available phy. Some elements of the field are changeable and savable. See the definition in Table 2.

Table 2: Pattern Generation for Phy X

Bit	7	6	5	4	3	2	1	0
Byte 0	Minimum Controllable Link Rate Supported							
1	Maximum Controllable Link Rate Supported							
2	Pattern Generation Enable							
3	Pattern Generation Test Pattern							
4	User Test Pattern Length							
5 – 7	Reserved							
8 – 9	User Test Pattern (word 0)							
10 – 11	User Test Pattern (word 1)							
12 – 13	User Test Pattern (word 2)							
14 – 15	User Test Pattern (word 3)							
16 – 17	User Test Pattern (word 4)							
18 – 19	User Test Pattern (word 5)							
20 – 21	User Test Pattern (word 6)							
22 – 23	User Test Pattern (word 7)							



### 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 Pattern Generation controls
0x01 – 0x07	Reserved
0x08	Phy supports Pattern Generation controls for 1,5 Gb/s
0x09	Phy supports Pattern Generation 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 Pattern Generation Enable

The value in the Pattern Generation Enable field is returned as 0 in a MODE SENSE operation. In a MODE SELECT, the field contains one of the values defined in Table 4 to enable Pattern Generation controls. The field is changeable, but not savable. When pattern generation for the designated link rate is specified in a MODE SELECT operation, the target shall respond with a completion status for the command, close the open connection and allow the link to go idle. Once in an idle state, the transmitter shall begin transmitting the specified pattern until the target device is powered off. It will be necessary for the target device to maintain the device firmware settings and any previous *Signal Class* and/or *Signal Stepping* characteristics that may have been set.

**Table 4: Pattern Generation Enable**

Value	Definition
0x00	No operation
0x01 – 0x07	Reserved
0x08	Enable Pattern Generation for 1,5 Gb/s
0x09	Enable Pattern Generation for 3,0 Gb/s
0x0A – 0xFF	Reserved



## 1.7.4 Pattern Generation Test Pattern

The value in the Pattern Generation Test Pattern field contains the test pattern the transmitter shall use in generating a bit stream for Pattern Generation measurements. The values shown in Table 5 may indicate predefined patterns or a user pattern defined the User Test Pattern field. The field is changeable and savable.

**Table 5: Pattern Generation Test Pattern**

Value	Definition
0x00	Select user defined pattern in the User Pattern field
0x01 – 0x0F	Reserved for predefined patterns
0x10 – 0xFF	Reserved

## 1.7.5 User Test Pattern Length

The value in the User Test Pattern Length field contains the number of valid words in the User Defined Test Pattern field. The value may range from 0 to 8 indicating a maximum user defined test pattern of 8 words. The field is changeable and savable.

## 1.7.6 User Test Pattern

The value in the User Test Pattern field is a defined in Table 6. The field is changeable and savable.

**Table 6: User Test Pattern**

Bit	7	6	5	4	3	2	1	0	
Byte	Reserved						Disparity		Control
0	Reserved						Disparity		Control
1	Character								

### 1.7.6.1 Disparity

The value in the Disparity field is used to specify whether the Character field represents a positive or negative running disparity. The values are shown in Table 7. If the running disparity of the Character field cannot be controlled, then a check condition shall occur and an error return of invalid parameter shall be returned.

**Table 7: Disparity**

Value	Description
00b	Running disparity not specified, use the appropriate running disparity for the line condition.
01b	Use the positive running disparity encoding of the character.
10b	Use the negative running disparity encoding of the character.
11b	Reserved



### **1.7.6.2 Control**

The value in the Control field is used to specify whether the Character field represents a control or data encoding. If the value is a 0, then the Character field represents a data encoding. If the value is a 1, then the Character field represents a control encoding.

### **1.7.6.3 Character**

The value in the Character field is used to specify the 8b/10b character to encode in the test pattern.