

**TO** : John Lohmeyer, Chairman, X3T9.2 Committee (SCSI)  
**FROM** : Doug Pickford, Western Digital Corporation  
**Subject** : Proposed Extensions for SCSI-3, Standard Physical Layer Access  
**Document** : X3T9.2/89-1XX, Rev 0  
**Date** : July 2, 1990

### Overview

Enclosed within is a series of nine (9) proposals which can be discussed, accepted or rejected on an individual or collective basis. These proposals have been accumulated as a result of extensive research and effort to understand the requirements of a specific group within the Disk Drive Industry; the System Integrator and the Tester Manufacturer. Further, it is my firm belief the satisfying of these requirements will serve the mass at large.

The road to this point, for those unfamiliar, has been one of failed attempts and misunderstandings. But, a good deal of time was spent to understand the basic fundamentals (without any SCSI placement). These fundamentals and their impact on SCSI-3 are included on the subsequent page for historical purposes. I do believe the focus can now be on those specific items which are not currently provided for within SCSI, and I must admit the list is not long.

So, to restate the overall goal of these proposals:

"To provide the necessary tools, such that standardized Physical Layer Access can become a reality"

Please Note #1: There exists a Disk Drive Consortium which is attempting to piece together a document on how to use the tools, I am simply trying to get the tools.

Please Note #2: The separation of each proposal into individual documents is purely up to the committee.

FUNDAMENTAL

ACTION

Diagnostic Mode, Levels of Protection.	Dropped. Not Required.
Direct Command Set	Dropped. Diagnostic type commands done via diagnostic pages.
Compliance Level Indication	Dropped. Left as a task for SCSI-3 in general (to be done via INQUIRY to indicate SCSI-3 compliance)
Cylinder Map	Proposal #1
Diagnostic Corruption Indication	Dropped. Handled via UNIT ATTENTION, Medium Format Corrupted.
Diagnostic Log Pages	Proposal #2, #3
DC/AC/High Freq Patterns (ERASE)	Proposal #4
Identify Sector Components	Proposal #5
Additional Channel Parameters	Proposal #6
Better FORMAT control	Dropped. Handled via better compliance of MODE SELECT. Consortium document should address this.
Physical and Absolute addressing modes	Dropped. Again, can be handled via compliance to MODE SELECT pages (control of sparing and skews).
Limited Area Formats	Proposal #7, #8, #9.

THAT'S IT!!!

**Proposal #1: Cylinder Map MODE page**

The Cylinder Map page is provided to control/communicate the layout of cylinders on the physical drive.

**Table 1**  
**Cylinder Map Mode Page**

Bit	7	6	5	4	3	2	1	0
Byte								
0	PS	RSVD	Page Code (0Dh)					
1	Page Length (xxh)							
2	CRASH	LATCH	DIRECTION	Reserved				
3	Reserved							
4	Cylinder Section Descriptor #1							
11								
.....								
m	Cylinder Section Descriptor #n							
m+7								

where  $m = 4+8n$ ,  $n$  being the number of Cylinder Section Descriptors.

Explanations: (for those fields not currently defined by SCSI-2)

**CRASH:** This field is used to indicate the location of the Crash Stop, should one be present.

- 00: Does not Apply
- 01: Crash Stop is at the Inner Diameter
- 10: Crash Stop is at the Outer Diameter
- 11: Reserved

**LATCH:** This field is used to indicate the location of the Latch (location for locked actuator), should one be present.

- 00: Does not Apply
- 01: Actuator Latch is at the Inner Diameter
- 10: Actuator Latch is at the Outer Diameter
- 11: Reserved

**DIRECTION:** This field is provided to communicate the direction of the actuator when the Logical Block Address is incremented (discounting Defect Management).

- 00: Does Not Apply
- 01: Logical Block Address increases from OD to ID
- 10: Logical Block Address decreases from OD to ID
- 11: Reserved

**Implementor's Note:** The above three fields are only reportable during MODE SENSE. Attempts to change these fields in a MODE SELECT shall cause the command to terminate in CHECK CONDITION status. The Sense Key shall be set to ILLEGAL REQUEST, Invalid Field in Parameter List.

Table 2  
 Cylinder Section Descriptor

Bit	7	6	5	4	3	2	1	0
Byte								
m	Reserved		R/W	SEEK				TYPE
m+1				Reserved				
m+2	(MSB)							---
m+3				Starting Cylinder				---
m+4								(LSB)
m+5	(MSB)							---
m+6				Ending Cylinder				---
m+7								(LSB)

**Explanations:**

**R/W: Read/Write.** This field determines whether the Initiator can read and write these cylinders. If this field is set to 0b, the cylinders specified cannot be read or written by the Initiator. If this field is set to 1b, the Initiator can control the contents of the logical blocks in this Cylinder section.

**SEEK:** This field is used to indicate whether these cylinders will be accessed during the course of drive operations. The use of these cylinders is unspecified. If this field is set to 0b, the cylinders defined in this Cylinder Section Descriptor will not be used during drive operations. If this field is set to 1b, the drive will make use of the cylinders defined in this Cylinder Section Descriptor.

**TYPE:** This field defines the type of cylinders described by this Cylinder Section Descriptor.

- 0000b User Cylinders (SCSI Address Space)
- 0001b Diagnostic Cylinders
- 0010b System Cylinders (reserved for drive operations)
- 0011b Unused, but part of data stroke
- 0100b-
- 1111b Reserved for future use.

**Starting Cylinder:** The beginning absolute cylinder number of the Cylinder Section.

**Ending Cylinder:** The last absolute cylinder number of the Cylinder Section.

**Implementor's Note #1:** The above two cylinder values (for each Cylinder Section Descriptor) are "absolute", i.e., relative to 0, cylinder locations and are not meant to be used as part of any other command at this time.

**Implementor's Note #2:** There is no implication that the Cylinder Sections must be returned in ascending order.

**Proposal #2: Format Status LOG Page**

This LOG page captures the state of the most recent successful FORMAT UNIT command performed.

**Table 3  
 Format Status LOG Page**

Bit	7	6	5	4	3	2	1	0
Byte								
0	Reserved		Page Code (08h)					
1	Reserved							
2	(MSB)	Page Length (0026h)						----
3								(LSB)
4	(MSB)	Format Options (0000h)						----
5		Parameter Code						(LSB)
6	DU	RSVD	RSVD	ETC	TMC	RSVD	LP	
7	Parameter Length (04h)							
8	Byte 1 of Format Unit CDB							
9	Byte 1 of Defect List Header							
10	Byte 2 of Defect List Header							
11	Byte 3 of Defect List Header							
12	(MSB)	Grown Defects (0001h) during Certification						----
13		Parameter Code						(LSB)
14	DU	RSVD	RSVD	ETC	TMC	RSVD	LP	
15	Parameter Length (02h)							
16	(MSB)	Event Count (xxxxh)						----
17								(LSB)
18	(MSB)	Blocks Reallocated (0002h)						----
19		Parameter Code						(LSB)

(continued next page)

Bit	7	6	5	4	3	2	1	0
20	DU	RSVD	RSVD	ETC	TMC	RSVD	LP	
21	Parameter Length (02h)							
22	(MSB)							
23	Event Count (xxxxh)							
	(LSB)							
24	(MSB)							
25	Spares Left Unallocated (0003h)							
	Parameter Code							
	(LSB)							
26	DU	RSVD	RSVD	ETC	TMC	RSVD	LP	
27	Parameter Length (02h)							
28	(MSB)							
29	Event Count (xxxxh)							
	(LSB)							

**Explanations:**

**Format Options:** This field contains four bytes which describe the most previous Format Unit operation performed (successfully).

**Byte 1 of Format Unit CDB:** This byte includes the FmtData bit (List passed by Initiator during DATA OUT), CmpLst (List passed by Initiator is complete) and Defect List Format bits.

**Byte 1 of Defect List Header:** This byte defines the Defect List options.

**Bytes 2,3 of Defect List Header:** These bytes define the Defect List Length (number of defects in the list).

**Grown Defects During Certification:** This is a counter of the number of defects detected as a result of performing Certification which were not already part of the Plist. If a Certification pass was not performed this field shall be set to 0000h

**Blocks Reallocated:** This is a counter of the total blocks reallocated as a result of the Format Unit operation and subsequent operation, (includes Grown defects after format).

**Spares Unallocated:** This is a counter of the total spare blocks which have yet to be allocated.

**Proposal #3: Log Control LOG Page**

This page maintains the Control information required to manage the storage of LOG data.

Table 4  
 Log Control LOG Page

Bit	7	6	5	4	3	2	1	0
0	Reserved		Page Code (09h)					
1	Reserved							
2	(MSB)							
3	Page Length (0006h)						(LSB)	
4	(MSB)							
5	Idle - Save Time Ratio (0000h)						(LSB)	
6	DU	RSVD	RSVD	ETC	TMC	RSVD	LP	
7	Parameter Length (02h)							
8	(MSB)							
9	Event Count (xxxxh)						(LSB)	

**Idle - Save Time Ratio:** This field indicates the count in seconds of Idle time which must expire before the device will automatically attempt to save the Log Pages to disk. The Target will only actually write the Log Pages to disk if there has been some change in the data since the previous Log Page save.

**Editorial Note:** Proposal 3 implies the removal of the DS and TSD bits in the LOG functions. Proposal 2 assumes the acceptance of this.



**Proposal #4: ERASE Diagnostic Page**

This command is provided for noise measurement purposes. This command need not actually imply either DC or AC erase or even the placement of some high frequency pattern, but must prepare the selected LBA range for relative error probability measurements.

There is no associated Receive Diagnostics Pages for this command. The status of the Send Diagnostics shall act as the status for the ERASE operation.

**Implementor's Note:** Such "ERASE" algorithms are currently being investigated.

Table 5  
 ERASE Diagnostic Page

Bit	7	6	5	4	3	2	1	0	
Byte									
0	Page Code (41h)								
1	Reserved								
2	(MSB)	Page Length (0008h)							
3								(LSB)	
4	(MSB)	Starting Logical Block							
5									
6									
7								(LSB)	
8	(MSB)	Transfer Length							
9									
10									
11								(LSB)	

**Explanations:**

**SEQ: Sequential.** If this bit is set to 1b, the LBA range specified must be in a sequential manner. This is to mean that no replaced blocks exist between STARTING LOGICAL BLOCK and (STARTING LOGICAL BLOCK + TRANSFER LENGTH). If this is not the case, this command shall terminate in CHECK CONDITION status. The Sense Key shall be set to MEDIUM ERROR, Block Sequence Error (currently only for Tape Devices). The medium shall not be altered under this condition. If this bit is set to 0b, the above restriction does not apply.

**Implementor's Note #1:** If this command results in CHECK CONDITION status for the above described reason, the Information Bytes in the Sense Data can be used to determine the first replaced block.

**Implementor's Note #2:** This command shall have no effect on actuator positioning information which may be placed on the medium.

**Starting Logical Block:** This is the first LBA from which the "ERASE" process is to start. If this field is set to a value outside the addressable range of the device, the Target shall terminate the command in CHECK CONDITION status. The Sense Key shall be set to ILLEGAL REQUEST, Invalid Field in CDB.

**Transfer Length:** The extent in logical blocks the "ERASE" process is to influence.

If the Starting Logical Block plus the Transfer Length should equal a value outside the addressable range of the device, the Target shall terminate the command in CHECK CONDITION status. The Sense Key shall be set to ILLEGAL REQUEST, Invalid Field in CDB.

**Proposal #5: Sector Composition Mode Page**

This Mode Page describes the pieces which make up a physical sector.

**Table 6**  
**Sector Components Mode Page**

Bit	7	6	5	4	3	2	1	0
Byte								
0	PS	RSVD	Page Code (0Eh)					
1	Page Length (n-3)							
2	(MSB)	Total Physical Sector Length						(LSB)
3								
4	(MSB)	Sector Component Descriptor #1						(LSB)
7								
.....								
m	Sector Component Descriptor #n							
m+4								

where  $m = 4+4n$ ,  $n$  being the number of Sector Component Descriptors.

Explanations: (for those fields not currently defined by SCSI-2)

**Total Physical Sector Length:** This is a count in bytes from a fixed relative point within a sector time to the next same point in the adjacent sector (e.g., sector pulse to sector pulse). This count field should be the sum of the Component Lengths of the subsequent Sector Component Descriptors.

**Implementor's Note:** It is highly probable that the target device can support the changing, i.e., MODE SELECT, of the individual component lengths as long as the sum (Total Physical Sector Length) remains intact.

Table 7  
 Sector Component Descriptor

Bit	7	6	5	4	3	2	1	0
Byte								
m	Component Type Code							
m+1	Reserved							
m+2	(MSB)	Component Length						
m+3							(LSB)	

Explanations:

**Component Type Code:** This field defines the basic category into which this sector component falls:

- 01h GAP Field
- 02h PLO SYNC Field
- 03h Sector ID (Cylinder Number)
- 04h Sector ID (Head Number)
- 05h Sector ID (Sector Number)
- 06h Sector ID (Flag byte)
- 07h Sector ID (CRC)
- 08h Sector ID (Other)
- 09h User Data Field
- 0Ah User Data ECC
- 0Bh User Data CRC
- 0Ch-  
FFh Other, Vendor Unique

**Implementor's Note:** To address shifting technologies, the **Other, Vendor Unique** category should be used in a non-repetitive manner. For example, if the target supports three fields which are not listed in the table above, then three sector component descriptors with codes between 0Ch and FFh should be used, but they should be unique (e.g., 0Ch, 0Dh and 0Eh).

**Component Length:** This field describes the byte length of the sector component.

**Implementor's Note:** It is highly recommended the Sector components are returned in order.

**Proposal #6: R/W Error Recovery Page (Amendment)**

Table 8  
 MODE Page 01h Read-Write Error Recovery Page

Bit	7	6	5	4	3	2	1	0
Byte								
0	Reserved		Page Code (01h)					
1	Page Length (12h)							
2	AWRE	ARRE	TB	RC	EER	PER	DTE	DCR
3	Read Retry Count							
4	Correction Span							
5	Head Offset Count							
6	Data Strobe Offset							
7	Reserved							
8	Write Retry Count							
9	Reserved							
10	(MSB)							
				Recovery Time Limit				
11	(LSB)							
12	TA	TV	Threshold #1					
13	TA	TV	Threshold #2					
14	TA	TV	Threshold #3					
15	TA	TV	Threshold #4					
16	TA	TV	Threshold #5					
17	TA	TV	Threshold #6					
18	TA	TV	Threshold #7					
19	TA	TV	Threshold #8					

Explanation: (for the fields not already part of SCSI-2)

**TA: Threshold Active.** This bit indicates whether this is the Peak Threshold currently being used by the Read Channel. If this bit is set to 1b, this threshold was used on the most recent disk access. If this bit is 0b, this threshold was not used on the most recent disk access.

**TV: Threshold Valid.** This bit indicates whether the Threshold level in bits 5-0 is valid. If this bit is set to 0b, bits 5-0 are Reserved and should be set to zero. If this field is set to 1b, bits 5-0 are a valid threshold value supported by the target.

**Threshold #n:** This field indicates a threshold percentage supported by the device. This value has been divided by 2. Thus if a 14h is written into this field, a 40% Peak Threshold Detection is available on this device.

**Implementor's Note #1:** This MODE Page is meaningful for both MODE SELECT and MODE SENSE. But, if the Initiator should attempt to set the threshold values (in MODE SELECT) to something not supportable, the command shall terminate in CHECK CONDITION status. The device may either round the value and post Sense data of RECOVERED ERROR, Rounded Parameter or reject the command and post Sense data of ILLEGAL REQUEST, Invalid Field in Parameter List.

**Implementor's Note #2:** If the concept of Peak Threshold detection is not meaningful to the Target, bytes 12 through 19 of the above MODE page should be considered Reserved and set to 00h.

**Proposal #7: Diagnostic Page 42h: FORMAT TRACK**

This command permits the Initiator to selectively format individual tracks on the drive.

Table 9  
 FORMAT TRACK Diagnostic Page

Bit	7	6	5	4	3	2	1	0
Byte								
0	Page Code (42h)							
1	Page Length (8+4n)h							
2								
3	Reserved							
4								
5	Cylinder							
6								
7	Head							
8	(MSB)	ID Table Entry #1						
11								(LSB)
.....								
m	(MSB)	ID Table Entry #n						
m+3								(LSB)

where n is the number of Sectors per Track this device supports. Should the provided diagnostic page not include enough ID Table entries for the entire track, the command shall be terminated in CHECK CONDITION status. The Sense Key shall be set to ILLEGAL REQUEST, Invalid Field in Parameter List.

The Data fields of the track in question are not controlled by this command. The state of the data after the successful completion of this command is indeterminate.

There is no associated RECIEVE DIAGNOSTICS RESULTS counterpart for this command.

**Implementor's Note:** Should anything about this command be technically unsupported, the device may reject this diagnostic request. In this case, Page 42h should not be reported via the Supported Pages Diagnostic Page.

**Explanations:**

**Cylinder:** This field defines the Physical Cylinder to which the actuator shall seek prior to the format operation occurring. Should this field be set a value outside the limits of the device (as defined by the Rigid Disk Drive Geometry MODE Page), the command shall be terminated in CHECK CONDITION status. The Sense Key shall be set to ILLEGAL REQUEST, Invalid Field in Parameter List.

**Head:** This field defines the Physical Head to which the device shall switch prior to the format operation occurring. Should this field be set a value outside the limits of the device (as defined by the Rigid Disk Drive Geometry MODE Page), the command shall be terminated in CHECK CONDITION status. The Sense Key shall be set to ILLEGAL REQUEST, Invalid Field in Parameter List.

**ID Table Entry:** This field describes the contents of the Sector ID components of each sector on the specified track.

Table 10  
 ID Table Entry

Bit	7	6	5	4	3	2	1	0
0	Cylinder							
1	Head							
2	Sector							

**Explanation:**

**Cylinder, Head, Sector:** These are the values to be placed in the Sector Header(s) which precedes the User Data. If these values are outside the range of the capabilities of the device, the command shall be terminated in CHECK CONDITION status. The Sense Key shall be set to ILLEGAL REQUEST, Invalid Field in Parameter List.

**Implementor's Note:** While the Sector Component's MODE Page may describe fields outside of the basic Cylinder, Head and Sector, currently this page does not support their contents' control by the Initiator.



**Proposal #8: Diagnostic Page 43h: FORMAT SECTOR**

This command permits the Initiator to selectively write the Sector ID field of a single sector. This command does not guarantee nor does it provide control over the state of the data field associated with this sector upon successful completion of this command.

Table 11  
 FORMAT SECTOR Diagnostic Page

Bit	7	6	5	4	3	2	1	0
Byte								
0	Page Code (43h)							
1	Reserved							
2	Page Length 08h							
3								
4	(MSB)	Logical Block Address						
7								(LSB)
8	(MSB)	Cylinder						
9								(LSB)
10	Head							
11	Sector							

There is no associated RECIEVE DIAGNOSTICS RESULTS counterpart for this command.

**Implementor's Note #1:** Should anything about this command be technically unsupported, the device may reject this diagnostic request. In this case, Page 43h should not be reported via the Supported Pages Diagnostic Page.

**Logical Block Address:** This field defines the LBA whose Sector ID is to be modified.

**Implementor's Note #2:** This diagnostic page can be used effectively in conjunction with the Translate Address page to determine existing sector ID values of a specific LBA.

**Cylinder, Head, Sector:** These are the values to be placed in the Sector Header(s) which precedes the User Data. If these values are outside the range of the capabilities of the device, the command shall be terminated in CHECK CONDITION status. The Sense Key shall be set to ILLEGAL REQUEST, Invalid Field in Parameter List.

**Implementor's Note #3:** While the Sector Component's MODE Page may describe fields outside of the basic Cylinder, Head and Sector, currently this page does not support their contents' control.

**Proposal #9: Diagnostic Page 44h: READ TRACK INTERLEAVE TABLE**

This command is for use in conjunction with the FORMAT TRACK command. This command returns an entire track's worth of Sector IDs in the order they come under the Read/Write heads starting from Index.

This command has both SEND DIAGNOSTICS and RECEIVE DIAGNOSTICS RESULTS ramifications.

Table 12  
 READ TRACK INTERLEAVE  
 SEND DIAGNOSTICS

Bit	7	6	5	4	3	2	1	0
0	Page Code (44h)							
1	Page Length (06h)							
2	Cylinder							
3								
4	Head							
5	Allocation Length							
7	(LSB)							

**Explanations:**

**Cylinder:** This field defines the Physical Cylinder to which the actuator shall seek prior to reading the Sector IDs. Should this field be set a value outside the limits of the device (as defined by the Rigid Disk Drive Geometry MODE Page), the command shall be terminated in CHECK CONDITION status. The Sense Key shall be set to ILLEGAL REQUEST, Invalid Field in Parameter List.

**Head:** This field defines the Physical Head to which the device shall switch prior to reading the Sector IDs. Should this field be set a value outside the limits of the device (as defined by the Rigid Disk Drive Geometry MODE Page), the command shall be terminated in CHECK CONDITION status. The Sense Key shall be set to ILLEGAL REQUEST, Invalid Field in Parameter List.

**Allocation Length:** This field describes the amount of data the Initiator can receive for the RECEIVE DIAGNOSTICS RESULTS. This field should be set to a minimum of  $4+(4*n)$ , where n is the number of sectors per track on this device. If this field is set to value less than this, the Target may either terminate the command in CHECK CONDITION status, setting the Sense Key to ILLEGAL REQUEST, Invalid Field in CDB, or may simply truncate the returned data (RECEIVE DIAGNOSTICS RESULTS).

Table 13  
 READ TRACK INTERLEAVE  
 RECEIVE DIAGNOSTIC RESULTS

Bit	7	6	5	4	3	2	1	0
Byte								
0	Page Code (44h)							
1	Reserved							
2	Page Length (xxh)							
3								
4	ID Table Entry #1							
7	(LSB)							
.....								
m	ID Table Entry #n							
m+3	(LSB)							

where *n* is the number of Sectors per Track this device supports given the Allocation Length in the corresponding SEND DIAGNOSTICS command was large enough to service all of the return data.

The Data fields of the track in question are not affected by this command.

**Implementor's Note:** Should anything about this command be technically unsupported, the device may reject this diagnostic request. In this case, Page 44h should not be reported via the Supported Pages Diagnostic Page.

Explanations:

**ID Table Entry:** This field describes the contents of the Sector ID components of each sector on the specified track.

Table 14  
 ID Table Entry

Bit	7	6	5	4	3	2	1	0
0	Cylinder							
1	Head							
2	Sector							
3								

Explanation:

**Cylinder, Head, Sector:** These are the values to be placed in the Sector Header(s) which precede the User Data.

**Implementor's Note:** While the Sector Component's MODE Page may describe fields outside of the basic Cylinder, Head and Sector, currently this page does not support the reporting of such.