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SCSI Enclosure Services Specification

Ultrastar® Data60

Regulatory Model H4060-J
Document D018-000233-000
Revision 03
February 2023

Table of Contents

Revision History

Date	Revision	Comment
November 2017	1.0	Initial release
February 2018	1.1	Updated the following: • SES Supported Diagnostics Page (00h) *(page 21)* • Configuration Page (01h) *(page 22)* • Enclosure Status/Control and Threshold Status/Control *(page 32)* • Element Descriptor *(page 43)* • Additional Element Status Diagnostic Page (0Ah) *(page 52)*
December 2018	1.2	Updated the following: • LED Duty Cycles *(page 14)* • String Out/In Diagnostic Page (04h) *(page 40)*
April 2019	1.3	Updated "SAS Expander Elements" values. See Additional Element Status Diagnostic Page (0Ah) *(page 52)*.
September 2019	1.4	• Updated SES Supported Diagnostics Page (00h) *(page 21)* to include reference to Subenclosure Nickname Control/ Status Diagnostic Page (0Fh) *(page 57)* • Added Subenclosure Nickname Control/Status Diagnostic Page (0Fh) *(page 57)*
December 2019	1.5	Rebranded document to WD design
April 2020	1.6	• Updated explanation of drive spin-up algorithm in Drive Spin-up Staggering *(page 3)* • Added note about drive LED behavior during insertion in Drive Assembly LED *(page 13)* • Updated identifier field in SEP Capabilities VPD Pages (C1h) *(page 96)* to match actual string returned from an inquiry
October 2020	1.7	• Corrected number of Cooling and Voltage Sensor elements in Configuration Page (01h) *(page 22)* • Updated images in LEDs *(page 7)*
December 2020	1.8	Added UK Import Representation Contact
September 2021	01	Changed document number from 1ET1104 to D018-000233-000
October 2022	02	Updated to new branding

Date	Revision	Comment
February 2023	03	Added the SES Element Code information to each Element in the SES Elements *(page 62)* section.

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Autonomous Behavior

In This Chapter:

1.1 SCSI Enclosure Processor

All expanders contained within a single I/O module, operate as a single entity known as the SCSI Enclosure Processor (SEP). The SEP is the virtual device that implements all SES functionality defined by this document. In the case of an I/O module containing more than one SAS expander, the designated primary expander operates as a SCSI initiator/target. The expanders designated as the secondary expander, operate SMP only, and are not visible to hosts via SCSI.

The SEP design assigns all responsibility for enclosure management policy, status gathering, and so on, to the primary expander. The secondary expander is not directly involved in parsing or building SES pages and does not communicate with any of the enclosure management components (for example, LEDs, fans, power supplies, sensors, and so on). The only role of the secondary expander is to connect the additional drives to the primary expander into the SAS fabric.

The secondary expander is responsible only for performing the following actions associated with its directly attached drives:

- staggering spin-up
- enabling/disabling attached physical layers (PHY)
- handling zoning requests

1.2 Offline State

The enclosure has the ability to enter offline state. The offline state is designed to protect the enclosure and its data, along with the larger data center ecosystem against cases of serious risk of data or SAS fabric corruption if the enclosure were to attempt to operate.

During offline state, the drives are powered off and are not presented to hosts. This leaves the SEP as the only SAS target in the enclosure. In the offline state, the SEP fully responds to host commands other than those that would cause the disk drives to be powered on or presented to hosts. The offline state is volatile, and will not automatically recur after an enclosure reset or power cycle unless, the conditions which warrant it, recur.

There are several conditions which can cause a SEP to enter offline state. The exact reason for the particular state is reported in the Help Text Diagnostic Page (03h) *(page 39)* and String Out/In Diagnostic Page (04h) *(page 40)*.

The following is a list of possible conditions that can cause SEP to enter an offline state:

- Enclosure VPD data unreadable or corrupted
- Enclosure is in thermal shutdown state
- SEP cannot communicate with all expanders in the design

1.3 SAS Fabric Management

The SEP autonomously performs the following functions relative to SAS fabric management:

- Configures SAS PHYs to appropriate transceiver settings
- Programs each expander with a unique SAS address from Enclosure VPD data
- Provides appropriate branding specific Inquiry data from Enclosure VPD data
- Provides SMP initiator and target services on all expanders

- Exposes a virtual SSP initiator and target services on the primary expander only
- Enables physical layers connected to drives and host cables only if a drive/cable is connected

1.4 Drive Compatibility Checking

At system power up, the SEP scans drives to ascertain their vendor and model numbers. SEP runs checks to ensure that they are compatible with the enclosure architecture. If a drive is incompatible with the Ultrastar Data60 , it will not appear to hosts, and the corresponding Host, Drive, and Interconnect Port Management *(page 3)* instance will be marked as unrecoverable in SES Enclosure Status Page 2.

1.5 Drive Spin-up Staggering

When the enclosure is powered-on, all drives are automatically spun-up per the following algorithm, to avoid drawing an excessive amount of current:

1. 4-second initial delay
2. The two secondary expanders spin-up 6 drives every 4 seconds until all slots have spun up

1.6 Event Logging

The SEP has a non-volatile event logging subsystem contained in enclosure level VPD EEPROM. Entries are time stamped with an incrementing tick counter, or time of day in the server environment, where RTC is available.

Entries are logged to indicate a variety of events, the types of events include the following:

- SEP boot events
- Entry or exit from offline state
- CRU configuration changes
- Code updates
- Crash records

Note: The event log buffer erases the oldest entries when it is full.

1.7 Host, Drive, and Interconnect Port Management

The SCSI Enclosure Processor (SEP) monitors the physical layers (PHY) which connect the Serial Attached SCSI (SAS) expanders to other devices. The monitoring indicates link up, link down, and link partial up status. A partial link up status condition means that not all of the PHYs in a wide port have achieved linked status or not all of the PHYs in a wide port are linked at the same link rate.

Host port interconnect link status issues are signaled using the host port light-emitting diodes (LED), and by marking the corresponding SCSI Enclosure Services (SES) SAS Connector Element instance with **Non-Critical** or **Critical** status.

Drive interconnect link status issues are signaled using the drive LEDs, and by marking the corresponding SES Array Device Slot Element instance with **Non-Critical** or **Critical** status.

Expander interconnect link status issues are signaled using the host port LEDs, and by marking the corresponding SES SAS Expander Element instance with **Non-Critical** or **Critical** status.

1.8 Thermal Management

1.8.1 Closed Loop Fan Algorithm

The SCSI Enclosure Processor (SEP) periodically polls the current readings of both enclosure and drive temperature sensors. It automatically adjusts the fan pulse-width modulation (PWM) values to the minimum necessary air flow that maintains all enclosure component temperatures, including drives, at or below a factory set level across the ambient temperature range allowed for the product. The algorithm incorporates both time and temperature based hysteresis to avoid over-compensation phenomena.

1.8.2 Thermal Compromise Handling

In the event an enclosure becomes thermally compromised, the fans are run at full speed regardless of temperature readings. An example of an enclosure becoming thermally compromised is missing a required customer replaceable unit (CRU), or another serious fault.

1.8.3 Thermal Offline State

If the enclosure temperature readings exceed critical values for a period of time that constitutes a risk to continued safe operation, the enclosure enters an offline state. In an offline state, one or more drives are taken offline. This might mean that they are spun down and powered off. The host may continue to send and receive SCSI Enclosure Services (SES) diagnostic pages in offline state, however the SCSI Enclosure Processor (SEP) rejects SCSI Enclosure Services (SES) requests that power up drives that have been taken offline.

Note: The thermal shutdown condition self-resolves once temperatures have reached a safe level.

1.8.4 Enclosure Shutdown

Certain classes of thermal fault conditions require the enclosure to autonomously shut down as much of the enclosure as possible. If this occurs, the enclosure will return to low-power state. The host may continue to send and receive SCSI Enclosure Services (SES) diagnostic pages in low-power state, but this condition does not self-resolve. The intent is that user intervention follows to ascertain and mitigate the reason for the shutdown.

Platform Firmware Overview

In This Chapter:

2.1 SAS Topology

The SAS Topology of the Ultrastar Data60 is shown in the figure below. The Ultrastar Data60 architecture provides six x4 MiniSAS HD port host connections per IOM. These ports can be used with standard cables to connect to the MiniSAS HD port located on an arbitrary third party SAS host. The availability of six MiniSAS HD ports per IOM permits daisy chained topologies.

Figure 1: SAS Topology

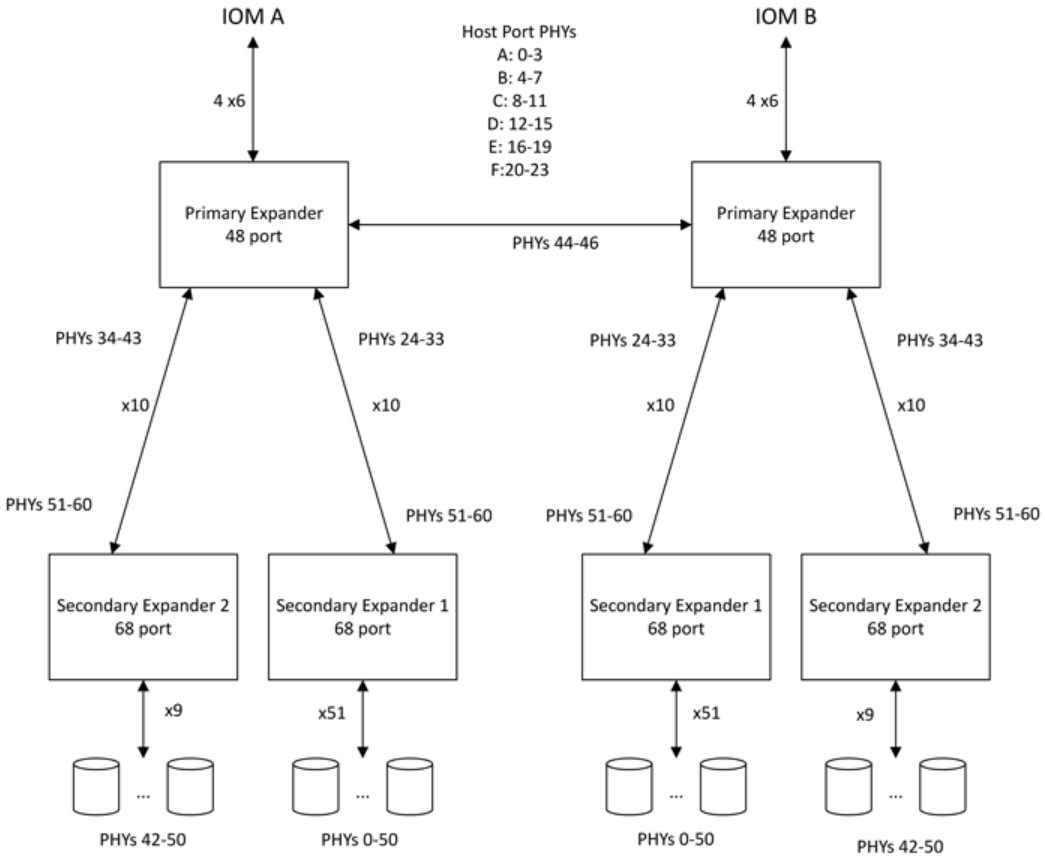


Figure 2: Phy to Slot Mapping

FANS												
Slot 48	Slot 49	Slot 50	Slot 51	Slot 52	Slot 53			Slot 54	Slot 55	Slot 56	Slot 57	Slot 58	Slot 59
S1-39	S1-40	S1-41	S1-42	S1-43	S1-44			S1-45	S1-46	S1-47	S1-48	S1-49	S1-50
Slot 36	Slot 37	Slot 38	Slot 39	Slot 40	Slot 41			Slot 42	Slot 43	Slot 44	Slot 45	Slot 46	Slot 47
S1-27	S1-28	S1-29	S1-30	S1-31	S1-32			S1-33	S1-34	S1-35	S1-36	S1-37	S1-38
Slot 24	Slot 25	Slot 26	Slot 27	Slot 28	Slot 29			Slot 30	Slot 31	Slot 32	Slot 33	Slot 34	Slot 35
S1-15	S1-16	S1-17	S1-18	S1-19	S1-20	IOM B	IOM A	S1-21	S1-22	S1-23	S1-24	S1-25	S1-26
Slot 12	Slot 13	Slot 14	Slot 15	Slot 16	Slot 17			Slot 18	Slot 19	Slot 20	Slot 21	Slot 22	Slot 23
S1-3	S1-4	S1-5	S1-6	S1-7	S1-8			S1-9	S1-10	S1-11	S1-12	S1-13	S1-14
Slot 0	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5			Slot 6	Slot 7	Slot 8	Slot 9	Slot 10	Slot 11
S1-0	S2-42	S1-1	S2-43	S2-44	S2-45			S2-46	S2-47	S2-48	S2-49	S2-50	S1-2

2.2 SG3 Utilities

The **sg3_utils** package contains utilities that send SCSI commands to devices. Sg3_utils are available for Linux and Windows platforms and can be obtained from http://sg.danny.cz/sg/sg3_utils.html. The **SG3 index** in the section tables that follow can be used with the sg_ses command to obtain data for the specific element instance (for example, sg_ses /dev/sg2 --page=2 --index=0,3 retrieves information for drive 4, and so on).

It is recommended that the Ultrastar Data60 be used with V1.47 or later of the SG3 distribution, as this release fixes several known issues in previous releases.

2.3 Supported Drive Models

At discovery, the SEP examines the Inquiry data of all attached SAS and SATA drives to determine if they are a supported type.

The enclosure uses the following rules to determine if a drive is supported:

- Inquiry Vendor String must be HGST, WDC, and/or SanDisk

The SEP rejects the use of unsupported drive types. If the drive is found to not be a supported drive type, the drive is powered down. The SES Page 2 Array Device Slot instance corresponding to an unsupported SAS and SATA drive is reported with an Element Status Code of “Unrecoverable”.

2.4 LEDs

2.4.1 Front and Rear IO LEDs

The Ultrastar Data60 has a number of LEDs on the exterior of the enclosure that display various system statuses. The three LEDs on the front mirror three on the rear, allowing the general status of the enclosure to be determined from either side of the rack.

Figure 3: Front LEDs Location

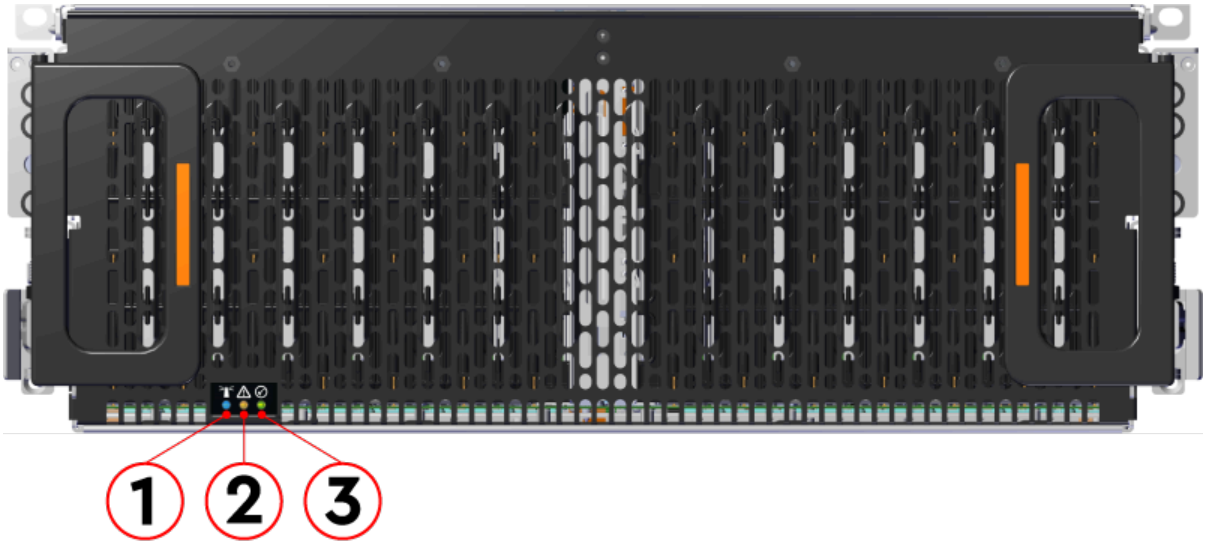


Table 2: Front LEDs Identification

Number	LED Name	Color	Behavior
1	Identify	Blue	**Blink** @ 1 Hz (50% duty cycle) – Blinks only when Identification has been activated. Will blink when **any** component is identified.
2	Fault	Amber	**Off** – Enclosure has no fault **Blink** @ 1 Hz (50% duty cycle) – Enclosure has a fault
3	Power	Green	**Solid** – Powered On

In addition to the three enclosure status LEDs, the rear provides LEDs for the Ethernet and SAS ports.

Figure 4: Rear LEDs Location

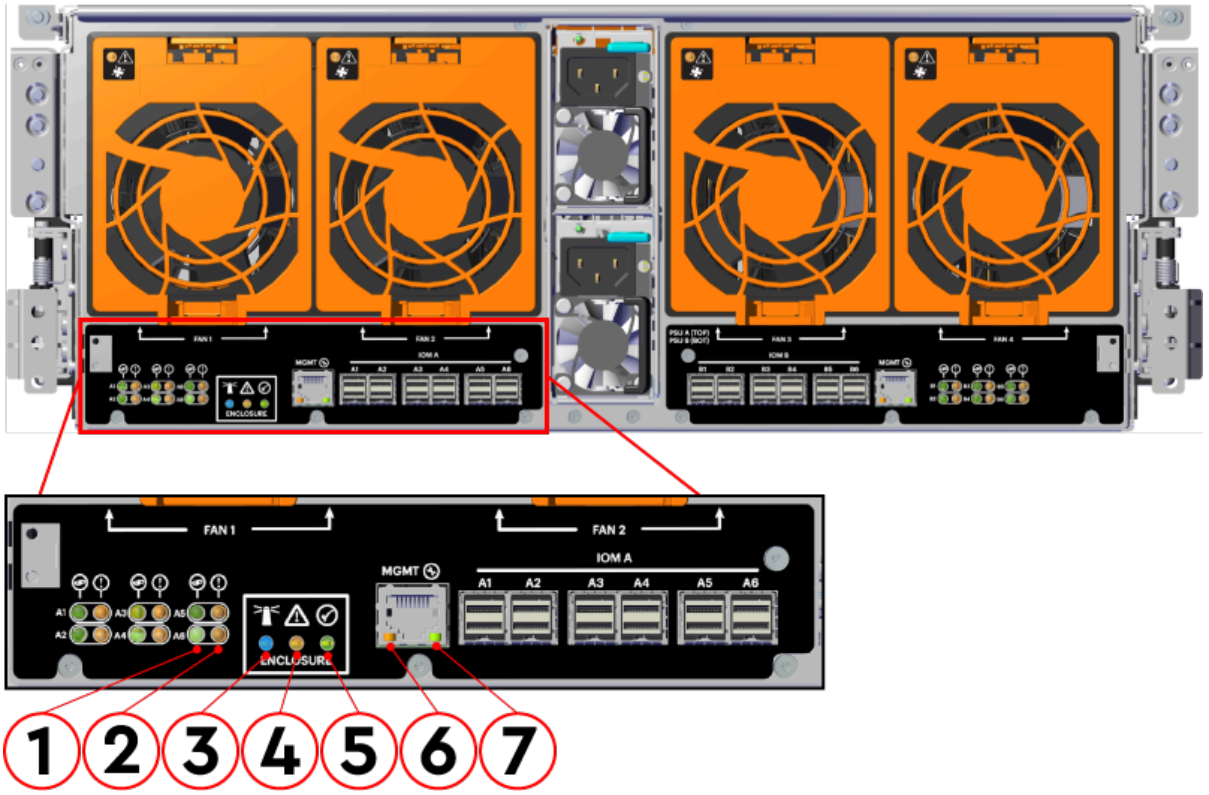


Table 3: Rear LEDs Identification

Number	LED Name	Color	Behavior
1	SAS Link Status	Green	**Off** – SAS cable not connected **Solid** – SAS cable connected
2	SAS Fault Status	Amber	**Off** – No SAS connection fault **Blink** @ 1 Hz (50% duty cycle) – SAS connection fault
3	Identification	Blue	**Blink** @ 1 Hz (50% duty cycle) – Blinks only when Identification has been activated. Will blink when **any** component is identified.
4	Fault	Amber	**Off** – Enclosure has no fault **Blink** @ 1 Hz (50% duty cycle) – Enclosure has a fault
5	Power	Green	**Solid** – Powered On
6	Ethernet Connector Speed	Green/ Amber	**Off** – Operating at 10 Mbps **Green Solid** – Operating at 100 Mbps **Amber Solid** – Operating at 1Gbps
7	Ethernet Connectors Link/Activity	Green	**Off** – No Connection **Blink** – Activity **Solid** – Connected

2.4.2 IOM LEDs

The IOM has three LEDs, one each for power, fault, and identification.

Figure 5: IOM LEDs Location

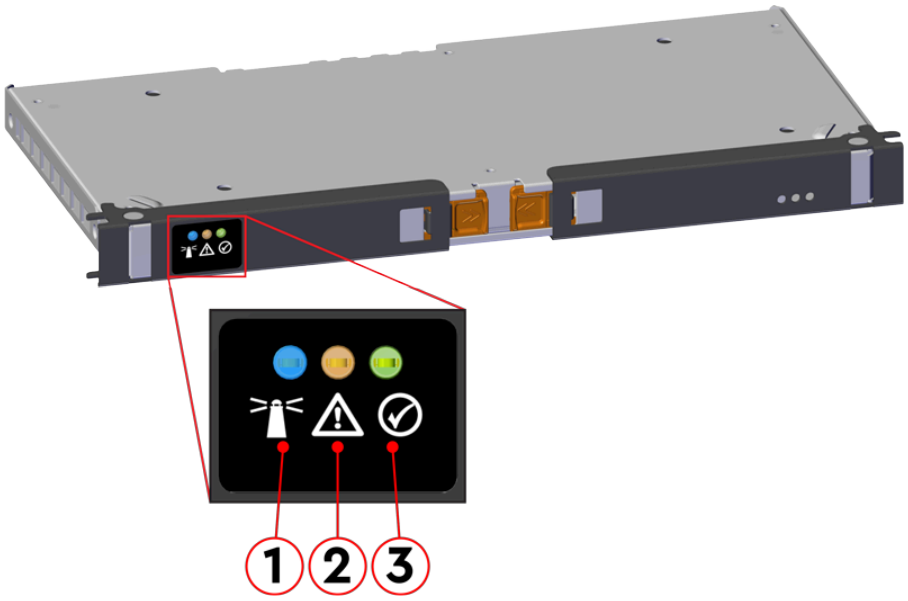


Table 4: IOM LEDs Identification

Number	LED Name	Color	Behavior
1	IOM Identification	Blue	**Off** - Not being identified **Blink** @ 0.5 Hz (75% duty cycle) – Blinks only when IOM Identification has been activated
2	IOM Fault	Amber	**Off** - IOM is functioning normally **Blink** @ 0.5 Hz (75% duty cycle) – IOM has Fault
3	IOM Power	Green	**Off** – IOM is off **Solid** – IOM is on

2.4.3 IOM Fan LED

The IOM Fan has a single LED with three distinct states for fault condition, identification, and power off.

Figure 6: IOM Fan LED Location

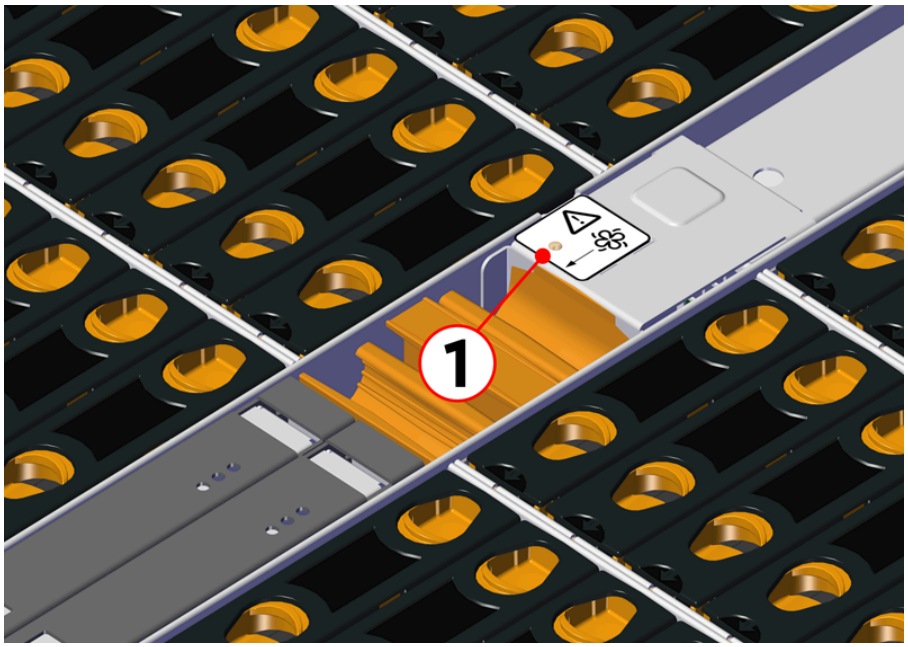


Table 5: IOM Fan LED Identification

Number	LED Name	Color	Behavior
1	IOM Fan LED	Amber	**Off** – IOM Fan is on and reporting no faults **Blink** @ 1 Hz (50% duty cycle) – IOM Fan is reporting faults **Blink** @ 2 Hz (50% duty cycle) – IOM Fan is being identified

2.4.4 PSU LED

The PSU has a single, multi-function LED. See the following tables for a detailed functional description.

Figure 7: PSU LED Location (Delta PSU shown)

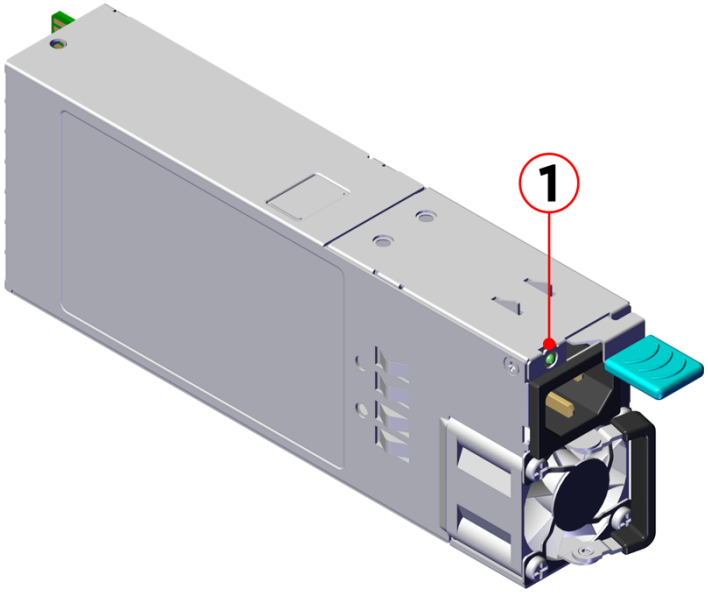


Table 6: PSU LED Identification

#	LED Name	Color	Delta Behavior	Artesyn Behavior
1	PSU Multi-Function LED	Green/ Amber	**Off** – PSU disconnected from power	**Off** – PSU disconnected from power
		Green	**Blink** @ 0.5Hz (50% duty cycle) – AC present and 12VSB on **Blink** @ 2Hz (50% duty cycle) – PSU in firmware update mode **Solid** – PSU on and reporting no faults	**Blink** @ 1Hz (50% duty cycle) – AC present and 12VSB on **Blink** @ 2Hz (50% duty cycle) – PSU in firmware update mode **Solid** – PSU on and reporting no faults
		Amber	**Blink** @ 0.5Hz (50% duty cycle) – PSU reporting warnings **Solid** – PSU disconnected from power, or critical fault causing a shutdown failure	**Blink** @ 1Hz (50% duty cycle) – PSU reporting warnings **Solid** – PSU disconnected from power while second PSU is connected to power, or critical fault causing a shutdown failure, or compatibility fault

2.4.5 Rear Fan LED

The Rear Fan has a single LED with three distinct states for indicating a fault condition, identification, or normal operation.

Figure 8: Fan LED Location

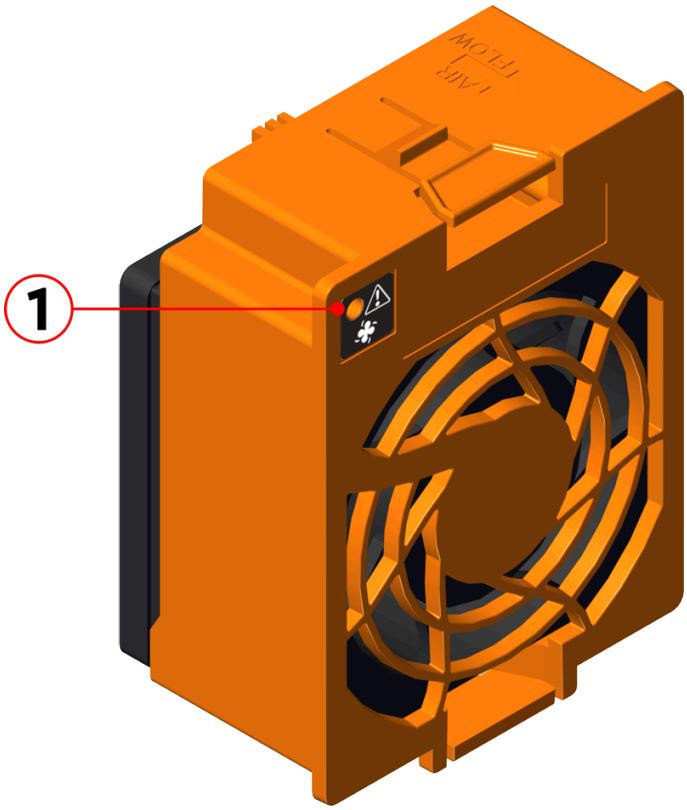


Table 7: Fan LED Identification

Number	LED Name	Color	Behavior
1	Fan LED	Amber	**Off** – Fan is on and reporting no faults **Blink** @ 1 Hz (50% duty cycle) – Fan is reporting faults **Blink** @ 2 Hz (50% duty cycle) – Fan is being identified

2.4.6 Drive Assembly LED

The HDD drive assembly itself does not contain an LED, but it instead the multi-function LED is located on the drive slot. This amber LED has three distinct states for indicating a fault condition, identification, or normal operation.

Figure 9: HDD Assembly LED Location

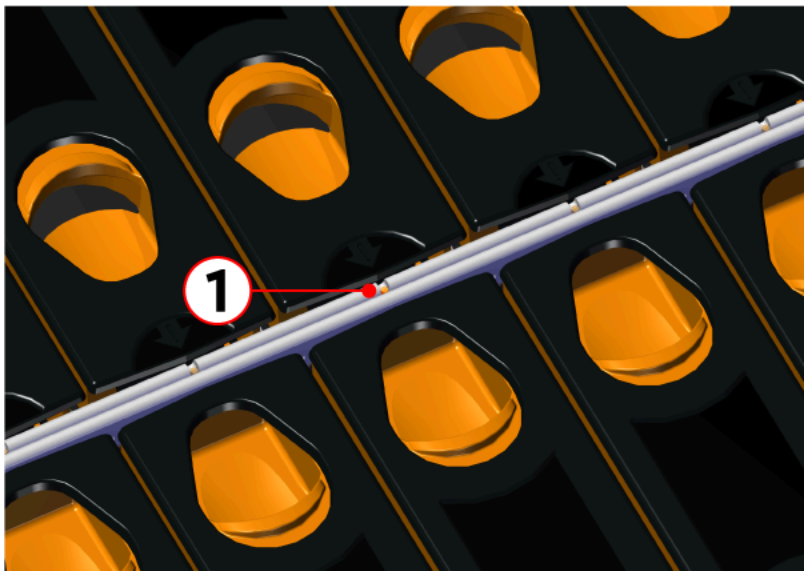


Table 8: HDD Assembly LED Identification

Number	LED Name	Color	Behavior
1	HDD Drive Multi-Function LED	Amber	**Off** – Drive has no faults **Blink** @ 1 Hz (50% duty cycle) – Drive fault **Blink** @ 2 Hz (50% duty cycle) – Drive identify

Note: During service events—when a drive is hot plugged or replaced and the drive installed properly—the LED state of that drive slot will change to solid ON. This is to provide the user with visual feedback that the drive has been successfully connected and has been discovered by the expander. Once the enclosure has been slid back into the rack and the OPEN bit on the door sensor element is 0, the LED will return to the previously set state (Ident, Fault, or Off).

For example: A drive in slot 0 needs to be replaced. The fault bit on Array Slot descriptor 0 is set to indicate to the service technician which drive slot to replace. This will cause the LED to blink at 1Hz (50% duty cycle). When the service technician pulls out the enclosure, inserts a new drive, and successfully installs the drive, the slot LED state will change to solid ON to indicate that the drive was properly installed. When the service technician pushes the enclosure back into the rack and the OPEN bit of the door sensor element changes from 1 to 0, the LED state of drive slot 0 will change back to the fault indication blink rate (1 Hz 50% duty cycle).

2.5 LED Duty Cycles

The enclosure supports visual indicators that conform to the flash patterns displayed in the following table:

Table 9: Visual Indicator Duty Cycles

Pattern	Duty Cycle
ON	Green - 100%
OFF	0%
Identify	Blue - 1Hz, 0.5 second period, 50% duty cycle
Fault	Amber - 50%

SMP Commands

In This Chapter:

3.1 SMP Commands

The following table lists the Serial Management Protocol (SMP) commands supported by Ultrastar Data60 :

Note: If a section reference is provided in the **Section** column of the table, the referenced section provides additional details about the implementation of the SMP command that is not fully explained in the SPL-2 standard.

Table 10: SEP Supported SMP Commands

Name	Op Code	Section
REPORT GENERAL	00h	Report General *(page 18)*
REPORT MANUFACTURER INFO	01h	SPL-2 Report Manufacturer Information *(page 18)*
REPORT SELF-CONFIGURATION STATUS	03h	SPL-2
REPORT ZONE PERMISSION TABLE	04h	SPL-2
REPORT ZONE MANAGER PASSWORD	05h	SPL-2
REPORT BROADCAST	06h	SPL-2
DISCOVER	10h	Discover and Discover List *(page 18)*
REPORT PHY ERROR LOG	11h	SPL-2
REPORT PHY SATA	12h	SPL-2
REPORT ROUTE INFORMATION	13h	SPL-2
REPORT PHY EVENT	14h	SPL-2
DISCOVER LIST	20h	Discover and Discover List *(page 18)*
REPORT PHY EVENT LIST	21h	SPL-2
REPORT EXPANDER ROUTE TABLE LIST	22h	SPL-2
CONFIG GENERAL	80h	SPL-2
ENABLE DISABLE ZONING	81h	SPL-2
ZONED BROADCAST	85h	SPL-2
ZONE LOCK	86h	SPL-2
ZONE ACTIVATE	87h	SPL-2
ZONE UNLOCK	88h	SPL-2
CONFIGURE ZONE MANAGER PASSWORD	89h	SPL-2
CONFIGURE ZONE PHY INFORMATION	8Ah	SPL-2
CONFIGURE ZONE PERMISSION TABLE	8Bh	SPL-2
CONFIGURE ROUTE INFORMATION	90h	SPL-2

Name	Op Code	Section
PHY CONTROL	91h	Discover and Discover List *(page 18)*
PHY TEST	92h	SPL-2
CONFIGURE PHY EVENT	93h	SPL-2

3.2 Report General

The response frame for Serial Management Protocol (SMP) **Report General** contains a field labeled **NUMBER OF PHYS**. This indicates the total number of physical layers (PHY) supported by the responding expander. In the Ultrastar Data60 , the **NUMBER OF PHYS** is always reported as **one** higher than the actual number of physical PHYs in the responding expander. This is due to the presence of a virtual PHY inside each expander device.

3.3 Report Manufacturer Information

The response frame for SMP **Report Manufacturer Information** reports the firmware revision of the expanders in the vendor unique field located in bytes **52-59**.

3.4 Discover and Discover List

Each enclosure contains a single primary expander, and one or more secondary expanders. When information about a secondary expander's virtual PHY is returned, the response frame indicates support for SMP initiator/target capability. When information about a primary expander's virtual PHY is returned, the response frame indicates support for both SMP initiator/target and Serial SCSI Protocol (SSP) initiator/target capabilities.

3.5 Physical Layer Control

It is not recommended that hosts manipulate the PHY enabled states. The SCSI Enclosure Processor (SEP) intends to manage PHY enable and disable operations autonomously.

3.6 Zoning Support

The SCSI Enclosure Processor (SEP) implements T10 defined Serial Management Protocol (SMP) controlled zoning, and has the capability to save the host defined zoning parameters in non-volatile memory.

The SEP's zoning capability limits the ability of the host to discover and communicate in-band with specific drives. Zoning is not designed to limit the SEP's ability to manage drives or drive slots, nor does it limit the ability of SCSI Enclosure Services (SES) clients of the SEP to manage drives. All installed drives and drive slots are exposed through the SES management interface, to all host clients, regardless of the currently active zoning configuration.

SES Diagnostic Pages

In This Chapter:

4.1 SES Model

The SCSI Enclosure Processor (SEP) follows the Standalone Enclosure Services Process model described in the SES standard. Each enclosure's SEP performs SCSI Enclosure Services (SES) management independently of other enclosures that are connected together within a Serial Attached SCSI (SAS) domain. Each SEP manages only the SES elements located inside the local enclosure. Each enclosure reports the topology as a single primary sub-enclosure as defined by the SES standard.

The SEP does not support dynamic changes to the reported configuration. As a result, the SEP always reports a fixed GENERATION CODE of 00000000h.

4.1.1 Sequencing of SCSI Operations

Hosts can send SCSI Enclosure Services (SES) control diagnostic page requests to perform a variety of operations, such as, requesting light-emitting diode (LED) flash patterns, recording predicted, known component failures, request power cycle of one or more drives, do a code download, and so on. All control operations follow a synchronous completion model, for example, the SEP will send SCSI status only when the requested operation has been completed, or to notify the host that the requested operation cannot be performed.

Hosts can request SES status diagnostic pages that contain customer replaceable unit (CRU), drive presence, health information, SAS topology maps, temperatures, fan speeds, voltages, currents, and so on. These operations follow a non-blocking completion model, for example, the SEP returns the last known status, rather than blocking the completion of the SCSI operation, and doing an immediate polling operation before replying.

4.1.2 Reserved Bit Checking

The SCSI Enclosure Processor (SEP) parses received SCSI Enclosure Services (SES) control pages to validate that no reserved bits are set. If one or more reserved bits are set, the command is terminated with a **Check Condition** status, a sense key of Illegal Request/Invalid Field in Parameter List, and the byte/bit location of the first illegal set bit is reported in the SKS field portion of the sense data. In this case, no portion of the rejected SES control request is acted upon. The SEP then discards valid portions of the page which occur before or after the illegal set bit.

Note: If a SES control page sets a bit that is supported by T10, but is unsupported by the SEP, the SEP will ignore it.

4.1.3 Partial SCSI Enclosure Services Pages

A host may send a partial SCSI Enclosure Services (SES) control page. The SCSI Enclosure Processor (SEP) will parse and consume as much of the page as is indicated by the PAGE LENGTH field in the page.

A host may request a partial SES status page. The SEP will return the page as requested, up to the smaller of the specified Command Descriptor Block (CDB) allocation length, or the size of the available data.

4.1.4 Predictive Failure

In the first generation of the Ultrastar Data60 , the SCSI Enclosure Processor (SEP) does not provide predictive failure capabilities for enclosure components. Future generations of enclosures may support the ability to predict the failure of drives connected to Array Device Slot element instances.

Hosts may designate an element instance as failed or predicted to fail by sending an appropriate SCSI Enclosure Services (SES) control request.

4.2 SES Supported Diagnostics Page (00h)

The following table displays the Supported SCSI Enclosure Services Diagnostic pages:

Table 11: Supported SCSI Enclosure Services Diagnostic Pages

Byte/Bit		7	6	5	4	3	2	1	0
PAGE HEADER									
0	00h	PAGE CODE (00h)							
1	01h	Reserved							
2	02h	PAGE LENGTH (10/000Ah)							
3	03h								
SUPPORTED SES PAGE LIST									
4	04h	SUPPORTED DIAGNOSTIC PAGES diagnostic page (00h)							
5	05h	CONFIGURATION STATUS diagnostic page (01h)							
6	06h	ENCLOSURE CONTROL/STATUS diagnostic page (02h)							
7	07h	HELP TEXT diagnostic page (03h)							
8	08h	STRING OUT/IN diagnostic page (04h)							
9	09h	THRESHOLD OUT/IN diagnostic page (05h)							
10	0Ah	ELEMENT DESCRIPTOR STATUS diagnostic page (07h)							
11	0Bh	ADDITIONAL ELEMENT STATUS diagnostic page (0Ah)							
12	0Ch	DOWNLOAD MICROCODE CONTROL/STATUS diagnostic page (0Eh)							
13	0Dh	SUBENCLOSURE NICKNAME CONTROL/STATUS diagnostic page (0Fh)							
14	0Eh	TAG DATA OUT/IN PAGE (10h)							
15	0Fh	MINI-SAS HD CABLE VPD DIAGNOSTIC PAGE (17h)							

The following table displays the Ultrastar Data60 SES Supported pages and sizes:

Table 12: SES Supported Pages and Sizes

Dec	Hex	Page	Code
15	000Fh	Supported Page List	00h
252	00FCh	Configuration Page	01h

Dec	Hex	Page	Code
812	032Ch	Enclosure Control/Status	02h
Variable	Variable	Help Text (Variable)	03h
127	7Fh	String In/Out (Variable)	04h
812	032Ch	Threshold Control/Status	05h
5232	1470h	Element Descriptor Status	07h
2736	0AB0h	Additional Element Status	0Ah
23	17h	Download Microcode Control (Variable)/Status	0Eh
48	30h	Subenclosure Nickname Status	0Fh
4099	1003h	Tag Data	10h
4100	1004h	Mini-SAS HD Cable VPD Status	17h

4.3 Configuration Page (01h)

The Configuration diagnostic page returns information about the enclosure, including a list of elements in the enclosure. The element list includes all elements with defined element status or control methods. The Configuration diagnostic page also provides descriptive text identifying element types in detail.

The element count for each element type is equal to the total number of the specific element type that could be installed in the present enclosure configuration.

The following table displays the Configuration Diagnostic page:

Table 13: Configuration Diagnostic Page

Byte/Bit		7	6	5	4	3	2	1	0
PAGE HEADER									
0	00h	PAGE CODE (01h)							
1	01h	NUMBER OF SUB-ENCLOSURES (00h)							
2	02h	(MSB)	PAGE LENGTH (n - 3)						
3	03h								(LSB)
GENERATION CODE									
4	04h	(MSB)	GENERATION CODE (00000000h)						
7	07h								(LSB)
ENCLOSURE DESCRIPTOR									
8	08h	Reserved	RELATIVE ENCLOSURE SERVICES PROCESS IDENTIFIER			Reserved	NUMBER OF ENCLOSURE SERVICES PROCESSES		
9	09h	SUB-ENCLOSURE IDENTIFIER (00h)							
10	0Ah	NUMBER OF TYPE DESCRIPTORS							
11	0Bh	ENCLOSURE DESCRIPTOR LENGTH (24h)							

Byte/Bit		7	6	5	4	3	2	1	0
12	0Ch		ENCLOSURE LOGICAL IDENTIFIER (SAS ADDR: 5XXXXXXXh)						
19	13h								
20	14h		ENCLOSURE VENDOR IDENTIFICATION						
27	1Bh								
28	1Ch		PRODUCT IDENTIFICATION						
43	2Bh								
44	2Ch		PRODUCT REVISION LEVEL						
47	2Fh								
TYPE DESCRIPTOR HEADER LIST									
48	30h	First Element Type – Identifier							
49	31h	First Element Type - Number of Possible Elements							
50	32h	Sub-enclosure Id (0/00h)							
51	33h	First Element Type – Type Descriptor Text Length							
		...							
		...							
		...							
		...							
		Last Element Type - Identifier							
		Last Element Type - Number of Possible Elements							
		Sub-enclosure Id (0/00h)							
		Last Element Type – Type Descriptor Text Length							
TYPE DESCRIPTOR TEXT									
			First Element Type Descriptor Text						
			...						
			Last Element Type Descriptor Text						
n									

The ENCLOSURE VENDOR IDENTIFICATION and PRODUCT IDENTIFICATION fields are identical to those reported by standard Inquiry data. The exact strings that are reported are defined by enclosure VPD.

The following table displays the Ultrastar Data60 - Configuration Page information:

Table 14: Ultrastar Data60 - Configuration Page

Offsets		Size	Description		Element Counts	
Dec	Hex				Dec	Hex
0	0000h	8	SES Page Header			
8	0008h	40	Enclosure Descriptor			
48	0030h	4	Element Type #1	Array Slot (17h)	60	003Ch
52	0034h	4	Element Type #2	Enclosure (0Eh)	1	0001h
56	0038h	4	Element Type #3	Power Supply (02h)	2	0002h
60	003Ch	4	Element Type #4	Cooling (03h)	8	0008h
64	0040h	4	Element Type #5	Temperature Sensors (04h)	86	0056h
68	0044h	4	Element Type #6	ESCE (07h)	2	0002h
72	0048h	4	Element Type #7	SAS Expanders (18h)	6	0006h
76	004Ch	4	Element Type #8	SAS Connectors (19h)	12	000Ch
80	0050h	4	Element Type #9	Voltage Sensors (12h)	8	0008h
84	0054h	4	Element Type #10	Current Sensors (13h)	8	0008h
88	0058h	4	Element Type #11	Door (05h)	1	0001h
Descriptor Text						
92	005Ch	16	Element Text #1	('Array Slots')		
108	006Ch	16	Element Text #2	('Enclosure')		
124	007Ch	16	Element Text #3	('Power Supply')		
140	008Ch	16	Element Text #4	('Cooling')		
156	009Ch	16	Element Text #5	('Temp Sensor')		
172	00ACh	16	Element Text #6	('IOM')		
188	00BCh	16	Element Text #7	('SAS Expander')		
204	00CCh	16	Element Text #8	('SAS Connector')		
220	00DCh	16	Element Text #9	('Voltage Sensor')		
236	00ECh	16	Element Text #10	('Current Sensor')		
252	00FCh	16	Element Text #11	('Enclosure Cover')		
252	00FCh			End of Page		

4.4 Enclosure and Threshold Diagnostic Pages (02h and 05h)

The Enclosure Control and Enclosure Status diagnostic pages provide access to the control and status elements identified by the SCSI Enclosure Services (SES) standard. The Enclosure Control diagnostic page is written using the SEND DIAGNOSTIC CDB. The Enclosure Status diagnostic page is read by sending a RECEIVE DIAGNOSTIC RESULTS CDB with a page code valid (PCV) bit set to one and a PAGE CODE field set to 02h.

4.4.1 Overview of Control/Status Element Handling

The SCSI Enclosure Processor (SEP) parses a control element instance only if SELECT bit is set. Reserved bits are ignored in a control instance, overall or element, if the block SELECT bit is not set.

If the SELECT bit is set on an overall control element, that overall control element's settings are used to provide control for all of the elements with the type representing the overall control element. If an individual instance's element control block has its SELECT bit set, the settings in the individual instance element control block take precedence over the settings in the overall control element block.

The SEP forms overall status element blocks by combining the status fields of each of the underlying element instance blocks for all of the elements of the type that the overall status element represents.

This process is referred to as status field promotion, and is subject to the following rules:

- Status fields in which bits are promoted using logical OR, the overall status element block will contain a set bit if any of the underlying element instance blocks have that bit set (for example, IDENTIFY, FAIL, prdFail, OFF, and so on).
- Status fields which are measured readings are not promoted to the overall status element corresponding to those values are set to all zeroes in the overall status element block (for example, temperature readings, voltage readings, fan RPMs, fan speed codes, and so on).
- The ELEMENT STATUS CODE field is promoted by copying the worst case value of the reported ELEMENT STATUS CODE of any of the underlying element instance blocks. The following list displays the priority order of ELEMENT STATUS code values, from highest to lowest. The following list also serves to document the entire set of supported values of the ELEMENT STATUS CODE field, and their meanings:
    - **No Access Allowed (8h)**
        - SEP has placed this component into a state where it is not accessible to the host. An example of this is a drive that has been taken offline due to a thermal fault.
    - **Unknown (6h)**
        - SEP had an internal BIST failure or cannot communicate with the element instance to ascertain its status due to a communication failure, for example, if the I2C bus is down.
    - **Unrecoverable (4h)**
        - SEP is reporting a condition which is unrecoverable and requires manual intervention. An example of this is the presence of an unsupported drive type or a thermal fault that has resulted in a transition to low power state.
    - **Critical (2h)**

        - SEP is reporting a failure condition, or a sensor reading that exceeded the over or under critical threshold.
    - **Noncritical (3h)**
        - SEP is reporting a warning condition, a predicted failure, or a sensor reading that exceeded the over or under warning threshold.
    - **Not Installed (5h)**
        - The element instance is not installed.
    - **Not Available (7h)**
        - The element instance is installed, but status information is not available for a reason that does not indicate a communication failure. An example of this is if a drive is powered down and therefore its temperature sensor cannot be read, or a drive temperature sensor has not yet been polled to ascertain its reading.
    - **OK (1h)**
        - None of the aforementioned conditions are present.

The SEP sets the Enclosure Status page header status bits to summarize the status conditions of any element instance reported by the page. The following displays status conditions of element instances:

- **INVOP**
    - This bit is never set
- **INFO**
    - This bit is always set
- **NON CRIT**
    - This bit is set to indicate that one or more element instances has an Element Status Code value of Noncritical (3h)
- **CRIT**
    - This bit is set to indicate that one or more element instances has an Element Status Code value of Critical (2h)
- **UNRECOV**
    - This bit is set to indicate that one or more element instances has an Element Status Code of Unrecoverable (4h) or Unknown (6h)

4.4.2 Overview of Visual Indicator Handling

The SCSI Enclosure Processor (SEP) provides users with visual indication of various conditions within the enclosure. Visual indication is provided through light-emitting diodes (LED) which are located nearby or inside components within the enclosure. Each visual indicator consists of a single LED, which displays a flash pattern that is used to signal different types of conditions. Each LED flash pattern has a corresponding priority associated with it. The priority is used to choose which flash pattern to display when multiple conditions warranting a flash pattern are simultaneously present.

The following list displays the LED flash patterns supported by the SEP, from highest to lowest priority:

- LED on with **100%** duty cycle

- LED on with **Identify** flash pattern duty cycle (2 second period, 87.5%)
- LED on with **Fault** flash pattern duty cycle (0.5 second period, 50%)
- LED off with **0%** duty cycle

Visual indicators can be autonomously set and cleared in response to enclosure detected conditions, or they may be set or cleared with the SES Enclosure Control page 02h. The following list displays the ELEMENT STATUS CODE values lead to the display of a **fault** flash pattern:

- Unknown (6h)
- Unrecoverable (4h)
- Critical (2h)
- Noncritical (3h)

There are many cases in the enclosure design in which a single LED will serve as a shared visual indicator for multiple **child** components. An example of this would be a visual indicator located in the Enclosure Services Controller Electronics (ESCE). All of the SCSI Enclosure Services (SES) element instances located within that ESCE share the same visual indicator (for example, SAS expanders, temperature, voltage, and current sensors, and so on). If more than one condition for which a visual indication was required is simultaneously present among the set of components sharing a visual indicator, only the highest priority visual indication would be displayed on the visual indicator's LED.

It is possible that more than one condition requiring visual indication is simultaneously present on any single element instance. For example, the SEP could detect an over-temperature condition on a temperature sensor, and the host could request Identify to help a service technician locate the faulty temperature sensor. The SEP would operate only the **Fault** flash pattern on the temperature sensor's visual indicator until the Identify request was made, at which time, the visual indicator would change to displaying the higher priority **Identify** flash pattern. If the Identify request was turned off by the host, the LED would resume displaying the **Fault** flash pattern, assuming that the over-temperature fault condition was still present.

4.4.3 Interaction of Visual Indicators and Host Initiated Identify/ Fault Requests

The SCSI Enclosure Services (SES) standard states that host SES Enclosure Control bits RQST IDENT and RQST FAULT, control visual indications on the associated element instance. The SES Enclosure Status page bits IDENT and FAULT indicate that a visual indication for the associated element instance, is active. In accordance with the previously mentioned indication, the SEP ignores host requests to identify or fail an element instance if the associated visual indicator is not physically present in the current enclosure topology.

4.4.4 Page Layout

The following table displays the Enclosure Control Diagnostic page:

Table 15: Enclosure Control Diagnostic Page

Byte/Bit		7	6	5	4	3	2	1	0
PAGE HEADER									
0	0000h	PAGE CODE (02h)							

Byte/Bit		7	6	5	4	3	2	1	0
1	0001h	Reserved				INFO	NON CRIT	CRIT	UNRECOV
2	0002h	(MSB)	PAGE LENGTH (n - 3)						
3	0003h								(LSB)
GENERATION CODE									
4	0004h	(MSB)	GENERATION CODE (00000000h)						
7	0007h								(LSB)
First Element Type									
8	0008h	First Element Type – Overall Control / Status							
12	000Ch		First Element Type – First Instance Control/Status						
			...						
			First Element Type – Last Instance Control/Status						
...									
		...							
			...						
Last Element Type									
		Last Element Type – Overall Control/Status							
			Last Element Type – First Instance Control/Status						
			...						
			Last Element Type – Last Instance Control/Status						

The following table displays the Enclosure Status Diagnostic page:

Table 16: Enclosure Status Diagnostic Page

Byte/Bit		7	6	5	4	3	2	1	0
PAGE HEADER									
0	0000h	PAGE CODE (02h)							
1	0001h	Reserved			INVOP (0b)	INFO (1b)	NON CRIT	CRIT	UNRECOV
2	0002h	(MSB)	PAGE LENGTH (n - 3)						
3	0003h	(MSB)							
GENERATION CODE									
4	0004h		GENERATION CODE (00000000h)						
7	0007h								

Byte/Bit		7	6	5	4	3	2	1	0
First Element Type									
8	0008h	First Element Type – Overall Status							
12	000Ch		First Element Type – First Instance Status						
			...						
			First Element Type – Last Instance Status						
...									
		...							
			...						
Last Element Type									
			Last Element Type – First Instance Status						
			...						
n			Last Element Type – Last Instance Status						

Each enclosure defined by the Ultrastar Data60 architecture contains a factory default set of thresholds for temperature, voltage, and current sensor components.

These thresholds may be overwritten to a more conservative set of user defined values by a host using the Threshold Out page (for example, lowering the high warning/critical threshold or raising the low warning/critical threshold, and so on). User defined thresholds override the factory default thresholds. User defined changes to thresholds are volatile, and are only in effect until the next time the SCSI Enclosure Processor (SEP) is power cycled or reset.

If a host attempts to establish thresholds which are less conservative than the factory defaults the SEP will return a Check Condition status without changing any threshold parameters specified in that request (for example, raising the high warning/critical thresholds or lowering the low warning/critical thresholds, and so on).

The Threshold diagnostic page follows the same element instance layout as the Enclosure Control and Enclosure Status diagnostic pages. For each element type, there is an overall entry followed by individual entries for each instance.

The following table displays the Threshold Out Diagnostic page:

Table 17: Threshold Out Diagnostic Page

Byte/Bit		7	6	5	4	3	2	1	0
PAGE HEADER									
0	0000h	PAGE CODE (05h)							
1	0001h	Reserved							
2	0002h	(MSB)	PAGE LENGTH (n - 3)						
3	0003h								(LSB)
GENERATION CODE									

Byte/Bit		7	6	5	4	3	2	1	0
4	0004h		GENERATION CODE (00000000h)						
7	00007h								
First Element Type									
8	0008h		First Element Type – First Instance Threshold						
12	000Ch		...						
			First Element Type – Last Instance Threshold						
...									
			...						
			...						
Last Element Type									
			Last Element Type – First Instance Threshold						
			...						
n			Last Element Type – Last Instance Threshold						

The following table displays the Threshold In Diagnostic page:

Table 18: Threshold In Diagnostic Page

Byte/Bit		7	6	5	4	3	2	1	0
PAGE HEADER									
0	0000h	PAGE CODE (05h)							
1	0001h	Reserved			INVOP (0b)	Reserved			
2	0002h	(MSB)	PAGE LENGTH (n - 3)						
3	0003h								(LSB)
GENERATION CODE									
4	0004h		GENERATION CODE (00000000h)						
7	0007h								
First Element Type									
8	0008h	First Element Type – Overall Threshold							
12	000Ch		First Element Type – First Instance Threshold						
			...						
			First Element Type – Last Instance Threshold						
			...						

Byte/Bit		7	6	5	4	3	2	1	0
			...						
		Last Element Type – Overall Threshold							
			Last Element Type – First Instance Threshold						
			...						
			Last Element Type – Last Instance Threshold						

Each threshold entry follows the format below. The following list displays thresholds regarding rule about ordering of values:

Note: User supplied thresholds must comply with the rules regarding ordering of values.

- For temperature sensor thresholds, it is required that the following relationships hold true for any threshold value which is specified (e.g. is non-zero):
  - HIGH CRITICAL>HIGH WARNING>LOW WARNING>LOW CRITICAL
- For voltage and current sensor thresholds, it is required that the following relationships hold true for any threshold value which is specified (e.g. is non-zero):
  - HIGH CRITICAL>HIGH WARNING
  - LOW CRITICAL>LOW WARNING

The following table displays the Element Threshold Descriptor information:

Table 19: Element Threshold Descriptor

Byte/Bit	7	6	5	4	3	2	1	0
0	HIGH CRITICAL THRESHOLD							
1	HIGH WARNING THRESHOLD							
2	LOW WARNING THRESHOLD							
3	LOW CRITICAL THRESHOLD							

4.4.5 Default Thresholds

The following table displays the default thresholds and, for voltage and current sensors, the nominal readings used to compute threshold violations:

Note:

- The current sensors have no **low** thresholds. The threshold values are expressed in the same order as they are defined in SES.
- The threshold values are as follows: **high critical/high warning/low warning/low critical**

Table 20: SES Default Thresholds

Element Type and Instance	Threshold Values	Nominal Values
Temperature Sensors (°C)		
Drive	59/56/7/5	N/A
Baseboard 42/T-Board (Inlet)	40/36/7/5	N/A
Baseboard 60 (Exhaust)	55/50/7/5	N/A
IOM Ambient (LM75)	75/70/5/1	N/A
IOM Expanders	100/95/5/1	N/A
Expander Ambient (IOM MEM)	75/70/5/1	N/A
PSU Ambient (AMB)	54/52/5/1	N/A
PSU PFC Hot (HOT)	105/95/5/1	N/A
PSU FB HotSpot (PRI)	105/95/5/1	N/A
Voltage Sensors		
PSU AC Input	256/250/190/184	220
PSU 12V Output	12.5/12.4/11.5/11.4	12
IOM 5V Output	5.2/5.1/4.9/4.8	4.9
IOM 12V Input	14/13/11/10	4
Current Sensors (±10% for critical and ±5% non-critical)		
PSU AC Input	9/8.5/0/0	N/A
PSU 12V Output (High Line)	125.4/118.8/0/0	0.1
PSU 12V Output (Low Line)	77.9/73.8/0/0	0.1
CURR IOM 5V Output	80.75/76.5/0/0	N/A
CURR IOM 12V Input	42.75/40.5/0/0	N/A

4.4.6 Offsets for the Enclosure Status/Control and Threshold Out/In Pages

The element instance offsets are the same for the following SES diagnostic pages:

- Element Status: **Page 02h**
- Element Control: **Page 02h**
- Threshold In: **Page 05h**
- Threshold Out: **Page 05h**

The following tables provide offsets to each element instance in a Ultrastar Data60 . All CRUs do not need to be present (for example, missing drives, IOMs, or PSUs), the page size and offsets remain the same.

4.4.6.1 Enclosure Status/Control and Threshold Status/Control

The Enclosure Control and Enclosure Status diagnostic pages provide access to the control and status elements identified by the SCSI Enclosure Services (SES) standard. The Enclosure Control diagnostic page is written using the SEND DIAGNOSTIC CDB. The Enclosure Status diagnostic page is read by sending a RECEIVE DIAGNOSTIC RESULTS CDB with a page code valid (PCV) bit set to one and a PAGE CODE field set to 02h.

The following tables provide offsets to each element instance in a Ultrastar Data60 :

Table 21: SES Page Offsets for Enclosure Status/Control and Threshold Pages

Offsets		Size	Element Index			Description
Dec	Hex		SG3	Abs	Rel	
0	0000h	8				SES Page Header
Array Slot Elements						
8	0008h	4	0,-1	0		Array Slot Overall
12	000Ch	4	0,0	1	0	Array Slot #0
16	0010h	4	0,1	2	1	Array Slot #01
20	0014h	4	0,2	3	2	Array Slot #02
24	0018h	4	0,3	4	3	Array Slot #03
28	001Ch	4	0,4	5	4	Array Slot #04
32	0020h	4	0,5	6	5	Array Slot #05
36	0024h	4	0,6	7	6	Array Slot #06
40	0028h	4	0,7	8	7	Array Slot #07
44	002Ch	4	0,8	9	8	Array Slot #08
48	0030h	4	0,9	10	9	Array Slot #09
52	0034h	4	0,10	11	10	Array Slot #10
56	0038h	4	0,11	12	11	Array Slot #11
60	003Ch	4	0,12	13	12	Array Slot #12
64	0040h	4	0,13	14	13	Array Slot #13
68	0044h	4	0,14	15	14	Array Slot #14
72	0048h	4	0,15	16	15	Array Slot #15
76	004Ch	4	0,16	17	16	Array Slot #16
80	0050h	4	0,17	18	17	Array Slot #17
84	0054h	4	0,18	19	18	Array Slot #18
88	0058h	4	0,19	20	19	Array Slot #19
92	005Ch	4	0,20	21	20	Array Slot #20
96	0060h	4	0,21	22	21	Array Slot #21
100	0064h	4	0,22	23	22	Array Slot #22

Offsets		Size	Element Index			Description
Dec	Hex		SG3	Abs	Rel	
104	0068h	4	0,23	24	23	Array Slot #23
108	006Ch	4	0,24	25	24	Array Slot #24
112	0070h	4	0,25	26	25	Array Slot #25
116	0074h	4	0,26	27	26	Array Slot #26
120	0078h	4	0,27	28	27	Array Slot #27
124	007Ch	4	0,28	29	28	Array Slot #28
128	0080h	4	0,29	30	29	Array Slot #29
132	0084h	4	0,30	31	30	Array Slot #30
136	0088h	4	0,31	32	31	Array Slot #31
140	008Ch	4	0,32	33	32	Array Slot #32
144	0090h	4	0,33	34	33	Array Slot #33
148	0094h	4	0,34	35	34	Array Slot #34
152	0098h	4	0,35	36	35	Array Slot #35
156	009Ch	4	0,36	37	36	Array Slot #36
160	00A0h	4	0,37	38	37	Array Slot #37
164	00A4h	4	0,38	39	38	Array Slot #38
168	00A8h	4	0,39	40	39	Array Slot #39
172	00ACh	4	0,40	41	40	Array Slot #40
176	00B0h	4	0,41	42	41	Array Slot #41
180	00B4h	4	0,42	43	42	Array Slot #42
184	00B8h	4	0,43	44	43	Array Slot #43
188	00BCh	4	0,44	45	44	Array Slot #44
192	00C0h	4	0,45	46	45	Array Slot #45
196	00C4h	4	0,46	47	46	Array Slot #46
200	00C8h	4	0,47	48	47	Array Slot #47
204	00CCh	4	0,48	49	48	Array Slot #48
208	00D0h	4	0,49	50	49	Array Slot #49
212	00D4h	4	0,50	51	50	Array Slot #50
216	00D8h	4	0,51	52	51	Array Slot #51
220	00DCh	4	0,52	53	52	Array Slot #52
224	00E0h	4	0,53	54	53	Array Slot #53
228	00E4h	4	0,54	55	54	Array Slot #54
232	00E8h	4	0,55	56	55	Array Slot #55
236	00ECh	4	0,56	57	56	Array Slot #56

Offsets		Size	Element Index			Description
Dec	Hex		SG3	Abs	Rel	
240	00F0h	4	0,57	58	57	Array Slot #57
244	00F4h	4	0,58	59	58	Array Slot #58
248	00F8h	4	0,59	60	59	Array Slot #59
Enclosure Element						
252	00FCh	4	1,-1	61		Enclosure Overall
256	0100h	4	1,0	62	0	Enclosure #00
Power Supply Element						
260	0104h	4	2,-1	63		Power Supply Overall
264	0108h	4	2,0	64	0	Power Supply A
268	010Ch	4	2,1	65	1	Power Supply B
Cooling Elements						
272	0110h	4	3,-1	66		Fan Overall
276	0114h	4	3,0	67	0	Fan #0
280	0118h	4	3,1	68	1	Fan #1
284	011Ch	4	3,2	69	2	Fan #2
288	0120h	4	3,3	70	3	Fan #3
292	0124h	4	3,4	71	4	Fan #4
296	0128h	4	3,5	72	5	Fan #5
Temperature Elements						
300	012Ch	4	4,-1	73		Temperature Sensor Overall
304	0130h	4	4,0	74	0	Temperature #0
308	0134h	4	4,1	75	1	Temperature #01
312	0138h	4	4,2	76	2	Temperature #02
316	013Ch	4	4,3	77	3	Temperature #03
320	0140h	4	4,4	78	4	Temperature #04
324	0144h	4	4,5	79	5	Temperature #05
328	0148h	4	4,6	80	6	Temperature #06
332	014Ch	4	4,7	81	7	Temperature #07
336	0150h	4	4,8	82	8	Temperature #08
340	0154h	4	4,9	83	9	Temperature #09
344	0158h	4	4,10	84	10	Temperature #10
348	015Ch	4	4,11	85	11	Temperature #11
352	0160h	4	4,12	86	12	Temperature #12
356	0164h	4	4,13	87	13	Temperature #13

Offsets		Size	Element Index			Description
Dec	Hex		SG3	Abs	Rel	
360	0168h	4	4,14	88	14	Temperature #14
364	016Ch	4	4,15	89	15	Temperature #15
368	0170h	4	4,16	90	16	Temperature #16
372	0174h	4	4,17	91	17	Temperature #17
376	0178h	4	4,18	92	18	Temperature #18
380	017Ch	4	4,19	93	19	Temperature #19
384	0180h	4	4,20	94	20	Temperature #20
388	0184h	4	4,21	95	21	Temperature #21
392	0188h	4	4,22	96	22	Temperature #22
396	018Ch	4	4,23	97	23	Temperature #23
400	0190h	4	4,24	98	24	Temperature #24
404	0194h	4	4,25	99	25	Temperature #25
408	0198h	4	4,26	100	26	Temperature #26
412	019Ch	4	4,27	101	27	Temperature #27
416	01A0h	4	4,28	102	28	Temperature #28
420	01A4h	4	4,29	103	29	Temperature #29
424	01A8h	4	4,30	104	30	Temperature #30
428	01ACh	4	4,31	105	31	Temperature #31
432	01B0h	4	4,32	106	32	Temperature #32
436	01B4h	4	4,33	107	33	Temperature #33
440	01B8h	4	4,34	108	34	Temperature #34
444	01BCh	4	4,35	109	35	Temperature #35
448	01C0h	4	4,36	110	36	Temperature #36
452	01C4h	4	4,37	111	37	Temperature #37
456	01C8h	4	4,38	112	38	Temperature #38
460	01CCh	4	4,39	113	39	Temperature #39
464	01D0h	4	4,40	114	40	Temperature #40
468	01D4h	4	4,41	115	41	Temperature #41
472	01D8h	4	4,42	116	42	Temperature #42
476	01DCh	4	4,43	117	43	Temperature #43
480	01E0h	4	4,44	118	44	Temperature #44
484	01E4h	4	4,45	119	45	Temperature #45
488	01E8h	4	4,46	120	46	Temperature #46
492	01ECh	4	4,47	121	47	Temperature #47

Offsets		Size	Element Index			Description
Dec	Hex		SG3	Abs	Rel	
496	01F0h	4	4,48	122	48	Temperature #48
500	01F4h	4	4,49	123	49	Temperature #49
504	01F8h	4	4,50	124	50	Temperature #50
508	01FCh	4	4,51	125	51	Temperature #51
512	0200h	4	4,52	126	52	Temperature #52
516	0204h	4	4,53	127	53	Temperature #53
520	0208h	4	4,54	128	54	Temperature #54
524	020Ch	4	4,55	129	55	Temperature #55
528	0210h	4	4,56	130	56	Temperature #56
532	0214h	4	4,57	131	57	Temperature #57
536	0218h	4	4,58	132	58	Temperature #58
540	021Ch	4	4,59	133	59	Temperature #59
544	0220h	4	4,60	134	60	Temperature #60
548	0224h	4	4,61	135	61	Temperature #61
552	0228h	4	4,62	136	62	Temperature #62
556	022Ch	4	4,63	137	63	Temperature #63
560	0230h	4	4,64	138	64	Temperature #64
564	0234h	4	4,65	139	65	Temperature #65
568	0238h	4	4,66	140	66	Temperature #66
572	023Ch	4	4,67	141	67	Temperature #67
576	0240h	4	4,68	142	68	Temperature #68
580	0244h	4	4,69	143	69	Temperature #69
584	0248h	4	4,70	144	70	Temperature #70
588	024Ch	4	4,71	145	71	Temperature #71
592	0250h	4	4,72	146	72	Temperature #72
596	0254h	4	4,73	147	73	Temperature #73
600	0258h	4	4,74	148	74	Temperature #74
604	025Ch	4	4,75	149	75	Temperature #75
608	0260h	4	4,76	150	76	Temperature #76
612	0264h	4	4,77	151	77	Temperature #77
616	0268h	4	4,78	152	78	Temperature #78
620	026Ch	4	4,79	153	79	Temperature #79
624	0270h	4	4,80	154	80	Temperature #80
628	0274h	4	4,81	155	81	Temperature #81

Offsets		Size	Element Index			Description
Dec	Hex		SG3	Abs	Rel	
632	0278h	4	4,82	156	82	Temperature #82
636	027Ch	4	4,83	157	83	Temperature #83
640	0280h	4	4,84	158	84	Temperature #84
644	0284h	4	4,85	159	85	Temperature #85
ESCE Element						
648	0288h	4	5,-1	160		ESCE Overall
652	028Ch	4	5,0	161	0	ESCE A
656	0290h	4	5,1	162	1	ESCE B
Expander Element						
660	0294h	4	6,-1	163		SAS Expander Overall
664	0298h	4	6,0	164	0	SAS Expander #0
668	029Ch	4	6,1	165	1	SAS Expander #01
672	02A0h	4	6,2	166	2	SAS Expander #02
676	02A4h	4	6,3	167	3	SAS Expander #03
680	02A8h	4	6,4	168	4	SAS Expander #04
684	02ACh	4	6,5	169	5	SAS Expander #05
Connector Element						
688	02B0h	4	7,-1	170		Connector Overall
692	02B4h	4	7,0	171	0	Connector #0
696	02B8h	4	7,1	172	1	Connector #01
700	02BCh	4	7,2	173	2	Connector #02
704	02C0h	4	7,3	174	3	Connector #03
708	02C4h	4	7,4	175	4	Connector #04
712	02C8h	4	7,5	176	5	Connector #05
716	02CCh	4	7,6	177	6	Connector #06
720	02D0h	4	7,7	178	7	Connector #07
724	02D4h	4	7,8	179	8	Connector #08
728	02D8h	4	7,9	180	9	Connector #09
732	02DCh	4	7,10	181	10	Connector #10
736	02E0h	4	7,11	182	11	Connector #11
Voltage Sensor Element						
740	02E4h	4	8,-1	183		Voltage Overall
744	02E8h	4	8,0	184	0	Voltage Sensor #0
748	02ECh	4	8,1	185	1	Voltage Sensor #01

Offsets		Size	Element Index			Description
Dec	Hex		SG3	Abs	Rel	
752	02F0h	4	8,2	186	2	Voltage Sensor #02
756	02F4h	4	8,3	187	3	Voltage Sensor #03
760	02F8h	4	8,4	188	4	Voltage Sensor #04
764	02FCh	4	8,5	189	5	Voltage Sensor #05
Current Sensor Elements						
768	0300h	4	9,-1	190		Current Sensor Overall
772	0304h	4	9,0	191	0	Current Sensor #0
776	0308h	4	9,1	192	1	Current Sensor #01
780	030Ch	4	9,2	193	2	Current Sensor #02
784	0310h	4	9,3	194	3	Current Sensor #03
788	0314h	4	9,4	195	4	Current Sensor #04
792	0318h	4	9,5	196	5	Current Sensor #05
796	031Ch	4	9,6	197	6	Current Sensor #06
800	0320h	4	9,7	198	7	Current Sensor #07
Door Elements						
804	0324h	4	10,-1	199		Door Overall
808	0328h	4	10,0	200	0	Door #0
812	03Ch	**END OF PAGE**				

4.5 Help Text Diagnostic Page (03h)

The following table displays the Help Text diagnostics page information:

Table 22: Help Text Diagnostic Page

Byte/Bit		7	6	5	4	3	2	1	0
PAGE HEADER									
0	00h	PAGE CODE (03h)							
1	01h	Reserved							
2	02h	(MSB)	PAGE LENGTH (0 to 2000h)						
3	03h								(LSB)
HELP TEXT									
4	04h	HELP TEXT (0 to 8192 bytes)							
N/A	N/A								

Byte/Bit		7	6	5	4	3	2	1	0
n									

4.6 String Out/In Diagnostic Page (04h)

The String Out/In diagnostic page is used to transfer command and status information between the host and the enclosure that does not fit elsewhere into the SES defined model for enclosure management.

The String Out page is used to transfer a command and zero or more command parameters from the host to the enclosure.

The following table displays the String Out Diagnostic page:

Table 23: String Out Diagnostic Page

Byte/Bit		7	6	5	4	3	2	1	0
PAGE HEADER									
0	0000h	PAGE CODE (04h)							
1	0001h	Reserved							
2	0002h	(MSB)	PAGE LENGTH (n - 3)						
3	0003h								(LSB)
STRING OUT DATA									
4	0004h		COMMAND						
			ARGUMENT						
			...						
n			ARGUMENT N						

Table 24: String Out Command Reset Command List

Operation	COMMAND (reset)	SUB COMMAND (hard reset)	COMPONENT	INSTANCE
Enclosure – hard reset	02h	00h	00h	00h
IOM – hard reset			01h	**IOM A**: 00h
				IOM B: 01h
				Close/local IOM: C0h
				Far/remote IOM: F0h

The following table displays the String Out Diagnostic Reset page:

Table 25: String Out Diagnostic Page Enclosure and IOM Resets

Byte/Bit		7	6	5	4	3	2	1	0
PAGE HEADER									
0	0000h	PAGE CODE (04h)							
1	0001h	Reserved							
2	0002h	(MSB)	PAGE LENGTH (n - 3)						
3	0003h								(LSB)
STRING OUT DATA									
4	0004h		COMMAND						
5	0005h		SUB COMMAND						
6	0006h		COMPONENT						
7	0007h		INSTANCE						

The String Out Reset examples contain a Device (<dev>), Command (<cmd>), Sub Command (<sub cmd>), Component (<component>), and in Instance (<Instance>) for each example. Use the table in this section to complete all of the bolded placeholders in the following string: sg_ses **<dev>** -p 4 –c –data=**<cmd>**, **<sub cmd>**, **<component>**, **<instance>**. If the enclosure component of value of 00h is used followed by an instance of an IOM, the default behavior is to reset the enclosure.

Table 26: String Out Reset Examples

Hardware	Reset Examples
Enclosure	sg_ses <dev> -p 4 –c –data=02,00,00,00
IOM A	sg_ses <dev> -p 4 –c –data=02,00,01,00
IOM B	sg_ses <dev> -p 4 –c –data=02,00,01,01
Close/Local IOM	sg_ses <dev> -p 4 –c –data=02,00,01,C0
Far/Remote IOM	sg_ses <dev> -p 4 –c –data=02,00,01,F0

The following table displays the String In Diagnostic page:

Note: The String In page is used to transfer status from the enclosure to the host.

Table 27: String In Diagnostic Page

Byte/Bit		7	6	5	4	3	2	1	0
PAGE HEADER									
0	00h	PAGE CODE (04h)							
1	01h	Reserved							
2	02h	(MSB)	PAGE LENGTH (7Ch)						
3	03h								(LSB)
STRING IN DATA									

Byte/Bit		7	6	5	4	3	2	1	0
4	04h	(MSB)	TICK COUNTER						
7	07h								(LSB)
8	08h	(MSB)	MONITOR LOOP COUNTER						
11	0Bh								(LSB)
12	0Ch	(MSB)	MONITOR LOOP RECENT LATENCY						
15	0Fh								(LSB)
16	10h	(MSB)	MONITOR LOOP MAXIMUM LATENCY						
19	13h								(LSB)
20	14h	(MSB)	OFFLINE STATE REASON MASK						
23	17h								(LSB)
24	18h	(MSB)	POWER STATE						
27	1Bh								(LSB)
28	1Ch	(MSB)	PSU A AC FAILURE COUNTER						
31	1Fh								(LSB)
32	20h	(MSB)	PSU B AC FAILURE COUNTER						
35	23h								(LSB)
36	24h	(MSB)	PHY RESET – LAST ID						
39	27h								(LSB)
40	28h	(MSB)	PHY RESET – EVENT COUNT						
43	2Bh								(LSB)
44	2Ch	(MSB)	BIST FAILURE – EVENT COUNT						
47	2Fh								(LSB)
48	30h	Reserved							
127	7Fh								

The TICK COUNTER field is a 32 bit value that reports the number of seconds that the SCSI Enclosure Processor (SEP) has been running.

The MONITOR LOOP COUNTER is a 32 bit value that indicates the number of iterations of the background monitor loop.

The MONITOR LOOP RECENT LATENCY is a 32 bit value that indicates the latency in milliseconds of the most recent invocation of the background monitor loop.

The IDLE LOOP MAXIMUM LATENCY is a 32 bit value that indicates the maximum latency in milliseconds of any invocation of the background monitor loop since the most recent SEP boot.

The OFFLINE STATE REASON MASK field reports the reason(s) for the current offline state condition. The following list displays bitmask values:

- **00000000h**: enclosure is not offline
- **00000001h**: unsupported drive configuration
- **00000002h**: SEP is unable to read enclosure Vital Product Data (VPD)

- **00000004h**: thermal fault condition

The POWER STATE field is a 32 bit value that indicates the power state of the enclosure. The values reported range from 0, standby power only, to 3, full power. Values of 1 and 2 indicate intermediate states.

The PSU A AC FAILURE COUNTER and PSU B AC FAILURE COUNTER fields are 32 bit values that indicate the number of times that the respective power supply detected a failure of the AC input voltage. These counters are not reset to zero if a power supply is inserted or removed.

The PHY RESET – LAST ID and PHY RESET – EVENT COUNT fields are used to report cases where the SEP autonomously resets a host, disc, or interconnect physical layer (PHY) because it negotiated to a suboptimal link rate.

The PHY RESET – LAST ID field reports the ID of the last PHY to be reset, and the PHY RESET – EVENT COUNT reports the total number of times any PHY has been reset in an attempt to improve a suboptimal link rate.

The BIST FAILURE – EVENT COUNT field is a 32 bit value which reports the number of times that the enclosure detected a built-in self-test (BIST) failure. The counter is volatile, and will reset to 0 when the enclosure is reset of powers on.

4.7 Element Descriptor Page (07h)

The Element Descriptor Page can be returned in one of two formats, with or without Manufacturing/ Customer (MFC) data. MFC data is enabled by default. If no MFC data is required this feature can be disabled at manufacturing resulting in the shorter page length. The MFC data is ASCII printable data with unused portions filled with ASCII spaces (20h). The MFC data is intended to contain information necessary for inventory tracking but may contain any ASCII data determined by manufacturing and/or customers. These fields are settable only during manufacturing. See individual Element Descriptor Format sections for details.

4.7.1 Element Descriptor

The Element Descriptor page contains ASCII byte arrays which report information about the enclosure instances. The ASCII fields in the Element Descriptor page are not NULL terminated. The element descriptor page contains information about SES defined element type instances as well as other CRU types not directly modeled by SES such as the drives. The exact information provided for each element includes the following types of data:

- Location (indicates parent CRU)
- Part Number
- Serial Number
- Firmware Revision

The Element Descriptor diagnostic page follows the same element instance layout as the Enclosure Control and Enclosure Status diagnostic pages. For each element type, there is an overall entry followed by individual entries for each instance.

The following table displays the Element Descriptor Diagnostic page:

Table 28: Element Descriptor Diagnostic Page

Byte/Bit	7	6	5	4	3	2	1	0
PAGE HEADER								

Byte/Bit		7	6	5	4	3	2	1	0
0	0000h	PAGE CODE (07h)							
1	0001h	Reserved							
2	0002h	(MSB)	PAGE LENGTH (n – 3)						
3	0003h								(LSB)
GENERATION CODE									
4	0004h		GENERATION CODE (00000000h)						
7	0007h								
First Element Type									
8	0008h	First Element Type – Overall Element Descriptor							
12	000Ch		First Element Type – First Instance Element Descriptor						
			...						
			First Element Type – Last Instance Element Descriptor						
...									
			...						
Last Element Type									
Last Element Type – Overall Element Descriptor									
			Last Element Type – First Instance Threshold						
			...						
			Last Element Type – Last Instance Threshold						

The following tables displays offsets to each element instance in the Ultrastar Data60 :

Note: All CRUs need not be present (for example, drives, or PSU). The page size and offsets remain the same.

Table 29: Ultrastar Data60 - Element Descriptor

Without MFC Data		Size	Element Index			Description	
Dec	Hex		SG3	Abs	Rel		
0	0000h	8				SES Page Header	
Array Slot Elements							
8	0008h	4	0,-1	0		Array Slot Overall	
12	000Ch	32	0,0	1	0	Array Slot #0	SLOT 000,<SERIAL #>
44	002Ch	32	0,1	2	1	Array Slot #1	SLOT 001,<SERIAL #>
76	004Ch	32	0,2	3	2	Array Slot #2	SLOT 002,<SERIAL #>

Without MFC Data		Size	Element Index			Description	
Dec	Hex		SG3	Abs	Rel		
108	006Ch	32	0,3	4	3	Array Slot #3	SLOT 003,<SERIAL #>
140	008Ch	32	0,4	5	4	Array Slot #4	SLOT 004,<SERIAL #>
172	00ACh	32	0,5	6	5	Array Slot #5	SLOT 005,<SERIAL #>
204	00CCh	32	0,6	7	6	Array Slot #6	SLOT 006,<SERIAL #>
236	00ECh	32	0,7	8	7	Array Slot #7	SLOT 007,<SERIAL #>
268	010Ch	32	0,8	9	8	Array Slot #8	SLOT 008,<SERIAL #>
300	012Ch	32	0,9	10	9	Array Slot #9	SLOT 009,<SERIAL #>
332	014Ch	32	0,10	11	10	Array Slot #10	SLOT 010,<SERIAL #>
364	016Ch	32	0,11	12	11	Array Slot #11	SLOT 011,<SERIAL #>
396	018Ch	32	0,12	13	12	Array Slot #12	SLOT 012,<SERIAL #>
428	01ACh	32	0,13	14	13	Array Slot #13	SLOT 013,<SERIAL #>
460	01CCh	32	0,14	15	14	Array Slot #14	SLOT 014,<SERIAL #>
492	01ECh	32	0,15	16	15	Array Slot #15	SLOT 015,<SERIAL #>
524	020Ch	32	0,16	17	16	Array Slot #16	SLOT 016,<SERIAL #>
556	022Ch	32	0,17	18	17	Array Slot #17	SLOT 017,<SERIAL #>
588	024Ch	32	0,18	19	18	Array Slot #18	SLOT 018,<SERIAL #>
620	026Ch	32	0,19	20	19	Array Slot #19	SLOT 019,<SERIAL #>
652	028Ch	32	0,20	21	20	Array Slot #20	SLOT 020,<SERIAL #>
684	02ACh	32	0,21	22	21	Array Slot #21	SLOT 021,<SERIAL #>
716	02CCh	32	0,22	23	22	Array Slot #22	SLOT 022,<SERIAL #>
748	02ECh	32	0,23	24	23	Array Slot #23	SLOT 023,<SERIAL #>
780	030Ch	32	0,24	25	24	Array Slot #24	SLOT 024,<SERIAL #>
812	032Ch	32	0,25	26	25	Array Slot #25	SLOT 025,<SERIAL #>
844	034Ch	32	0,26	27	26	Array Slot #26	SLOT 026,<SERIAL #>
876	036Ch	32	0,27	28	27	Array Slot #27	SLOT 027,<SERIAL #>
908	038Ch	32	0,28	29	28	Array Slot #28	SLOT 028,<SERIAL #>
940	03ACh	32	0,29	30	29	Array Slot #29	SLOT 029,<SERIAL #>
972	03CCh	32	0,30	31	30	Array Slot #30	SLOT 030,<SERIAL #>
1004	03ECh	32	0,31	32	31	Array Slot #31	SLOT 031,<SERIAL #>
1036	040Ch	32	0,32	33	32	Array Slot #32	SLOT 032,<SERIAL #>
1068	042Ch	32	0,33	34	33	Array Slot #33	SLOT 033,<SERIAL #>
1100	044Ch	32	0,34	35	34	Array Slot #34	SLOT 034,<SERIAL #>
1132	046Ch	32	0,35	36	35	Array Slot #35	SLOT 035,<SERIAL #>

Without MFC Data		Size	Element Index			Description	
Dec	Hex		SG3	Abs	Rel		
1164	048Ch	32	0,36	37	36	Array Slot #36	SLOT 036,<SERIAL #>
1196	04ACh	32	0,37	38	37	Array Slot #37	SLOT 037,<SERIAL #>
1228	04CCh	32	0,38	39	38	Array Slot #38	SLOT 038,<SERIAL #>
1260	04ECh	32	0,39	40	39	Array Slot #39	SLOT 039,<SERIAL #>
1292	050Ch	32	0,40	41	40	Array Slot #40	SLOT 040,<SERIAL #>
1324	052Ch	32	0,41	42	41	Array Slot #41	SLOT 041,<SERIAL #>
1356	054Ch	32	0,42	43	42	Array Slot #42	SLOT 042,<SERIAL #>
1388	056Ch	32	0,43	44	43	Array Slot #43	SLOT 043,<SERIAL #>
1420	058Ch	32	0,44	45	44	Array Slot #44	SLOT 044,<SERIAL #>
1452	05ACh	32	0,45	46	45	Array Slot #45	SLOT 045,<SERIAL #>
1484	05CCh	32	0,46	47	46	Array Slot #46	SLOT 046,<SERIAL #>
1516	05ECh	32	0,47	48	47	Array Slot #47	SLOT 047,<SERIAL #>
1548	060Ch	32	0,48	49	48	Array Slot #48	SLOT 048,<SERIAL #>
1580	062Ch	32	0,49	50	49	Array Slot #49	SLOT 049,<SERIAL #>
1612	064Ch	32	0,50	51	50	Array Slot #50	SLOT 050,<SERIAL #>
1644	066Ch	32	0,51	52	51	Array Slot #51	SLOT 051,<SERIAL #>
1676	068Ch	32	0,52	53	52	Array Slot #52	SLOT 052,<SERIAL #>
1708	06ACh	32	0,53	54	53	Array Slot #53	SLOT 053,<SERIAL #>
1740	06CCh	32	0,54	55	54	Array Slot #54	SLOT 054,<SERIAL #>
1772	06ECh	32	0,55	56	55	Array Slot #55	SLOT 055,<SERIAL #>
1804	070Ch	32	0,56	57	56	Array Slot #56	SLOT 056,<SERIAL #>
1836	072Ch	32	0,57	58	57	Array Slot #57	SLOT 057,<SERIAL #>
1868	074Ch	32	0,58	59	58	Array Slot #58	SLOT 058,<SERIAL #>
1900	076Ch	32	0,59	60	59	Array Slot #59	SLOT 059,<SERIAL #>
Enclosure Element							
1932	078Ch	4	1,-1	61		Enclosure Overall	
1936	0790h	128	1,0	62	0	Enclosure #00	ENCLOSURE,<ENC PART #>,<ENC SERIAL #>,<BRD Part #>,<BRD Serial #>
Power Supply Element							
2064	0810h	4	2,-1	63		Power Supply Overall	
2068	0814h	96	2,0	64	0	Power Supply #00	POWER SUPPLY A,<PART #>,<SERIAL #>,<REV>,<NAME>,<CAPACITY>

Without MFC Data		Size	Element Index			Description	
Dec	Hex		SG3	Abs	Rel		
2164	0874h	96	2,1	65	1	Power Supply #01	POWER SUPPLY B,<PART #>,<SERIAL #>,<REV>,<NAME>,<CAPACITY>
Cooling Element							
2260	08D4h	4	3,-1	66		Fan Overall	
2264	08D8h	20	3,0	67	0	Fan #00	FAN ENCL 1
2284	08ECh	20	3,1	68	1	Fan #01	FAN ENCL 2
2304	0900h	20	3,2	69	2	Fan #02	FAN ENCL 3
2324	0914h	20	3,3	70	3	Fan #03	FAN ENCL 4
2344	0928h	20	3,4	71	4	Fan #04	FAN IOM 1
2364	093Ch	20	3,5	72	5	Fan #05	FAN IOM 2
Temperature Element							
2384	0950h	4	4,-1	73		Temperature Sensor Overall	
2388	0954h	20	4,0	74	0	Temperature #0	TEMP SLOT 000
2408	0968h	20	4,1	75	1	Temperature #1	TEMP SLOT 001
2428	097Ch	20	4,2	76	2	Temperature #2	TEMP SLOT 002
2448	0990h	20	4,3	77	3	Temperature #3	TEMP SLOT 003
2468	09A4h	20	4,4	78	4	Temperature #4	TEMP SLOT 004
2488	09B8h	20	4,5	79	5	Temperature #5	TEMP SLOT 005
2508	09CCh	20	4,6	80	6	Temperature #6	TEMP SLOT 006
2528	09E0h	20	4,7	81	7	Temperature #7	TEMP SLOT 007
2548	09F4h	20	4,8	82	8	Temperature #8	TEMP SLOT 008
2568	0A08h	20	4,9	83	9	Temperature #9	TEMP SLOT 009
2588	0A1Ch	20	4,10	84	10	Temperature #10	TEMP SLOT 010
2608	0A30h	20	4,11	85	11	Temperature #11	TEMP SLOT 011
2628	0A44h	20	4,12	86	12	Temperature #12	TEMP SLOT 012
2648	0A58h	20	4,13	87	13	Temperature #13	TEMP SLOT 013
2668	0A6Ch	20	4,14	88	14	Temperature #14	TEMP SLOT 014
2688	0A80h	20	4,15	89	15	Temperature #15	TEMP SLOT 015
2708	0A94h	20	4,16	90	16	Temperature #16	TEMP SLOT 016
2728	0AA8h	20	4,17	91	17	Temperature #17	TEMP SLOT 017
2748	0ABCh	20	4,18	92	18	Temperature #18	TEMP SLOT 018
2768	0AD0h	20	4,19	93	19	Temperature #19	TEMP SLOT 019

Without MFC Data		Size	Element Index			Description	
Dec	Hex		SG3	Abs	Rel		
2788	0AE4h	20	4,20	94	20	Temperature #20	TEMP SLOT 020
2808	0AF8h	20	4,21	95	21	Temperature #21	TEMP SLOT 021
2828	0B0Ch	20	4,22	96	22	Temperature #22	TEMP SLOT 022
2848	0B20h	20	4,23	97	23	Temperature #23	TEMP SLOT 023
2868	0B34h	20	4,24	98	24	Temperature #24	TEMP SLOT 024
2888	0B48h	20	4,25	99	25	Temperature #25	TEMP SLOT 025
2908	0B5Ch	20	4,26	100	26	Temperature #26	TEMP SLOT 026
2928	0B70h	20	4,27	101	27	Temperature #27	TEMP SLOT 027
2948	0B84h	20	4,28	102	28	Temperature #28	TEMP SLOT 028
2968	0B98h	20	4,29	103	29	Temperature #29	TEMP SLOT 029
2988	0BACh	20	4,30	104	30	Temperature #30	TEMP SLOT 030
3008	0BC0h	20	4,31	105	31	Temperature #31	TEMP SLOT 031
3028	0BD4h	20	4,32	106	32	Temperature #32	TEMP SLOT 032
3048	0BE8h	20	4,33	107	33	Temperature #33	TEMP SLOT 033
3068	0BFCh	20	4,34	108	34	Temperature #34	TEMP SLOT 034
3088	0C10h	20	4,35	109	35	Temperature #35	TEMP SLOT 035
3108	0C24h	20	4,36	110	36	Temperature #36	TEMP SLOT 036
3128	0C38h	20	4,37	111	37	Temperature #37	TEMP SLOT 037
3148	0C4Ch	20	4,38	112	38	Temperature #38	TEMP SLOT 038
3168	0C60h	20	4,39	113	39	Temperature #39	TEMP SLOT 039
3188	0C74h	20	4,40	114	40	Temperature #40	TEMP SLOT 040
3208	0C88h	20	4,41	115	41	Temperature #41	TEMP SLOT 041
3228	0C9Ch	20	4,42	116	42	Temperature #42	TEMP SLOT 042
3248	0CB0h	20	4,43	117	43	Temperature #43	TEMP SLOT 043
3268	0CC4h	20	4,44	118	44	Temperature #44	TEMP SLOT 044
3288	0CD8h	20	4,45	119	45	Temperature #45	TEMP SLOT 045
3308	0CECh	20	4,46	120	46	Temperature #46	TEMP SLOT 046
3328	0D00h	20	4,47	121	47	Temperature #47	TEMP SLOT 047
3348	0D14h	20	4,48	122	48	Temperature #48	TEMP SLOT 048
3368	0D28h	20	4,49	123	49	Temperature #49	TEMP SLOT 049
3388	0D3Ch	20	4,50	124	50	Temperature #50	TEMP SLOT 050
3408	0D50h	20	4,51	125	51	Temperature #51	TEMP SLOT 051
3428	0D64h	20	4,52	126	52	Temperature #52	TEMP SLOT 052

Without MFC Data		Size	Element Index			Description	
Dec	Hex		SG3	Abs	Rel		
3448	0D78h	20	4,53	127	53	Temperature #53	TEMP SLOT 053
3468	0D8Ch	20	4,54	128	54	Temperature #54	TEMP SLOT 054
3488	0DA0h	20	4,55	129	55	Temperature #55	TEMP SLOT 055
3508	0DB4h	20	4,56	130	56	Temperature #56	TEMP SLOT 056
3528	0DC8h	20	4,57	131	57	Temperature #57	TEMP SLOT 057
3548	0DDCh	20	4,58	132	58	Temperature #58	TEMP SLOT 058
3568	0DF0h	20	4,59	133	59	Temperature #59	TEMP SLOT 059
3588	0E04h	20	4,60	134	60	Temperature #60	TEMP IOM A AMB
3608	0E18h	20	4,61	135	61	Temperature #61	TEMP IOM B AMB
3628	0E2Ch	20	4,62	136	62	Temperature #62	TEMP BB 60 1
3648	0E40h	20	4,63	137	63	Temperature #63	TEMP BB 60 2
3668	0E54h	20	4,64	138	64	Temperature #64	TEMP BB 42 1
3688	0E68h	20	4,65	139	65	Temperature #65	TEMP BB 42 2
3708	0E7Ch	20	4,66	140	66	Temperature #66	TEMP PRI A DIE
3728	0E90h	20	4,67	141	67	Temperature #67	TEMP SEC1 A DIE
3748	0EA4h	20	4,68	142	68	Temperature #68	TEMP SEC2 A DIE
3768	0EB8h	20	4,69	143	69	Temperature #69	TEMP PRI B DIE
3788	0ECCh	20	4,70	144	70	Temperature #70	TEMP SEC1 B DIE
3808	0EE0h	20	4,71	145	71	Temperature #71	TEMP SEC2 B DIE
3828	0EF4h	20	4,72	146	72	Temperature #72	TEMP PRI A MEM
3848	0F08h	20	4,73	147	73	Temperature #73	TEMP SEC1 A MEM
3868	0F1Ch	20	4,74	148	74	Temperature #74	TEMP SEC2 A MEM
3888	0F30h	20	4,75	149	75	Temperature #75	TEMP PRI B MEM
3908	0F44h	20	4,76	150	76	Temperature #76	TEMP SEC1 B MEM
3928	0F58h	20	4,77	151	77	Temperature #77	TEMP SEC2 B MEM
3948	0F6Ch	20	4,78	152	78	Temperature #78	TEMP IOM A 5V
3968	0F80h	20	4,79	153	79	Temperature #79	TEMP IOM B 5V
3988	0F94h	20	4,80	154	80	Temperature #80	TEMP PSU A AMB
4008	0FA8h	20	4,81	155	81	Temperature #81	TEMP PSU A HOT
4028	0FBCh	20	4,82	156	82	Temperature #82	TEMP PSU A PRI
4048	0FD0h	20	4,83	157	83	Temperature #83	TEMP PSU B AMB
4068	0FE4h	20	4,84	158	84	Temperature #84	TEMP PSU B HOT
4088	0FF8h	20	4,85	159	85	Temperature #85	TEMP PSU B PRI

Without MFC Data		Size	Element Index			Description	
Dec	Hex		SG3	Abs	Rel		
ESCE Element							
4108	100Ch	4	5,-1	160		ESCE Overall	
4112	1010h	160	5,0	161	0	ESCE #0	ESCE IOMA,<PART #>,<SERIAL #>,<SAS>,<IP>
4272	10B0h	160	5,1	162	1	ESCE #1	ESCE IOMB,<PART #>,<SERIAL #>,<SAS>,<IP>
Expander Element							
4432	1150h	4	6,-1	163		SAS Expander Overall	
4436	1154h	40	6,0	164	0	SAS Expander #0	EXP IOMA 0,<FW VER>,<SAS>
4476	117Ch	40	6,1	165	1	SAS Expander #1	EXP IOMA 1,<FW VER>,<SAS>
4516	11A4h	40	6,2	166	2	SAS Expander #2	EXP IOMA 2,<FW VER>,<SAS>
4556	11CCh	40	6,3	167	3	SAS Expander #3	EXP IOMB 0,<FW VER>,<SAS>
4596	11F4h	40	6,4	168	4	SAS Expander #4	EXP IOMB 1,<FW VER>,<SAS>
4636	121Ch	40	6,5	169	5	SAS Expander #5	EXP IOMB 2,<FW VER>,<SAS>
Connector Element							
4676	1244h	4	7,-1	170		Connector Overall	
4680	1248h	20	7,0	171	0	Connector #0	CONN HOST 00
4700	125Ch	20	7,1	172	1	Connector #01	CONN HOST 01
4720	1270h	20	7,2	173	2	Connector #02	CONN HOST 02
4740	1284h	20	7,3	174	3	Connector #03	CONN HOST 03
4760	1298h	20	7,4	175	4	Connector #04	CONN HOST 04
4780	12ACh	20	7,5	176	5	Connector #05	CONN HOST 05
4800	12C0h	20	7,6	177	6	Connector #06	CONN HOST 06
4820	12D4h	20	7,7	178	7	Connector #07	CONN HOST 07
4840	12E8h	20	7,8	179	8	Connector #08	CONN HOST 08
4860	12FCh	20	7,9	180	9	Connector #09	CONN HOST 09
4880	1310h	20	7,10	181	10	Connector #10	CONN HOST 10
4900	1324h	20	7,11	182	11	Connector #11	CONN HOST 11
Voltage Sensor Element							

Without MFC Data		Size	Element Index			Description	
Dec	Hex		SG3	Abs	Rel		
4920	1338h	4	8,-1	183		Voltage Overall	
4924	133Ch	20	8,0	184	0	Voltage Sensor #00	VOLT PSU A AC IN
4944	1350h	20	8,1	185	1	Voltage Sensor #01	VOLT PSU A 12V OUT
4964	1364h	20	8,2	186	2	Voltage Sensor #02	VOLT PSU B AC IN
4984	1378h	20	8,3	187	3	Voltage Sensor #03	VOLT PSU B 12V OUT
5004	138Ch	20	8,4	188	4	Voltage Sensor #04	VOLT IOM A 5V
5024	13A0h	20	8,5	189	5	Voltage Sensor #05	VOLT IOM B 5V
Current Sensor Element							
5044	13B4h	4	9,-1	190		Current Sensor Overall	
5048	13B8h	20	9,0	191	0	Current Sensor #00	CURR PSU A IN
5068	13CCh	20	9,1	192	1	Current Sensor #01	CURR PSU A OUT
5088	13E0h	20	9,2	193	2	Current Sensor #02	CURR PSU B IN
5108	13F4h	20	9,3	194	3	Current Sensor #03	CURR PSU B OUT
5128	1408h	20	9,4	195	4	Current Sensor #04	CURR IOM A 12V
5148	141Ch	20	9,5	196	5	Current Sensor #05	CURR IOM A 5V
5168	1430h	20	9,6	197	6	Current Sensor #06	CURR IOM B 12V
5188	1444h	20	9,7	198	7	Current Sensor #07	CURR IOM B 5V
Door Element							
5208	1458h	4	10,-1	199		Door Overall	
5212	145Ch	20	10,0	200	0	Door #00	ENCLOSURE COVER
5232	1470h						

4.8 Overall Element Descriptor Format

4.8.1 Overall Element Descriptor

The following table displays the enclosure - Overall Element Descriptor information:

Note: The Overall Element Descriptor for all element types is not used and will only contain a blank header.

Table 30: Ultrastar Data60 - Overall Element Descriptor

Offsets		Size	Description
Dec	Hex		
0	0000h	2	Reserved (0000h)
2	0002h	2	Descriptor Length (0000h)
4	0004h	END OF DESCRIPTOR	

4.9 Additional Element Status Diagnostic Page (0Ah)

The Additional Element Status diagnostic page contains additional status information about three types of SCSI Enclosure Services (SES) defined element instances:

- Array Device Slot Elements
- Enclosure Services Controller Electronics (ESCE) Elements
- Serial Attached SCSI (SAS) Expander Elements

The following table displays the Additional Element Status Diagnostic page:

Table 31: Additional Element Status Diagnostic

Byte/Bit		7	6	5	4	3	2	1	0
PAGE HEADER									
0	0000h	PAGE CODE (0Ah)							
1	0001h	Reserved							
2	0002h	(MSB)	PAGE LENGTH (n – 3)						
3	0003h								(LSB)
GENERATION CODE									
4	0004h		GENERATION CODE (00000000h)						
7	0007h								
ADDITIONAL ELEMENT STATUS - ARRAY SLOTS									

Byte/Bit		7	6	5	4	3	2	1	0
8	0008h		Array Device Slot Additional Element Status – first instance						
43	002Bh								
...	...	...							
			Array Device Slot Additional Element Status – last instance						
ADDITIONAL ELEMENT STATUS - ESCE									
			ESCE Element – first instance						
		...							
			ESCE Element – last instance						
ADDITIONAL ELEMENT STATUS - SAS EXPANDERS									
			SAS Expander Element Descriptor – first instance						
		...							
			SAS Expander Element Descriptor – last instance						

The following tables displays offsets an Array Slot, SAS Expander, and SEP Processor in a Ultrastar Data60 :

Table 32: Additional Element Status

Offsets		Size	Element Index		Description
Dec	Hex		SG3	Abs	
0	0000h	8			SES Page Header
Array Slot Elements					
8	0008h	36	0,0	0	Array Slot #0
44	002Ch	36	0,1	1	Array Slot #1
80	0050h	36	0,2	2	Array Slot #2
116	0074h	36	0,3	3	Array Slot #3
152	0098h	36	0,4	4	Array Slot #4
188	00BCh	36	0,5	5	Array Slot #5
224	00E0h	36	0,6	6	Array Slot #6
260	0104h	36	0,7	7	Array Slot #7
296	0128h	36	0,8	8	Array Slot #8
332	014Ch	36	0,9	9	Array Slot #9

Offsets		Size	Element Index		Description
Dec	Hex		SG3	Abs	
368	0170h	36	0,10	10	Array Slot #10
404	0194h	36	0,11	11	Array Slot #11
440	01B8h	36	0,12	12	Array Slot #12
476	01DCh	36	0,13	13	Array Slot #13
512	0200h	36	0,14	14	Array Slot #14
548	0224h	36	0,15	15	Array Slot #15
584	0248h	36	0,16	16	Array Slot #16
620	026Ch	36	0,17	17	Array Slot #17
656	0290h	36	0,18	18	Array Slot #18
692	02B4h	36	0,19	19	Array Slot #19
728	02D8h	36	0,20	20	Array Slot #20
764	02FCh	36	0,21	21	Array Slot #21
800	0320h	36	0,22	22	Array Slot #22
836	0344h	36	0,23	23	Array Slot #23
872	0368h	36	0,24	24	Array Slot #24
908	038Ch	36	0,25	25	Array Slot #25
944	03B0h	36	0,26	26	Array Slot #26
980	03D4h	36	0,27	27	Array Slot #27
1016	03F8h	36	0,28	28	Array Slot #28
1052	041Ch	36	0,29	29	Array Slot #29
1088	0440h	36	0,30	30	Array Slot #30
1124	0464h	36	0,31	31	Array Slot #31
1160	0488h	36	0,32	32	Array Slot #32
1196	04ACh	36	0,33	33	Array Slot #33
1232	04D0h	36	0,34	34	Array Slot #34
1268	04F4h	36	0,35	35	Array Slot #35
1304	0518h	36	0,36	36	Array Slot #36
1340	053Ch	36	0,37	37	Array Slot #37
1376	0560h	36	0,38	38	Array Slot #38
1412	0584h	36	0,39	39	Array Slot #39
1448	05A8h	36	0,40	40	Array Slot #40
1484	05CCh	36	0,41	41	Array Slot #41
1520	05F0h	36	0,42	42	Array Slot #42
1556	0614h	36	0,43	43	Array Slot #43

Offsets		Size	Element Index		Description
Dec	Hex		SG3	Abs	
1592	0638h	36	0,44	44	Array Slot #44
1628	065Ch	36	0,45	45	Array Slot #45
1664	0680h	36	0,46	46	Array Slot #46
1700	06A4h	36	0,47	47	Array Slot #47
1736	06C8h	36	0,48	48	Array Slot #48
1772	06ECh	36	0,49	49	Array Slot #49
1808	0710h	36	0,50	50	Array Slot #50
1844	0734h	36	0,51	51	Array Slot #51
1880	0758h	36	0,52	52	Array Slot #52
1916	077Ch	36	0,53	53	Array Slot #53
1952	07A0h	36	0,54	54	Array Slot #54
1988	07C4h	36	0,55	55	Array Slot #55
2024	07E8h	36	0,56	56	Array Slot #56
2060	080Ch	36	0,57	57	Array Slot #57
2096	0830h	36	0,58	58	Array Slot #58
2132	0854h	36	0,59	59	Array Slot #59
ESCE Elements					
2168	0878h	20	5,0	60	ESCE #0
2188	088Ch	20	5,0	61	ESCE #1
SAS Expander Elements					
2208	08A0h	114	6,0	62	SAS Expander #0
2322	0912h	152	6,1	63	SAS Expander #1
2474	09AAh	152	6,0	64	SAS Expander #2
2626	0A42h	114	6,1	65	SAS Expander #3
2740	0AB4h	152	6,0	66	SAS Expander #4
2892	0B4Ch	152	6,1	67	SAS Expander #5
3044	0BE4h	**END OF PAGE**			

4.10 Download Microcode Control/Status Diagnostic Page (0Eh)

The Download Microcode diagnostic page is used to transmit a firmware image to the enclosure services process.

The PAGE LENGTH field indicates the number of bytes in the header block and data bytes.

The MODE field is set to the value 0Eh to indicate that a segment of firmware is being downloaded to the SCSI Enclosure Processor (SEP). The length of the entire firmware image is in FIRMWARE IMAGE LENGTH. The data associated with the current segment of firmware being downloaded is located in FIRMWARE PACKET DATA, the length of the current segment is in FIRMWARE PACKET LENGTH, and the offset of the segment is in BUFFER OFFSET. The host must send the individual segments in order of increasing BUFFER OFFSET.

The MODE field is set to the value 0Fh to pass notification to the SEP to begin using the new firmware image data sent by previous commands with the MODE field set to 0Eh. When the MODE field is set to 0Fh, FIRMWARE PACKET LENGTH is expected to be 00h.

The BUFFER ID field must always be set to 00h. The SEP code update process automatically detects the firmware components provided in the data phase and distributes the new images to the expanders, power supply, and so on. Drives are not updated via this mechanism. In the case of SEP code update, the enclosure automatically distributes the received code image to all expanders in the enclosure.

The following table displays the Download Microcode Control Diagnostic page:

Table 33: Download Microcode Control Diagnostic Page

Byte/Bit		7	6	5	4	3	2	1	0
PAGE HEADER									
0	00h	PAGE CODE (0Eh)							
1	01h	SUBENCLOSURE IDENTIFIER (00h)							
2	02h	(MSB)	PAGE LENGTH (n – 3)						
3	03h								(LSB)
DOWNLOAD MICROCODE DATA HEADER									
4	04h	EXPECTED GENERATION CODE (00000000h)							
7	07h								
8	08h	MODE (0Eh or 0Fh)							
9	09h	Reserved							
10	0Ah								
11	0Bh	BUFFER ID (00h)							
12	0Ch	BUFFER OFFSET (0000h – End of Image)							
15	0Fh								
16	10h	FIRMWARE IMAGE LENGTH (Total length of firmware image)							
19	13h								
20	14h	FIRMWARE PACKET LENGTH (Length of FIRMWARE PACKET DATA)							
23	17h								
DOWNLOAD MICROCODE DATA									
24	18h	FIRMWARE PACKET DATA (512, 1024, 2048, up to 4096 bytes)							
m									
m+1		Pad with 00h to a multiple of 4-bytes, if needed							

Byte/Bit		7	6	5	4	3	2	1	0
n									

The following table displays the Download Microcode Status Diagnostic page:

Note: The Download Microcode status page is used to retrieve status information about the previous download control operation.

Table 34: Download Microcode Status Diagnostic Page

Byte/Bit		7	6	5	4	3	2	1	0
PAGE HEADER									
0	00h	PAGE CODE (0Eh)							
1	01h	NUMBER OF SECONDARY SUBENCLOSURES (00h)							
2	02h	PAGE LENGTH (14h)							
3	03h								
DOWNLOAD MICROCODE STATUS									
4	04h	GENERATION CODE (00000000h)							
7	07h								
8	08h	Reserved							
9	09h	SUBENCLOSURE IDENTIFIER (00h)							
10	0Ah	DOWNLOAD MICROCODE STATUS							
11	0Bh	DOWNLOAD MICROCODE ADDITIONAL STATUS							
12	0Ch	DOWNLOAD MICROCODE MAXIMUM SIZE							
15	0Fh								
16	10h	Reserved							
18	12h								
19	13h	DOWNLOAD MICROCODE EXPECTED BUFFER ID							
20	14h	DOWNLOAD MICROCODE EXPECTED BUFFER OFFSET							
23	17h								

4.11 Subenclosure Nickname Control/Status Diagnostic Page (0Fh)

The **Subenclosure Nickname** page stores a text string that serves as a nickname for the specified subenclosure. The nickname is saved to nonvolatile storage (e.g., a flash ROM) so it may be retrieved after future hard resets.

Control Page

The following table displays the format of the **Subenclosure Nickname Control Diagnostic Page**:

Table 35: Subenclosure Nickname Control Diagnostic Page

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	PAGE CODE (0Fh)							
1	01h	SUBENCLOSURE IDENTIFIER							
2	02h	(MSB)	PAGE LENGTH (0024h)						
3	03h								(LSB)
4	04h	(MSB)	EXPECTED GENERATION CODE						
...									
7	07h								(LSB)
8	08h	SUBENCLOSURE NICKNAME							
...									
39	27h								

- The **Subenclosure Identifier** field specifies the subenclosure to which the application client is sending the nickname.
- The **Page Length** field specifies the number of bytes that follow in the diagnostic page.
- The **Subenclosure Nickname** field specifies the subenclosure nickname.

Status Page

The following table displays the format of the **Subenclosure Nickname Status Diagnostic Page**:

Table 36: Subenclosure Nickname Status Diagnostic Page

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	PAGE CODE (0Fh)							
1	01h	NUMBER OF SECONDARY SUBENCLOSURES							
2	02h	(MSB)	PAGE LENGTH (n - 3)						
3	03h								(LSB)
4	04h	(MSB)	GENERATION CODE						
...									

Byte/Bit		7	6	5	4	3	2	1	0
7	07h								(LSB)
Subenclosure Nickname Status Descriptor List									
8	08h	Subenclosure nickname status descriptor (primary subenclosure) (see Table 36: Subenclosure Nickname Status Descriptor *(page 59)*)							
...									
47	2Fh								

- The **Number of Secondary Subenclosures** field indicates the number of secondary subenclosure nickname status descriptor values that are included, not including the primary subenclosure.
- The **Page Length** field indicates the number of bytes that follow in the diagnostic page.
- The **Subenclosure Nickname Status Descriptor List** contains a status descriptor for each subenclosure nickname reported.

The following table defines the format of each descriptor—the first is for the primary subenclosure, and the rest are for secondary subenclosures.

Table 37: Subenclosure Nickname Status Descriptor

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	Reserved							
1	01h	SUBENCLOSURE IDENTIFIER							
2	02h	SUBENCLOSURE ENCLOSURE NICKNAME STATUS							
3	03h	SUBENCLOSURE ENCLOSURE NICKNAME ADDITIONAL STATUS							
4	04h	Reserved							
5	05h								
6	06h	(MSB)	SUBENCLOSURE NICKNAME LANGUAGE CODE						
7	07h								(LSB)
8	08h	SUBENCLOSURE NICKNAME							
...	...								
39	27h								

- The **Subenclosure Identifier** field indicates the subenclosure to which the nickname status descriptor applies.
- The **Subenclosure Nickname Status** field indicates the status of nickname operations for the subenclosure, defined in Table 37: Subenclosure Nickname Status Field *(page 59)*.
- The **Subenclosure Nickname Additional Status** field provides additional status for certain values of the **Subenclosure Nickname Status** field, described in Table 37: Subenclosure Nickname Status Field *(page 59)*.
- The **Subenclosure Nickname** field indicates the subenclosure nickname.

Table 38: Subenclosure Nickname Status Field

Code	Description
00h	No errors

Code	Description
80h	Error in one or more of the Subenclosure Nickname Control diagnostic page fields. The SUBENCLOSURE NICKNAME ADDITIONAL STATUS field shall be set to the offset of the lowest byte of the field in the Subenclosure Nickname Control diagnostic page that has an error.
81h	Internal error. The nickname is lost.
82h	Internal error. The previous nickname preserved.
All others	Reserved

4.12 Tag Data Out/In Diagnostic Page (10h)

The Tag Data diagnostic page is a vendor unique SCSI Enclosure Services (SES) diagnostic page that provides the host with access to a 4096 byte tag data buffer. The tag data buffer is non-volatile, and is stored in Enclosure vital product data (VPD).

This buffer can be written with arbitrary American Standard Code for Information Interchange (ASCII) or hexadecimal (HEX) data. Each write to the tag data buffer, regardless of the size written, replaces the entire contents of the tag data buffer. Writing 0 bytes, PAGE LENGTH = 3, will clear the tag data buffer.

On reads, the PAGE LENGTH will indicate the length of the tag data which has actually been stored in the enclosure. In other words, reading the tag data buffer returns an amount of data equal to the length of the last write to the tag data buffer, rather than the maximum size of the Tag Data region.

The following table displays the Tag Data Out/In page:

Table 39: Tag Data Out/In Diagnostic Page

Byte/Bit		7	6	5	4	3	2	1	0
PAGE HEADER									
0	00h	PAGE CODE (10h)							
1	01h	Reserved							
2	02h	(MSB)	PAGE LENGTH (0 to 1000h)						
3	03h								(LSB)
TAG DATA									
4	04h	TAG DATA (0-4096 bytes)							
4099	1003h								

4.13 MiniSAS HD Cable VPD Diagnostic Page (17h)

The MiniSAS HD Cable VPD Diagnostic Page is a vendor unique SES diagnostic page that provides the host with access to the VPD information located in the MiniSAS HD host port cables. The information provided for each port is described in the following table. The content in the individual fields are defined by **SFF-8644**. If a MiniSAS HD port does not have a cable plugged into it, the corresponding fields for that port are populated with zeros (00h) in the table below.

Table 40: MiniSAS HD Cable VPD Diagnostic Page

Byte/Bit		7	6	5	4	3	2	1	0
PAGE HEADER									
0	00h	PAGE CODE (17h)							
1	01h	Reserved							
2	02h	(MSB)	PAGE LENGTH (1000h)						
3	03h								(LSB)
CABLE VPD DATA									
4	04h	MINI-SAS HD PORT A – LOWER PAGE 00 (byte 0)							
...	...	...							
131	83h	MINI-SAS HD PORT A – LOWER PAGE 00 (byte 127)							
132	84h	MINI-SAS HD PORT A – UPPER MEMORY MAP PAGE 00 (byte 0)							
...	...	...							
259	103h	MINI-SAS HD PORT A – UPPER MEMORY MAP PAGE 00 (byte 127)							
260	104h	MINI-SAS HD PORT H – LOWER PAGE 00 (byte 0)							
...	...	...							
387	183h	MINI-SAS HD PORT H – LOWER PAGE 00 (byte 127)							
388	184h	MINI-SAS HD PORT H – UPPER MEMORY MAP PAGE 00 (byte 0)							
...	...	...							
4100	1004h	MINI-SAS HD PORT H – UPPER MEMORY MAP PAGE 00 (byte 127)							

SES Elements

In This Chapter:

5.1 SES Element Status Codes

This section provides referential information related to SES element types and supported element status codes.

Table 41: SES Element Types

PSU (0x02)	Voltage Sensor (0x12)
Fan (0x03)	Current Sensor (0x13)
Temperature Sensor (04)	Array Slot (0x17)
Door (0x05)	Expander (0x18)
Encl Services Controller Electronics (IOM) (0x7)	SAS Connector (0x19)
Enclosure (0x0e)	—

Note: Some of the element statuses can be effected by hosts issuing Page 2 control requests. Most of these have not been accounted for in the list of Supported Element Status Codes.

The following is a list of Supported Element Status Codes:

Status Code	Status Value
OK	1
CRITICAL	2
NONCRIT	3
UNRECOV	4
NOTINST	5
UNKNOWN	6
NOTAVAIL	7
NOACCESS	8

When the host sets a nonCrit, Crit, or unRecov bit using control page 2, the bit is marked as FAULT_REQUESTER_SES. When the page 3 builder runs, it displays a result of "HOST" for these entries in the page 2 header. If marked for any other reason, it will display "SES" as seen in the following example:

```
|Enclosure Overall Status|
 NON-CRIT=1 (SES)
 CRIT=1 (HOST)
```

There are statuses that help indicate what sets the bits on individual elements. They are displayed by the page 3 builder and include:

Value	Specification
SES	set by host via page 2 control

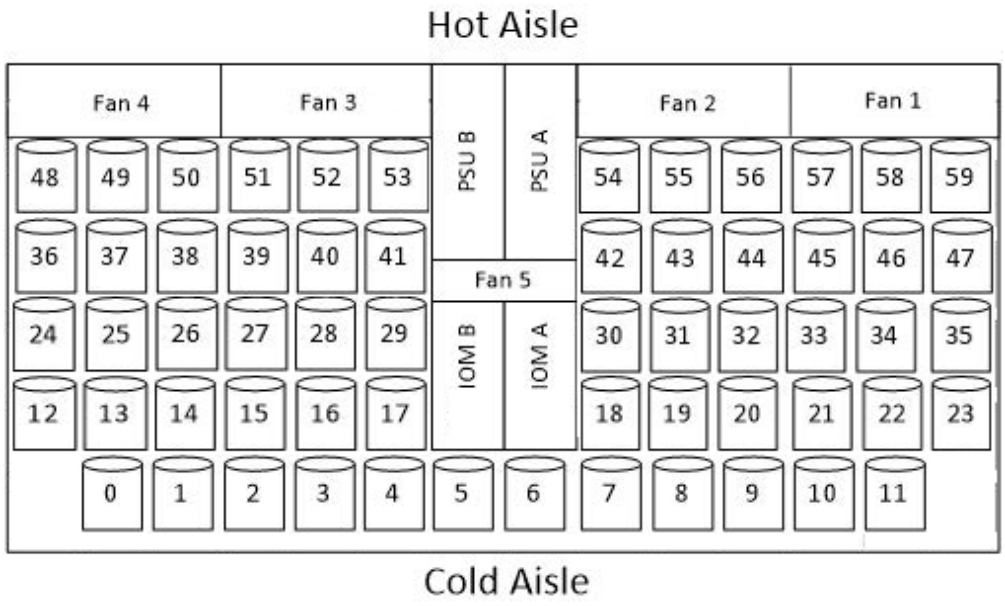
Value	Specification
THRESHOLD	set by voltage, current or temperature threshold exceptions
SES GEN	set by SES generic update on critical or non-critical state
SES ELEM	set by SES element update
THERMAL	set as result of thermal compromise
CONFIG	set when enclosure misconfiguration has been detected

The following is an example of the status bit on an individual element:

```
|SES Status|
 TEMP SLOT B33:Critical(THRESHOLD)
```

5.2 Array Slot

Figure 10: Physical Array Slot Layout



Note: While the enclosure supports SPC-5 compliant device reporting, the enclosure primarily supports commands for SPC-4 compliant devices.

Note: RQST IDENT, PRDFAIL, DEVICE OFF, and RQST FAULT are considered persistent for Array device fields. When these fields are set through a control request page 2, they will retain their state through enclosure resets and drive replacements. To clear these fields when set by page 2, another page 2 must be sent with the desired field cleared. If these fields are set without control page 2, then they will not be persistent and will clear on reset or drive replacement.

5.2.1 Array Device Slot Element Control and Status Elements

The following table displays the Array Device Slot Element Control information:

Table 44: Array Device Slot Element Control

Byte/Bit		7	6	5	4	3	2	1	0
COMMON CONTROL									
0	00h	SELECT	PRDFAIL	Reserved	RST SWAP			Reserved	
1	01h	RQST OK	RQST RSVD DEVICE	RQST HOT SPARE	RQST CONS CHECK	RQST IN CRIT ARRAY	RQST IN FAILED ARRAY	RQST REBUILD/ REMAP	RQST R/R ABORT
2	02h	RQST ACTIVE	DO NOT REMOVE	Reserved	RQST MISSING	RQST INSERT	RQST REMOVE	RQST IDENT	Reserved
3	03h	Reserved		RQST FAULT	DEVICE OFF	ENABLE BYP A (0b)	ENABLE BYP B (0b)	Reserved	

The DEVICE OFF bit is used to power a drive off. The drive power-off operation will complete asynchronously with respect to host initiated I/O operations to that drive or others in the array. Due to limitations, some drive types supported by the Ultrastar Data60 architecture contain a finite maximum number of power cycles. The SCSI Enclosure Processor (SEP) will reject a DEVICE OFF request until a minimum relaxation time has elapsed since the last DEVICE OFF request for that Array Device slot. This will only occur if a large number of DEVICE OFF requests have been performed on that slot in the lifetime of the drive. Should this occur, the host will be given a Check Condition with sense data indicating which Array Device Slot Element instance requires this relaxation time.

During thermal shutdown conditions, the SEP will reject external host commands to control drive power. Once the SEP has exited thermal shutdown state, drive power states will be automatically returned to their prior states and future host requests to control drive power will be honored.

The following table displays the Array Device Slot Element Status:

Table 45: Array Device Slot Element Status

Byte/ Bit		7	6	5	4	3	2	1	0
COMMON STATUS									
0	00h	Reserved	PRDFAIL	Reserved	SWAP	ELEMENT STATUS CODE			
ARRAY DEVICE SLOT STATUS									
1	01h	OK	RSVD DEVICE	HOT SPARE	CONS CHECK	IN CRIT ARRAY	IN FAILED ARRAY	REBUILD/ REMAP	R/R ABORT
2	02h	APP CLIENT BYPASSED A (0b)	DO NOT REMOVE	ENCLOSUR BYPASSED A (0b)	ENCLOSUR BYPASSED B (0b)	READY TO INSERT	RMV	IDENT	REPORT (0b)

Byte/ Bit		7	6	5	4	3	2	1	0
3	03h	APP CLIENT BYPASSED B (0b)	FAULT SENSED	FAULT REQSTD	DEVICE OFF	BYPASSEI A (0b)	BYPASSEI B (0b)	DEVICE BYPASSEI A (0b)	DEVICE BYPASSED B (0b)

The ELEMENT STATUS CODE has a value of CRITICAL to indicate that the corresponding Array Device Slot is unable to communicate because the interconnect physical layer (PHY) has not achieved a link up state.

The ELEMENT STATUS CODE has a value of NON-CRITICAL to indicate that the corresponding Array Device Slot is able to communicate, but the interconnect PHY is operating at a non-optimal link rate.

The DEVICE OFF bit is true if the corresponding drive is powered off. A drive can be powered off in response to a host sending a SES Page 2 control page, or if the enclosure autonomously powers a drive off during a thermal offline state.

Table 46: Array Slot (0x17)

Status Code	Trigger
OK	Nominal
CRITICAL	Array slot device PHY not linked
NONCRIT	Array slot device PHY linked but not at expected rate
UNRECOV	Unsupported Drive in slot
NOTINST	Element not present
NOTAVAIL	• Temperature can not be read • Array element is present but off
NOACCESS	• Element is taken offline by thermal monitor. Temperature data also lost • Zoning is enabled but zone group of element is not accessible

5.2.2 Array Slot Element Descriptor

The following table displays the enclosure - Array Slot Element Descriptor information:

Note: The Location field will indicate the slot number within the enclosure. Unused bytes will be populated with ASCII space characters.

Table 47: Ultrastar Data60 - Array Slot Element Descriptor

Offsets		Size	Description
Dec	Hex		
Header			

Offsets		Size	Description
Dec	Hex		
0	00h	2	Reserved(0000h)
2	02h	2	Length (001Ch)
Descriptor			
4	04h	28	"SLOT NN", <SERIAL #>
32	20h	END OF DESCRIPTOR	

5.2.3 Additional Element Status Descriptor

The following table displays the Additional Element Status Descriptor – Array Device Slot information:

Table 48: Additional Element Status Descriptor – Array Device Slot

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	INVALID (0b)	Reserved		EIP (1b)	PROTOCOL IDENTIFIER (0110b)			
1	01h	ADDITIONAL ELEMENT STATUS DESCRIPTOR LENGTH (22h)							
2	02h	Reserved						EIIO (1b)	
3	03h	ELEMENT INDEX							
4	04h	NUMBER OF PHY DESCRIPTORS (1b)							
5	05h	TYPE (00b)		Reserved					NOT ALL PHYS (1b)
6	06h	Reserved							
7	07h	DEVICE SLOT NUMBER							
PHY DESCRIPTOR LIST									
8	08h	Reserved	DEVICE TYPE			Reserved			
9	09h	Reserved							
10	0Ah	Reserved				SSP INIT (0B)	STP INIT (0B)	SMP INIT (0B)	Reserved
11	0Bh	SATA PORT SELECTO (0b)	Reserved			SSP TARG	STP TARG (0b)	SMP TARG	SATA DEVICE (0b)
12	0Ch	ATTACHED SAS ADDRESS							
19	13h								

Byte/Bit		7	6	5	4	3	2	1	0
20	14h	SAS ADDRESS							
27	1Bh								
28	1Ch	PHY IDENTIFIER							
29	1Dh	Reserved							
35	23h								

The DEVICE TYPE field has the value 001b if a disk drive PHY is connected and linked at any link rate, and the value 000b otherwise.

The SSP TARG and SMP TARG bits have the value 1b if a disk drive PHY is connected and linked at any link rate, and the value 0b otherwise.

5.3 Enclosure

5.3.1 Enclosure Element Control and Status

The following table displays the Enclosure Element Control information:

Note: The Ultrastar Data60 architecture does not support power cycling the enclosure via the Enclosure element type. The capability to perform enclosure resets is provided in the String Out/In Diagnostic Page (04h) *(page 40)* section.

Table 49: Enclosure Element Control

Byte/Bit		7	6	5	4	3	2	1	0
COMMON CONTROL									
0	00h	SELECT	PRDFAIL	Reserved	RST SWAP	Reserved			
ENCLOSURE CONTROL									
1	01h	REQUEST IDENT	Reserved						
2	02h	POWER CYCLE REQUEST (00b)	POWER CYCLE DELAY (000000b)						
3	03h	POWER OFF DURATION (000000b)						REQUEST FAIL	REQUEST WARNING

The following table displays the Enclosure Element Status information:

Table 50: Enclosure Element Status

Byte/Bit	7	6	5	4	3	2	1	0
COMMON STATUS								

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	Reserve	PRDFAIL	Reserve	SWAP	ELEMENT STATUS CODE			
ENCLOSURE STATUS									
1	01h	IDENT	Reserved						
2	02h	TIME UNTIL POWER CYCLE (000000b)						FAILURE INDICATION	WARNING INDICATION
3	03h	POWER OFF DURATION (000000b)						FAILURE REQUESTED	WARNING REQUESTED

The SCSI Enclosure Processor (SEP) does not support host requests to power cycle or power off the enclosure.

The FAILURE INDICATION and WARNING INDICATION bits are only set to indicate failure and warning conditions which are requested by hosts by sending an Enclosure Element Control block. The WARNING INDICATION bit is set to 1 to indicate that either the PRDFAIL or the WARNING REQUESTED bits in the Enclosure Element Control block was set.

The FAILURE INDICATION and WARNING INDICATION bits do not serve as failure and warning summary bits for conditions that may exist in other element instances within the enclosure. The CRIT and NON CRIT bits in byte 1 of Enclosure Status Diagnostic page header indicate if any element instance within the enclosure is being reported with a critical or non-critical condition.

Table 51: Enclosure (0x0e)

Status Code	Trigger
OK	Nominal
CRITICAL	• Thermal compromise • IOM missing in dual IOM enclosure
NONCRIT	rqstWarn from HOST
NOTINST	Element not present

5.3.2 Enclosure Element Descriptor

The following table displays the enclosure - Enclosure Element Descriptor information:

Note: The VPD version contains a two byte ASCII value indicating the version of the VPD data. Unused bytes are populated with ASCII space characters.

Table 52: Ultrastar Data60 - Array Slot Element Descriptor

Offsets		Size	Description
Dec	Hex		
Header			
0	00h	2	Reserved(0000h)
2	02h	2	Length (007Ch)

Offsets		Size	Description
Dec	Hex		
Descriptor			
4	04h	28	"ENCLOSURE", <ENC PART #>, <ENC SERIAL #>, <BRD Part #>, <BRD Serial #>
128	80h	END OF DESCRIPTOR	

5.4 Power Supply

The Location field value will be set to a 16 byte ASCII string that describes the instance of the power supply. Unused bytes will be filled with ASCII space characters.

The Part Number and Serial Number fields will be blank (ASCII space characters) for missing or not installed power supplies. The Location field will always be reported, even if the power supply is not installed.

5.4.1 Power Supply Element Control and Status

The following table displays the Power Supply Element Control information:

Table 53: Power Supply Element Control

Byte/Bit		7	6	5	4	3	2	1	0
COMMON CONTROL									
0	00h	SELECT	PRDFAIL	Reserved	RST SWAP	Reserved			
POWER SUPPLY CONTROL									
1	01h	REQUES IDENT	DO NOT REMOVE (0b)	Reserved					
2	02h	Reserved							
3	03h	Reserved	RQST FAIL	RQST ON (1b)	Reserved				

Table 54: Power Supply Element Status

Byte/Bit		7	6	5	4	3	2	1	0
COMMON STATUS									
0	00h	Reserved	PRDFAIL	Reserved	SWAP	ELEMENT STATUS CODE			
POWER SUPPLY STATUS									

Byte/Bit		7	6	5	4	3	2	1	0
1	01h	RQST IDENT	DO NOT REMOVE	Reserved					
2	02h	Reserved				DC OVER VOLTAGE	DC UNDER VOLTAGE	DC OVER CURRENT	Reserved
3	03h	HOT SWAP	FAIL	RQSTED ON (1b)	OFF (0b)	OVERTEM FAIL	TEMP WARN	AC FAIL	DC FAIL

The SCSI Enclosure Processor (SEP) does not support host requests to turn off power supplies.

The DO NOT REMOVE bit is set to one when the HOT SWAP bit is set to zero, and is set to zero when the HOT SWAP bit is set to one.

The HOT SWAP bit reports the value 1b if the reported power supply instance may be inserted or removed without powering off the enclosure. The HOT SWAP bit will be set to 1b in the following instances:

- The power supply is not installed

  OR

- The power supply is installed, and the partner power supply is installed, powered on, and its Element Status Code is **OK (01h)**

Table 55: PSU (0x02)

Status Code	Trigger
OK	Nominal
CRITICAL	• PMBus: DC over volt • PMBus: DC under volt • PMBus: DC over current • PMBus: Temperature fail • PMBus: AC fail • PMBus: PSU off • PMBus: DC fail **Note:** PMBus == PMBus STATUS_WORD bit derivatives
NONCRIT	PMBus: Temperature warn
NOTINST	Element not present
UNKNOWN	Lost I2C communications

5.4.2 Power Supply Element Descriptor

The following table displays the Enclosure - Power Supply Element Descriptor information:

Note: The Location field value will be set to a 16 byte ASCII string that describes the instance of the power supply. Unused bytes will be populated with ASCII space characters.

Table 56: Enclosure - Power Supply Element Descriptor

Offsets				Size	Description
w/o MFC		With MFC			
Dec	Hex	Dec	Hex		
0	0000h	0	0000h	2	Reserved (0000h)
2	0002h	2	0002h	2	Descriptor Length (0042h/0062)
4	0004h	4	0004h	16	Location (**POWER SUPPLY N**)
20	0014h	20	0014h	16	Part Number ()
36	0024h	36	0024h	18	Serial Number ()
54	0036h	54	0036h	16	Firmware Revision ()
		70	0046h	32	Power Supply MFC
70	0046h	102	0066h	END OF DESCRIPTOR	

5.5 Cooling

The Location field value will be set to a 16 byte ASCII string that describes the instance of the fan. Unused bytes will be filled with ASCII space characters.

All fields will remain, even if a fan is not installed, since the Part Number and Serial Number come from the fan controller which is not removed when replacing a fan.

5.5.1 Rear Fan Cooling Element Control and Status

The following table displays the Cooling (Fan) Element Control information:

Table 57: Cooling (Fan) Element Control

Byte/Bit		7	6	5	4	3	2	1	0
COMMON CONTROL									
0	00h	SELECT	PRDFAIL	Reserved	RST SWAP	Reserved			
COOLING (FAN) CONTROL									
1	01h	REQUEST IDENT	DO NOT REMOVE (0b)	Reserved					

Byte/Bit		7	6	5	4	3	2	1	0
2	02h	Reserved							
3	03h	Reserved	RQST FAIL	RQST ON (1b)	Reserved		REQUESTED SPEED CODE (000b)		

The following table displays the Cooling (Fan) Element Status information:

Note: The SEP does not support host requests to turn off cooling elements or to manually set a requested fan speed.

Table 58: Cooling (Fan) Element Status

Byte/Bit		7	6	5	4	3	2	1	0
COMMON STATUS									
0	00h	Reserved	PRDFAIL	Reserved	SWAP	ELEMENT STATUS CODE			
COOLING FAN STATUS									
1	01h	IDENT	DO NOT REMOVE (0b)	Reserved			(MSB)		
2	02h	ACTUAL FAN SPEED							(LSB)
3	03h	HOT SWAP (1b)	FAIL	RQSTED ON (1b)	OFF	Reserved	ACTUAL SPEED CODE		

The ELEMENT STATUS CODE can report a value of CRITICAL to indicate that one or more fans are not spinning as fast as they are expected to.

The ACTUAL FAN SPEED field reports the current fan speed in units of **10 RPM**. For example, the value 300h would be reported to indicate a fan speed of 7680 RPM.

The HOT SWAP bit has the value 1b, if fans can be swapped without requiring or causing a power cycle event.

The OFF bit is set to indicate that the corresponding fan is not operating.

Table 59: Fan (0x03)

Status Code	Trigger
OK	Nominal
CRITICAL	Fan failed
NOTINST	Element not present
UNKNOWN	Lost I2C communications
OK	Nominal
CRITICAL	Temperature over/under critical threshold
NONCRIT	Temperature over/under warning threshold
NOTINST	Element not present

Status Code	Trigger
UNKNOWN	Lost I2C communications
NOTAVAIL	Sensor can not be read successfully
NOACCESS	Corresponding array element was taken offline by thermal monitor, access to temperature data lost

5.5.2 Cooling Element Descriptor

The following table displays the Enclosure - Cooling (Rear Fans) Element Descriptor information:

Note: The Location field value will be set to a 16 byte ASCII string that describes the instance of the fan. Unused bytes will be populated with ASCII space characters.

Table 60: Enclosure - Cooling (Rear Fans) Element Descriptor

Offsets				Size	Description
w/o MFC		With MFC			
Dec	Hex	Dec	Hex		
0	0000h	0	0000h	2	Reserved (0000h)
2	0002h	2	0002h	2	Descriptor Length (0030h/006Ah)
4	0004h	4	0004h	16	Location (**PSU N FAN N**)
20	0014h	20	0014h	16	Part Number ()
36	0024h	36	0024h	16	Serial Number ()
		52	0034h	58	Cooling MFC
52	0034h	110	006Eh	END OF DESCRIPTOR	

5.6 Temperature

The Location field value will be set to a 16 byte ASCII string that describes the instance of the temperature sensor. Unused bytes will be filled with ASCII space characters.

5.6.1 Temperature Sensor Element Control and Status

The following table displays the Temperature Sensor Element Control information:

Note: The Ultrastar Data60 architecture does not support power cycling the enclosure via the Enclosure element type. The capability to perform enclosure resets is provided in the String Out/In Diagnostic Page (04h) *(page 40)* section.

Table 61: Temperature Sensor Element Control

Byte/Bit		7	6	5	4	3	2	1	0
COMMON CONTROL									
0	00h	SELECT	PRDFAIL	DISABLE (0b)	RST SWAP	Reserved			
TEMPERATURE SENSOR CONTROL									
1	01h	REQUEST IDENT	REQUEST FAIL	Reserved					
2	02h	Reserved							
3	03h	Reserved							

Note: The SCSI Enclosure Processor (SEP) does not support host requests to disable temperature sensors.

The following table displays the Temperature Sensor Element Status information:

Table 62: Temperature Sensor Element Status

Byte/Bit		7	6	5	4	3	2	1	0
COMMON STATUS									
0	00h	Reserved	PRDFAIL	DISABLEI (0b)	SWAI	ELEMENT STATUS CODE			
TEMPERATURE SENSOR STATUS									
1	01h	IDENT	FAIL	Reserved					
2	02h	TEMPERATURE							
3	03h	Reserved				OT FAILURE	OT WARNINC	UT FAILURE	UT WARNING

The TEMPERATURE field reports the current temperature in units of degrees Celsius offset by 20.For example, a value of 40h, or 64 decimal, is used to report an actual temperature of 44 degrees Celsius.

The OT/UT FAILURE or OT/UT WARNING bits are set if a temperature sensor is reporting a value that exceeds the corresponding critical or warning threshold values defined by the default Vital Product Data (VPD) based thresholds as modified by the Threshold Out page. The thresholds in current use may be discovered by using the Threshold In Diagnostic page.

Temperature sensors which are located on drives are polled less often than temperature sensors located on other components. This is to minimize the impact of SCSI Enclosure Processor (SEP) initiated polling on host initiated I/Os.

Table 63: Temperature Sensor (04)

Status Code	Trigger
OK	Nominal
CRITICAL	Temperature over/under critical threshold
NONCRIT	Temperature over/under warning threshold

Status Code	Trigger
NOTINST	Element not present
UNKNOWN	Lost I2C communications
NOTAVAIL	Sensor can not be read successfully
NOACCESS	Corresponding array element was taken offline by thermal monitor, access to temperature data lost

5.6.2 Temperature Element Descriptor

The following table displays the Enclosure - Temperature Element Descriptor information:

Table 64: Enclosure - Temperature Element Descriptor

Offsets		Size	Description
Dec	Hex		
0	0000h	2	Reserved (0000h)
2	0002h	2	Descriptor Length (0010h)
4	0004h	16	Location (**TEMP<location>**)
20	0014h	END OF DESCRIPTOR	

5.7 Door

The Location field value will be set to a 16 byte ASCII string that describes the instance of the door. Unused bytes will be filled with ASCII space characters.

5.7.1 Door Element Control and Status

In the Ultrastar Data60 architecture, the Door element manages a door.

The following table displays the Door information:

Table 65: Door Element Control

Byte/Bit		7	6	5	4	3	2	1	0
COMMON CONTROL									
0	00h	SELECT	PRDFAIL	DISABLE (0b)	RST SWAP	Reserved			
DOOR CONTROL									
1	01h	REQUEST IDENT	RQST FAIL	Reserved					
2	02h	Reserved							

Byte/Bit		7	6	5	4	3	2	1	0
3	03h	Reserved							UNLOCK(01b)

The following table displays the Door Element Status information:

Table 66: Door Element Status

Byte/Bit		7	6	5	4	3	2	1	0
COMMON STATUS									
0	00h	Reserved	PRDFAIL	DISABLE (0b)	SWAP	ELEMENT STATUS CODE			
DOOR STATUS									
1	01h	IDENT	FAIL	RESERVED					
2	02h	RESERVED							
3	03h	RESERVED						OPEN	UNLOCKED(01b)

Table 67: Door (0x5)

Status Code	Trigger
OK	Nominal
CRITICAL	Door switch open

5.7.2 Door Element Descriptor

The following table displays the Door Element Descriptor information:

Table 68: Door Element Descriptor

Offsets		Size	Description
Dec	Hex		
0	0000h	2	Reserved (0000h)
2	0002h	2	Descriptor Length (0010h)
4	0004h	16	Location (**ENCLOSURE COVER**)
20	0014h	END OF DESCRIPTOR	

5.8 ESCE

The Location field value will be set to **IOM**. Unused bytes will be populated with ASCII space characters.

5.8.1 Enclosure Services Controller Electronics Element Control and Status

In the Ultrastar Data60 architecture, the Enclosure Services Controller Electronics (ESCE) element type is used to represent the IO Module (IOM).

The following table displays the Enclosure Services Controller Electronics Element Control information:

Table 69: Enclosure Services Controller Electronics Element Control

Byte/Bit		7	6	5	4	3	2	1	0
COMMON CONTROL									
0	00h	SELECT	PRDFAIL	Reserved	RST SWAP	Reserved			
ENCLOSURE SERVICES CONTROLLER ELECTRONICS CONTROL									
1	01h	RQST IDENT	RQST FAIL	DO NOT REMOVE (0b)	RQST REMOVE (0b)	Reserved			
2	02h	Reserved							SELECT ELEMENT (0b)
3	03h	Reserved							

Note: The SEP does not support host requests to assign the active enclosure services processor.

The following table displays the Enclosure Services Controller Electronics information:

Table 70: Enclosure Services Controller Electronics Element Status

Byte/Bit		7	6	5	4	3	2	1	0
COMMON STATUS									
0	00h	Reserved	PRDFAIL	Reserved	SWAP	ELEMENT STATUS CODE			
ENCLOSURE SERVICES CONTROLLER ELECTRONICS STATUS									
1	01h	IDENT	FAIL	DO NOT REMOVE	RMV	Reserved			
2	02h	Reserved							REPORT

Byte/Bit		7	6	5	4	3	2	1	0
3	03h	Dual ESM: HOT SWAP (1b) Single ESM: HOT SWAP (0b)							

The ELEMENT STATUS CODE can report a value of CRITICAL to indicate that one or more firmware revisions within the I/O Module (IOM) are incompatible with each other.

A DO NOT REMOVE bit set to one to indicate that the ESCE should not be removed. A DO NOT REMOVE bit set to zero to indicate that the ESCE may be removed.

The RMV bit is set to 0 in non-redundant IOM configurations, and is set to 1 in redundant IOM configurations.

Table 71: Encl Services Controller Electronics (IOM) (0x7)

Status Code	Trigger	Recommended Action
OK	Nominal	—
CRITICAL	• Incompatible firmware revisions detected • OOBM communications lost (if configured) • IOM A missing in a dual enclosure • IOM B missing in a dual enclosure	—
NOTINST	Element not present	—
NOTAVAIL	When Single Tenant, element not present	—
NOACCESS	When Single Tenant, dual is not enabled and running on Esce instance 1	—

5.8.2 Additional Element Status Descriptor—ESCE

The following table displays the Additional Element Status Descriptor – ESCE information:

Table 72: Additional Element Status Descriptor – ESCE

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	INVALID	Reserved		EIP (1b)	PROTOCOL IDENTIFIER (0110b)			
1	01h	ADDITIONAL ELEMENT STATUS DESCRIPTOR LENGTH (12h)							
2	02h	Reserved						EIIOE (01b)	
3	03h	ELEMENT INDEX							
4	04h	NUMBER OF PHY DESCRIPTORS (01h)							

Byte/Bit		7	6	5	4	3	2	1	0
5	05h	TYPE (01b)		Reserved					
6	06h	Reserved							
7	07h								
8	08h	PHY IDENTIFIER							
9	09h	Reserved							
10	0Ah	CONNECTOR ELEMENT INDEX							
11	0Bh	OTHER ELEMENT INDEX							
12	0Ch	SAS ADDRESS							
13	13h								

5.9 SAS Expander

The Location field value will be set to a 16 byte ASCII string that describes the instance of the SAS expander. Unused bytes will be filled with ASCII space characters.

5.9.1 SAS Expander Element Control and Status

The following table displays the SAS (SAS) Expander Element Control information:

Table 73: SAS Expander Element Control

Byte/Bit		7	6	5	4	3	2	1	0
COMMON CONTROL									
0	00h	SELECT	PRDFAIL	Reserved	RST SWAP	Reserved			
SAS EXPANDER CONTROL									
1	01h	REQUEST IDENT	REQUEST FAIL	Reserved					
2	02h	Reserved							
3	03h	Reserved							

The following table displays the SAS Expander Element Status information:

Table 74: SAS Expander Element Status

Byte/Bit		7	6	5	4	3	2	1	0
COMMON STATUS									
0	00h	Reserved	PRDFAIL	Reserved	SWAP	ELEMENT STATUS CODE			
SAS EXPANDER STATUS									

Byte/Bit		7	6	5	4	3	2	1	0
1	01h	IDENT	FAIL	Reserved					
2	02h	Reserved							
3	03h								

The ELEMENT STATUS CODE can report a value of CRITICAL to indicate that the corresponding SAS Expander is unable to communicate with the other SAS Expanders in the SCSI Enclosure Processor (SEP).

The ELEMENT STATUS CODE can report a value of NON-CRITICAL to indicate that one or more PHYs used to interconnect SAS Expanders within the SEP are not up, or are not operating at the optimal physical link rate.

Table 75: Expander (0x18)

Status Code	Trigger
OK	Nominal
NOTINST	Element is not present

5.9.2 SAS Expander Element Descriptor

The following table displays the Enclosure - SAS Expander Element Descriptor information:

Table 76: Enclosure - SAS Expander Element Descriptor

Offsets		Size	Description
Dec	Hex		
0	0000h	2	Reserved (0000h)
2	0002h	2	Descriptor Length (0030h)
4	0004h	16	Location (**EXP <expander>**)
20	0014h	16	Firmware Revision (**XXXX-YYY**)
36	0024h	16	Init String Revision (**XXXX-YYY**)
52	0034h	END OF DESCRIPTOR	

5.9.3 Additional Element Status Descriptor—SAS Expander

The following table displays the Additional Element Status Descriptor – SAS Expander (68 port) information:

Table 77: Additional Element Status Descriptor – 68 Port SAS Expander

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	INVALID	Reserved		EIP (1b)	PROTOCOL IDENTIFIER (0110b)			
1	01h	ADDITIONAL ELEMENT STATUS DESCRIPTOR LENGTH (96h)							

Byte/Bit		7	6	5	4	3	2	1	0
2	02h	Reserved							EIIO (1b)
3	03h	ELEMENT INDEX							
4	04h	NUMBER OF PHY DESCRIPTORS							
5	05h	TYPE (01b)		Reserved					
6	06h	Reserved							
7	07h								
8	08h	SAS Address							
15	0Fh								
EXPANDER PHY DESCRIPTOR LIST									
16	10h	CONNECTOR ELEMENT INDEX #1							
17	11h	OTHER ELEMENT INDEX #1							
...	...	...							
150	96h	CONNECTOR ELEMENT INDEX #68							
151	97h	OTHER ELEMENT INDEX #68							

5.10 SAS Connector

The Location field value will be set to a 16 byte ASCII string that describes the instance of the SAS connector. Unused bytes will be populated with ASCII space characters.

5.10.1 SAS Connector Element Control and Status

In the Ultrastar Data60 architecture, the SAS Connector element type is used to represent both SAS host port connections within the enclosure, and SAS expansion port connections that lead to other enclosures.

The following table displays the SAS Connector Element Control information:

Table 78: SAS Connector Element Control

Byte/Bit		7	6	5	4	3	2	1	0
COMMON CONTROL									
0	00h	SELECT	PRDFAIL	Reserved	RST SWAP	Reserved			
SAS CONNECTOR CONTROL									
1	01h	REQUEST IDENT	Reserved						
2	02h	Reserved							

Byte/Bit		7	6	5	4	3	2	1	0
3	03h	Reserved	REQUEST FAIL	Reserved					

The following table displays the SAS Connector Element Status information:

Table 79: SAS Connector Element Status

Byte/Bit		7	6	5	4	3	2	1	0
COMMON STATUS									
0	00h	Reserved	PRDFAIL	Reserved	SWAP	ELEMENT STATUS CODE			
SAS CONNECTOR STATUS									
1	01h	IDENT	CONNECTOR TYPE						
2	02h	CONNECTOR PHYSICAL LINK							
3	03h	MATED	FAIL	OC (0b)	Reserved				

The ELEMENT STATUS CODE has a value of CRITICAL to indicate that the corresponding SAS Connector has a cable inserted but is unable to communicate because none of the PHYs on the port have achieved a link up state.

The ELEMENT STATUS CODE has a value of NON-CRITICAL to indicate that the corresponding SAS Connector has a cable inserted and is able to communicate, but one or more PHYs on the port have not achieved a link up state, or the PHYs within the port that have achieved a link up state are using different link rates.

Table 80: SAS Connector (0x19)

Status Code	Trigger
OK	Nominal
CRITICAL	• If active cable detected and cable configuration is invalid • No PHY on host port is linked
NONCRIT	• Dual IOM is not configured and running on IOM B • Host port has < 4 PHYs linked • Host port has PHY link mismatches
NOTINST	• Connector not present • Connector present but cable not plugged in

5.10.2 SAS Connector Element Descriptor

The following table displays the Enclosure - Serial Attached SCSI (SAS) Connector Element Descriptor information:

Table 81: Enclosure - SAS Connector Element Descriptor

Offsets		Size	Description
Dec	Hex		
0	0000h	2	Reserved (0000h)
2	0002h	2	Descriptor Length (0010h)
4	0004h	16	Location (**CONN HOST X**)
20	0014h	END OF DESCRIPTOR	

5.11 Voltage Sensor

The Location field value will be set to a 16 byte ASCII string that describes the instance of the voltage sensor. Unused bytes will be populated with ASCII space characters.

5.11.1 Voltage Sensor Element Control and Status

The following table displays the Voltage Sensor Element Control information:

Table 82: Voltage Sensor Element Control

Byte/Bit		7	6	5	4	3	2	1	0
COMMON CONTROL									
0	00h	SELECT	PRDFAIL	DISABLED (0b)	RST SWAP	Reserved			
VOLTAGE SENSOR CONTROL									
1	01h	REQUEST IDENT	REQUEST FAIL	Reserved					
2	02h	Reserved							
3	03h	Reserved							

Note: The SEP does not support host requests to disable voltage sensors.

The following table displays the Voltage Sensor Element Status information:

Table 83: Voltage Sensor Element Status

Byte/Bit		7	6	5	4	3	2	1	0
COMMON STATUS									
0	00h	Reserved	PRDFAIL	DISABLED (0b)	SWAP	ELEMENT STATUS CODE			
VOLTAGE SENSOR STATUS									

Byte/Bit		7	6	5	4	3	2	1	0
1	01h	IDENT	FAIL	Reserved		WARN OVER	WARN UNDER	CRIT OVER	CRIT UNDER
2	02h	(MSB)	VOLTAGE						
3	03h								(LSB)

The VOLTAGE field reports the current voltage in units of **10 millivolts**. For example, the value 200h would be reported to indicate a voltage of 5120 millivolts.

Table 84: Voltage Sensor (0x12)

Status Code	Trigger
OK	Nominal
CRITICAL	Over/under critical threshold
NONCRIT	Over/under warning threshold
NOTINST	Element not present
UNKNOWN	Lost I2C communications

5.11.2 Voltage Sensor Element Descriptor

The following table displays the Enclosure - Voltage Element Descriptor information:

Table 85: Enclosure - Voltage Element Descriptor

Offsets		Size	Description
Dec	Hex		
0	0000h	2	Reserved (0000h)
2	0002h	2	Descriptor Length (0010h)
4	0004h	16	Location (**XXXV <name>**)
20	0014h	END OF DESCRIPTOR	

5.12 Current Sensor

The Location field value will be set to a 16 byte ASCII string that describes the instance of the current sensor. Unused bytes will be populated with ASCII space characters.

5.12.1 Current Sensor Element Control and Status

The following table displays the Current Sensor Element Control information:

Table 86: Current Sensor Element Control

Byte/Bit		7	6	5	4	3	2	1	0
COMMON CONTROL									
0	00h	SELECT	PRDFAIL	DISABLED (0b)	RST SWAP	Reserved			
CURRENT SENSOR CONTROL									
1	01h	REQUEST IDENT	REQUEST FAIL	Reserved					
2	02h	Reserved							
3	03h	Reserved							

Note: The SEP does not support host requests to disable current sensors.

The following table displays the Current Element Status information:

Table 87: Current Sensor Element Status

Byte/Bit		7	6	5	4	3	2	1	0
COMMON STATUS									
0	00h	Reserved	PRDFAIL	DISABLED (0b)	SWAP	ELEMENT STATUS CODE			
CURRENT STATUS									
1	01h	IDENT	FAIL	Reserved		WARN OVER	Reserved	CRIT OVER	Reserved
2	02h	(MSB)	CURRENT						
3	03h								(LSB)

The CURRENT field reports the current in units of **10 milliamps**. For example, the value 200h would be reported to indicate a current of 5120 milliamps.

Table 88: Current Sensor (0x13)

Status Code	Trigger
OK	Nominal
CRITICAL	Over/under critical threshold
NONCRIT	Over/under warning threshold
NOTINST	Element not present
UNKNOWN	Lost I2C communications

5.12.2 Current Sensor Element Descriptor

The following table displays the Enclosure - Current Element Descriptor information:

Table 89: Enclosure - Current Element Descriptor

Offsets		Size	Description
Dec	Hex		
0	0000h	2	Reserved (0000h)
2	0002h	2	Descriptor Length (0010h)
4	0004h	16	Location (**CURRENT <name>**)
20	0014h	END OF DESCRIPTOR	

SCSI Commands

In This Chapter:

6.1 SEP SCSI Behavior Overview

The following section describes the generic SCSI behavior of the SEP:

- SEP supports up to **four** concurrent initiators
- SEP does not support SCSI command linking or queue tags
- SEP operates with a command Queue Depth of **one** per host
- All commands are processed in FIFO order

Note: The exception is Task Management commands (for example, Abort Task, and so on.)

The following table lists the SCSI commands supported by the SCSI Enclosure Processor (SEP):

Table 90: ***Supported SCSI Commands***

Command Name	Op Code	Reference
TEST UNIT READY	00h	SPC-4
INQUIRY	12h	SPC-4
REQUEST SENSE	03h	SPC-4
SEND DIAGNOSTIC	1Dh	SPC-4
RECEIVE DIAGNOSTIC RESULTS	1Ch	SPC-4
REPORT LUNS	10h	SPC-4
MODE SELECT (10)	55h	SPC-4
MODE SENSE (10)	5Ah	SPC-4
LOG SELECT	4Ch	SPC-4
LOG SENSE	4Dh	SPC-4

6.2 Test Unit Ready

The following table displays the Test Unit Ready commands:

Table 91: Test Unit Ready

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	OPERATION CODE (00h)							
1	01h		Reserved						
4	04h								
5	05h	CONTROL (00h)							

The **TEST UNIT READY** command requests that the device server indicates if the logical unit is ready. If the SEP is able to accept SES page commands without returning **CHECK CONDITION** status, then the SEP shall complete the command with a **GOOD** status. If the SEP is nonoperational, the device server shall terminate the command with a **CHECK CONDITION** status, with the sense key set to **NOT READY**.

Note: The Ultrastar Data60 SEP can enter an offline state in which SEP remains available, but the disk drives are not presented to hosts. Because the SEP remains available, the SEP will return a **SCSI GOOD** status in response to **TEST UNIT READY** even if it is in offline state.

6.3 Request Sense

The REQUEST SENSE command requests that the SEP return sense data in the data phase of the operation. It is seldom used because SAS provides auto-sense in the response frame following the completion of each SCSI command.

The following table displays the Request Sense commands:

Table 92: Request Sense Command

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	OPERATION CODE (03h)							
1	01h	Reserved							DESC (0b)
2	02h	Reserved							
3	03h	Reserved							
4	04h	ALLOCATION LENGTH							
5	05h	CONTROL (00h)							

6.4 Inquiry

The INQUIRY command requests the SEP to return information regarding the logical unit and SCSI target device.

The following table displays the Inquiry commands:

Table 93: Inquiry Command

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	OPERATION CODE (12h)							
1	01h	Reserved						Obsolete	EVPD
2	02h	PAGE CODE							
3	03h	(MSB)	ALLOCATION LENGTH						
4	04h								(LSB)
5	05h	CONTROL (00h)							

EVPD bit set to 0 specifies that the logical unit shall return the standard INQUIRY data. If the PAGE CODE field is not set to 0 and the EVPD bit is set to 0, then the command will terminate with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB. If the EVPD bit is set to 1, the PAGE CODE field specifies which page of vital product data information the logical unit shall return. If the page code is not implemented by the logical unit the command will terminate with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

6.4.1 Standard INQUIRY Data

The following table displays the Standard Inquiry commands:

Table 94: Standard Inquiry Command

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	PERIPHERAL QUALIFIER (000b)			PERIPHERAL DEVICE TYPE (0Dh)				
1	01h	RMB (0b)	LU_CONG (0b)	Reserved					
2	02h	VERSION (06h)							
3	03h	Reserved	Reserved	NormACA (0b)	HiSup (0b)	Response Data Format (2h)			
4	04h	ADDITIONAL LENGTH (5Bh)							
5	05h	SCCS (0b)	ACC (0b)	TPGS (00b)		3PC (0b)	Reserved		PROTECT (0b)
6	06h	Reserved	EncServ (1b)	VS (0b)	MultiP (0b)	Reserved	Reserved	Reserved	ADDR16 (0b)
7	07h	Reserved	Reserved	WBUS16 (0b)	SYNC (0b)	Reserved	Reserved	CMDQUE (1b)	VS (0b)
8	08h	VENDOR IDENTIFICATION							
15	0Fh								
16	10h	PRODUCT IDENTIFICATION							
31	1Fh								
32	20h	PRODUCT REVISION (FIRMWARE REV)							
35	23h								
36	24h	DETAILED FIRMWARE REVISION							
55	37h								
56	38h	Reserved							
57	39h								
58	3Ah	VERSION DESCRIPTOR: SAM-5 (00A0h)							
59	3Bh								

Byte/Bit		7	6	5	4	3	2	1	0
60	3Ch		VERSION DESCRIPTOR: SAS-2 (0C20h)						
61	3Dh								
62	3Eh		VERSION DESCRIPTOR: SPC-5 (0460 => 05C0, 0580=>0584)						
63	3Fh								
64	40h		VERSION DESCRIPTOR: SES-3 (0580h)						
65	41h								
66	42h		Reserved(00h)						
95	5Fh								

The **VENDOR IDENTIFICATION** command contains an 8 byte ASCII string that reports the vendor name. This string is left justified in the field and is not NULL terminated. The string that is reported is defined by enclosure VPD.

The **PRODUCT IDENTIFICATION** command contains a 16 byte ASCII string that reports the product name. The string is left justified in the field and is not NULL terminated. The string that is reported is defined by enclosure VPD.

The **PRODUCT REVISION** command contains a 4 bytes which indicate the firmware revision information. In the released code images, each of the 4 bytes is an ASCII encoded decimal digit. The first 2 bytes represent the release major number, and the second 2 bytes represent the release minor number. In the unreleased code images, the first byte of the PRODUCT REVISION field will contain something other than an ASCII encoded decimal digit.

The **DETAILED FIRMWARE REVISION** command contains an ASCII string that represents the full SEP product firmware revision. The information is left justified within the field, and is padded with spaces.

The following is the format breakdown of **-BBB MM.mm.rr**:

- **BBB**: 3 digit decimal build number
- **MM**: is the major revision number of the firmware framework
- **mm**: is the minor revision number of the firmware framework
- **rr**: is the sub-minor revision number of the firmware framework

6.4.2 Supported INQUIRY Vital Product Pages

The following table displays the Supported INQUIRY VPD pages:

Table 95: Supported INQUIRY VPD Pages

VPD Page Name	Page Code
Supported VPD Pages	00h
Unit Serial Number	80h
Device Identification	83h
Extended INQUIRY Data	86h
SEP Capabilities	C1h

Note: These VPD pages are returned by an INQUIRY command with the EVPD bit set to one, and contain product information about the SEP.

6.4.2.1 Supported VPD Pages (00h)

The following table displays the Supported VPD pages:

Table 96: Supported VPD Pages

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	PERIPHERAL QUALIFIER (000b)			PERIPHERAL DEVICE TYPE (0Dh)				
1	01h	PAGE CODE (00h)							
2	02h	(MSB)	PAGE LENGTH (05h)						
3	03h								(LSB)
SUPPORTED VPD PAGE LIST									
4	04h	SUPPORTED VPD PAGES (00h)							
5	05h	UNIT SERIAL NUMBER (80h)							
6	06h	DEVICE IDENTIFICATION (83h)							
7	07h	EXTENDED INQUIRY DATA (86h)							
8	08h	SEP CAPABILITIES (C1h)							

Note: The Supported VPD Pages VPD page contains a list of the Inquiry VPD page codes supported by the SEP.

6.4.2.2 Unit Serial Number VPD Pages (80h)

The following table displays the Unit Serial Number VPD page:

Table 97: Unit Serial Number VPD Page

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	PERIPHERAL QUALIFIER (000b)			PERIPHERAL DEVICE TYPE (0Dh)				
1	01h	PAGE CODE (80h)							
2	02h	(MSB)	PAGE LENGTH (0018h)						
3	03h								(LSB)
SERIAL NUMBER									
4	04h	(MSB)	PRODUCT SERIAL NUMBER						

Byte/Bit		7	6	5	4	3	2	1	0
27	1Bh								(LSB)

QUALIFIER is set to 0 to indicate that the LUN specified in the Command Block is currently supported.

PERIPHERAL DEVICE TYPE is set to 0 to indicate that the device is Direct Access.

PAGE CODE is set to the value of the page code field in the CDB.

PAGE LENGTH specifies the length of the following page data.

PRODUCT SERIAL NUMBER field contains right aligned ASCII data that reports the HDD serial number. The field is not NULL terminated.

6.4.2.3 Device Identification Pages (83h)

The following table displays the Device Identification page:

Table 98: Device Identification Page

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	PERIPHERAL QUALIFIER (000b)			PERIPHERAL DEVICE TYPE (0Dh)				
1	01h	PAGE CODE (83h)							
2	02h	(MSB)	PAGE LENGTH (2Ch)						
3	03h								(LSB)
DESIGNATOR LIST									
4	04h	PROTOCOL IDENTIFIER (6h)				CODE SET (1h)			
5	05h	PV (1b)	Reserved	ASSOCIATION (01b)		DESIGNATOR TYPE (3h)			
6	06h	Reserved							
7	07h	DESIGNATOR LENGTH (08h)							
8	08h	NAA (5h)				(MSB)			
...	...					IEEE COMPANY ID (if HGST: 00:0C:CAh)			
11	0Bh				(LSB)	(MSB)			
...	...					VENDOR SPECIFIC IDENTIFIER			
15	0Fh								(LSB)
16	10h	PROTOCOL IDENTIFIER (0h)				CODE SET (1h)			
17	11h	PV (0b)	Reserved	ASSOCIATION (00b)		DESIGNATOR TYPE (3h)			
18	12h	Reserved							
19	13h	DESIGNATOR LENGTH (08h)							

Byte/Bit		7	6	5	4	3	2	1	0
20	14h	NAA (5h)				(MSB)			
...	...					IEEE COMPANY ID (if HGST: 00:0C:CAh)			
23	17h				(LSB)	(MSB)			
...	...					VENDOR SPECIFIC IDENTIFIER			
27	1Bh								(LSB)
28	1Ch	PROTOCOL IDENTIFIER (6h)				CODE SET (1h)			
29	1Dh	PV (1b)	Reserved	ASSOCIATION (10b)		DESIGNATOR TYPE (3h)			
30	1Eh	Reserved							
31	1Fh	DESIGNATOR LENGTH (08h)							
32	20h	NAA (5h)				(MSB)			
...	...					IEEE COMPANY ID (if HGST: 00:0C:CAh)			
35	23h				(LSB)	(MSB)			
...	...					VENDOR SPECIFIC IDENTIFIER			
39	27h								(LSB)
40	28h	PROTOCOL IDENTIFIER (6h)				CODE SET (1h)			
41	29h	PV (1b)	Reserved	ASSOCIATION (01b)		DESIGNATOR TYPE (4h)			
42	2Ah	Reserved							
43	2Bh	DESIGNATOR LENGTH (04h)							
44	2Ch	(MSB)	RELATIVE TARGET PORT IDENTIFIER (00001h)						
47	2Fh								

The **Device Identification VPD** page provides the means to retrieve designation descriptors applying to the logical unit; SEP. The SEP reports four designation descriptors. Designators will consist of one of each of the following:

- Target port designator
- Logical unit designator
- Target device designator
- Relative target port designator

Note: Application clients should use the designation descriptors during system configuration activities to determine whether or not multiple paths exist to communicate with the same peripheral device.

6.4.2.4 Extended INQUIRY Data VPD Pages (86h)

The following table displays the Extended INQUIRY Data VPD page:

Table 99: Extended INQUIRY Data VPD Page

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	PERIPHERAL QUALIFIER (000b)				PERIPHERAL DEVICE TYPE (0Dh)			
1	01h	PAGE CODE (86h)							
2	02h	(MSB)	PAGE LENGTH (003Ch)						
3	03h								(LSB)
4	04h	ACTIVATE MICROCODE (00b)		SPT (000b)			GRD_CHK (0b)	APP_CHK (0b)	REF_CHK (0b)
5	05h	Reserved		UASK_SUP (0b)	GROUP_SUP (0b)	PRIOR_SUP (0b)	HEADSUP (0b)	ORDSUP (0b)	SIMPSUP (1b)
6	06h	Reserved				WU_SUP (0b)	CRD_SUP (0b)	NV_SUP (0b)	V_SUP (0b)
7	07h	Reserved			P_I_I_SUP (0b)	Reserved			LUICLR (0b)
8	08h	Reserved			R_SUP (0b)	Reserved	CBCS (0b)		
9	09h	Reserved				MULTI I_T NEXUS MICROCODE DOWNLOAD (0000b)			
10	0Ah	(MSB)	EXTENDED SELF-TEST COMPLETION MINUTES (0000h)						
11	0Bh								(LSB)
12	0Ch	POA_SUP (0b)	HRA_SUP (0b)	VSA_SUP (0b)	Reserved				
13	0Dh	MAXIMUM SUPPORTED SENSE DATA LENGTH (00h)							
14	0Eh		Reserved						
...	...								
63	3Fh								

The **Extended INQUIRY Data VPD** page provides the application client with a means to obtain extended INQUIRY information about the SEP.

6.4.2.5 SEP Capabilities VPD Pages (C1h)

The following table displays the SEP Capabilities VPD page:

Table 100: SEP Capabilities VPD Page

Byte/Bit	7	6	5	4	3	2	1	0
0	PERIPHERAL QUALIFIER(0)			DEVICE TYPE(0Dh)				
1	PAGE CODE(C1h)							
2	PAGE LENGTH(003Ch)							
3								
4	BOOTLOADER VERSION							
5	IDENTIFIER STRING("WDC-4U60")							
...								
15								
16	SEP SAS ADDRESS [unique to each IOM]							
...								
23								
24	SEP MAC ADDRESS [unique to each IOM]							
...								
31								
32	IOM IDENTIFIER('A' or 'B')							
33	SATA/SAS CONFIG(0 = SAS, 1=SATA[single IOM])							
34	RESERVED(0)							
...								
63								

The **SEP Capabilities VPD** page provides the application client with a means to uniquely identify the enclosure regardless of how the enclosure is branded. This page also indicates SEP capabilities that are unique to Ultrastar Data60 .

6.4.3 Send Diagnostic

The following table displays the SEND DIAGNOSTIC Command information:

Table 101: SEND DIAGNOSTIC Command

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	OPERATION CODE (1Dh)							

Byte/Bit		7	6	5	4	3	2	1	0
1	01h	SELF-TEST CODE			PF (1b)	Reserved	SELF TEST (0b)	DevOffL (0b)	UnitOffL (0b)
2	02h	Reserved							
3	03h	(MSB)	PARAMETER LIST LENGTH						
4	04h								(LSB)
5	05h	CONTROL (00h)							

The **SEND DIAGNOSTIC** command is used to send SES diagnostic page control requests to the SEP.

6.4.4 Receive Diagnostic Results

The following table displays the RECEIVE DIAGNOSTIC RESULTS Command information:

Table 102: RECEIVE DIAGNOSTIC RESULTS Command

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	OPERATION CODE (1Ch)							
1	01h	Reserved							PCV (1b)
2	02h	PAGE CODE							
3	03h	(MSB)	ALLOCATION LENGTH						
4	04h								(LSB)
5	05h	CONTROL (00h)							

The **RECEIVE DIAGNOSTIC RESULTS** command requests the device server return the SES diagnostic page specified by the page code field. The **PAGE CODE VALID** bit will always be set when requesting SES diagnostic pages.

6.4.5 Report Logical Unit Numbers

The following table displays the REPORT LUNS Command information:

Table 103: REPORT LUNS Command

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	OPERATION CODE (A0h)							
1	01h	Reserved							
2	02h	SELECT REPORT							
3	03h	Reserved							
4	04h								

Byte/Bit		7	6	5	4	3	2	1	0
5	05h								
6	06h	(MSB)							
7	07h								
8	08h								
9	09h								(LSB)
10	0Ah	Reserved							
11	0Bh	CONTROL (00h)							

The **REPORT LUNS** command returns a list of logical unit identifiers supported by the SEP.

Note: Only LUN 0 is supported.

The following table displays the REPORT LUNS Data information:

Table 104: REPORT LUNS Data

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	(MSB)							
1	01h								
2	02h								
3	03h								(LSB)
4	04h	(MSB)							
7	07h								(LSB)
8	08h	(MSB)							
...	...								
15	0Fh								(LSB)

6.4.6 Mode Select (10)

The **Mode Select** command is used to customize optional operating modes in the SEP. By default, mode parameters are saved in non-volatile memory; they remain in effect across SEP resets and power cycles until changed by a host command.

The following are examples of Mode parameters which are supported by the SEP:

- Automatic spin-up: full power mode – all drives powered on and spun-up

The following table displays the MODE SELECT Command information:

Table 105: MODE SELECT Command

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	OPERATION CODE (55h)							

Byte/Bit		7	6	5	4	3	2	1	0
		Reserved			PF	Reserved			SP
3	03h		Reserved						
4	04h								
5	05h								
		(MSB)							
									(LSB)
		CONTROL (00h)							

6.4.7 Mode Sense (10)

The **Mode Sense** command is used to read the settings of optional operating modes in the SEP. The specific operating parameters are selected by specifying a mode page, which contains the parameters.

The following table displays the MODE SENSE Command information:

Table 106: MODE SENSE Command

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	OPERATION CODE (5Ah)							
1	01h	Reserved			LLBAA	DBD	Reserved		
2	02h	PC		PAGE CODE					
3	03h	SUBPAGE CODE							
4	04h	Reserved							
5	05h		Reserved						
6	06h								
7	07h	(MSB)	ALLOCATION LENGTH						
8	08h								(LSB)
9	09h	CONTROL (00h)							

6.4.8 Log Select

The **LOG SELECT** command is used to erase the contents of non-volatile logs maintained by the SEP. The **PAGE CODE** and **SUBPAGE CODE** argument are used to specify which log buffer is being operated on.

The following table displays the LOG SELECT Command information:

Table 107: LOG SELECT Command

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	OPERATION CODE (4Ch)							

Byte/Bit		7	6	5	4	3	2	1	0
1	01h	Reserved						PCR	SP
2	02h	PC		PAGE CODE					
3	...	SUBPAGE CODE							
4	04h	Reserved							
5	05h								
6	06h								
7	07h	(MSB)	PARAMETER LIST LENGTH						
8	08h								(LSB)
9	09h	CONTROL (00h)							

6.4.9 Log Sense

The **LOG SENSE** command is used to read the contents of non-volatile logs maintained by the SEP. The **PAGE CODE** and **SUBPAGE CODE** argument are used to specify which log buffer is being operated on.

The following table displays the LOG SENSE Command information:

Table 108: LOG SENSE Command

Byte/Bit		7	6	5	4	3	2	1	0
0	00h	OPERATION CODE (4Dh)							
1	01h	Reserved							SP
2	02h	PC		PAGE CODE					
3	03h	SUBPAGE CODE							
4	04h	Reserved							
5	05h	(MSB)	PARAMETER POINTER						
6	06h								(LSB)
7	07h	(MSB)	ALLOCATION LENGTH						
8	08h								(LSB)
9	09h	CONTROL (00h)							