



Osage/Kiowa SCSI II Logging

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Introduction to Logging

- Logging provides device maintained statistical information during the life of the drive. The statistical information provided can assist in drive diagnostics and debug, qualification and acceptance testing, and system tuning. This provides a common data collection path for all environments in design engineering, manufacturing, and field service.
- Logging counters are data counters associated with one or more events. The counter is incremented whenever one of these events occurs provided the counter is enabled.

For Read, Write, and Verify Commands :

- Total errors corrected without delay (e.g., ECC On-The-Fly).
- Total errors corrected with possible delay (e.g., ECC, Wr Faults).
- Total errors corrected with retries.
- Total errors corrected.
- Total times correction algorithm processed.
- Total errors uncorrected.
- Total bytes processed.

Total corrected non-medium errors.

Cache Statistics Data :

- Number of blocks read or written.
- Number of blocks found in cache.
- Number of i/o requests that fit/not fit into segment.

- SCSI provides two commands, Log Sense and Log Select, to retrieve and initialize log counters. These group 2 (10 byte) commands are analogous to the Mode Sense and Select commands.
- Intermittent saving of Log Counters to disc is performed automatically. This insures statistical significance of counter values during power failures. Log Counters may also be saved at vendor-specific times via the Log Sense or Log Select commands.
- Logging provides an initiator the ability to set up controlled log reporting conditions. Control conditions consist of an initial condition and threshold limit. Threshold limit and testing criteria can be set and enabled through the Log Select command. Testing of the threshold limit is performed whenever a Log Counter is updated. The threshold criteria for comparing is defined as follows:

- Every update of the Log Counter value.
- Log Counter value equal to the Threshold value.
- Log Counter value not equal to the Threshold value.

Introduction to Logging (continued)

Log Counter value greater than the Threshold value.

Log Parameters

Information about events occurring during drive operation is stored in Log Parameters (Figure 1). A log parameter is a data structure that contains a counter and control information. The Parameter Code Field (Figure 1, Bytes 0 & 1) in a log parameter identifies the counter to a particular event. The counter is updated every time the event it measures occurs. A log parameter counter that is set or reaches its maximum value will remain at that value, even if further events occur.

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB) Parameter Code							
1	(LSB)							
2	DU	DS	TSD	ET	TMC	LBIN	LP	
3	Parameter Length (n-3)							
4	(MSB) Parameter Value							
---	---							
n	(LSB)							

Figure 1: Log Parameter Structure

The Parameter Value Field (Figure 1, Bytes 4-n) contains the counter value for the associated parameter code (Figure 1, Bytes 0 & 1). Each log parameter has two counters associated with it: the Current Cumulative Value, and the Current Threshold Value. The current cumulative value contains the number of events that have occurred since the last Parameter Code Reset (page 43). The current threshold value is used to test the cumulative value for initiator specified criteria.

The Parameter Length Field (Figure 1, Byte 3) in a log parameter specifies the counter's size in bytes. All counters are considered to be unsigned integers unless otherwise specified in this document. Table I shows the different counter sizes used in logging and the range of values supported.

Table I: Data Counter Sizes and Range of Values

Counter Size (in bytes)	Decimal Range of Counter
1	0 to 255
2	0 to 65535
4	0 to 4.29×10^9
8	0 to 1.84×10^{19}

The Parameter Control Byte (Figure 1, Byte 2) controls the usage of the log parameter and has several bit field definitions shown in Table II.

Log Parameters (continued)

Table II: Parameter Control Byte Flag Definitions

- DU - Disables Update of the Parameter Value.
- DS - Disables Saving of the Log Parameter to non-volatile memory.
- TSD - Target Save Disable indicates that the device does not provide a method for periodic saving of the Log Parameter or the target defined method of periodic saving has been disabled by an initiator.
- ET - Enable Threshold testing when the cumulative parameter value is updated.
- TMC - Threshold Met Criteria defines the test relationship between the cumulative and threshold parameter values.
- LBIN - List Parameter containing a binary field of non-ASCII characters.
- LP - A zero indicates the structure is a Log Parameter (data counter) and a one indicates that the structure is a List Parameter (ASCII string).

The Disable Update Flag (DU) is used by the log parameter cumulative value. A value of zero signifies that the counter will be updated when an event occurs. Except in response to a log select command, refer to page 43, a value of one in the DU flag signifies that the counter shall not be updated.

The DU flag will also be set when the current cumulative value reaches its maximum value. Upon reaching this maximum value, the data counter will not wrap around and start at zero. Incrementing of other counters within the same log page shall cease until re-initialized. If the data counter reaches its maximum value during the execution of a command, the drive completes the command. If the Report Log Exception Condition (RLEC) flag in the Control Mode Page (Figure 2, Byte 2 Bit 0) is set to a one, the drive will set the sense key to Unit Attention with the additional sense code set to Log Counter at Maximum. The Control Mode Page (Figure 2) is part of the Mode Sense and Select commands.

Bit Byte	7	6	5	4	3	2	1	0
0	PS	Reserv	Page Code (0Ah)					
1	Page Length (06h)							
2	Reserved							RLEC
3	Queue Algorithm Modifier				Reserved		QErr	DQue
4	EECA	Reserved			RAENP	UAAENP	EAENP	
5	Reserved							
6	(MSB)							
7	Ready AEN Holdoff Period							(LSB)

Figure 2: Control Mode Page (0Ah)

Log Parameters (continued)

A **Disable Save Flag (DS)** of zero signifies the Osage supports saving this log parameter to non-volatile memory. The log parameter will be saved in response to a log sense or log select command with the SP bit set to one (page 42 and page 43). If the DS bit is set to a one, either the Osage does not support saving or an initiator does not want to save this log parameter. If the Osage does not support saving a log parameter to non-volatile memory, the DS bit will not be allowed to change to zero.

A **Target Save Disable Flag (TSD)** of zero signifies the target provides a method for saving log parameters during drive operation. This saving operation will be performed often enough to insure statistical significance across power cycles. To insure statistical significance of log counters during active SCSI bus activity, issue either a log sense or log select command with the SP bit set to one. A TSD bit of one signifies that the Osage does not support or an initiator does not want to save this log parameter at target specified intervals.

The **Enable Threshold Flag (ET)** enables threshold testing if set to a one. A log parameter is tested for the threshold criteria whenever the log parameter is updated. Setting the ET bit to zero disables threshold testing for this log parameter.

Table III: Threshold Met Criteria Bit Definitions

Code	Basis for Comparison
00b	Every update of the Log Counter value
01b	Log Counter value equal to the Threshold value
10b	Log Counter value not equal to the Threshold value
11b	Log Counter value greater than the Threshold value

Threshold Met Criteria Bits (TMC) (Table II) define the testing method used if the Enable Threshold (ET) flag is set. After the cumulative counter is updated, the cumulative and threshold values are compared using the test criteria selected. If the test criteria is met, the drive will generate sense data for all initiators if the Report Log Exception Condition (RLEC) flag is set (Figure 2, Byte 2 Bit 0). The sense key will be set to Unit Attention with the additional sense code set to Threshold Condition Met.

The **List Binary Flag (LBIN)** is valid when the LP flag below is set to one. If the LP flag is one and the LBIN is zero then the list parameter is an ASCII string (i.e., code values 20h through 7Eh). When the LP and LBIN flags are both set to one then the list parameter is a list of non-ASCII data.

List Parameter Flag (LP) value of zero signifies that the log parameter contains a data counter. ASCII list parameters, LP bit set to one and LBIN bit set to zero, are currently not supported in Osage.

Log Pages

A **Log Page** consists of one or more log parameters grouped together into categories. These categories are organized by the different drive operations. The Osage supports the following log pages: **Write Page (02h)**, **Read Page (03h)**, **Verify Page (05h)**, **Non-Medium Page (06h)**, **Cache Statistics Page (37h)**

Log Pages (continued)

Parameter Code	Description
0001h	Error corrected with possible delay (e.g., write faults).
0002h	Total (e.g., re-writes).
0003h	Total errors corrected.
0004h	Total times correction algorithm processed.
0005h	Total bytes processed.
0006h	Total uncorrected errors.

Table IV: Write Page (02h)

Parameter Code 0001H - Error Corrected With Possible Delay

A retry was applied and successful in correcting a write fault error. 'With possible delay' means the correction took longer than a sector time so writing of later sectors was postponed (e.g., a lost revolution). The counter is incremented once for each logical block that requires a write fault retry. Two different blocks corrected during the same command count as two events.

Parameter Code 0002H - Total (e.g., re-writes)

This log parameter counts the number of recovered write errors that were not the result of a write fault. The counter is incremented once for each logical block that is written using retries.

Parameter Code 0003H - Total Errors Corrected

This is the total of all corrected errors encountered. It is the combination of parameter codes 0001h and 0002h. There will be no "double counting" of data errors among these two counters. All corrected write errors will be counted in one of these counters.

Parameter Code 0004H - Total Times Correction Algorithm Processed

This parameter code represents the number of retries or 'times correction algorithm processed'. If after five attempts a counter 0002h type error is corrected, then five is added to this counter. Also the number of unsuccessful retries applied to correct an error (counter 0006h type error) are also counted here.

Parameter Code 0005H - Total Bytes Processed

This is the number of bytes either successfully or unsuccessfully written to the disk drive. If the transfer stops because of an uncorrected error, only the logical blocks up to and including the one with the uncorrected error are counted. Data bytes received from an initiator during commands like Write Data Buffer and Mode Select are not count. Only user data bytes are counted.

Parameter Code 0006H - Total Uncorrected Errors

This parameter code represents the number of logical blocks for which an uncorrected write error has occurred.

Log Pages (continued)

Parameter Code	Read Page (03h) Description
0000h	Error corrected without substantial delay.
0001h	Error corrected with possible delay (e.g., ECC).
0002h	Total (e.g., re-reads including offsets/strobes).
0003h	Total errors corrected.
0004h	Total times correction algorithm processed.
0005h	Total bytes processed.
0006h	Total uncorrected errors.

Table V: Read Page (03h)

Parameter Code 0000H - Error Corrected Without Substantial Delay

An error correction code (ECC) was applied on-the-fly to get perfect data. 'Without substantial delay' means the correction did not delay reading of later sectors. The counter is incremented once for each logical block that requires correction. A corrected block with a double error is counted as one event. Two different blocks corrected during the same command are counted as two events.

Parameter Code 0001H - Error Corrected With Possible Delay

An error correction code (ECC) is applied to get perfect data. 'With possible delay' means the correction took longer than a sector time so reading of later sectors was postponed (e.g., a lost revolution). The counter is incremented once for each logical block that requires correction. A corrected block with a double error is counted as one event. Two different blocks corrected during the same command are counted as two events.

Parameter Code 0002H - Total (e.g., re-reads)

This parameter code represents the number of errors that are corrected by applying retries. This counts errors recovered, not the number of retries. If five retries must be used to recover one block of data, the counter is incremented by one and not five. If an error is not recoverable while applying retries and is recovered by ECC, it is not counted here. It is counted in parameter code 'Error Corrected With Possible Delay'.

Parameter Code 0003H - Total Errors Corrected

This is the total of all corrected errors encountered. It is the combination of parameter codes 0000h, 0001h and 0002h. There will be no "double counting" of data errors among these counters. All corrected data errors will be counted in one of these counters.

Parameter Code 0004H - Total Times Correction Algorithm Processed

This parameter code represents the number of retries, or 'times correction algorithm processed'. If after five attempts a counter 0002h type error is recovered, then five is added to this counter. If three retries must be used to get a stable ECC syndrome before a counter 0001h type error is corrected, then those three retries are also counted here. Also the number of unsuccessful retries applied to recover from an error (counter 0006h type error) are also counted here.

Log Pages (continued)

Parameter Code	Description
0000h	Error corrected without substantial delay.
0001h	Error corrected with possible delay.
0002h	Total (e.g., re-verify including offsets/strobes).
0003h	Total errors corrected.
0004h	Total times correction algorithm processed.
0005h	Total bytes processed.
0006h	Total uncorrected errors.

Table VII: Verify Page (05h)

Parameter Code 0000H - Error Corrected Without Substantial Delay

An error correction code (ECC) was applied on-the-fly to get perfect data. 'Without substantial delay' means the correction did not delay the reading of later sectors. The counter is incremented once for each logical block that requires correction. A corrected block with a double error is counted as one event. Two different blocks corrected during the same command are counted as two events.

Parameter Code 0001H - Error Corrected With Possible Delay

An error correction code (ECC) is applied to get perfect data. 'With possible delay' means the correction took longer than a sector time so verifying of later sectors was postponed (e.g., a lost revolution). The counter is incremented once for each logical block that requires correction.

Parameter Code 0002H - Total (e.g., re-verify)

This parameter code represents the number of errors that are corrected by applying retries. This counts errors recovered, not the number of retries. If five retries must be used to recover one block of data, the counter is incremented by one and not five. If an error is not recoverable while applying retries and is recovered by ECC, it is not counted here. It is counted in parameter code 'Error Corrected With Possible Delay'.

Parameter Code 0003H - Total Errors Corrected

This is the total of all corrected errors encountered. It is the combination of parameter codes 0000h, 0001h, and 0002h. There will be no "double counting" of data errors among these two counters. All corrected data errors will be counted in one of these counters.

Parameter Code 0004H - Total Times Correction Algorithm Processed

This parameter code represents the number of retries, or 'times correction algorithm processed'. If after five attempts a counter 0002h type error is recovered, then five is added to this counter. If three retries must be used to get a stable ECC syndrome before a counter 0001h type error is corrected, then those three retries are also counted here. Also the number of unsuccessful retries applied to recover from an error (counter 0006h type error) are also counted here.

Log Pages (continued)

Cache Statistics Page (37h)

<u>Parameter Code</u>	<u>Description</u>
0000h	Number of Blocks Read.
0001h	Number of Blocks Written.
0002h	Number of Blocks Found in Cache.
0003h	Number of I/O Requests That Fit Into Segment.
0004h	Number of I/O Requests Not Fitting Into Segment.

Table XVIII: Cache Statistics Page (37h)

Parameter Code 0000H - Number of Blocks Read

This parameter code represents the number of logical blocks that have been sent to an initiator.

Parameter Code 0001H - Number of Blocks Written

This parameter code represents the number of logical blocks that have been received from an initiator.

Parameter Code 0002H - Number of Blocks Found in Cache

This parameter code represents the number of logical blocks read from cache memory that have been sent to an initiator.

Parameter Code 0003H - Number of I/O Requests That Fit Into Segment

This parameter code represents the number of read and write commands that had data lengths equal or less than the current segment size.

Parameter Code 0004H - Number of I/O Requests Not Fitting Into Segment

This parameter code represents the number of read and write commands that had data lengths greater than the current segment size.

Log Sense Command

The Log Sense command provides a means for the initiator to retrieve statistical information maintained by the device. The log sense command is implemented as specified in the ANSI SCSI-2 specification. The ANSI SCSI-2 opcode for log sense is 04Dh. Figure 7 provides a layout of the command descriptor block for the Osage log sense command. In all cases, reserved bits and bytes must always be set to zero.

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (4Dh)							
1	Logical Unit Number			Reserved			PPC	SP
2	PC		Page Code					
3	Reserved							
4	Reserved							
5	(MSB)		Parameter Pointer					
6							(LSB)	
7	(MSB)		Allocation Length					
8							(LSB)	
9	Control Byte							

Figure 7: SCSI 2 Log Sense Command

The Page Code Field (Figure 7, Byte 2) designates the classification type of log sense data, also known as a Log Page, to be returned to the initiator. Similar log parameters are grouped together in log pages. Table XXXIV contains a list of the Osage supported log pages. Each log page begins with a four-byte page header followed by zero or more variable length log parameters. The log page format returned by the log sense command is defined in Figure 8.

Table XXXIV: Osage/Kiowa Log Pages

Page Code	Page Description
00h	Supported Log Pages
02h	Write Page
03h	Read Page
05h	Verify Page
06h	Non-Medium Page
37h	Cache Statistics Page

Log Sense Command (continued)

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved		Page Code					
1	Reserved							
2	(MSB)		Page Length (n-3)					
3							(LSB)	
	Log Parameter(s) if any							
4 - x+3	Log Parameter (First) (length x)							
	⋮							
n-y n	Log Parameter (Last) (length y)							

Figure 8: Log Page Format

Log Page Zero is a special log page containing the page codes supported by the device in the format defined in Figure 9. The Page Control (PC), Parameter Pointer, and Parameter Pointer Control (PPC) fields in the log sense command do not apply to log page zero.

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved		0	0	0	0	0	0
1	Reserved							
2	(MSB)		Page Length (n-3)					
3							(LSB)	
4	Page code page zero							
	⋮							
n	Page code of last supported page							

Figure 9: Log Page Zero Format

Log Sense Command (continued)

All log pages other than page zero return data to the initiator in a log parameter format under each log page header (Figure 8). Each log parameter begins with a four-byte parameter header followed by one or more bytes of parameter value data (Figure 1).

The Parameter Pointer Field (Figure 7, Bytes 5 & 6) allows an initiator to select which log parameters within a log page to be returned. A parameter pointer value of zero returns all available parameters in the specified log page. A non-zero parameter pointer informs the Osage to return log parameters from the specified log page, beginning with this parameter code. An error will be returned to the initiator if a log parameter does not exist above the parameter pointer.

The Parameter Pointer Control Field (PPC) (Figure 7, Byte 1 Bit 1) controls the meaning of the parameter pointer field (Figure 7, Bytes 5 & 6) as well as the type of log sense data returned to the initiator. If the PPC bit is cleared then the parameter pointer field allows the initiator to select which log parameters to be returned inside a log page. A parameter pointer value of zero returns all available parameters in a specified log page. A non-zero parameter pointer informs the Osage to return log parameters in a specified log page beginning with the parameter code field. If the PPC bit is set to one, the log sense command returns parameter codes that have changed since the last log sense or select command. The Osage will return only those parameter codes that are greater than or equal to the parameter pointer field. The data in the returned page consists of a list of zero or more two-byte parameter codes (Figure 10).

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved		Page Code					
1	Reserved							
2	(MSB)							
3	Page Length (n-3)						(LSB)	
Parameter codes of Changed Parameter(s) if any								
4 - 5	Parameter code (First) (length 2)							
.								
.								
.								
n-1 n	Parameter code (Last) (length 2)							

Figure 10: Changed Parameter Page Format

Log Sense Command (continued)

The Page Control Field (PC) (Figure 7, Byte 2 Bits 7 & 6) in the log sense command defines the type of parameter value (Figure 1, Bytes 4 - N) to be returned. If the PC field is set to '01', the **Current Cumulative Values** (Table XXXV) are returned. If the PC field is set to '00', the **Current Threshold Values** are returned. PC field values of '10' and '11' represent **Default Threshold Values** and **Default Cumulative Values** respectively.

Table XXXV: Page Control Field for the Log Sense command

PC Value	Type of Parameter Values
00b	Current Threshold Values
01b	Current Cumulative Values
10b	Default Threshold Values
11b	Default Cumulative Values

The Allocation Length Field (Figure 7 Bytes 7 & 8) informs the Osage about the amount of space available for returning log parameter data. If the allocation length is too small, the Osage will send as much data that can fit in the allocation length without curtailing a log parameter. The initiator can retrieve the rest of the log page information by setting the parameter pointer to the last returned parameter code and reissue the log sense command. This process may be repeated as necessary to retrieve all the available information.

A Save Parameters Field (SP) (Figure 7, Byte 1 Bit 0) of zero notifies the Osage not to save any log parameters in response to the current log sense command. An SP bit of one allows the Osage to save all log parameters identified as savable (page 5).

Log Select Command

The Log Select Command provides the initiator with the means to modify the logging information stored in the drive. The log select command is implemented as specified in the ANSI SCSI-2 specification. The ANSI SCSI-2 opcode for the log select command is 04Ch. Figure 11 provides a description of the command descriptor block for the Osage log select command. In all cases, reserved bits and bytes must always be set to zero.

Bit Byte	7	6	5	4	3	2	1	0	
0	Operation Code (4Ch)								
1	Logical Unit Number			Reserved			PCR	SP	
2	PC		Reserved						
3	Reserved								
4	Reserved								
5	Reserved								
6	Reserved								
7	(MSB)							Parameter List Length	
8									
9	Control Byte								

Figure 11:-SCSI 2 Log Select Command

Structures in the form of log parameters (page 3), within log pages (page 39) are defined as a way to manage the log data. The log select command provides for sending zero or more log pages to the Osage.

A **Parameter Code Reset Field (PCR)** (Figure 11, Byte 1 Bit 1) bit of one and a parameter list length (Figure 11, Bytes 7 & 8) of zero will cause all log parameters to be set to their default values. If the PCR bit is one, it is not permissible to set the parameter list length to a non-zero value. A PCR bit of zero specifies that the log parameters will not be reset.

A **Save Parameters Field (SP)** (Figure 11, Byte 1 Bit 0) bit of one implies that after performing the log select operation, all the log parameters marked as savable by their DS bit (page 5) will be saved to a non-volatile location. An SP bit of zero specifies that the log parameters will not be saved. An error will not be reported when the SP bit and DS bit of a log parameter are set to one. In this case, the log parameter value for that log parameter is not saved.

The **Page Control Field (PC)** (Figure 11, Byte 2 Bits 7 & 6) defines the type of parameter values being sent to the drive. The bit definitions for the page control field are shown in Table XXXVI. The **Current Cumulative Value** and **Current Threshold Value** may be updated by the initiator using the log select command.

The Osage will set all Current Cumulative Values to their Default Cumulative Values in response to a log select command with the PC field set to 11b and a parameter list length field set to zero. The Osage will also set the Current Threshold Values to their Default Threshold Values in response to a log select command with the PC field set to 10b and a parameter list length field set to zero.

Log Select Command (continued)

Table XXXVI: Page Control Field for the Log Select command

PC Value	Type of Parameter Values
00b	Threshold Values
01b	Cumulative Values
10b	Default Threshold Values
11b	Default Cumulative Values

The Parameter List Length Field (Figure 11, Bytes 7 & 8) specifies the length of the parameter list to be transferred from the initiator to the Osage during the SCSI data out phase. A parameter list length of zero implies that no pages shall be transferred and is not considered an error. The initiator should send pages in ascending page code order if multiple pages are to be sent in the data out phase. If multiple log parameters are to be sent during the data out phase, they also should be sent in ascending order by parameter code value. The initiator should not amputate log parameters or log page headers.