



Seagate Field-Accessible Reliability Metrics (FARM) Specification

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When referring to drive capacity, one gigabyte, or GB, equals one billion bytes and one terabyte, or TB, equals one trillion bytes. Your computer's operating system may use a different standard of measurement and report a lower capacity. In addition, some of the listed capacity is used for formatting and other functions, and thus does not be available for data storage. Actual quantities will vary based on various factors, including file size, file

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format, features and application software. Actual data rates may vary depending on operating environment and other factors. The export or re-export of hardware or software containing encryption may be regulated by the U.S. Department of Commerce, Bureau

Revisions

Rev.	Sec.	Date	Description
1.0	All	Jan 13, 2015	Initial Release
1.1	6, 7	Jan 30, 2015	Added log page definitions and structure for all pages and error sense code descriptions.
1.2	All	Feb 3, 2015	Clarified currently supported parameters and updated conventions.
1.3	All	Feb 26, 2015	Updated to include options for feature register to retrieve historical data from disc or generate new data. Updated all log page contents with new data.
1.4	6	March 3, 2015	Added missing parameter from V1.3 to Page05 data.
1.5	6	March 3, 2015	Added SMART Seek Error Rate Raw value to Page05 data.
1.6	1, 4, 6	March 17, 2015	Added SMART Frame parameters to Page01, Page04, Page05 data. Added approximate log access time.
1.7	2, 6, 8	April 2, 2015	Added Asserts since Power-On to Page03, Error Statistics. Added applicable definitions and acronyms. Removed Fly Height from Page05 since this does not be supported until MakaraPlus. Added Test Plan (Section 8).
1.8	6	May 7, 2015	Clarified which parameters are not supported on Megalodon. Corrected offsets in Page 03 and Page 05
1.9	4, 5, 8	July 2, 2015	Added requirement to save a new copy of the FARM log after the completion of any IDD routine. Added fly height delta to Page05.
1.10	5	April 29, 2016	Added number of disc slip recalibrations performed.
1.11	5	Jan 13, 2017	Add incorrect byte offsets in Sec 5 starting at ACFF 1X SINE
1.12	5	May 18, 2017	Fix incorrect byte offsets in Sec 5 starting at MR Head Resistance from most recent SMART Summary Frame by Head
2.0	9	August 2, 2017	Added SAS FARM specifications
2.1	6	August 2, 2017	Add new assert info field to page 3
2.2	6,9	November 17, 2017	Added 2 new (by head) fields in Reliability statistics Table 11 (for SATA) and added 2 new by head parameters (0x21 and 0x22) in parameter code table 14 for SAS
2.3	6,9	January 11, 2018	Added 3 new (by head) DOS Scan count per head parameters to Table11 (for SATA) and added 3 new (by head) parameters (0x23,0x24,0x25) in parameter code table 14 for SAS
2.4	6,9	January 26, 2018	1. Added 2 new fields in Error Statistics LogPage 3, Table 9, for SATA (SMART attribute 187 Raw and FRU if smart trip)

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Rev.	Sec.	Date	Description
			<ol style="list-style-type: none"> Added 4 new fields in Reliability statistics LogPage 5, Table 11 for SATA (WPOH by head, RV absolute mean, Max RV absolute Mean and idletime from SMART summary frame.) Added 1 new by head parameter (0x26) in parameter code Table 14 for SAS Added 3 new fields in Error Statistics Parameter 0x03 for SAS (Flash LED code and address, SMART attribute 187 Raw (SATA Only) and FRU if smart trip) in Table 18. Added 3 new fields in Reliability Statistics Parameter 0x05 for SAS (RV absolute mean, Max RV absolute Mean and idletime from SMART summary frame) in Table 20
2.5	6,9	March 5,2018	Added 1 new (by head) DOS Scan Write Threshold per head parameters to Table11 (for SATA) and added 1 new (by head) parameters (0x27) in parameter code table 14 for SAS
2.6	9	April 16, 2018	<ol style="list-style-type: none"> Added (copied from SATA) information and explanation about status byte of each field of Log parameter in SAS section (Tables 5 and 6) for readability. Modified Log parameter 0 (Table 15) and Parameter 1 (Table 16), Parameter 4 (Table 19) and Parameter 5 (Table 20) multiple fields along with revision numbers (redefined multiple fields as reserved since SAS support is unavailable for those fields)
2.7	6,9	April 23, 2018	<ol style="list-style-type: none"> Added Spin up Time to Ready of last power cycle and Time held in Staggered Spin of last power on sequence to Page 1 (SAS & SATA) Added 8 entries for Flash LED (assert) info to page 3 and changed the old Flash LED info to an index into the last entry added to the Flash LED info array. (SATA only)
2.8	9	May 18, 2018	<ol style="list-style-type: none"> Removed Added Spin up Time to Ready of last power cycle and Time held in Staggered Spin of last power on sequence from Parameter 0x01 for SAS as SAS parameter can have max length of 252 bytes and 4 bytes header so total 256 bytes Marked multiple fields in Parameter 0x04 and 0x05 as 'reserved' if SAS equivalent is not possible or 'not supported for SAS' if current code support is missing. [Note: The fields marked as reserved can be reused for other fields in future]

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Rev.	Sec.	Date	Description
2.9	5	June 13, 2018	Added new SATA feature code “3” to pull the FARM factory frame
2.10	6	October 26, 2018	Added logging of last 8 Read/Write Retry events
2.11	5	December 3, 2018	Added second MR head resistance for MSMR drives
2.12	5	December 13, 2018	Clarify that BER is always negative and there is a “negative zero” case. Also clarify that Disc slip is a magnitude.
2.13	5	January 4, 2019	Add Factory frame for SAS and fix minor offset calculation mistake in table 11 for Second MR Head Resistance
2.14	6	January 10, 2019	Add drive model number to page 1
2.15	6	January 17, 2019	Add drive recording type and has drive been depopped to page 1
3.0	6	February 15, 2019	Add Super Parity on the Fly Recovery counts to page 3
3.1	6	March 8, 2019	Add reallocations by reason to page 3
3.2	9	March 28, 2019	Add Super Parity on the Fly Recovery counts to SAS
3.2.1	6,9	April 23, 2019	Align wording for reallocated sectors and reallocation candidate sectors. Formerly defined as g-list and pending.
3.3	6	June 19, 2019	Add Max Number of Available Sectors for Reassignment to Page 1
3.4	6	June 25, 2019	Add 3 new dither fields to page 2
3.5	6	July 30, 2019	Edit the layout of Read/Write Retry information (log page 3) to accommodate greater than 16 heads
3.6	9	September 27, 2019	SAS – Edit the layout of the FARM Logpage ‘Error Statistics’ Parameter Structure (Table 18). Remove reserved fields at the end of the structure that cause the size of the page to be over 8 bits. This allows correct page size reporting.
3.7	6	November 21, 2019	Add Current, Minimum, and Maximum 5V and 12V input to page 4
4.0	9	May 7, 2019	<p>Moved following fields to ‘by LUN’ parameter codes (0x0051 – 0x008F). See SAS FARM log page.</p> <ul style="list-style-type: none"> • Head Load Events/Count • No of Reallocated Sectors • No of Reallocated Candidate Sectors • Time of Last IDD test • Sub Cmd of Last IDD Test • No of Glist Reclamations • Servo Status • No of Alts before IDD • No of Alts after IDD • No of Resident Glist before IDD • No of Resident Glist after IDD • Scrub List before Scan

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Rev.	Sec.	Date	Description
			<ul style="list-style-type: none"> • Scrub List after Scan • Number of DOS Scans performed • Number of LBAs corrected by ISP • Number of valid parity sectors • RV Absolute Mean • Max RV Absolute Mean • Idle Time
4.1	9	October 14, 2019	<p>Move Super Parity on the Fly Recovery from 'Error Statistics' Parameter to 'By LUN' Parameter</p> <p>Add reserved fields to SAS Parameter 0x04 for future expansion</p>
4.2	6,9	February 5, 2020	<p>Add Date of Assembly to SATA Page 1 and SAS Parameter 0x1.</p> <p>Remove changes from revision 3.0, 3.2, and 4.1 "Super Parity on the Fly" as it is obsolete.</p>
4.2.1	6,9	February 20, 2020	No functional change. Remove obsolete references, general spec cleanup
4.3	6,11	March 10, 2020	<p>Add Power Telemetry Parameter.</p> <p>SATA page 4:</p> <p>12V Power Average(mw)</p> <p>12V Power Min(mw)</p> <p>12V Power Max(mw)</p> <p>5V Power Average(mw)</p> <p>5V Power Min(mw)</p> <p>5V Power Max(mw)</p> <p>SAS page 4 Environmental Statistics:</p> <p>12V Power Average(mw)</p> <p>12V Power Min(mw)</p> <p>12V Power Max(mw)</p> <p>5V Power Average(mw)</p> <p>5V Power Min(mw)</p> <p>5V Power Max(mw)</p>
4.4	6,11	March 19, 2020	Add Commands by Radius from SMART Summary Frame to SATA Page 2 and SAS Parameter 2
4.5	6,11	April 1, 2020	Add FAFH Parameters to SATA page 5, reserve parameter codes for FAFH in SAS.
4.6	11	April 7, 2020	Add CRC Errors to SAS Parameter 3 from SAS Protocol Spec

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Rev.	Sec.	Date	Description
4.7	6,11	April 9, 2020	1) Add depop headmask to Page 1 SATA and Parameter 6 (new parameter) SAS. 2) Add FLED timestamp and power cycle info to page 3 SATA (SAS implementation to follow)
4.8	6,11	April 17, 2020	Remove support for Workload Rating Percentage field
4.9	11	April 23, 2020	Create new SAS Parameter 7 as an extension to Parameter 4 and add 5V and 12V input data To Parameter 6 add: <ul style="list-style-type: none"> • ProductID • Recording Type • Depopulation State • Max number of available disc sectors for reassignment
4.10	11	April 23, 2020	Added FLED timestamp and power cycle info to the 'By Actuator' FLED location for SAS Added Reallocation by cause as a new 'by actuator reallocation' parameter
4.11	11	April 26, 2020	To SAS Parameter 6 add: <ul style="list-style-type: none"> • Time to Ready of the last power cycle • Time the drive is held in staggered spin
4.12	11	May 2, 2020	Added servo spin up time field to SAS Parameter Code 6.
4.13	11	May 4, 2020	Add support for the already defined FAFH parameters for SAS
4.14	6,11	May 18, 2020	Add "Reason for Frame Capture" to Log Page 0 (SATA) and Parameter Code 0 (SAS)
4.14.1	4, 5, 10 12, 13	June 4, 2020	Add FARM Frame Capture functionality.
4.15	6, 9	June 10, 2020	In SATA, added 3 unrecoverable read error counters (2 by head counters and 1 by drive counter) to Page 3 In SAS, added 1 by drive counter to parameter code 5 and added 2 new By head parameter codes (0x28 and 0x29) for the 3 unrecoverable read error counters.
4.16	6,11	June 30, 2020	Add "Number of LBAs Corrected by Super Parity" to SAS By Actuator Parameter and SATA Page 5.
4.17	6,12,13	July 23, 2020	Create new SATA log address 0xC6 for FARM Frames data

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Rev.	Sec.	Date	Description
4.17.1	11	July 28, 2020	Update parameter lengths for SAS Parameters
4.17.2	6	Sept. 24, 2020	Cum Unrecoverable read has wrong offsets.
4.18	6,11	Oct 26, 2020	Add Low, Mid, High Frequency score for current vibration as well as worst ever score for each to SATA Page 4 and SAS 'By Actuator' Parameter.
4.19	6,11	Oct 30, 2020	SATA Page 2 – Add transfer length bins for reads and writes and add queue depth bins. SATA Page 5 – Add Primary super parity coverage percentage SAS Parameter 2 – Add transfer length bins for reads and writes SAS Parameter 8 – Create parameter 8 and add queue depth bins SAS By Actuator Parameter – Add Primary super parity coverage percentage
4.20	6,11	Nov 18, 2020	Add 3 new HAMR specific fields to SATA Page 5, offsets: 8888..10231 Add the same HAMR specific fields to SAS 'By Head' Parameters: 0x2A and 0x36..0x3B
4.21	6	Nov 18, 2020	Add By Actuator fields to SATA for Actuator 1, the fields for Actuator 0 remain where they were but added a note about Actuator 0. Page 1 – offsets 376..391 added Page 2 – offsets 396..319 added Page 3 – offsets 952..1359 added Page 4 – offsets 304..351 added Page 5 – offsets 10242..10410 added
4.21.1	6,11	Jan 6, 2021	Fix verbiage of MR Head Resistance source from SMART Summary Frame to latest SMART Frame
4.21.2	6	Jan 21, 2021	Remove duplicate fields in SATA Page 5 added in rev 4.21and fix offsets of remaining parameters. Number of DOS Scans Performed, Actuator 1 Number of LBAs Corrected by ISP, Actuator 1 Number of Valid Parity Sectors, Actuator 1
4.21.3	6	Jan. 29, 2021	Offset issue with Post LFA Optimal BER by head is 10 off.
4.21.4	5	Mar. 4, 2021	Added Feature 0x2 for Workload Trace (WLTR) data retrieval by FARM 0xC6
4.22	6,11	Mar 24, 2021	Add 4 new HAMR specific fields to SATA Page 5, offsets:

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Rev.	Sec.	Date	Description
			10376..12295 Add the same HAMR specific fields to SAS 'By Head' Parameters: 0x2B-0x2F, 0x3C-0x3F, 0x4F
4.23	6	May 31, 2021	Added hot write statistics fields to SATA page2 Offsets: 320...3119
4.23.1	All	June 13, 2021	Modify format from new spec Seagate templates
4.24	6,11	June 22, 2021	Added SMR Parity Percentage to SATA Page 5 and SAS By Actuator Parameter
4.24.1	13	June 25, 2021	Added Workload Trace information and layout to section 13

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1. Scope of Document

The purpose of this document is to define the vendor-specific Field-Accessible Reliability Metrics log. This document will describe log access, log structure and definitions of log parameters.

2. Acronyms and Conventions

ACFF	Alternating Coefficient Feed-Forward (per-revolution compensation)
ASR	Asynchronous Signal Recovery
BIE	Bits in Error
CRC	Cyclic Redundancy Check
CTO	Command Time-out
DOS	Directed Offline Scan
DRAM	Dynamic Random Access Memory
DST	Drive Self Test
DVGA	Delta Variable Gain Amplifier
EWLM	Enhanced Workload Management
FARM	Field Accessible Reliability Metrics
FVGA	Filter Variable Gain Amplifier
H2SAT	Head Health Self-Assessment Test
IDD	In-Drive Diagnostics (OVD)
IOEDC	Input/Output Error Detection Code
ISP	Intermediate Super Parity
LBA	Logical Block Address
LFA	Laser Field Adjust (HAMR)
LUN	Logical Unit
MR	Magneto Resistive
NVC	Non-Volatile Cache
POH	Power on Hours
PZT	[Micro-actuator] Piezoelectric Transducer
RAW	Read After Write
RV	Rotational Vibration
RVGA	Running Average Variable Gain Amplifier
TMD	Timing Mark Detect

SMART Summary Frame Velocity Observer

A set of SMART data capturing 168 hours of drive history.
The divergence of the actuator coil requested current to the measured current during a seek operation

Standard Definitions

All standard ATA commands and status definitions shall be referred to in all uppercase throughout this document.

3. Related Documentation

ACS Specification

Seagate IDD Specification

T10 Specification

T13 Specification

4. SATA FARM (Log 0xA6, 0xC6) Overview

The Field-Accessible Reliability Metrics (FARM) log provides a single source of information for drive health and predictive failure information. The log is also designed for ease of use. The log structure is based on pages that are 32 512-byte blocks in length, with every page and parameter containing self-descriptive information.

A READ LOG (DMA) EXT command can pull the FARM , which is reported in the Directory Log. A SMART READ LOG command results in an ABRT status.

The size of one FARM log is 96kB. This is accessible by log address 0xA6.

The maximum size for all FARM data is 2592 KB. This includes (1) current frame generated on-the-fly, one (1) host disc copy, sixteen (16) Time Series Frames, two (2) Long Term Save Frames, six (6) Sticky Frames, and one (1) Factory copy. This data is accessible by log address 0xC6.

The data lengths associated with each feature code are detailed in **Section 5**.

Space is reserved on SATA for 24 heads.

5. SATA Log Access and Structure

You can read FARM data by issuing a READ LOG (DMA) EXT command to log 0xA6. The command structure is shown below in **Table 1a**. Access times for each valid FEATURE register selection are also shown in **Table 1a**.

Table 1a Command Structure for Reading FARM Log

Field	Description
Command	0x2F (Read Log Ext)
	0x74 (Read Log DMA Ext)
LBA	7:0 0xA6 (Log Address)
	15:8 Log Page Offset LSB in 512 byte blocks
	39:32 Log Page Offset MSB in 512 byte blocks
Count	Number of 16kB log pages to be read
Feature	0 – Default: Generate and report new FARM data but do not save to disc (~50ms)
	1 – Generate and report new FARM data and save to disc (~70ms)
	2 – Report previous FARM data from disc (~45ms)
	3 – Report FARM factory data from disc (~45ms)

Selecting a FEATURE register of 0 to generate and report new FARM data gathers the data from the drive at the time when the command is received; this also populates the log structure, and transfers to the host. This option does **not** save the data to the FARM disc file. This option returns 96 KB of meaningful data to the host.

Selecting a FEATURE register of 1 to generate and report new FARM data gathers the data from the drive at the time the command is received, populates the log structure, saves the data to the FARM disc file, and transfers to the host. This option returns 96 KB of meaningful data to the host.

Selecting a FEATURE register of 2 reports the saved FARM Log from the last time the log is read with feature register set to 0. If feature 1 is requested, no new log data is generated. Space is only reserved for 1 historical capture at this time. If this option is requested and there is no valid disc copy, the command is aborted by the drive. This option returns 96 KB of meaningful data to the host.

Selecting a FEATURE register of 3 reports the saved FARM Log from the factory process. This option reports “FACTORY” in ASCII for Log Copy Number in pages 1-5. If this option is requested and there is no valid disc copy, the command is aborted by the drive. This option returns 96 KB of meaningful data to the host.

The FARM Time Series can be read by issuing a READ LOG (DMA) EXT command to log 0xC6. The command structure is shown below in **Table 1b**. Access times for each valid FEATURE register selection are also shown in **Table 1b**.

Table 2b Command Structure for Reading FARM Frames Log

Field	Description
Command	0x2F (Read Log Ext)
	0x74 (Read Log DMA Ext)
LBA	7:0 0xC6 (Log Address)
	15:8 Log Page Offset LSB in 512 byte blocks
	39:32 Log Page Offset MSB in 512 byte blocks
Count	Number of 16kB log pages to be read
Feature	0 – Report all FARM frames from disc (~250ms)
	1 – Report all FARM data (~250ms)
	2 – Return WLTR data at Log Page Offset (LBA field) with length specified in Count field

Selecting a FEATURE register of 0 reports all FARM frames saved on disc. The data return order is as follows:

1. Time Series Frames (16): Most recent frame first
2. Long Term Save Frames (2): Most recent frame first
3. Sticky Frames (6): Fixed offset for each frame type

This option returns 2304 KB of meaningful data to the host with zero padding up to 2592 KB. See **Section 12** and **Section 13** for more information on the FARM Frame Capture feature.

Selecting a FEATURE register of 1 reports all FARM data. The data return order is as follows:

1. Current frame generated on-the-fly (1)
2. Host disc copy (1): If not present, data region is 0's
3. Time Series Frames (16): Most recent frame first
4. Long Term Save Frames (2): Most recent frame first
5. Sticky Frames (6): Fixed offset for each frame type
6. Factory copy (1)

This option returns 2592 KB of meaningful data to the host. See **Section 12** and **Section 13** for more information on the FARM Frame Capture feature.

Selecting a FEATURE register of 0x2 returns workload trace (WLTR) data. This option returns 2048 KB of meaningful data to the host with zero padding up to 2592 KB. See section 13 “Workload Trace Information” and “Workload Trace Layout” for more information.

The structure for the FARM is shown in **Table 2**. Note that each 16kB-page has a unique identifier located in the first two 64-bit fields of each respective page. The log header page structure, log page 0, is shown in **Table 4**, while the structure for log pages 1 through 5 is shown in **Table 5**. Explanations of each page are given in **Section 6**. Unused space in each page is reserved for future development.

Table 3 FARM Structure

Page	Description
0	FARM Header – See Table 4
1	General Drive Information
2	Workload Statistics
3	Error Statistics
4	Environmental Statistics
5	Reliability Statistics

Table 4 FARM Header Structure

Byte Offset	Data Type	Description
0..7	Qword	Log Signature = 0x00004641524D4552
8..15	Qword	Log Major Revision
16..23	Qword	Log Minor Revision
24..31	Qword	Number of Pages Supported
32..39	Qword	Log Size in Bytes
40..47	Qword	Page Size in Bytes
48..55	Qword	Maximum Drive Heads Supported
56..63	Qword	Number of Historical Copies
64..71	Qword	Reason for Frame Capture
72..16383	Qword	Reserved

Table 5 FARM Pages 1-5 Structure

Byte Offset	Data Type	Description
0..7	Qword	Log Page Number
8..15	Qword	Log Copy Number
16..23	Qword	Field 1
24..31	Qword	Field 2
...	Qword	...
N..16383	Qword	Reserved

The first byte of each field in each page contains a bit-mapped status. The structure for each field is shown in **Table 6**.

Table 6 Individual Field Structure

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0
Status Byte See Table 7	Field Data	Field Data	Field Data	Field Data	Field Data	Field Data	Field Data

Table 7 Status Byte Structure

Bit	7	6	5	4	3	2	1	0
Description	Field Supported	Field Valid	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

The FARM logs also save a new copy of the log data to disc at the completion of any host-requested In-Drive Diagnostics event.

6. SATA Log Page Definitions

This section defines, at a high level, the type of information found in each log page of the Field-Accessible Reliability Metrics. The following log pages contain examples of the type of information that could be added and are subject to change. Fields in red indicate that the field is unsupported in the current log revision.

Log Page 0: Header

The first 4kB block of the FARM contains information about the structure and contents of the following log pages. Additionally, the header contains a unique signature to be used for validity checking. The header structure is defined in **Table 4**.

Log Page 1: General Drive Information

The general drive information recorded in Log Page 1 contains descriptive, high-level drive information. Data contained in Log Page 1 is shown in **Table 8**:

Table 8 FAR Page 1 Structure

Byte Offset	Data Type	Description
0..7	Qword	Page Number = 1
8..15	Qword	Copy Number
16..23	Qword	Serial Number [0:3]
24..31	Qword	Serial Number [4:7]
32..39	Qword	World Wide Name [0:3]
40..47	Qword	World Wide Name [4:7]
48..55	Qword	Device Interface ("SATA" in ASCII)
56..63	Qword	48-bit Device Capacity
64..71	Qword	Physical Sector Size in Bytes
72..79	Qword	Logical Sector Size in Bytes
80..87	Qword	Device Buffer Size in Bytes
88..95	Qword	Number of Heads
96..103	Qword	Device Form Factor (ID Word 168)
104..111	Qword	Rotational Rate of Device (ID Word 217)
112..119	Qword	Firmware Revision [0:3]
120..127	Qword	Firmware Revision [4:7]
128...135	Qword	ATA Security State (ID Word 128)
136..143	Qword	ATA Features Supported (ID Word 78)
144..151	Qword	ATA Features Enabled (ID Word 79)
152..159	Qword	Power-on Hours
160..167	Qword	Spindle Power-on Hours
168..175	Qword	Head Flight Hours, Actuator 0
176..183	Qword	Head Load Events, Actuator 0
184..191	Qword	Power Cycle Count
192..199	Qword	Hardware Reset Count

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Byte Offset	Data Type	Description
200..207	Qword	SMART Spin-Up time in milliseconds
208..215	Qword	NVC Status on Power-on
216..223	Qword	Time Available to Save User Data to Non-volatile Memory Over Last Power Cycle (in 100us)
224..231	Qword	Timestamp of most recent SMART Summary Frame in Power-On Hours Milliseconds
232..239	Qword	Timestamp of last SMART Summary Frame in Power-On Hours Milliseconds
240...247	Qword	Time to ready of the last power cycle in milliseconds
248...255	Qword	Time drive is held in staggered spin during the last power on sequence in milliseconds
256...335	Qword[10]	Lower 32 bits = Partial Model number
336...343	Qword	Drive Recording Type – see below
344...351	Qword	Is drive currently depopped – 1 = depopped, 0 = not depopped
352...359	Qword	Max Number of Available Sectors for Reassignment – Value in disc sectors
360...367	Qword	Date of Assembly in ASCII “YYWW” where YY is the year and WW is the calendar week
368...375	Qword	Depopulation Head Mask
376..383	Qword	Head Flight Hours, Actuator 1
384..391	Qword	Head Load Events, Actuator 1
392..16383	Qword	Reserved

Drive Recording Type

Bit	7	6	5	4	3	2	1	0
Description	Field Supported	Field Valid	Reserved	Reserved	Reserved	Reserved	CMR	SMR

Log Page 2: Workload Statistics

The workload statistics recorded in Log Page 2 of the FARM log contains information specific to the use case of the device. The structure for Log Page 2 is shown in **Table 9**.

Table 9 FARM Page 2 Structure

Byte Offset	Data Type	Description
0..7	Qword	Page Number = 2
8..15	Qword	Copy Number
16..23	Qword	Rated Workload Percentage (No longer Supported)
24..31	Qword	Total Number of Read Commands
32..39	Qword	Total Number of Write Commands
40..47	Qword	Total Number of Random Read Commands
48..55	Qword	Total Number of Random Write Commands
56..63	Qword	Total Number Of Other Commands
64..71	Qword	Logical Sectors Written
72..79	Qword	Logical Sectors Read
80..87	Qword	Number of dither events during current power cycle, Actuator 0
88..95	Qword	Number of times dither is held off during random workloads during current power cycle, Actuator 0
96..103	Qword	Number of times dither is held off during sequential workloads during current power cycle, Actuator 0
104..111	Qword	Number of Read commands from 0-3.125% of LBA space for last 3 SMART Summary Frames
112..119	Qword	Number of Read commands from 3.125-25% of LBA space for last 3 SMART Summary Frames
120..127	Qword	Number of Read commands from 25-50% of LBA space for last 3 SMART Summary Frames
128..135	Qword	Number of Read commands from 50-100% of LBA space for last 3 SMART Summary Frames
136..143	Qword	Number of Write commands from 0-3.125% of LBA space for last 3 SMART Summary Frames
144..151	Qword	Number of Write commands from 3.125-25% of LBA space for last 3 SMART Summary Frames
152..159	Qword	Number of Write commands from 25-50% of LBA space for last 3 SMART Summary Frames
160..167	Qword	Number of Write commands from 50-100% of LBA space for last 3 SMART Summary Frames
168..175	Qword	Number of Read Commands of transfer length <=16KB space for last 3 SMART Summary Frames
176..183	Qword	Number of Read Commands of transfer length (16KB – 512KB] for last 3 SMART Summary Frames
184..191	Qword	Number of Read Commands of transfer length (512KB – 2MB] for last 3 SMART Summary Frames
192..199	Qword	Number of Read Commands of transfer length > 2MB for last 3 SMART Summary Frames
200..207	Qword	Number of Write Commands of transfer length <=16KB for last 3 SMART Summary Frames
208..215	Qword	Number of Write Commands of transfer length (16KB – 512KB] for last 3 SMART Summary Frames
216..223	Qword	Number of Write Commands of transfer length (512KB – 2MB] for last 3 SMART Summary Frames
224..231	Qword	Number of Write Commands of transfer length > 2MB for last 3 SMART Summary Frames
232..239	Qword	Count of Queue Depth =1 at 30s intervals for last 3 SMART Summary Frames

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240..247	Qword	Count of Queue Depth =2 at 30s intervals for last 3 SMART Summary Frames
248..255	Qword	Count of Queue Depth 3-4 at 30s intervals for last 3 SMART Summary Frames
256..263	Qword	Count of Queue Depth 5-8 at 30s intervals for last 3 SMART Summary Frames
264..271	Qword	Count of Queue Depth 9-16 at 30s intervals for last 3 SMART Summary Frames
272..279	Qword	Count of Queue Depth 17-32 at 30s intervals for last 3 SMART Summary Frames
280..287	Qword	Count of Queue Depth 33-64 at 30s intervals for last 3 SMART Summary Frames
288..295	Qword	Count of Queue Depth >64 at 30s intervals for last 3 SMART Summary Frames
296..303	Qword	Number of dither events during current power cycle, Actuator 1
304..311	Qword	Number of times dither is held off during random workloads during current power cycle, Actuator 1
312..319	Qword	Number of times dither is held off during sequential workloads during current power cycle, Actuator 1
320..3119	Qword	Hot write statistics: including metadata and 2400-band/region workload rating data
3120..16383	Qword	Reserved

Hot Write Statistics

Byte 320	Byte 321	Byte 322	Byte 323	Byte 324	Byte 325	Byte 326	Byte 327
POH time 0	POH time 1	POH period length 0	POH period Length 1	Highest band write count 0	Highest band write count 1	Highest band write count 2	FARM status byte
Byte 328	Byte 329	Byte 330	Byte 331	Byte 332	Byte 333	Byte 334	Byte 335
Highest band write count 3	Highest band write count 4	Reserved 0	Reserved 1	Reserved 2	Number of valid entries 0	Number of valid entries 1	FARM status byte
Byte 336	Byte 337	Byte 338	Byte 339	Byte 340	Byte 341	Byte 342	Byte 343
Band size 0	Band size 1	XOR signature 0	XOR Signature 1	XOR signature 2	XOR Signature 3	Band 0 rating data	FARM status byte
Byte 344	Byte 345	Byte 346	Byte 347	Byte 348	Byte 349	Byte 350	Byte 351
Band 1 rating data	Band 2 rating data	Band 3 rating data	Band 4 rating data	Band 5 rating data	Band 6 rating data	Band 7 rating data	FARM status byte

....

Byte 3080	Byte 3081	Byte 3082	Byte 3083	Byte 3084	Byte 3085	Byte 3086	Byte 3087
Band 2394 rating data	Band 2395 rating data	Band 2396 rating data	Band 2397 rating data	Band 2398 rating data	Band 2399 rating data	Reserved	FARM status byte

....

Byte 3112	Byte 3113	Byte 3114	Byte 3115	Byte 3116	Byte 3117	Byte 3118	Byte 3119
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

Band rating data

Value	Definition
0	Band is not written
A scale of 1 ~ 0xFF	Band hotness rating 0xFF: Hottest 1: Coldest

Log Page 3: Error Statistics

The error statistics recorded in Log Page 3 provides data specific to error handling. The structure for Log Page 3 is shown in **Table 10**.

Table 10 FARM Page 3 Structure

Byte Offset	Data Type	Description
0..7	Qword	Page Number = 3
8..15	Qword	Copy Number
16..23	Qword	Number of Unrecoverable Read Errors
24..31	Qword	Number of Unrecoverable Write Errors
32..39	Qword	Number of Reallocated Sectors, Actuator 0
40..47	Qword	Number of Read Recovery Attempts
48..55	Qword	Number of Mechanical Start Retries
56..63	Qword	Number of Reallocation Candidate Sectors ¹ , Actuator 0
64..71	Qword	Number of ASR Events
72..79	Qword	Number of Interface CRC Errors
80..87	Qword	Spin Retry Count (Most recent value from array at byte 401 of attribute sector)
88..95	Qword	Spin Retry Count (SMART Attribute 10 Normalized)
96..103	Qword	Spin Retry Count (SMART Attribute 10 Worst Ever)
104..111	Qword	Number of IOEDC Errors (SMART Attribute 184 Raw)
112..119	Qword	CTO Count Total (SMART Attribute 188 Raw[0..1]) ²
120..127	Qword	CTO Count Over 5s (SMART Attribute 188 Raw[2..3])
128..135	Qword	CTO Count Over 7.5s (SMART Attribute 188 Raw[4..5])
136..143	Qword	Total Flash LED (Assert) Events, Actuator 0
144..151	Qword	Index of last entry in FLED Info array below, in case the array wraps, Actuator 0
152..159	Qword	Uncorrectable errors (SMART Attribute 187 Raw)
160...167	Qword	Reserved
168...231	Qword[8]	Info on the last 8 Flash LED (assert) Events, wrapping array, Actuator 0
232...295	Qword[8]	Info on the last 8 Read/Write Retry events, wrapping array, Actuator 0
296...311	Qword[2]	Reserved
312...431	Qword[15]	Reallocated sectors by cause, Actuator 0
432...495	Qword[8]	Universal Timestamp (us) of last 8 Flash LED (assert) Events, wrapping array, Actuator 0
496...559	Qword[8]	Power Cycle of the last 8 Flash LED (assert) Events, wrapping array, Actuator 0
560..567	Qword	Cumulative Lifetime Unrecoverable Read errors due to Error Recovery Control (e.g. ERC timeout)
568..759	Qword[24]	Cumulative Lifetime Unrecoverable Read Repeating by head
760..951	Qword[24]	Cumulative Lifetime Unrecoverable Read Unique by head
952..959	Qword	Number of Reallocated Sectors, Actuator 1
960..967	Qword	Number of Reallocation Candidate Sectors ³ , Actuator 1
968..975	Qword	Total Flash LED (Assert) Events, Actuator 1
976..983	Qword	Index of last entry in FLED Info array below, in case the array wraps, Actuator 1
984..1047	Qword[8]	Info on the last 8 Flash LED (assert) Events, wrapping array, Actuator 1
1048..1111	Qword[8]	Info on the last 8 Read/Write Retry events, wrapping array, Actuator 1
1112..1231	Qword[15]	Reallocated sectors by cause, Actuator 1

¹ As defined by Device Statistics Log definition (ACS). Does not include FLAGGED UNC, but does include PSEUDO UNC.

² Byte offset 112, CTO Count, refers to the number of command time-outs as defined by an active command being interrupted by a HRST, SRST, COMRESET, or other command.

³ As defined by Device Statistics Log definition (ACS). Does not include FLAGGED UNC, but does include PSEUDO UNC.

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1232..1295	Qword[8]	Universal Timestamp (us) of last 8 Flash LED (assert) Events, wrapping array, Actuator 1
1296..1359	Qword[8]	Power Cycle of the last 8 Flash LED (assert) Events, wrapping array, Actuator 1
1360..16383	Qword	Reserved

Read Write Retry Information

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0
Status Byte See Table 7	Error Type	RW Retry Log Entry MSB	RW Retry Log Entry LSB	Zone Group MSB	Zone Group LSB	Head	Retry Count

Reallocated sectors by cause

Index	Cause for Reallocation
0	Host Read – Generic
1	Host Read – Uncorrectable
2	Host Read – RAW
3	Host Write – Generic
4	Host Write – Uncorrectable
5	Host Write – RAW
6	Background Read Generic
7	Background Read – Reliability
8	Background Read – Recovery
9	Background Read – Host Self Test
10	Background Write – Generic
11	Background Write – Reliability
12	Background Write – Recovery
13	Background Write – Host Self Test
14	Servo Wedge

Log Page 4: Environmental Statistics

The environmental statistics recorded in Log Page 4 provide information on the device environment. The structure and definitions for Log Page 4 are shown in **Table 11**.

Table 11 FARM Page 4 Structure

Byte Offset	Data Type	Description
0..7	Qword	Page Number = 4
8..15	Qword	Copy Number
16..23	Qword	Current Temperature in Celsius
24..31	Qword	Highest Temperature in Celsius
32..39	Qword	Lowest Temperature in Celsius
40..47	Qword	Average Short Term Temperature in Celsius ⁴
48..55	Qword	Average Long Term Temperature in Celsius ³
56..63	Qword	Highest Average Short Term Temperature in Celsius ³
64..71	Qword	Lowest Average Short Term Temperature in Celsius ³
72..79	Qword	Highest Average Long Term Temperature in Celsius ³
80..87	Qword	Lowest Average Long Term Temperature in Celsius ³
88..95	Qword	Time In Over Temperature in Minutes ³
96..103	Qword	Time In Under Temperature in Minutes ³
104..111	Qword	Specified Max Operating Temperature in Celsius
112..119	Qword	Specified Min Operating Temperature in Celsius
120..127	Qword	Over-Limit Shock Events Count(SMART Attribute 191 Raw)
128..135	Qword	High Fly Write Count (SMART Attribute 189 Raw)
136..143	Qword	Current Relative Humidity (in units of .1%)
144..151	Qword	Humidity Mixed Ratio multiplied by 8 (divide by 8 to get actual value)
152..159	Qword	Current Motor Power, value from most recent SMART Summary Frame
160..167	Qword	Current 12V input in mV
168..175	Qword	Minimum 12V input from last 3 SMART Summary Frames in mV
176..183	Qword	Maximum 12V input from last 3 SMART Summary Frames in mV
184..191	Qword	Current 5V input in mV
192..199	Qword	Minimum 5V input from last 3 SMART Summary Frames in mV
200..207	Qword	Maximum 5V input from last 3 SMART Summary Frames in mV
208..215	Qword	12V Power Average(mw) – Highest of the three summary frames
216..223	Qword	12V Power Min(mw) – Lowest of last 3 SMART summary frames
224..231	Qword	12V Power Max(mw) – Highest of last 3 SMART summary frames
232..239	Qword	5V Power Average (mw) – Highest of the last 3 SMART summary frames
240..247	Qword	5V Power Min(mw) – Lowest of last 3 SMART summary frames
248..255	Qword	5V Power Max(mw) – Highest of last 3 SMART summary frames
256..263	Qword	Current Low Frequency Vibe Score, Actuator 0
264..271	Qword	Current Mid Frequency Vibe Score, Actuator 0
272..279	Qword	Current High Frequency Vibe Score, Actuator 0
280..287	Qword	Worst Low Frequency Vibe Score, Actuator 0
288..295	Qword	Worst Mid Frequency Vibe Score, Actuator 0
296..303	Qword	Worst High Frequency Vibe Score, Actuator 0
304..311	Qword	Current Low Frequency Vibe Score, Actuator 1
312..319	Qword	Current Mid Frequency Vibe Score, Actuator 1
320..327	Qword	Current High Frequency Vibe Score, Actuator 1
328..335	Qword	Worst Low Frequency Vibe Score, Actuator 1

⁴ As defined in Device Statistics (ACS Specification)

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Byte Offset	Data Type	Description
336..343	Qword	Worst Mid Frequency Vibe Score, Actuator 1
344..351	Qword	Worst High Frequency Vibe Score, Actuator 1
352..16383	Qword	Reserved

Log Page 5: Reliability Statistics

The reliability statistics recorded in Log Page 5 contains data obtained from diagnostic tools and preventative internal operations. Log structure and definitions for Log Page 5 are shown in **Table 12**.

Note: BER is a negative or zero value. For values between -1 and 0, the decimal part of the float value can be assumed as negative. Negative zero cannot be expressed due to the two's complement conversion from a floating point variable to a signed integer.

Table 12 FARM Page 5 Structure

Byte Offset	Data Type	Description
0..7	Qword	Page Number = 5
8..15	Qword	Copy Number
16..23	Qword	Timestamp of last IDD test in Hours (POH), Actuator 0
24..31	Qword	Sub-command of last IDD test, Actuator 0
32..223	Qword[24]	Magnitude of Disc Slip in micro-inches by Head
		7 Parameter Status
		6 Reserved
		5:4 Whole part of float value, signed
		3:0 Decimal part of float value, unsigned, multiplied by 10,000
224..415	Qword[24]	Bit Error Rate of Zone 0 by Drive Head
		7 Parameter Status
		6 Reserved
		5:4 Whole part of float value, signed
		3:0 Decimal part of float value, unsigned, multiplied by 10,000
416..423	Qword	Number of Reallocated Sector Reclamations, Actuator 0
424..431	Qword	Servo Status (follows standard DST error code definitions), Actuator 0
432..439	Qword	Number of Slipped Sectors Before IDD Scan, Actuator 0
440..447	Qword	Number of Slipped Sectors After IDD Scan, Actuator 0
448..455	Qword	Number of Resident Reallocated Sectors Before IDD Scan, Actuator 0
456..463	Qword	Number of Resident Reallocated Sectors After IDD Scan, Actuator 0
464..471	Qword	Number of Successfully Scrubbed Sectors Before IDD Scan, Actuator 0
472..479	Qword	Number of Successfully Scrubbed Sectors After IDD Scan, Actuator 0
480..487	Qword	Number of DOS Scans Performed, Actuator 0
488..495	Qword	Number of LBAs Corrected by ISP, Actuator 0
496..503	Qword	Number of Valid Parity Sectors, Actuator 0
504..695	Qword[24]	DOS Write Refresh Count
696..703	Qword	Number of RAW Operations
704..895	Qword[24]	DVGA Skip Write Detect by Head
896..1087	Qword[24]	RVGA Skip Write Detect by Head
1088..1279	Qword[24]	FVGA Skip Write Detect by Head
1279..1471	Qword[24]	Skip Write Detect Threshold Exceeded Count by Head
1472..1479	Qword	Error Rate (SMART Attribute 1 Raw)
1480..1487	Qword	Error Rate (SMART Attribute 1 Normalized)
1488..1495	Qword	Error Rate (SMART Attribute 1 Worst)
1496..1503	Qword	Seek Error Rate (SMART Attribute 7 Raw)
1504..1511	Qword	Seek Error Rate (SMART Attribute 7 Normalized)
1512..1519	Qword	Seek Error Rate (SMART Attribute 7 Worst)
1520..1527	Qword	High Priority Unload Events (SMART Attribute 192 Raw)
1528..1535	Qword	MicroActuator Lock-out, head mask accumulated over last 3 SMART Summary Frames
1536..1727	Qword[24]	ACFF Sine 1X, value from most recent SMART Summary Frame by Head

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Byte Offset	Data Type	Description
1728..1919	Qword[24]	ACFF Cosine 1X, value from most recent SMART Summary Frame by Head
1920..2111	Qword[24]	PZT Calibration, value from most recent SMART Summary Frame by Head
2112..2303	Qword[24]	MR Head Resistance from most recent SMART Frame by Head
2304..2495	Qword[24]	Number of TMD over last 3 SMART Summary Frames by Head
2496..2687	Qword[24]	Velocity Observer over last 3 SMART Summary Frames by Head
2688..2879	Qword[24]	Number of Velocity Observer over last 3 SMART Summary Frames by Head
2880..3455	Qword[24][3]	Current H2SAT trimmed mean bits in error by Head, by Test Zone
3456..4031	Qword[24][3]	Current H2SAT iterations to converge by Head, by Test Zone
4032..4223	Qword[24]	Current H2SAT percentage of codewords at iteration level by Head, averaged across Test Zones
4224..4415	Qword[24]	Current H2SAT amplitude by Head, averaged across Test Zones
4416..4607	Qword[24]	Current H2SAT asymmetry by Head, averaged across Test Zones
4608..5183	Qword[24][3]	Applied fly height clearance delta per head in thousandths of one Angstrom. Diameter 0: Outer Diameter 1: Inner Diameter 2: Middle
5184..5191	Qword	Number of disc slip recalibrations performed
5192..5383	Qword[24]	Number of Reallocated Sectors per head
5384..5575	Qword[24]	Number of Reallocation Candidate Sectors per head
5576..5583	Qword	Helium Pressure Threshold Trip (1 – trip 0 – no trip)
5584..5775	Qword[24]	DOS Ought to scans count per head
5776..5967	Qword[24]	DOS Need to scans count per head
5968..6159	Qword[24]	DOS Write Fault scans per head
6160..6351	Qword[24]	Write Workload Power-on Time in Seconds, value from most recent SMART Frame by Head
6352..6359	Qword	RV Absolute Mean, value from most recent SMART Summary Frame in rad/s ² , Actuator 0
6360..6367	Qword	Max RV Absolute Mean, value from most recent SMART Summary Frame in rad/s ² , Actuator 0
6368..6375	Qword	Idle Time, value from most recent SMART Summary Frame in seconds, Actuator 0
6376..6567	Qword[24]	DOS Write Count Need-To Threshold per head
6568..6759	Qword[24]	Second Head, MR Head Resistance from most recent SMART Frame by Head
6760..6951	Qword[24]	FAFH Measurement Status, bitwise OR across all diameters per head
6952..7143	Qword[24]	FAFH HF/LF Relative Amplitude in tenths, maximum value across all 3 zones per head
7144..7719	Qword[24][3]	FAFH Bit Error Rate, write then read BER on reserved tracks Diameter 0: Outer Diameter 1: Inner Diameter 2: Middle 7 Parameter Status 6 Reserved 5:4 Whole part of float value, signed 3:0 Decimal part of float value, unsigned, multiplied by 10,000
7720..8295	Qword[24][3]	FAFH Low Frequency Passive Clearance in ADC counts Diameter 0: Outer Diameter 1: Inner Diameter 2: Middle
8296..8871	Qword[24][3]	FAFH High Frequency Passive Clearance in ADC counts Diameter 0: Outer Diameter 1: Inner Diameter 2: Middle
8872..8879	Qword	Number of LBAs Corrected by Parity Sector, Actuator 0
8880..8887	Qword	Primary Super Parity Coverage Percentage, Actuator 0

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Byte Offset	Data Type	Description
8888..9079	Qword[24]	Number of total Laser Field Adjust iterations performed per head
9080..9655	Qword[24][3]	Laser Operating Current by head Zone 0 Zone 1 Zone 2
9656..10231	Qword[24][3]	Post LFA Optimal BER by head Zone 0 Zone 1 Zone 2
10232..10239	Qword	Timestamp of last IDD test in Hours (POH), Actuator 1
10240..10247	Qword	Sub-command of last IDD test, Actuator 1
10248..10255	Qword	Number of Reallocated Sector Reclamations, Actuator 1
10256..10263	Qword	Servo Status (follows standard DST error code definitions), Actuator 1
10264..10271	Qword	Number of Slipped Sectors Before IDD Scan, Actuator 1
10272..10279	Qword	Number of Slipped Sectors After IDD Scan, Actuator 1
10280..10287	Qword	Number of Resident Reallocated Sectors Before IDD Scan, Actuator 1
10288..10295	Qword	Number of Resident Reallocated Sectors After IDD Scan, Actuator 1
10296..10303	Qword	Number of Successfully Scrubbed Sectors Before IDD Scan, Actuator 1
10304..10311	Qword	Number of Successfully Scrubbed Sectors After IDD Scan, Actuator 1
10312..10319	Qword	Number of DOS Scans Performed, Actuator 1
10320..10327	Qword	Number of LBAs Corrected by ISP, Actuator 1
10328..10335	Qword	Number of Valid Parity Sectors, Actuator 1
10336..10343	Qword	RV Absolute Mean, value from most recent SMART Summary Frame in rad/s^2, Actuator 1
10344..10351	Qword	Max RV Absolute Mean, value from most recent SMART Summary Frame in rad/s^2, Actuator 1
10352..10359	Qword	Idle Time, value from most recent SMART Summary Frame in seconds, Actuator 1
10360..10367	Qword	Number of LBAs Corrected by Parity Sector, Actuator 1
10368..10375	Qword	Primary Super Parity Coverage Percentage, Actuator 1
10376..10567	Qword[24]	Number of Reader Writer offset Iterations by head
10568..11143	Qword[24][3]	Micro Jog Offset by head Zone 0 Zone 1 Zone 2
11144..11719	Qword[24][3]	Pre LFA Bit Error Rate Zone 0 Zone 1 Zone 2
11720..12295	Qword[24][3]	Zero Percent Shift Bit Error Rate Zone 0 Zone 1 Zone 2
12296..12303	Qword	Primary Super Parity Coverage Percentage SMR/SWR, Actuator 0
12304..12311	Qword	Primary Super Parity Coverage Percentage SMR/SWR, Actuator 1
12312..16373	Qword	Reserved

Micro-actuator lock-out status is a bit-mapped value with each bit of the value representing a head on the device. If a bit is set, the corresponding head has been locked out or has the micro-actuator dual state servo system disabled. Head 0 is represented by bit 0, Head 1 by bit 1, and so on.

7. SATA Error Sense Codes

Sense codes are returned in Requested Sense Extended command if an error occurs while pulling the log. The supported sense codes are shown in **Table 13**.

Table 13 Error Codes for FARM as Reported by Request Sense Ext

Sense Code	Error Description
0x05240036	Invalid request length for log.
0x09800048	Firmware cannot allocate a background cache file to hold log.
0x09800049	DRAM file is not large enough to hold contents.
0x05240083	Valid FARM disc copy requested but does not exist.
0x05240084	Invalid feature register specified in command

8. SATA Test Plan

This section contains a high-level test plan for the FARM logging feature. Test requirements are numbered for ease of reference. In this section, 'log' is a generic term that refers to the FARM log.

1. Log Access

- 1.1. Verify Directory Log listing for Field Accessible Reliability Metrics is consistent with specifications defined in Section 5.
- 1.2. Log shall not be accessible by SMART READ LOG SECTOR command
- 1.3. Log shall be accessible by READ LOG (DMA) EXT command
 - 1.3.1. Read commands exceeding log length result in ABRT
 - 1.3.2. Reads to log with dirty writes in user cache shall not result in an assert condition
- 1.4. Any WRITE LOG command shall result in ABRT status
- 1.5. Verify FEATURE register options
 - 1.5.1. FEATURE register set to '0' generates new data and does not save to disc
 - 1.5.2. FEATURE register set to '1' generates new data and saves that data to disc
 - 1.5.3. FEATURE register set to '2' reads previously saved log from disc and does not generate new data
 - 1.5.4. FEATURE register set to '3' reads factory saved log
- 1.6. Verify that the log is saved to disc at the completion of any host-requested In-Drive Diagnostic test.

2. Log Structure

- 2.1. Verify 'Status' byte of each field maps to a definition described in
- 2.2. **Table 7**
- 2.3. Any field marked 'Not Supported' in the status byte shall not contain data in the remaining seven bytes of data.
- 2.4. Verify header page length is as defined in **Table 4**
- 2.5. Verify page lengths are as defined in **Table 5**

3. Parameter Validation

- 3.1. Verify log header is as defined in **Table 4**

- 3.2.** Verify page number fields are as defined in **Table 8 – Table 12**
- 3.3.** Any field marked 'Not Supported' in the status byte shall not contain data in the remaining seven bytes of data.
- 3.4.** Parameters validated by STX firmware engineering team on a by-revision basis.

9. SAS FARM Overview

The FARM log provides a single source of information for drive health and predictive failure information.

10. SAS Log Access and Structure

SAS uses LogSense (see 6.9 is SPC-5) and Logselect (see 6.8 is SPC-5) commands to access FARM log.

Following SAS commands can be used in lieu of SATA unique Read Log (DMA) Extended command to achieve various functions as described in Table 14 Command Structure for Reading FARM Log .

1. SATA Option 0 – Default: Generate and report new FARM data but do not save to disc. SAS shall use Log Sense command with SP bit in command CDB (byte 1, bit 0) set to 0
2. SATA Option 1 – Generate and report new FARM data and save to disc:
SAS does not support ‘Save to Disc’ option on this page as this page represents summary data from other logs and those logs are already saved to disc and thus does not want to save duplicate data.
3. SATA Option 2 – Report previous FARM data from disc.
SAS does not support ‘Save to Disc’ option on this page as this page represents summary data from other logs and those logs are already saved to disc and thus does not want to save duplicate data.
4. SATA Option 3 – Report FARM factory data from disc.
Use subpage 0x04. Same log structure as the standard FARM log. Copy Number fields will indicate “FACTORY” in ASCII.
14. SATA Option 4 – Report all FARM frames from disc
SAS does not support this option because one Log Sense command can return a maximum of 64 KB of data to the host. Each FARM frame is accessed with a separate Log Sense command. See **Section 13** for Subpage code information.
14. SATA Option 5 – Report all FARM data
SAS does not support this option because one Log Sense command can return a maximum of 64 KB of data to the host. Each FARM frame is accessed with a separate Log Sense command. See **Section 13** for Subpage code information.

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FARM Log uses Logpage number 0x3D, Subpage 0x03 for current FARM data and Subpage 0x04 for factory FARM data. The structure of the Logpage is as follows

Table 13 FARM Sub Pages Structure

Bit Byte	7	6	5	4	3	2	1	0
0	DS(1)	SPF(1)	Page Code (0x3D)					
1	Subpage code (0x03, 0x04, and 0x10 and above*)							
2	Page Length (n-3)							
3								
FARM Logpage log parameters								
4	FARM Logpage log parameter [First]							
...								
...	FARM Logpage log parameter [Last]							
N								

*See **Section 13** for information regarding Subpage codes 0x10 and above

DS: Disable Save: should be 1 as this page is NOT savable to disc.

SPF: Subpage Format: should be 1 as FARM Log is implemented as a subpages 0x03 and 0x04 of Logpage 0x3D.

SATA has FARM Log divided into 6 4K pages. SAS uses new parameter code for each SATA page.

All Parameters on this subpage are of 'Binary List format' type. Log sense on this page returns 'Current cumulative counters' for Subpage 0x03 irrespective of 'PC' field in Log sense command and 'FARM counters' for Subpage 0x04 irrespective of 'PC' field in Log sense command.

Not all the data fields on this page are Resettable' or 'changeable' by Log Select command because this page represents the summary of data from other logs. Therefore, resetting or changing the parameters/data on this page can cause undesired effects on the data of other Logpages.

Note: Bit Error Rate is a negative or zero value. For values between -1 and 0, the decimal part of the float value can be assumed as negative. Negative zero cannot be expressed due to the two's complement conversion from a floating point variable to a signed integer.

For Bit Error Rate Parameter layout, see Table 11.

11. SAS Log Parameter Definitions

Table 14 FARM Logpage Parameters grouped by various statistics

Parameter Code	Description	Reference
0x0000	FARM Header Parameter	(Table 17)
0x0001	General Drive Information Parameter	(Table 18)
0x0002	WorkLoad Statistics Parameter	(Table 19)
0x0003	Error Statistics Parameter	(Table 20)
0x0004	Environmental Statistics Parameter	(Table 21)
0x0005	Reliability Statistics Parameter	(Table 22)
0x0006	General Drive Information Parameter Continued	(Table 23)
0x0007	Environmental Statistics Parameter Continued	(Table 24)
0x0008	WorkLoad Statistics Parameter Continued	(Table 25)
0x0009-0x000F	Reserved for future statistics	
FARM Logpage By Head Parameter codes		(Table 26)
0x0010	Disc Slip in micro-inches by Head	
0x0011	Bit Error Rate of Zone 0 by Drive Head	
0x0012	DOS Write Refresh Count	
0x0013	DVGA Skip Write Detect by Head	
0x0014	RVGA Skip Write Detect by Head	
0x0015	FVGA Skip Write Detect by Head	
0x0016	Skip Write Detect Threshold Exceeded Count by Head	
0x0017	ACFF Sine 1X, value from most recent SMART Summary Frame by Head (Multiply this value by 16 to get actual value)	
0x0018	ACFF Cosine 1X, value from most recent SMART Summary Frame by Head (Multiply this value by 16 to get actual value)	
0x0019	PZT Calibration, value from most recent SMART Summary Frame by Head	
0x001A	MR Head Resistance from most recent SMART Frame by Head	
0x001B	Number of TMD over last 3 SMART Summary Frames by Head	
0x001C	Velocity Observer over last 3 SMART Summary Frames by Head	
0x001D	Number of Velocity Observer over last 3 SMART Summary Frames by Head	
0x001E	Current H2SAT percentage of codewords at iteration level by Head, averaged across Test Zones	
0x001F	Current H2SAT amplitude by Head, averaged across Test Zones	
0x0020	Current H2SAT asymmetry by Head, averaged across Test Zones	
0x0021	Number of Reallocated Sectors	
0x0022	Number of Reallocation Candidate Sectors	
0x0023	DOS Ought to scan count per head	
0x0024	DOS Need to scan count per head	

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Parameter Code	Description	Reference
0x0025	DOS Write Fault scan count per head	
0x0026	Write Workload Power-on Time in Seconds, value from most recent SMART Frame by Head	
0x0027	DOS Write Count Need-To Threshold per head	
0x0028	Cumulative Lifetime Unrecoverable Read Repeat by head	
0x0029	Cumulative Lifetime Unrecoverable Read Unique by head	
0x002A	Number of total Laser Field Adjust iterations performed per head	
0x002B	Number of total Reader Writer Offset iterations performed per head	
0x002C	Pre LFA Zone 0 Bit Error Rate	
0x002D	Pre LFA Zone 1 Bit Error Rate	
0x002E	Pre LFA Zone 2 Bit Error Rate	
0x002F	Zero Percent Shift Zone 0 Bit Error Rate	
0x0030	Current H2SAT trimmed mean bits in error by Head, by Test Zone 0	
0x0031	Current H2SAT trimmed mean bits in error by Head, by Test Zone 1	
0x0032	Current H2SAT trimmed mean bits in error by Head, by Test Zone 2	
0x0033	Current H2SAT iterations to converge by Head, by Test Zone 0	
0x0034	Current H2SAT iterations to converge by Head, by Test Zone 1	
0x0035	Current H2SAT iterations to converge by Head, by Test Zone 2	
0x0036	Laser Operating Current by head, by Test Zone 0	
0x0037	Laser Operating Current by head, by Test Zone 1	
0x0038	Laser Operating Current by head, by Test Zone 2	
0x0039	Post LFA Optimal BER by head, by Test Zone 0	
0x003A	Post LFA Optimal BER by head, by Test Zone 1	
0x003B	Post LFA Optimal BER by head, by Test Zone 2	
0x003C	Micro Jog Offset Zone 0	
0x003D	Micro Jog Offset Zone 1	
0x003E	Micro Jog Offset Zone 2	
0x003F	Zero Percent Shift Zone 1 Bit Error Rate	
0x0040	Applied fly height clearance delta per head in thousandths of one Angstrom. Diameter 0: Outer	
0x0041	Applied fly height clearance delta per head in thousandths of one Angstrom. Diameter 1: Inner	
0x0042	Applied fly height clearance delta per head in thousandths of one Angstrom. Diameter 2: Middle	
0x0043	Second Head MR Head Resistance from most recent SMART Frame by Head	
0x0044	FAFH Measurement Status, bitwise OR across all diameters per head	

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Parameter Code	Description	Reference
0x0045	FAFH HF/LF Relative Amplitude in tenths, maximum magnitude value across all 3 zones per head, can be negative or positive	
0x0046	FAFH Bit Error Rate, write then read BER on reserved tracks Diameter 0: Outer	
0x0047	FAFH Bit Error Rate, write then read BER on reserved tracks Diameter 1: Outer	
0x0048	FAFH Bit Error Rate, write then read BER on reserved tracks Diameter 2: Outer	
0x0049	FAFH Low Frequency Passive Clearance in ADC counts Diameter 0: Outer	
0x004A	FAFH Low Frequency Passive Clearance in ADC counts Diameter 1: Outer	
0x004B	FAFH Low Frequency Passive Clearance in ADC counts Diameter 2: Outer	
0x004C	FAFH High Frequency Passive Clearance in ADC counts Diameter 0: Outer	
0x004D	FAFH High Frequency Passive Clearance in ADC counts Diameter 1: Outer	
0x004E	FAFH High Frequency Passive Clearance in ADC counts Diameter 2: Outer	
0x004F	Zero Percent Shift Zone 2 Bit Error Rate	
FARM Logpage By Actuator parameter codes		
0x0050	Actuator 0 parameters.	(Table 27)
0x0051	Actuator 0 FLED Info parameters	(Table 28)
0x0052	Actuator 0 Reallocation parameters	(Table 29)
0x0053-0x005F	Reserved for future expansion	
0x0060	Actuator 1 parameters	(Table 27)
0x0061	Actuator 1 FLED Info parameters	(Table 28)
0x0062	Actuator 1 Reallocation parameters	(Table 29)
0x0063-0x006F	Reserved for future expansion	
0x0070	Actuator 2 parameters	(Table 27)
0x0071	Actuator 2 FLED Info parameters	(Table 28)
0x0072	Actuator 2 Reallocation parameters	(Table 29)
0x0072-0x007F	Reserved for future expansion	
0x0080	Actuator 3 parameters	(Table 27)
0x0081	Actuator 3 FLED Info parameters	(Table 28)
0x0082	Actuator 3 Reallocation parameters	(Table 29)
0x0083-0x008F	Reserved for future expansion	

The first byte of each 64 bit field in each log parameter contains a bit-mapped status. The structure for each field is shown in **Table 6**. (Copied from SATA section so using same Table Number)

Table 15 Individual Field Structure

Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0
Status Byte See Table 7	Field Data	Field Data	Field Data	Field Data	Field Data	Field Data	Field Data

Table 16 Status Byte Structure

Bit	7	6	5	4	3	2	1	0
Description	Field Supported	Field Valid	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved

Table 17 FARM Logpage 'FARM Header' Parameter Structure

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB) Parameter code (0000h) (LSB)							
1								
2	Parameter control byte							
	DU	Obsolete	TSD	Obsolete			Format and Linking	
3	Parameter Length (72)							
4-11	Log Signature = 0x00004641524D4552 (FARM ER in ASCII)							
12-19	Log Major Revision							
20-27	Log Minor Revision							
28-35	Number of Log Parameters supported							
36-43	Log Page Size in Bytes							
44-51	Reserved							
52-59	Maximum Drive Heads Supported							
60-67	Reserved							
68-75	Reason for Frame Capture							

Table 18 FARM Logpage 'General Drive Information' Parameter Structure

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB) Parameter code (0001h)							
1	(LSB)							
2	Parameter control byte							
	DU	Obsolete	TSD	Obsolete			Format and Linking	
3	Parameter Length (248)							
4-11	Page Number = 1							
12-19	Copy Number							
20-27	Serial Number [3:0]							
28-35	Serial Number [7:4]							

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Bit Byte	7	6	5	4	3	2	1	0
36-43	World Wide Name [3:0]							
44-51	World Wide Name [7:4]							
52-59	Device Interface ("SAS" in ASCII)							
60-67	48-bit Device Capacity							
68-75	Physical Sector Size in Bytes							
76-83	Logical Sector Size in Bytes							
84-91	Device Buffer Size in Bytes							
92-99	Number of Heads							
100-107	Device Form Factor							
108-115	Rotational Rate of Device							
116-123	Firmware Revision [3:0]							
124-131	Firmware Revision [7:4]							
132-139	Reserved							
140-147	Reserved							
148-155	Reserved							
156-163	Power-on Hours							
164-171	Reserved							
172-179	Reserved							
180-187	Reserved							
188-195	Power Cycle Count							
196-203	Hardware Reset Count							
204-211	Reserved							
212-219	NVC Status on Power-on							
220-227	Time Available to Save User Data to Non-volatile Memory Over Last Power Cycle (in 100us)							
228-235	Timestamp of first SMART Summary Frame in Power-On Hours Milliseconds							
236-243	Timestamp of last SMART Summary Frame in Power-On Hours Milliseconds							
244-251	Date of Assembly in ASCII "YYWW" where YY is the year and WW is the calendar week							

Table 19 FARM Logpage 'WorkLoad Statistics' Parameter Structure

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB) Parameter code (0002h)							
1	(LSB)							
2	Parameter control byte							
	DU	Obsolete	TSD	Obsolete			Format and Linking	
3	Parameter Length (208)							
4-11	Page Number = 2							
12-19	Copy Number							
20-27	Rated Workload Percentage (No longer Supported)							
28-35	Total Number of Read Commands							
36-43	Total Number of Write Commands							
44-51	Total Number of Random Read Commands							
52-59	Total Number of Random Write Commands							
60-67	Total Number Of Other Commands							
68-75	Logical Sectors Written							
76-83	Logical Sectors Read							
84-91	Number of Read commands from 0-3.125% of LBA space for last 3 SMART Summary Frames							
92-99	Number of Read commands from 3.125-25% of LBA space for last 3 SMART Summary Frames							
100-107	Number of Read commands from 25-50% of LBA space for last 3 SMART Summary Frames							

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Bit Byte	7	6	5	4	3	2	1	0
108-115	Number of Read commands from 50-100% of LBA space for last 3 SMART Summary Frames							
116-123	Number of Write commands from 0-3.125% of LBA space for last 3 SMART Summary Frames							
124-131	Number of Write commands from 3.125-25% of LBA space for last 3 SMART Summary Frames							
132-139	Number of Write commands from 25-50% of LBA space for last 3 SMART Summary Frames							
140-147	Number of Write commands from 50-100% of LBA space for last 3 SMART Summary Frames							
148-155	Number of Read Commands of transfer length <=16KB for last 3 SMART Summary Frames							
156-163	Number of Read Commands of transfer length (16KB – 512KB] for last 3 SMART Summary Frames							
164-171	Number of Read Commands of transfer length (512KB – 2MB] for last 3 SMART Summary Frames							
172-179	Number of Read Commands of transfer length > 2MB for last 3 SMART Summary Frames							
180-187	Number of Write Commands of transfer length <=16KB for last 3 SMART Summary Frames							
188-195	Number of Write Commands of transfer length (16KB – 512KB] for last 3 SMART Summary Frames							
196-203	Number of Write Commands of transfer length (512KB – 2MB] for last 3 SMART Summary Frames							
204-211	Number of Write Commands of transfer length > 2MB for last 3 SMART Summary Frames							

Table 20 FARM Logpage ‘Error Statistics’ Parameter Structure

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB) Parameter code (0003h)							
1	(LSB)							
2	Parameter control byte							
	DU	Obsolete	TSD	Obsolete			Format and Linking	
3	Parameter Length (232)							
4-11	Page Number = 3							
12-19	Copy Number							
20-27	Number of Unrecoverable Read Errors (From EWLM)							
28-35	Number of Unrecoverable Write Errors (From EWLM)							
36-43	Reserved							
44-51	Reserved							
52-59	Number of Mechanical Start Retries (Log Page 0x06, PC 0xD110)							
60-67	Reserved							
68-75	Reserved							
76-83	Reserved							
84-91	Reserved							
92-99	Reserved							
100-107	Reserved							
108-115	Number of IOEDC Errors (not supported for SAS)							
116-123	Reserved							
124-131	Reserved							
132-139	Reserved							
140-147	Reserved							
148-155	Reserved							
156-163	Reserved							
164-171	FRU code if smart trip from most recent SMART Frame							
172-179	Invalid DWord Count (Port A)							
180-187	Invalid DWord Count (Port B)							
188-195	Disparity Error Count (Port A)							
196-203	Disparity Error Count (Port B)							
204-211	Loss of DWord Sync (Port A)							
212-219	Loss of DWord Sync (Port B)							

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220-227	Phy Reset Problem (Port A)
228-235	Phy Reset Problem (Port B)

Table 21 FARM Logpage 'Environmental Statistics' Parameter Structure

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB) Parameter code (0004h)							
1	(LSB)							
2	Parameter control byte							
	DU	Obsolete	TSD	Obsolete				Format and Linking
3	Parameter Length (208)							
4-11	Page Number = 4							
12-19	Copy Number							
20-27	Current Temperature in Celsius (Lower 16 bits are a signed integer in units of 0.1C)							
28-35	Highest Temperature in Celsius (Lower 16 bits are a signed integer in units of 0.1C)							
36-43	Lowest Temperature in Celsius (Lower 16 bits are a signed integer in units of 0.1C)							
44-51	Reserved							
52-59	Reserved							
60-67	Reserved							
68-75	Reserved							
76-83	Reserved							
84-91	Reserved							
92-99	Reserved							
100-107	Reserved							
108-115	Specified Max Operating Temperature in Celsius							
116-123	Specified Min Operating Temperature in Celsius							
124-131	Reserved							
132-139	Reserved							
140-147	Current Relative Humidity (in units of .1%)							
148-155	Humidity Mixed Ratio multiplied by 8 (divide by 8 to get actual value)							
156-163	Current Motor Power, value from most recent SMART Summary Frame							
164-171	12V Power Average(mw) - Highest of the three summary frames							
172-179	12V Power Min(mw) - Lowest of last 3 SMART summary frames							
180-187	12V Power Max(mw) - Highest of last 3 SMART summary frames							
188-195	5V Power Average (mw) - Highest of the last 3 SMART summary frames							
196-203	5V Power Min(mw) - Lowest of last 3 SMART summary frames							
204-211	5V Power Max(mw) - Highest of last 3 SMART summary frames							

Table 22 FARM Logpage' Reliability Statistics' Parameter Structure

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB) Parameter code (0005h)							
1	(LSB)							
2	Parameter control byte							
	DU	Obsolete	TSD	Obsolete			Format and Linking	
3	Parameter Length (232)							
4-11	Page Number = 5							
12-19	Copy Number							
20-27	Reserved							
28-35	Reserved							
36-43	Reserved							
44-51	Reserved							
52-59	Reserved							
60-67	Reserved							
68-75	Reserved							
76-83	Reserved							
84-91	Reserved							
92-99	Reserved							
100-107	Reserved							
108-115	Reserved							
116-123	Reserved							
124-131	Number of RAW Operations							
132-139	Cumulative Lifetime Unrecoverable Read errors due to Error Recovery Control (e.g. ERC timeout)							
140-147	Reserved							
148-155	Reserved							
156-163	Reserved							
164-171	Reserved							
172-179	Reserved							
180-187	Reserved							
188-195	MicroActuator Lock-out, head mask accumulated over last 3 SMART Summary Frames							
196-203	Number of Disc Slip Recalibrations performed							
204-211	Helium Pressure Threshold Trip (1 – trip 0 – no trip)							
212-219	Reserved							
220-227	Reserved							
228-235	Reserved							

Table 23 FARM Logpage 'General Drive Information Continued' Parameter Structure

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB) Parameter code (0006h)							
1	(LSB)							
2	Parameter control byte							
	DU	Obsolete	TSD	Obsolete			Format and Linking	
3	Parameter Length (104)							
4-11	Page Number = 6							
12-19	Copy Number							
20-27	Depopulation Head Mask							
28-35	Product ID [3:0]							
36-43	Product ID [7:4]							
44-51	Product ID [11:8]							
52-59	Product ID [15:12]							
60-67	Drive Recording Type – see “Drive Recording Type” Table below							
68-75	Is drive currently depopped – 1 = depopped, 0 = not depopped							
76-83	Max Number of Available Sectors for Reassignment – Value in disc sectors							
84-91	Time to Ready of the last power cycle in milliseconds							
92-99	Time the drive is held in staggered spin in milliseconds							
100-107	The last servo spin up time in milliseconds							

Drive Recording Type

Bit	7	6	5	4	3	2	1	0
Description	Field Supported	Field Valid	Reserved	Reserved	Reserved	Reserved	CMR	SMR

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Table 24 FARM Logpage 'Environmental Statistics Continued' Parameter Structure

Bit	7	6	5	4	3	2	1	0
Byte								
0	(MSB) Parameter code (0007h)							
1	(LSB)							
2	Parameter control byte							
	DU	Obsolete	TSD	Obsolete			Format and Linking	
3	Parameter Length (64)							
4-11	Page Number = 7							
12-19	Copy Number							
20-27	12V input from most recent SMART Summary Frame in mV							
28-35	Minimum 12V input from last 3 SMART Summary Frames in mV							
36-43	Maximum 12V input from last 3 SMART Summary Frames in mV							
44-51	5V input from most recent SMART Summary Frame in mV							
52-59	Minimum 5V input from last 3 SMART Summary Frames in mV							
60-67	Maximum 5V input from last 3 SMART Summary Frames in mV							

Table 25 FARM Logpage 'WorkLoad Statistics Continued' Parameter Structure

Bit Byte	7	6	5		4	3	2	1	0
0	(MSB)	Parameter code (0008h)							
1		(LSB)							
2	Parameter control byte								
	DU	Obsolete	TSD		Obsolete	Format and Linking			
3	Parameter Length (80)								
4-11	Page Number = 8								
12-19	Copy Number								
20-27	Count of Queue Depth =1 at 30s intervals for last 3 SMART Summary Frames								
28-35	Count of Queue Depth =2 at 30s intervals for last 3 SMART Summary Frames								
36-43	Count of Queue Depth 3-4 at 30s intervals for last 3 SMART Summary Frames								
44-51	Count of Queue Depth 5-8 at 30s intervals for last 3 SMART Summary Frames								
52-59	Count of Queue Depth 9-16 at 30s intervals for last 3 SMART Summary Frames								
60-67	Count of Queue Depth 17-32 at 30s intervals for last 3 SMART Summary Frames								
68-75	Count of Queue Depth 33-64 at 30s intervals for last 3 SMART Summary Frames								
76-83	Count of Queue Depth >64 at 30s intervals for last 3 SMART Summary Frames								

Table 26 FARM Logpage 'By Head' Parameter Structure

Bit Byte	7	6		5	4	3	2	1	0
0	(MSB)	Parameter code (00010h-002Fh)							
1		(LSB)							
2		Parameter control byte							
	DU	Obsolete		TSD	Obsolete			Format and Linking	
3		Parameter Length (8*N (No of heads))							
4-11		Head 0 Value							
12-19		Head 1 Value							
20-27		Head 2 Value							
28-35		Head 3 Value							
36 - (8*N)+3								

Table 27 FARM Logpage 'By Actuator' Parameter Structure

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)	Parameter code (00050h, 00060h (current parameter code), 00070h & 00080h						
1	(Future parameter code)							(LSB)
2	Parameter control byte							
	DU	Obsolete	TSD	Obsolete			Format and Linking	
3	Parameter Length (240)							
4-11	Page Number							
12-19	Copy Number							
20-27	Actuator ID							
28-35	Head Load Events							
36-43	Reserved							
44-51	Reserved							
52-59	Timestamp of last IDD test							
60-67	Sub-command of last IDD test							
68-75	Number of G-list reclamations							
76-83	Servo Status (follows standard DST error code definitions)							
84-91	Number of Slipped Sectors Before IDD Scan							
92-99	Number of Slipped Sectors After IDD Scan							
100-107	Number of Resident Reallocated Sectors Before IDD Scan							
108-115	Number of Resident Reallocated Sectors After IDD Scan							
116-123	Number of Successfully Scrubbed Sectors Before IDD Scan							
124-131	Number of Successfully Scrubbed Sectors After IDD Scan							
132-139	Number of DOS Scans Performed							
140-147	Number of LBAs Corrected by ISP							
148-155	Number of Valid Parity Sectors							
156-163	RV Absolute Mean, value from most recent SMART Summary Frame in rad/s^2							
164-171	Max RV Absolute Mean, value from most recent SMART Summary Frame in rad/s^2							
172-179	Idle Time, value from most recent SMART Summary Frame in seconds							
180-187	Number of LBAs Corrected by Parity Sector							
188-195	Current Low Frequency Vibe Score							
196-203	Current Mid Frequency Vibe Score							

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Bit Byte	7	6	5	4	3	2	1	0
204-211	Current High Frequency Vibe Score							
212-219	Worst Low Frequency Vibe Score							
220-227	Worst Mid Frequency Vibe Score							
228-235	Worst High Frequency Vibe Score							
236-243	Primary Super Parity Coverage Percentage							
244-251	Primary Super Parity Coverage Percentage SMR							

Table 28 FARM Logpage 'By Actuator' Parameter Structure for FLED Info

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB) Parameter code (00051h, 00061h (current parameter code), 00071h & 00081h							
1	(Future parameter code) (LSB)							
2	Parameter control byte							
	DU	Obsolete	TSD	Obsolete			Format and Linking	
3	Parameter Length (232)							
4-11	Page Number							
12-19	Copy Number							
20-27	Actuator ID							
28-35	Total Flash LED (Assert) Events							
36-43	Index of last entry in FLED Info array below, in case the array wraps							
44-107	Info on the last 8 Flash LED (assert) Events, wrapping array							
108-171	Universal Timestamp (us) of last 8 Flash LED (assert) Events, wrapping array							
172-235	Power Cycle of the last 8 Flash LED (assert) Events, wrapping array							

Table 29 FARM Logpage 'By Actuator' Parameter Structure for Reallocation parameters

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB) Parameter code (00052h, 00062h (current parameter code), 00072h & 00082h							
1	(Future parameter code) (LSB)							
2	Parameter control byte							
	DU	Obsolete	TSD	Obsolete			Format and Linking	
3	Parameter Length (160)							
4-11	Page Number							
12-19	Copy Number							
20-27	Actuator ID							
28-35	Number of Reallocated Sectors							
36-43	Number of Reallocated Candidate Sectors							
44-163	Reallocated sectors by cause, see below. This is a 15 element array, each element is 8 bytes							

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Reallocated sectors by cause

Index	Cause for Reallocation
0	Host Read – Generic
1	Host Read – Uncorrectable
2	Host Read – RAW
3	Host Write – Generic
4	Host Write – Uncorrectable
5	Host Write – RAW
6	Background Read Generic
7	Background Read – Reliability
8	Background Read – Recovery
9	Background Read – Host Self Test
10	Background Write – Generic
11	Background Write – Reliability
12	Background Write – Recovery
13	Background Write – Host Self Test
14	Servo Wedge

12. FARM Frame Capture Overview

FARM Frame Capture provides up to 24 additional historical copies of FARM data. Each frame is generated on the fly and immediately saved-to-disc when triggered by specific drive events. The types of FARM frames are as follows:

1. Time Series Frames (16)
 - a. Saved-to-disc weekly
 - b. Once 16 frames have been saved to disc, oldest frame replaced on each save
2. Long Term Frames (2)
 - a. Saved-to-disc every 13-weeks
 - b. Once 2 frames have been saved to disc, oldest frame replaced on each save
3. Sticky Frames (6)
 - a. Saved-to-disc during specific drive events detailed later in this document
 - b. Once 6 frames have been saved to disc, no more frames are saved to disc
 - i. Exception: certain Sticky Frame subtypes can replace older copies of the same subtype

13. FARM Frame Access and Structure

SATA

Log Address 0xC6.

Feature code 0 - Read 24 disc copies (24 * 96k). Data return order is as follows:

1. Time Series Frames (16): Most recent frame first
2. Long Term Save Frames (2): Most recent frame first
3. Sticky Frames (6): Fixed offset for each frame type
4. Zero padding up to the size of feature code 1

Feature code 1 - Read all FARM data (current frame from memory, host disc copy, 24 saved frames, Factory copy), up to 27 * 96k. Data return order is as follows:

1. Current frame generated on-the-fly (1)
2. Host disc copy (1): If not present, data region is 0's
3. Time Series Frames (16): Most recent frame first
4. Long Term Save Frames (2): Most recent frame first
5. Sticky Frames (6): Fixed offset for each frame type
6. Factory copy (1)

SAS

Part of Log Page Code 0x3D.

Separate Log Subpage Code for each saved frame.

- 0x10 – 0x1F: Time Series Frames (16): Most recent frame first

- 0xC0 – 0xC1: Long Term Save Frames (2): Most recent frame first
- 0xC2 – 0xC7: Sticky Frames (6): Fixed Subpage code for each frame type
 - 0xC2: 1000 G-list disc entries (1000 4K sectors) Frame
 - 0xC3: 1st unrecovered read error (excluding RTL)
 - 0xC4: 10th unrecovered read error (excluding RTL)
 - 0xC5: 1st fatal command time out
 - 0xC6: Last frame prior to most recent CFW or SFW update
 - 0xC7: When temperature exceeds 70 °C

Frame Type Identification

The “Reason for Frame Capture” field in the header of the FARM log indicates the reason for a FARM Frame Capture. , the Field Data contains one of the following values.

- Field Data Value of “0”: FARM log DRAM copy, FARM log disc copy, or FARM Factory copy
- Field Data Value of “1”: Time Series Frame
- Field Data Value of “2”: Long Term Frame
- Field Data Value of “3”: 1000 G-list disc entries (1000 4K sectors) Frame
- Field Data Value of “4”: 1st unrecovered read error (excluding RTL)
- Field Data Value of “5”: 10th unrecovered read error (excluding RTL)
- Field Data Value of “6”: 1st fatal command time out
- Field Data Value of “7”: Last frame prior to most recent CFW or SFW update
- Field Data Value of “8”: When temperature exceeds 70 °C

Workload Trace Information

Workload Trace is a feature that records read and write workload information. More specifically, it records:

- The starting LBAs and Transfer Lengths of read and write operations,
- Read and write hardware streaming events, and
- One Second Markers.

The following commands are each considered a “read operation”:

- Read
- Verify

The following commands are each considered a “write operation”:

- Write
- Write And Verify

The recorded information is from the host perspective; it is like a bus trace without the timestamp and protocol information. Workload trace data from field returns will be used by Firmware Development to determine real-world drive workloads.

Workload Trace Layout

Each Workload Trace frame shall be 512KB in length, equivalent to 0x400 (1024) system sectors or 0x80000 bytes. Frames contain a Frame Header, trace data, and a Frame Footer. Reserved bytes and Pad bytes are set to zero. All fields use Little Endian byte order (least significant byte first, most significant byte last).

Table 30 Workload Trace Frame layout

Offset	0	1	2	3	4	5		6	7	8	9	A	B	C	D	E	F	
0x00	Frame Header Signature				Frame Number			Revision		Start Timestamp (Universal Timestamp)								
0x10		End Timestamp (Universal Timestamp)								Previous Frame Offset in Bytes				Cycle Count		Pad1		
0x20	Frame Size in Bytes					Duration of This Frame				Read Operations This Frame				Write Operations This Frame				
0x30	One Second Markers This Frame					Reserved				Reserved								
.	Trace Data																	.
.																		.
.																		.
0x7FFF0										Frame Footer Signature				Pad2		Frame Number		

Frame Header Signature

(in the byte order as read from memory or disk)

Offset:	0	1	2	3
hex:	3C	48	54	57

Frame Footer Signature

(in the byte order as read from memory or disk)

Offset:	0	1	2	3
hex:	08	46	54	57

Universal Timestamp format

(in the byte order as read from memory or disk)

Offset:	0	1	2	3	4	5	6	7
Desc:	Power On Time in microseconds						Power Cycle Count	

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Frame Header fields

Name	Size (bits)	Description
Frame Header Signature	32	Frame Header signature. The least significant byte (byte offset 0) indicates the size of the Frame Header in bytes.
Frame Number	16	Index number of the frame. Starts at 0, increments to 0xFFFF, wraps to 0 as necessary.
Revision	16	Revision of the Workload Trace feature.
Start Timestamp (Universal Timestamp)	64	Timestamp when this frame began to be built. Universal firmware timestamp format.
End Timestamp (Universal Timestamp)	64	Timestamp when this frame was completed. Universal firmware timestamp format.
Previous Frame Offset in Bytes	32	Byte offset of the SIM File where the last trace frame was saved.
Cycle Count	16	Workload Trace cycle to which this frame belongs.
Pad1	16	Unused.
Frame Size in Bytes	32	Size of the frame in bytes. Includes Frame Header and all trace entries. Does not include Frame Footer.
Duration of This Frame	32	Duration of this frame in seconds.
Read Operations This Frame	32	Number of read operations in this trace frame.
Write Operations This Frame	32	Number of write operations in this trace frame.
One Second Markers This Frame	32	Number of one second markers in this trace frame.

Frame Footer fields

Name	Size (bits)	Description
Frame Footer Signature	32	Frame Footer signature. The least significant byte (byte offset 0) indicates the size of the Frame Footer in bytes.
Pad2	16	Unused.
Frame Number	16	Index number of the frame. Shall contain the same value as the Frame Number field in the Frame Header.

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Commands That Shall Be Traced – SATA

Command	Traced as
Read	Read operation
Read DMA	Read operation
Read Multiple	Read operation
Read FPDMA Queued	Read operation
Write	Write operation
Write DMA	Write operation
Write Multiple	Write operation
Write FPDMA Queued	Write operation