Seagate
Field-Accessible Reliability Metrics (FARM)
Public Specification

Rev 4.28
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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
3.5	All	August 6, 2019	Initial Release
4.17.1	All	August 12, 2020	Update to align with latest FARM version 4.17.1
4.17.2	Sec. 6	September 24, 2020	Cum Unrecoverable read has wrong offsets.
4.21.1	Sec. 6	January 25, 2021	Add SATA multi-actuator fields, Command Transfer length, Queue bins, unrecoverable reads, Vibration scores, Protection coverage.
4.21.3	Sec. 6	January 29, 2021	Documentation error in the offset of the new additions.
4.23.1	Update to align with latest FARM version 4.23.1	June 14, 2021	Modify format from new spec Seagate templates
4.28	Update to align with FARM version 4.28	October 21, 2022	Add Data Protect, ReGen, Power Telemetry, SP Coverage for SMR and SAS H2SAT parameters to be equivalent to SATA.

Contents

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
IOEDC	Input/Output Error Detection Code
ISP	Intermediate Super Parity
LBA	Logical Block Address
LUN	Logical Unit
MR	Magneto Resistive
POH	Power on Hours
PZT	Piezoelectric Transducer [Micro-actuator]
RAW	Read After Write
RV	Rotational Vibration
RVGA	Running Average Variable Gain Amplifier
TMD	Timing Mark Detect

SMART Summary Frame	A set of SMART data capturing 168 hours of drive history.
Velocity Observer	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
   T10 Specification
   T13 Specification

4. **SATA FARM (Log 0xA6) 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 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)
	0x47 (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 (~30ms)
	1 – Generate and report new FARM data and save to disc (~55ms)
	2 – Report previous FARM data from disc (~30ms)
	3 – Report FARM factory data from disc (~30ms)

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 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 3**, while the structure for log pages 1 through 5 is shown in **Table 4**. Explanations of each page are given in **Section 6**. Unused space in each page is reserved for future development.

Table 2 FARM Structure

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

Table 3 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	Reserved
64..71	Qword	Reason for Frame Capture
72..16383	Qword	Reserved

Table 4 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 5**.

Table 5 Individual Field Structure

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

Table 6 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 3**.

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 7**:

Table 7 FARM 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

Byte Offset	Data Type	Description
200..207	Qword	SMART Spin-Up time in milliseconds
208..223	Qword	Reserved
224..231	Qword	Lowest Timestamp of Power-On Hours in Milliseconds for Time Restricted parameters
232..239	Qword	Highest Timestamp of Power-On Hours in Milliseconds for Time Restricted parameters
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..399	Qword	HAMR Data Protect Status: 1 = Data Protect, 0 = No Data Protect
400..407	Qword	Regen Head Mask: bitmap where 1 = bad head, 0 = good head
408..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 8**.

Table 8 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 restricted time range.
112..119	Qword	Number of Read commands from 3.125-25% of LBA space for restricted time range.
120..127	Qword	Number of Read commands from 25-50% of LBA space for restricted time range.
128..135	Qword	Number of Read commands from 50-100% of LBA space for restricted time range.
136..143	Qword	Number of Write commands from 0-3.125% of LBA space for restricted time range.
144..151	Qword	Number of Write commands from 3.125-25% of LBA space for restricted time range.
152..159	Qword	Number of Write commands from 25-50% of LBA space for restricted time range.
160..167	Qword	Number of Write commands from 50-100% of LBA space for restricted time range.
168..175	Qword	Number of Read Commands of transfer length <=16KB space for restricted time range.
176..183	Qword	Number of Read Commands of transfer length (16KB – 512KB] for restricted time range.
184..191	Qword	Number of Read Commands of transfer length (512KB – 2MB] for restricted time range.
192..199	Qword	Number of Read Commands of transfer length > 2MB for restricted time range.
200..207	Qword	Number of Write Commands of transfer length <=16KB for restricted time range.
208..215	Qword	Number of Write Commands of transfer length (16KB – 512KB] for restricted time range.
216..223	Qword	Number of Write Commands of transfer length (512KB – 2MB] for restricted time range.
224..231	Qword	Number of Write Commands of transfer length > 2MB for restricted time range.
232..239	Qword	Count of Queue Depth =1 at 30s intervals for restricted time range.
240..247	Qword	Count of Queue Depth =2 at 30s intervals for restricted time range.

248..255	Qword	Count of Queue Depth 3-4 at 30s intervals for restricted time range.
256..263	Qword	Count of Queue Depth 5-8 at 30s intervals for restricted time range.
264..271	Qword	Count of Queue Depth 9-16 at 30s intervals for restricted time range.
272..279	Qword	Count of Queue Depth 17-32 at 30s intervals for restricted time range.
280..287	Qword	Count of Queue Depth 33-64 at 30s intervals for restricted time range.
288..295	Qword	Count of Queue Depth >64 at 30s intervals for restricted time range.
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..16383	Qword	Reserved

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 9**.

Table 9 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...431	Qword[2]	Reserved

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[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.

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..1231	Qword	Reserved
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

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 10**.

Table 10 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..135	Qword	Reserved
136..143	Qword	Current Relative Humidity (in units of .1%)
144..151	Qword	Reserved
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 for restricted time range. in mV
176..183	Qword	Maximum 12V input from for restricted time range. in mV
184..191	Qword	Current 5V input in mV

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

Byte Offset	Data Type	Description
192..199	Qword	Minimum 5V input from for restricted time range. in mV
200..207	Qword	Maximum 5V input from for restricted time range. in mV
208..215	Qword	Average 12V power (mW) – Average power value from the last PT (Power Telemetry) log
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	Average 5V power (mW) – Average power value from the last PT (Power Telemetry) log
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..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 11**.

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 11 FARM Page 5 Structure

Byte Offset	Data Type	Description
0..7	Qword	Page Number = 5
8..15	Qword	Copy Number
16..487	Qword	Reserved
480..487	Qword	Number of DOS Scans Performed, Actuator 0
488..495	Qword	Number of LBAs Corrected by ISP, Actuator 0
496..703	Qword	Reserved
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..2111	Qword	Reserved
2112..2303	Qword[24]	MR Head Resistance from most recent SMART Frame by Head
2304..2495	Qword	Reserved
2496..2687	Qword[24]	Velocity Observer over for restricted time range. by Head
2688..2879	Qword[24]	Number of Velocity Observer over for restricted time range. 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

Byte Offset	Data Type	Description
6352..6567	Qword	Reserved
6568..6759	Qword[24]	Second Head, MR Head Resistance from most recent SMART Frame by Head
6760..8871	Qword	Reserved
8872..8879	Qword	Number of LBAs Corrected by Parity Sector, Actuator 0
8880..8887	Qword	Primary Super Parity Coverage Percentage, Actuator 0
8888.10319	Qword	Reserved
10320..10327	Qword	Number of LBAs Corrected by ISP, Actuator 1
10328..10359	Qword	Reserved
10360..10367	Qword	Number of LBAs Corrected by Parity Sector, Actuator 1
10368..12295	Qword	Reserved
12296..12303	Qword	Primary Super Parity Coverage Percentage SMR/HSMR-SWR, Actuator 0
12304..12311	Qword	Primary Super Parity Coverage Percentage SMR/HSMR-SWR, Actuator 1
12312..16373	Qword	Reserved

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 12**.

Table 12 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** 6
   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 3**
   2.5. Verify page lengths are as defined in **Table 4**

3. **Parameter Validation**
   3.1. Verify log header is as defined in **Table 3**
   3.2. Verify page number fields are as defined in **Table 7** – **Table 11**
   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 13 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.

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)							
2	Page Length (n-3)							
3								
	FARM Logpage log parameters							
4 …	FARM Logpage log parameter [First]							
… N	FARM Logpage log parameter [Last]							

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)
0x0010-0x0019	Reserved	
0x001A	MR Head Resistance from most recent SMART Frame by Head	
0x001B-0x001E	Reserved	
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	Reserved	
0x0026	Write Workload Power-on Time in Seconds, value from most recent SMART Frame by Head	
0x0027	Reserved	
0x0028	Cumulative Lifetime Unrecoverable Read Repeat by head	
0x0029	Cumulative Lifetime Unrecoverable Read Unique by head	
0x002A-002F	Reserved	
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	
0x0036-0042	Reserved	
0x0043	Second Head MR Head Resistance from most recent SMART Frame by Head	

Parameter Code	Description	Reference
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 5**. (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 6**	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)					
1								(LSB)
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]							
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 restricted time range.							
92-99	Number of Read commands from 3.125-25% of LBA space for restricted time range.							
100-107	Number of Read commands from 25-50% of LBA space for restricted time range.							
108-115	Number of Read commands from 50-100% of LBA space for restricted time range.							
116-123	Number of Write commands from 0-3.125% of LBA space for restricted time range.							
124-131	Number of Write commands from 3.125-25% of LBA space for restricted time range.							
132-139	Number of Write commands from 25-50% of LBA space for restricted time range.							
140-147	Number of Write commands from 50-100% of LBA space for restricted time range.							
148-155	Number of Read Commands of transfer length <=16KB for restricted time range.							
156-163	Number of Read Commands of transfer length (16KB – 512KB] for restricted time range.							
164-171	Number of Read Commands of transfer length (512KB – 2MB] for restricted time range.							
172-179	Number of Read Commands of transfer length > 2MB for restricted time range.							
180-187	Number of Write Commands of transfer length <=16KB for restricted time range.							
188-195	Number of Write Commands of transfer length (16KB – 512KB] for restricted time range.							
196-203	Number of Write Commands of transfer length (512KB – 2MB] for restricted time range.							
204-211	Number of Write Commands of transfer length > 2MB for restricted time range.							

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)							
36-51	Reserved							
52-59	Number of Mechanical Start Retries (Log Page 0x06, PC 0xD110)							
60-163	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)
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	Reserved							
156-163	Current Motor Power, value from most recent restricted time range data set.							
164-171	Average 12V power (mW) – Average power value from the last Power Telemetry log							
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	Average 5V power (mW) – Average power value from the last Power Telemetry log							
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							

Power Telemetry Notes:

- Power Telemetry is running continuously by default.

- Upon reading FARM log, Power Telemetry will be stopped to collect data (if running) and then resume measurement once data averaging is complete.

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							
20-123	Reserved							
124-131	Number of RAW Operations							
132-139	Cumulative Lifetime Unrecoverable Read errors due to Error Recovery Control (e.g. ERC timeout)							
140-203	Reserved							
204-211	Helium Pressure Threshold Trip (1 – trip 0 – no trip)							
212-235	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							
108-115	HAMR Write Protect Status: 1 = Write Protect, 0 = No Write Protect							
116-123	Regen Head Mask: bitmap where 1 = bad head, 0 = good head							

Drive Recording Type

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

Table 24 FARM Logpage 'Environmental Statistics Continued' Parameter Structure

Bit Byte	7	6	5	4	3	2	1	0
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 for restricted time range. in mV							
36-43	Maximum 12V input from for restricted time range. in mV							
44-51	5V input from most recent SMART Summary Frame in mV							
52-59	Minimum 5V input from for restricted time range. in mV							
60-67	Maximum 5V input from for restricted time range. 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 restricted time range.								
28-35	Count of Queue Depth =2 at 30s intervals for restricted time range.								
36-43	Count of Queue Depth 3-4 at 30s intervals for restricted time range.								

44-51	Count of Queue Depth 5-8 at 30s intervals for restricted time range.
52-59	Count of Queue Depth 9-16 at 30s intervals for restricted time range.
60-67	Count of Queue Depth 17-32 at 30s intervals for restricted time range.
68-75	Count of Queue Depth 33-64 at 30s intervals for restricted time range.
76-83	Count of Queue Depth >64 at 30s intervals for restricted time range.

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							
36-131	Reserved							
132-139	Number of DOS Scans Performed							
140-147	Number of LBAs Corrected by ISP							
148-179	Reserved							
180-187	Number of LBAs Corrected by Parity Sector							
188-235	Reserved							
236-243	Primary Super Parity Coverage Percentage CMR / HSMR-SOBR							
244-251	Primary Super Parity Coverage Percentage SMR / HSMR-SWR							

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	Reserved							