Authorization	Signature / Approval	Date

Field-Accessible Reliability Metrics Specification
Seagate Technology
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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

Contents

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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
LUN	Logical Unit Number
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	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
Seagate IDD Specification
T10 Specification
T13 Specification

4. SATA Field-Accessible Reliability Metrics (Log 0xA6, 0xC6) Overview

The intent of the Field-Accessible Reliability Metrics log is to provide a single source of information regarding drive health and predictive failure information. The log was also designed with ease of use in mind: 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 be used to pull the Field-Accessible Reliability Metrics, which is reported in the Directory Log. A SMART READ LOG command will result in an ABRT status.

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

The maximum size of all FARM data is 2592 KB. This accounts for one (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 via log address 0xC6.

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

Space has been reserved on SATA for 24 heads.

5. SATA Log Access and Structure

The Field-Accessible Reliability Metrics can be read 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 (~7ms)
	1 – Generate and report new FARM data and save to disc (~45ms)
	2 – Report previous FARM data from disc (~20ms)
	3 – Report FARM factory data from disc (~20ms)

Selecting a FEATURE register of 0 to generate and report new FARM data will gather the data from the drive at the time the command is received, populate the log structure, and transfer to the host. This option will **not** save the data to the FARM disc file. This option will return 96 KB of meaningful data to the host.

Selecting a FEATURE register of 1 to generate and report new FARM data will gather the data from the drive at the time the command is received, populate the log structure, save the data to the

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FARM disc file, and transfer to the host. This option will return 96 KB of meaningful data to the host.

Selecting a FEATURE register of 2 will report the saved FARM Log from the last time the log was read with feature register set to 0. If feature 1 is requested, no new log data will be 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 will be aborted by the drive. This option will return 96 KB of meaningful data to the host.

Selecting a FEATURE register of 3 will report the saved FARM Log from the factory process. This option will report "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 will be aborted by the drive. This option will return 96 KB of meaningful data to the host.

The Field-Accessible Reliability Metrics 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
	1 – Report all FARM data

Selecting a FEATURE register of 0 will report all FARM frames saved on disc. The data return order will be 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 will return 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 will report all FARM data. The data return order will be as follows:
1. Current frame generated on-the-fly (1)
2. Host disc copy (1): If not present, data region will be 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 will return 2592 KB of meaningful data to the host. See **Section 12** and **Section 13** for more information on the FARM Frame Capture feature.

The structure for the Field-Accessible Reliability Metrics 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 Field-Accessible Reliability Metrics 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 Field-Accessible Reliability Metrics 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 Field-Accessible Reliability Metrics 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 within 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

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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 Field Accessible Reliability Metrics shall 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 will define, at a high level, the type of information found within 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 Field-Accessible Reliability Metrics contains information about the structure and contents of the following log pages. Additionally, the header will contain 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 Field-Accessible Reliability Metrics 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
176..183	Qword	Head Load Events
184..191	Qword	Power Cycle Count

192..199	Qword	Hardware Reset Count
200..207	Qword	SMART Spin-Up time in milliseconds
208..215	Qword	Reserved
216..223	Qword	Reserved
224..231	Qword	Reserved
232..239	Qword	Reserved
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..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 Field-Accessible Reliability Metrics log will contain information specific to the use case of the device. The structure for Log Page 2 is shown in **Table 9**.

Table 9 Field-Accessible Reliability Metrics Page 2 Structure

Byte Offset	Data Type	Description
0..7	Qword	Page Number = 2
8..15	Qword	Copy Number
16..23	Qword	Reserved
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
88..95	Qword	Number of times dither was held off during random workloads during current power cycle
96..103	Qword	Number of times dither was held off during sequential workloads during current power cycle
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..16383	Qword	Reserved

Log Page 3: Error Statistics

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

Table 10 Field-Accessible Reliability Metrics 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
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]
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
144..151	Qword	Index of last entry in FLED Info array below, in case the array wraps
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
232…295	Qword[8]	Reserved
296…311	Qword[2]	Reserved
312…431	Qword[15]	Reserved
432…495	Qword[8]	Universal Timestamp (us) of last 8 Flash LED (assert) Events, wrapping array
496…559	Qword[8]	Power Cycle of the last 8 Flash LED (assert) Events, wrapping array
560..567	Qword	Cumulative Lifetime Unrecoverable Read errors due to Error Recovery Control (e.g. ERC timeout)
568..791	Qword[24]	Cumulative Lifetime Unrecoverable Read Repeating by head
792..1015	Qword[24]	Cumulative Lifetime Unrecoverable Read Unique by head
1016..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

[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.

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Log Page 4: Environmental Statistics

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

Table 11 Field-Accessible Reliability Metrics 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 [3]
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	Reserved
128..135	Qword	Reserved
136..143	Qword	Current Relative Humidity (in units of .1%)
144..151	Qword	Reserved
152..159	Qword	Current Motor Power Scalar
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..16383	Qword	Reserved

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[3] As defined in Device Statistics (ACS Specification)

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Log Page 5: Reliability Statistics

The reliability statistics recorded in Log Page 5 will contain 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 Field-Accessible Reliability Metrics Page 5 Structure

Byte Offset	Data Type	Description
0..7	Qword	Page Number = 5
8..15	Qword	Copy Number
16..23	Qword	Reserved
24..31	Qword	Reserved
32..223	Qword[24]	Reserved
224..415	Qword[24]	Reserved
416..423	Qword	Reserved
424..431	Qword	Reserved
432..439	Qword	Reserved
440..447	Qword	Reserved
448..455	Qword	Reserved
456..463	Qword	Reserved
464..471	Qword	Reserved
472..479	Qword	Reserved
480..487	Qword	Reserved
488..495	Qword	Reserved
496..503	Qword	Reserved
504..695	Qword[24]	Reserved
696..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..1535	Qword	Reserved
1536..1727	Qword[24]	Reserved
1728..1919	Qword[24]	Reserved
1920..2111	Qword[24]	Reserved
2112..2303	Qword[24]	MR Head Resistance from most recent SMART Summary Frame by Head
2304..2495	Qword[24]	Reserved
2496..2687	Qword[24]	Reserved
2688..2879	Qword[24]	Reserved
2880..3455	Qword[24][3]	Reserved

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3456..4031	Qword[24][3]	Reserved
4032..4223	Qword[24]	Reserved
4224..4415	Qword[24]	Reserved
4416..4607	Qword[24]	Reserved
4608..5183	Qword[24][3]	Reserved
5184..5191	Qword	Reserved
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]	Reserved
5776..5967	Qword[24]	Reserved
5968..6159	Qword[24]	Reserved
6160..6351	Qword[24]	Write Workload Power-on Time in Seconds, value from most recent SMART Summary Frame by Head
6352..6359	Qword	Reserved
6360..6367	Qword	Reserved
6368..6375	Qword	Reserved
6376..6567	Qword[24]	Reserved
6568..6759	Qword[24]	Second Head, MR Head Resistance from most recent SMART Summary Frame by Head
6760..6951	Qword[24]	Reserved
6952..7143	Qword[24]	Reserved
7144..7719	Qword[24][3]	Reserved
7720..8295	Qword[24][3]	Reserved
8296..8871	Qword[24][3]	Reserved
8872..8879	Qword	Number of LBAs Corrected by Parity Sector
8880..16383	Qword	Reserved

Micro-actuator lock-out status is a bit mapped value with each bit of the value representative of 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 will be 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

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8. **SATA Test Plan**
   This section contains a high-level test plan for the Field Accessible Reliability Metrics logging feature. Test requirements are numbered for ease of reference. Throughout this section, 'log' is a generic term used when referring to the Field Accessible Reliability Metrics 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 via SMART READ LOG SECTOR command
      1.3. Log shall be accessible via 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.

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9. SAS Field-Accessible Reliability Metrics Overview

The intent of the Field-Accessible Reliability Metrics log is to provide a single source of information regarding drive health and predictive failure information.

10. SAS Log Access and Structure

SAS will use 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 will 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 will 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.
5. SATA Option 4 – Report all FARM frames from disc
SAS will 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.
6. SATA Option 5 – Report all FARM data
SAS will 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.

FARM Log will use 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 Field-Accessible Reliability Metrics 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]
... N	FARM Logpage log parameter [Last]

*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 will be implemented as a subpages 0x03 and 0x04 of Logpage 0x3D.

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

All Parameters on this subpage will be of 'Binary List format' type. Log sense on this page will return '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.

All the data fields on this page are not 'Resettable' or 'changeable' by Log Select command as this page represents the summary of data from other logs and thus resetting or changing the parameters/data on this page will cause undesired effects on the data of other Log Pages.

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)
0x0008-0x000F	Reserved for future statistics	
FARM Logpage By Head Parameter codes		(Table 25)
0x0010	Reserved	
0x0011	Reserved	
0x0012	Reserved	
0x0013	Reserved	
0x0014	Reserved	
0x0015	Reserved	
0x0016	Reserved	
0x0017	Reserved	
0x0018	Reserved	
0x0019	Reserved	
0x001A	MR Head Resistance from most recent SMART Summary Frame by Head	
0x001B	Reserved	
0x001C	Reserved	
0x001D	Reserved	
0x001E	Reserved	
0x001F	Reserved	
0x0020	Reserved	
0x0021	Number of Reallocated Sectors	
0x0022	Number of Reallocation Candidate Sectors	
0x0023	Reserved	
0x0024	Reserved	
0x0025	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-0x0042	Reserved for future expansion	
FARM Logpage By Head Parameter Codes Extended		(Table 25)

0x0043	Second Head MR Head Resistance from most recent SMART Summary Frame by Head	
0x0044-0x004F	Reserved	
FARM Logpage By Actuator parameter codes		
0x0050	Actuator 0 parameters.	(Table 26)
0x0051	Actuator 0 FLED Info parameters	(Table 27)
0x0052	Actuator 0 Reallocation parameters	(Table 28)
0x0053-0x005F	Reserved for future expansion	
0x0060	Actuator 1 parameters	(Table 26)
0x0061	Actuator 1 FLED Info parameters	(Table 27)
0x0062	Actuator 1 Reallocation parameters	(Table 28)
0x0063-0x006F	Reserved for future expansion	
0x0070	Actuator 2 parameters	(Table 26)
0x0071	Actuator 2 FLED Info parameters	(Table 27)
0x0072	Actuator 2 Reallocation parameters	(Table 28)
0x0072-0x007F	Reserved for future expansion	
0x0080	Actuator 3 parameters	(Table 26)
0x0081	Actuator 3 FLED Info parameters	(Table 27)
0x0082	Actuator 3 Reallocation parameters	(Table 28)
0x0083-0x008F	Reserved for future expansion	

The first byte of each 64 bit field within 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)				
1								(LSB)
2				Parameter control byte				
	DU	Obsolete	TSD	Obsolete			Format and Linking	
3				Parameter Length (72)				
4-11	Log Signature = 0x00004641524D4552 (FARMER 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							

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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	Reserved
220-227	Reserved
228-235	Reserved
236-243	Reserved
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 (144)							
4-11	Page Number = 2							
12-19	Copy Number							
20-27	Reserved							
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							
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							

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							

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	7	6	5	4	3	2	1	0
	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							
28-35	Number of Unrecoverable Write Errors							
36-43	Reserved							
44-51	Reserved							
52-59	Number of Mechanical Start Retries							
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	Reserved							
132-139	Reserved							
140-147	Reserved							
148-155	Reserved							
156-163	Reserved							
164-171	If SMART Trip present the reason code (FRU code)							
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 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	Reserved							
132-139	Reserved							
140-147	Reserved							
148-155	Reserved							

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156-163	Reserved
164-171	Reserved
172-179	Reserved
180-187	Reserved
188-195	Reserved
196-203	Reserved
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

Table 24 FARM Logpage 'Environmental Statistics Continued' Parameter Structure

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)		Parameter code (0007h)					

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Byte								
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 '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 26 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 (184)							
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	Reserved
164-171	Reserved
172-179	Reserved
180-187	Number of LBAs Corrected by Parity Sector

Table 27 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 28 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	

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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

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12. FARM Frame Capture Overview

The purpose of FARM Frame Capture is to provide 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 will be 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 will be as follows:

1. Current frame generated on-the-fly (1)
2. Host disc copy (1): If not present, data region will be 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.

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- 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 ºC

Frame Type Identification

The "Reason for Frame Capture" field within the header of the FARM log indicates the reason for a FARM Frame Capture. , the Field Data will contain 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 ºC