|  |  |  |
| --- | --- | --- |
| **Authorization** | **Signature / Approval** | **Date** |
|  |  |  |
|  |  |  |
|  |  |  |

**Field-Accessible Reliability Metrics Specification**

Seagate Technology

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# 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.

# 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** RunningAverage 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.

# Related Documentation

ACS Specification

Seagate IDD Specification

T10 Specification

T13 Specification

# 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.

# 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 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 1b** 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 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** Field-Accessible Reliability Metrics 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** 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 4** 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 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 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.

# 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 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** 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 8**.

### **Table 8** 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 9**.

### **Table 9** 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]](#footnote-2) |
| 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]](#footnote-3) |
| 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 6** | Error Type | RW Retry Log Entry MSB | RW Retry Log Entry LSB | Zone Group MSB | Zone Group LSB | Head | Retry Count |

## 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 10**.

### **Table 10** 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]](#footnote-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 Minutes3 |
| 96..103 | Qword | Time In Under Temperature in Minutes3 |
| 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 |

## 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 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** 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 |
| 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.

# 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 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 |

# 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. Verify Directory Log listing for Field Accessible Reliability Metrics is consistent with specifications defined in Section **5**.
   2. Log shall not be accessible via SMART READ LOG SECTOR command
   3. Log shall be accessible via READ LOG (DMA) EXT command
      1. Read commands exceeding log length result in ABRT
      2. Reads to log with dirty writes in user cache shall not result in an assert condition
   4. Any WRITE LOG command shall result in ABRT status
   5. Verify FEATURE register options
      1. FEATURE register set to ‘0’ generates new data and does not save to disc
      2. FEATURE register set to ‘1’ generates new data and saves that data to disc
      3. FEATURE register set to ‘2’ reads previously saved log from disc and does not generate new data
      4. FEATURE register set to ‘3’ reads factory saved log
   6. Verify that the log is saved to disc at the completion of any host-requested In-Drive Diagnostic test.
2. **Log Structure**
   1. Verify ‘Status’ byte of each field maps to a definition described in **Table 6**
   2. Any field marked ‘Not Supported’ in the status byte shall not contain data in the remaining seven bytes of data.
   3. Verify header page length is as defined in **Table 3**
   4. Verify page lengths are as defined in **Table 4**
3. **Parameter Validation**
   1. Verify log header is as defined in **Table 3**
   2. Verify page number fields are as defined in **Table 7** – **Table 11**
   3. Any field marked ‘Not Supported’ in the status byte shall not contain data in the remaining seven bytes of data.
   4. Parameters validated by STX firmware engineering team on a by-revision basis.

# 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.

# 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 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

1. 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.

1. 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.

1. 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] | | | | | | | |
| … |
|  |  | | | | | | | |
|  |
| … | 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 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.

# 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 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 (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 | | | | | | | |
| 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 | | | | | | | |
| 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 | | | | | | | |
| 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) | | | | | |  |
| 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 (Future parameter code) | | | | | |  |
| 1 |  | (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 (Future parameter code) | | | | | |  |
| 1 |  | (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 (Future parameter code) | | | | | |  |
| 1 |  | (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 | | | | | | | |

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

# 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.

* 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

1. As defined by Device Statistics Log definition (ACS). Does not include FLAGGED UNC, but does include PSEUDO UNC. [↑](#footnote-ref-2)
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. [↑](#footnote-ref-3)
3. As defined in Device Statistics (ACS Specification) [↑](#footnote-ref-4)