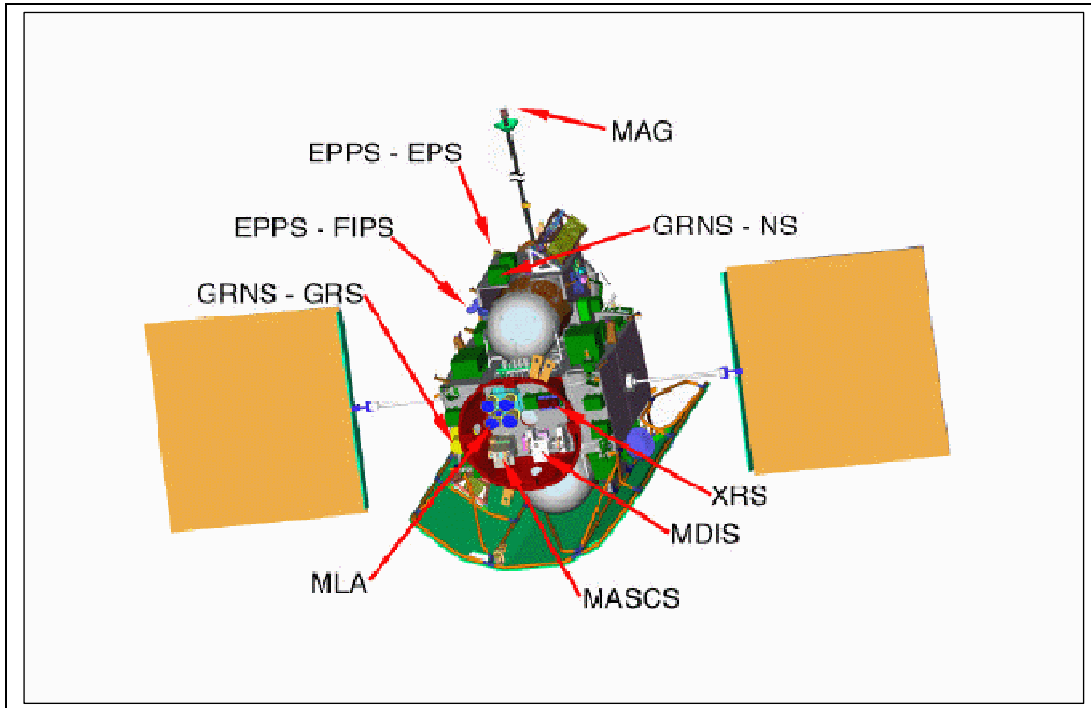


# MESSENGER Experiment Data Record Software Interface Specification for the Energetic Particle and Plasma Spectrometer

Version 3I, 7/9/2015



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**Document Review**

This document and the archive it describes have been through PDS Peer Review and have been accepted into the PDS archive.

George Ho, MESSENGER EPPS Instrument Scientist, has reviewed and approved this document.

Jim Raines, MESSENGER FIPS Instrument Engineer, has reviewed and approved this document.

Steve Joy, PDS PPI Node Representative, has reviewed and approved this document.

Susan Ensor, MESSENGER Science Operations Center Lead, has reviewed and approved this document

## Revision History

| Version Number | Date       | Changes  |
|----------------|------------|--|
| 3B             | 11/14/2009 | Updates for delivery 5.  |
| 3C             | 01/07/2010 | Added this revision history table. Minor edits.  |
| 3D             | 06/16/2011 | Replaced signature page with document review information.  |
| 3D             | 06/16/2011 | Added Experiment Data Record to document title.  |
|                | 10/31/11   | Corrected EPPS_LONG.FMT EPS_ELEC_PIX_SIZ and EPS_ION_PIX_SIZ values in section 8.16.   |
| 3E             | 12/15/11   | Updated document version, date, and revision history. Other minor document header/page number edits.   |
| 3F             | 5/25/12    | Change references to <i>Data Management and Science Analysis Plan</i> to <i>Data Management and Archiving Plan</i> . Reference <i>Data Management and Archiving Plan</i> for delivery schedule and delete delivery schedule table 12 from section 7. Minor edits.                      |
| 3G             | 11/20/2014 | Removed reference to .CSV file in sec. 5.4.1. Changed occurrences of “experimental” to “experiment” in references to EDRs.   |
| 3H             | 7/7/2015   | Note use of clock partitions in time tags in product labels following January 8, 2013 S/C clock reset (Section 5.4.2 Time Standards). Update reference to PDS file naming standard (was 27.3 now 36.3, in Section 6.5). Update EPPS EDR data archive volume for mission (Section 6.6). |
| 3I             | 7/9/2015   | Update to Figure 1 in Section 5.2.2.1. Update to sections 5.2.1, 5.2.2, and 5.2.3 to text to accurately reflect the number of current and retired data products.   |

## Table of Contents

|          |   |           |
|----------|---|-----------|
| <b>1</b> | <b>Purpose and Scope of Document</b> .....                                  | <b>6</b>  |
| 1.1      | Purpose .....   | 6         |
| 1.2      | Scope .....   | 6         |
| <b>2</b> | <b>Applicable Documents</b> .....   | <b>6</b>  |
| <b>3</b> | <b>Relationships with Other Interfaces</b> .....                            | <b>7</b>  |
| <b>4</b> | <b>Roles and Responsibilities</b> .....                                     | <b>8</b>  |
| <b>5</b> | <b>Data Product Characteristics and Environment</b> .....                   | <b>8</b>  |
| 5.1      | <b>Instrument Overview</b> .....  | <b>8</b>  |
| 5.1.1    | FIPS Overview.....  | 9         |
| 5.1.2    | EPS Overview .....  | 10        |
| 5.2      | <b>Data Product Overview</b> .....  | <b>10</b> |
| 5.2.1    | EPS Data Products.....  | 11        |
| 5.2.2    | FIPS Data Products .....  | 18        |
| 5.2.3    | EPPS Engineering and Status Data Product .....                              | 23        |
| 5.3      | <b>Data Processing</b> .....  | <b>24</b> |
| 5.3.1    | Data Processing Level.....  | 24        |
| 5.3.2    | Data Product Generation.....  | 24        |
| 5.3.3    | Data Flow.....  | 25        |
| 5.3.4    | Labeling and Identification .....   | 28        |
| 5.4      | <b>Standards Used in Generating Data Products</b> .....                     | <b>40</b> |
| 5.4.1    | PDS Standards .....   | 41        |
| 5.4.2    | Time Standards .....  | 41        |
| 5.4.3    | Coordinate Systems.....   | 41        |
| 5.4.4    | Data Storage Conventions.....   | 42        |
| 5.5      | <b>Data Validation</b> .....  | <b>42</b> |
| <b>6</b> | <b>Detailed Data Product Specification</b> .....                            | <b>44</b> |
| 6.1      | <b>Data Product Structure and Organization</b> .....                        | <b>44</b> |
| 6.2      | <b>Handling Errors</b> .....  | <b>44</b> |
| 6.3      | <b>Data Format Description</b> .....  | <b>45</b> |
| 6.4      | <b>Label and Header Descriptions</b> .....                                  | <b>45</b> |
| 6.5      | <b>File Naming Conventions</b> .....  | <b>47</b> |
| 6.6      | <b>Archive Volume and File Size</b> .....                                   | <b>49</b> |
| 6.7      | <b>Directory Structure and Contents for EPPS Documentation Volume</b> ..... | <b>50</b> |
| 6.7.1    | Directory Contents.....   | 50        |
| 6.8      | <b>Directory Structure and Contents for EPPS Data Volume</b> .....          | <b>51</b> |
| 6.8.1    | Directory Contents.....   | 52        |
| <b>7</b> | <b>Archive Release Schedule to PDS</b> .....                                | <b>53</b> |
| <b>8</b> | <b>Appendices</b> .....   | <b>53</b> |
| 8.1      | <b>EPSHIGH.FMT Table Fields</b> .....                                       | <b>53</b> |
| 8.2      | <b>EPSHI_HK.FMT Table Fields</b> .....                                      | <b>64</b> |
| 8.3      | <b>EPSMED.FMT Table Fields</b> .....  | <b>71</b> |
| 8.4      | <b>EPS_PHA.FMT Table Fields</b> .....                                       | <b>79</b> |
| 8.5      | <b>EPS_HIRES.FMT Table Fields</b> .....                                     | <b>81</b> |
| 8.6      | <b>EPS_LORES.FMT Table Fields</b> .....                                     | <b>82</b> |
| 8.7      | <b>EPS_SUM.FMT Table Fields</b> .....                                       | <b>92</b> |

|             |   |            |
|-------------|---|------------|
| <b>8.8</b>  | <b>EPS_SCAN.FMT Table Fields</b> .....                          | <b>96</b>  |
| <b>8.9</b>  | <b>FIPS_HI.FMT Table Fields</b> .....                           | <b>107</b> |
| <b>8.10</b> | <b>FIPS_HK.FMT Table Fields</b> .....                           | <b>110</b> |
| <b>8.11</b> | <b>FIPS_MED.FMT Table Fields</b> .....                          | <b>114</b> |
| <b>8.12</b> | <b>FIPS_PHA.FMT Table Fields</b> .....                          | <b>115</b> |
| <b>8.13</b> | <b>FIPS_SCAN.FMT Table Fields</b> .....                         | <b>117</b> |
| <b>8.14</b> | <b>FIPS_HRPVD.FMT Table Fields</b> .....                        | <b>118</b> |
| <b>8.15</b> | <b>EPPS_STATUS.FMT Table Fields</b> .....                       | <b>122</b> |
| <b>8.16</b> | <b>EPPS_LONG.FMT Table Fields</b> .....                         | <b>126</b> |
| <b>8.17</b> | <b>SPICE Kernel Files Used in MESSENGER Data Products</b> ..... | <b>133</b> |
| <b>8.18</b> | <b>CODMAC/NASA Definition of Processing Levels</b> .....        | <b>135</b> |
| <b>8.19</b> | <b>MESSENGER Glossary and Acronym List</b> .....                | <b>136</b> |

## 1 Purpose and Scope of Document

### 1.1 Purpose

This document will serve to provide users of the MESSENGER Energetic Particle and Plasma Spectrometer (EPPS) data products with a detailed description of the EPPS instrument, data product generation, validation and storage. Note that the EPPS is made up of two instrument subsystems, the Fast Imaging Plasma Spectrometer (FIPS), and the Energetic Particle Spectrometer (EPS). The FIPS and EPS will be described in individual sections within this document. They will be referred to separately when necessary and referred to as the EPPS instrument when dealing with areas common to both instruments. The FIPS covers the lower energy range of particles and measures the mass per charge (M/Q), energy per charge (E/Q) and incoming direction of each charged particle. The EPS covers the higher energy range and measures mass, energy, and incoming direction of each particle. The MESSENGER EPPS data products are deliverables to the Planetary Data System (PDS) and the scientific community that it supports. All data formats are based on the PDS standard.

### 1.2 Scope

The EPPS science data are divided into two categories: Level 2 edited-raw data (referred to as experiment data records or EDRs) and processed data (referred to as reduced data records or RDRs). RDRs are generated from EDRs, and represent data calibrated to a physical unit such as particle intensity (Level 3), resampled Level 4 data products, or derived Level 5 data products. This SIS describes the EPPS EDR data products.

EDRs consist of unprocessed instrument-count data including a description of the observation geometry (boresight, spacecraft, and target). In those cases where on-board compression has been applied, the EDRs will contain the decompressed version of the compressed instrument data as downlinked to the SOC through the Deep Space Network (DSN). The decompressed EDR data will be delivered to the PDS as CODMAC Level 2 data. EPPS's EDR is formatted to include standard PDS labels, spectra, pulse-height analysis and housekeeping data (instrument count data are otherwise unprocessed). To make full scientific utilization of the archived EDR data, processing such as conversion of data values into engineering units, and geometric rectification may be necessary. A detailed description of all data products in the EPPS's EDR follows.

In addition this SIS describes the EPPS documentation volume, which will contain products related to both the EDR and RDR level archives. The contents of the documentation volume will enable one to conduct useful analysis of the EDRs. The documentation volume is described in greater detail in section 6.6.

## 2 Applicable Documents

The MESSENGER EPPS SIS is responsive to the following Documents:

- Planetary Data System Standards Reference, Aug 1, 2003, Version 3.6. JPL D-7669, Part-2.

- MESSENGER Data Management and Archiving Plan. The Johns Hopkins University, APL. Document ID number 7384-9019
- MESSENGER Project Archive Generation, Validation, and Distribution Plan
- MESSENGER Mercury: Surface, Space Environment, Geochemistry, Ranging; A mission to Orbit and Explore the Planet Mercury, Concept Study, March 1999. Document ID number FG632/ 99-0479
- [PLR] Appendix 7 to the discovery program Plan; Program Level Requirement for the MESSENGER Discovery project; June 20, 2001.

This document references several other documents as well:

- Energetic Particle and Plasma Spectrometer (EPPS) Instrument Flight Software Specification, version 3. Horace Malcom, The Johns Hopkins University Applied Physics Laboratory document JHU/APL 7389-9041, November 12, 2003.
- FIPS Data Processing and Instrument Control, Steve Rogacki and Jim Raines, The University of Michigan Space Physics Research Laboratory document 082-170, rev. G, January 21, 2003.
- Livi et al. (The energetic particle spectrometer (EPS) on MESSENGER: Instrument description, characterization, and calibration, MESSENGER Project report, 2004.
- Zurbuchen et al. (The Fast Ion Plasma Spectrometer (FIPS) calibration report, MESSENGER Project report, 2004)
- Energetic Particle and Plasma Spectrometer (EPPS) Instrument Flight Software Specification, version 6. Horace Malcom/John Hayes, The Johns Hopkins University Applied Physics Laboratory document JHU/APL 7389-9041, rev B, July 12, 2008

This document has undergone several revisions. The following are those revisions available from the PDS:

- MESSENGER Software Interface Specification for the Energetic Particle and Plasma Spectrometer, Version 2F, 10/10/2006. First version delivered to PDS.
- MESSENGER Software Interface Specification for the Energetic Particle and Plasma Spectrometer, Version 2G, 12/10/2007. Second version delivered to PDS. This version describes Version V1.0 of the EPS and FIPS datasets. Minor changes.

### **3 Relationships with Other Interfaces**

The EPPS EDR data products are stored on Hard Disk and in an SQL (Structured Query Language) relational database for rapid mission access during mission operations. The data products will be electronically transferred to the PDS Planetary Plasma Interactions (PPI) Node according to the delivery schedule in the MESSENGER Data Management and Archiving Plan. The data in the EDR files themselves will be stored in a PDS binary TABLE object unless stated otherwise (section 5.2).

Due to changes in the EPPS flight software, several new EDR's have been added, and several have been retired. In addition, the formats of some of the EDR's have been updated. Due to these changes, the EPS and FIPS data sets have been advanced to version

V2.0. These versions supersede and replace version V1.0. The new data set identifiers are:

- MESS-E/V/H/SW-EPPS-2-EPS-RAWDATA-V2.0
- MESS-E/V/H/SW-EPPS-2-FIPS-RAWDATA-V2.0

The following table summarizes the changes from V1.0 to V2.0. Also see tables 2 and 8, following for more details.

**Table 1 Data Set Version Comparison**

| <b>EDR</b>  | <b>Data Set Version 1.0</b> | <b>Data Set Version 2.0</b> |
|-------------|-----------------------------|-----------------------------|
| EPSHIGH     | Exits                       | Retired, FSW6, 8/18/2008    |
| EPSHI_HK    | Exits                       | Retired, FSW5, 9/6/2007     |
| EPSMED      | Exits                       | Retired, FSW6, 8/18/2008    |
| EPS_PHA     | Exits                       | Changed, FSW6, 8/18/2008    |
| EPS_HIRES   | Not Included                | New, FSW6, 8/18/2008        |
| EPS_LORES   | Not Included                | New, FSW6, 8/18/2008        |
| EPS_SUM     | Not Included                | New, FSW6, 8/18/2008        |
| EPS_SCAN    | Not Included                | New, FSW6, 8/18/2008        |
| FIPS_HI     | Exits                       | Changed, FSW5, 9/6/2007     |
| FIPS_HK     | Exits                       | Retired, FSW5, 9/6/2007     |
| FIPS_MED    | Exits                       | Retired, FSW5, 9/6/2007     |
| FIPS_PHA    | Exits                       | Changed, FSW5, 9/6/2007     |
| FIPS_SCAN   | Not Included                | New, FSW6, 8/18/2008        |
| FIPS_HRPVD  | Not Included                | New, FSW6, 8/18/2008        |
| EPPS_STATUS | Exits                       | Retired, FSW5, 9/6/2007     |
| EPPS_LONG   | Not Included                | New, FSW5, 9/6/2007         |

## **4 Roles and Responsibilities**

The roles and responsibilities of the instrument teams, Applied Physics Lab (APL), Applied Coherent Technology (ACT), and the Planetary Data System (PDS) are defined in the MESSENGER Data Management and Archiving Plan.

## **5 Data Product Characteristics and Environment**

### **5.1 Instrument Overview**

The EPPS system encompasses two instrument subsystems – the Energetic Particle Spectrometer (EPS) and the Fast Imaging Plasma Spectrometer (FIPS). EPS covers the energy range of 25 to >500 keV for electrons, and 10 keV/nucleon to ~3 MeV total energy for ions. FIPS covers the energy/charge range of <50 eV/q to 20 keV/q. The Johns Hopkins University/Applied Physics Laboratory constructed the EPS instrument. It provides electron, high and low-energy ion as well as diagnostic events as a single stream of data that is placed into the EPS event FIFO for processing by the EPPS flight



software. The FIPS instrument was constructed by the University of Michigan Space Physics Research Laboratory. It provides a single serial stream of event data to the EPPS system at rates of up to 50K events/sec. The desired throughput for FIPS charged particle event processing as well as for EPS event processing is 5 kHz. FIPS generates a single 48-bit raw event packet format which includes a 1-bit header that identifies the event as a proton event or a non-proton event; an 11-bit TOF value; as well as a Wedge, Strip and ZigZag values (each 12 bits in size). In addition, the FIPS system generates counter and housekeeping information that the EPPS software can access via the I2C bus interface. Detailed descriptions of the EPS and FIPS sensor can be found, respectively, in Livi et al. (The energetic particle spectrometer (EPS) on MESSENGER: Instrument description, characterization, and calibration, MESSENGER Project report, 2004) and Zurbuchen et al. (The Fast Ion Plasma Spectrometer (FIPS) calibration report, MESSENGER Project report, 2004).

### *5.1.1 FIPS Overview*

The Fast Imaging Plasma Spectrometer (FIPS) sensor is designed to measure the distributions and composition of magnetosphere ions as well as to characterize the nature of the planetary magnetic field of Mercury. It will do this by measuring the mass per charge, the energy per charge, and incident angles for particles entering the sensor. The particle intensity is also calculated from the event rate information.

The FIPS consists of an electrostatic analyzer (ESA), located at the entrance to the sensor, a post acceleration chamber between the output of the ESA and the carbon foil, and a time-of-flight telescope. The ESA at the entrance to the FIPS acts as a wide-angle lens for ions. It only allows ions with a specific energy/charge band to enter through its output plane. This band is stepped through 64 values to complete one measurement cycle (scan). The times spent in each step can, in principal, be set to arbitrary values, different for each step. However, FIPS is normally operated in one of two stepping rates, once step per second (normal mode) or one step per 100 milliseconds (burst mode). When delays due to high voltage ramp-ups are included, these result in cycle times of 64 sec and 8 sec, respectively. Associated with each step in a scan is a voltage setting, a threshold, a settling time, and a duration or time interval after which the next voltage step is performed. Ions exit the output plane of the ESA and are then accelerated in the post acceleration chamber. This acceleration is done to boost low energy ions to penetrate the carbon foil. The acceleration also helps to reduce energy straggling and angular scattering – effects that cause degradation in mass resolution and imaging. The carbon foil serves as the source for secondary electrons, which are scattered out by the penetration ions. After penetrating the foil, the particle resides within the TOF (time-of-flight) chamber where velocity and incoming angle are computed. Velocity is determined by the time difference between the generation of secondary electrons in the start foil and a stop surface, and angle is determined by spatially imaging the position of the generation of the start secondary electrons. From the velocity, energy per charge, and the post acceleration potential it is then possible to calculate the mass per charge. The measured species for the FIPS range from H to Fe.

The FIPS instrument provides a single serial stream of event data to the EPPS system at rates of up to 50K events/sec. The EPPS software maintains a mass distribution spectrum for the FIPS instrument. This spectrum consists of a collection of two hundred fifty-six

bins (each 24 bits wide) that count the number of events corresponding to M/Q values. In addition the software maintains a set of 5 element energy spectra. Each FIPS spectrum corresponds to a specified M/Q range and consists of sixty-four 24-bit bins. For events whose M/Q values fall within one of the selected ranges, an energy value is computed and used to determine which bin within the corresponding spectrum to increment. The spectra are accumulated over an integral number of voltage scans, after which they are compressed and output in telemetry. FIPS also records 5 heavy ion energy-summed images (called “velocity distributions”) for each of the same 5 M/Q values plus one for protons. A commanded number of raw events will be recorded at each scan level.

### *5.1.2 EPS Overview*

The Energetic Particle Spectrometer (EPS) determines the distributions of the higher energy magnetospheric ion and electrons, including the composition of the ions to characterize the nature of the planetary field of Mercury. It does this by measuring the energy and velocity of the particles and then using a look-up table to determine the mass and therefore the species of particle. The measured species for the EPS include H, He, CNO, Fe, and electrons. Electrons are measured by solid-state detectors behind absorbing aluminum flashing.

The EPS sensor consists of a 60mm diameter, tuna-can-like cylinder, in which a start foil and stop foil, wrapped around opposite curved sides of the cylinder, constitute the time-of-flight chamber. An incoming particle hits the start foil and scatters one or more electron, which is attracted to the start anode ground. The particle continues and hits the stop foil, scattering other electrons, which are then attracted to the stop anode ground. The solid-state detectors outside of, but wrapped around the curved face of, the stop foil, then detect the particle and measure the energy state.

The detectors are arranged so that each detector senses the events within a given range of incidence angles. Each of the six detector modules is composed of four pixels: large and small ion and large and small electron. This provides 24 detector elements. At any one time, 12 of the 24 elements are used (6 ion and 6 electron detectors). Each of the six EPS detector modules also maintains its own spectrum via sixty-four 16-bit bins. Sixty-three bins will count the particle/energy combinations of interest, and one will count the remaining “background” events which do not fall in the particle/energy combinations of interest. The spectra are accumulated over a time set by ground command, after which they are compressed and reported in telemetry.

The EPS system also includes thirty-two 16-bit rate counters and three 24-bit rate counters that are read by the EPPS software every  $n$  seconds ( $n$  specified by command). EPS status and housekeeping data such as voltages, currents and temperatures are also periodically sampled.

## **5.2 Data Product Overview**

The EDR data products generated by the EPS and FIPS subsystems, as well as the EPPS instrument status EDR, are described in this section. For all the EDR products there is a detached PDS label file which describes the contents of one data file. Each label file will

have the same base name as the data file it is describing, with the extension “.LBL” to denote a label file. The label file defines the start time and end of the observation, product creation time, and the structure of the binary (or ASCII) tables.

The data product overview will first cover the EDRs unique to the EPS and FIPS subsystems, then describe the EPPS Engineering and Status EDR. There are a total of 8 current and 8 retired EDR data products. Of the current products, five of these are science and ancillary data products for the EPS instrument. Two others are science and ancillary data products for the FIPS instrument. The last is the engineering and status data products for the entire EPPS instrument. Each data file contains the data collected on a given earth day.

### *5.2.1 EPS Data Products*

The EPS portion of the data archive currently consists of five current and 3 retired EDR data products. The EPS instrument creates all of its different science data packets during one observation, but the packets are telemetered to the ground at different times. The different formats of these data packets do not lend themselves to standardization into one EDR file format. Therefore, different EDR formats have been developed, each of which captures one specific data grouping such as spectra or PHA data. A given EDR data file will contain all the observations obtained on same earth day. The following table shows the different EPS data products. Each data product is identified within the PDS label by a STANDARD\_DATA\_PRODUCT\_ID value (shown in parentheses).

The table has been updated to reflect an instrument flight software (FSW) version 6 upload on 8/18/2008, henceforth known as the FSW6 upload. The software changed to consolidate and improve instrument telemetry allocation on EPS. During the time of instrument check out shortly after launch, EPS’s time-of-flight section suffered a failure, subsequently, EPS lost its ability to measure ions by elemental mass species (can only now measure ion and electron). Hence a change of FSW is required to improve EPS’s ion and electron data products. This software upload changed the packet formatting such that two EPS EDRs had to be retired and be replaced by two new EDRs. Two additional EDRs had to be created to store data from two new instrument packets. Finally, the format for the EPS PHA EDR has been updated to be support slight changes in the PHA data. The new PHA data format will be consistent for EDRs before and after the flight software upload. The new flight software code was uploaded on 8/18/2008 and implemented on 8/19/2008. Thus, data on or after 8/19/2008 is generated from FSW6.

In addition, version 5 of the instrument flight software (FSW5), uploaded 9/6/2007, consolidated the EPS housekeeping data with FIPS housekeeping data in a new EDR, the EPPS\_LONG. Thus the High Priority Housekeeping (EPS\_HI\_HOUSEKEEPING) EDR has also been retired.

Version 7 of the instrument flight software (FSW7), uploaded on 8/18/2009, did not affect the format of the EPS EDRs. Thus, data on or after 8/18/2009 is of the same format as data generated from the FSW6 upload. FSW7 does affect the FIPS EDRs and changes are detailed in section 5.2.2.

**Table 2 EPS Data Products**

| <b>Current Data Products</b>   |  |
|--|--|
| <b>Data Product</b>  | <b>Product Description</b>   |
| EPS Pulse Height<br>(EPS_PULSE_HEIGHT)<br>EDR format changed by FSW6<br>on 8/18/2008                                       | <ul style="list-style-type: none"> <li>• PDS label file – describes data product and contains pointers to the data file:</li> <li>• PHA Data – contains Pulse Height Analysis data in binary table format. The PHA data product is generated from the high, medium, or low priority science packet. The priority level will be identified within the PDS label.</li> <li>• As of 8/18/2008 the PHA data product is generated from PHA data packets. There is no priority level associated with the PHA EDR since the high, medium, and low priority packets are retired on 8/18/2008.</li> </ul> |
| EPS_High Resolution Spectra<br>(EPS_HIRES_SPECTRA)<br>New FSW6 EDR introduced on<br>8/18/2008, replaces<br>EPS_HI_SPECTRA. | <ul style="list-style-type: none"> <li>• PDS label file – describes the data product and contains pointers to the data file:</li> <li>• Data file – high-res (energy channels) ion and electron energy spectra</li> </ul>  |
| EPS_Low Resolution Spectra<br>(EPS_LORES_SPECTRA)<br>New FSW6 EDR introduced on<br>8/18/2008, replaces<br>EPS_MED_SPECTRA. | <ul style="list-style-type: none"> <li>• PDS label file – describes the data product and contains pointers to the data file:</li> <li>• Data file – lo-res (energy channels) ion and electron energy spectra and rate counters.</li> </ul>   |
| EPS Summary Spectra<br>(EPS_SUMMARY_SPECTRA)<br>New FSW6 EDR introduced on<br>8/18/2008                                    | <ul style="list-style-type: none"> <li>• PDS label file – describes the data product and contains pointers to the data file:</li> <li>• Data file – Contains a subset of rate counters and low resolution energy spectra</li> </ul>  |
| EPS Scan<br>(EPS_SCAN_RATES)<br>New FSW6 EDR introduced on<br>8/18/2008  | <ul style="list-style-type: none"> <li>• PDS label file – describes the data product and contains pointers to the data file:</li> <li>• Data file – Contains the integrated hardware counters over four energy thresholds. Each threshold setting and integration lasts ¼ second.</li> </ul>   |
| <b>Retired Data Products</b>   |  |
| <b>Data Product</b>  | <b>Product Description</b>   |
| High Priority EPS Spectra<br>(EPS_HI_SPECTRA)<br>EDR retired by FSW6 on<br>8/18/2008                                       | <ul style="list-style-type: none"> <li>• PDS label file – describes the data product and contains pointers to the data file:</li> <li>• Spectra Data – contains spectral data, hardware and software rate counters in binary table format. Data and counter values are taken from the High Priority (order that they download to ground) Science Packet</li> </ul>   |
| High Priority Housekeeping<br>(EPS_HI_HOUSEKEEPING)<br>EDR retired by FSW5 on<br>9/6/2007.                                 | <ul style="list-style-type: none"> <li>• PDS label file – describes the data product and contains pointers to the data file:</li> <li>• Housekeeping ASCII table file – contains 33 fields of housekeeping data.</li> </ul>  |
| Medium Priority<br>EPS Spectra<br>(EPS_MED_SPECTRA)<br>EDR retired by FSW6 on<br>8/18/2008                                 | <ul style="list-style-type: none"> <li>• PDS label file – describes data product and contains pointers to the data file:</li> <li>• Spectra data – contains spectral data, hardware and software rate counters in binary table format. Data and counter values are taken from the Medium Priority (order that they download to ground) Science Packet.</li> </ul>  |

The EPS Spectra Data is stored as counts/accumulation for a number of defined data channels. The spectra are reported within 4 different classes of channels: high-resolution/low-resolution electron channels, and high-resolution/low-resolution ion channels. The channels are defined in Tables 2-5. The information provided in these tables is given for each of 6 different view directions. Note that the exact boundaries given with either energies or times-of-flight are subject to change via ground commands. Tables 2-5 list electron energy levels as recorded within the onboard sensors and electronics. The translations of those electronic levels to the energies of the incoming particles can be found in the Livi et al. (2004) Calibration report referenced at the beginning of this document.

Table 3 EPS Low-resolution Electron Channels (Based on Energy)

| <b>Channel</b> | <b>E1 (electronic)</b> | <b>E2(electronic)</b> | <b>Comments</b>      |
|----------------|------------------------|-----------------------|----------------------|
|                | keV                    | keV                   |                      |
| 0              | 0                      | 21                    | Below Discrimination |
| 1              | 21                     | 28                    | Below Discrimination |
| 2              | 28                     | 35                    |                      |
| 3              | 35                     | 56                    |                      |
| 4              | 56                     | 71                    |                      |
| 5              | 71                     | 112                   |                      |
| 6              | 112                    | 141                   |                      |
| 7              | 141                    | 224                   |                      |
| 8              | 224                    | 447                   |                      |
| 9              | 447                    | 708                   |                      |
| 10             | 708                    | 1000                  |                      |
| 11             |                        |                       | Overflow Channel     |

Table 4 EPS Low-resolution Ion Channels (Based on Energy)

| <b>Channel</b> | <b>E1 (electronic)</b> | <b>E2(electronic)</b> | <b>Comments</b>      |
|----------------|------------------------|-----------------------|----------------------|
|                | keV                    | keV                   |                      |
| 0              | 0                      | 20                    | Below Discrimination |
| 1              | 21                     | 27                    | Below Discrimination |
| 2              | 30                     | 36                    |                      |
| 3              | 43                     | 57                    |                      |
| 4              | 62                     | 89                    |                      |
| 5              | 88                     | 140                   |                      |
| 6              | 125                    | 343                   |                      |
| 7              | 177                    | 537                   |                      |
| 8              | 252                    | 841                   |                      |
| 9              | 357                    | 2065                  |                      |
| 10             | 507                    | 2750                  |                      |
| 11             |                        |                       | Overflow Channel     |

Table 5 EPS High-resolution Electron Channels (Based on Energy)

| <b>Channel</b> | <b>E1 (electronic)</b> | <b>E2(electronic)</b> | <b>Comments</b>      |
|----------------|------------------------|-----------------------|----------------------|
|                | keV                    | keV                   |                      |
| 0              | 0                      | 18                    | Below Discrimination |
| 1              | 18                     | 20                    | Below Discrimination |
| 2              | 20                     | 25                    | Below Discrimination |
| 3              | 25                     | 28                    | Below Discrimination |
| 4              | 28                     | 32                    |                      |
| 5              | 32                     | 35                    |                      |
| 6              | 35                     | 40                    |                      |
| 7              | 40                     | 45                    |                      |
| 8              | 45                     | 50                    |                      |
| 9              | 50                     | 56                    |                      |
| 10             | 56                     | 63                    |                      |
| 11             | 63                     | 71                    |                      |
| 12             | 71                     | 79                    |                      |
| 13             | 79                     | 89                    |                      |
| 14             | 89                     | 100                   |                      |
| 15             | 100                    | 112                   |                      |
| 16             | 112                    | 126                   |                      |
| 17             | 126                    | 141                   |                      |
| 18             | 141                    | 158                   |                      |
| 19             | 158                    | 178                   |                      |
| 20             | 178                    | 200                   |                      |
| 21             | 200                    | 224                   |                      |
| 22             | 224                    | 251                   |                      |
| 23             | 251                    | 282                   |                      |
| 24             | 282                    | 316                   |                      |
| 25             | 316                    | 355                   |                      |
| 26             | 355                    | 398                   |                      |
| 27             | 398                    | 447                   |                      |
| 28             | 447                    | 501                   |                      |
| 29             | 501                    | 562                   |                      |
| 30             | 562                    | 631                   |                      |
| 31             | 631                    | 708                   |                      |
| 32             | 708                    | 794                   |                      |
| 33             | 794                    | 891                   |                      |
| 34             | 891                    | 1000                  |                      |
| 35             |                        |                       | Overflow Channel     |

Table 6 EPS High-resolution Ion Channels (Based on Energy)

| <b>Channel</b> | <b>E1 (electronic)</b> | <b>E2(electronic)</b> | <b>Comments</b>      |
|----------------|------------------------|-----------------------|----------------------|
|                | keV                    | keV                   |                      |
| 0              | 0                      | 17                    | Below Discrimination |
| 1              | 17                     | 20                    | Below Discrimination |

|    |      |      |                      |
|----|------|------|----------------------|
| 2  | 20   | 23   | Below Discrimination |
| 3  | 23   | 27   | Below Discrimination |
| 4  | 27   | 31   |                      |
| 5  | 31   | 36   |                      |
| 6  | 36   | 42   |                      |
| 7  | 42   | 49   |                      |
| 8  | 49   | 57   |                      |
| 9  | 57   | 66   |                      |
| 10 | 66   | 77   |                      |
| 11 | 77   | 89   |                      |
| 12 | 89   | 104  |                      |
| 13 | 104  | 120  |                      |
| 14 | 120  | 140  |                      |
| 15 | 140  | 162  |                      |
| 16 | 162  | 188  |                      |
| 17 | 188  | 219  |                      |
| 18 | 219  | 254  |                      |
| 19 | 254  | 295  |                      |
| 20 | 295  | 343  |                      |
| 21 | 343  | 398  |                      |
| 22 | 398  | 462  |                      |
| 23 | 462  | 537  |                      |
| 24 | 537  | 624  |                      |
| 25 | 624  | 724  |                      |
| 26 | 724  | 841  |                      |
| 27 | 841  | 977  |                      |
| 28 | 977  | 1135 |                      |
| 29 | 1135 | 1318 |                      |
| 30 | 1318 | 1531 |                      |
| 31 | 1531 | 1778 |                      |
| 32 | 1778 | 2065 |                      |
| 33 | 2065 | 2399 |                      |
| 34 | 2399 | 2750 |                      |
| 35 |      |      | Overflow Channel     |

The element that is not represented in Tables 2-5 is directionality. The nominal total field-of-view (FOV) of EPS is  $160^\circ \times 12^\circ$ . Because the electron and ion Solid State Detectors (SSDs) are side-by-side, the total electron or high energy ion FOV in the long dimension is about 1/12 smaller ( $\sim 13^\circ$  smaller) or about  $147^\circ$ . And, the centers of the ion and electron FOV's are shifted with respect to each other by  $\sim 13^\circ$ . Let us define two angles within the MESSENGER spacecraft coordinate system: "alpha" is the angle from the +Y(s/c) axis and within the Y(s/c)-Z(s/c) plane (with "plus" angles viewing towards the +Z(s/c) axis); "beta" is the angle for rotations away from the Y(s/c)-Z(s/c) plane. With these definitions, the total FOV of EPS is roughly:  $(-80^\circ < \alpha < +80^\circ)$  and  $(-6^\circ < \beta < +6^\circ)$ . The ion FOV is  $(-67^\circ < \alpha < +80^\circ)$  and  $(-6^\circ < \beta < +6^\circ)$ . The electron

FOV is  $(-80^\circ < \alpha < +67^\circ)$  and  $(-6^\circ < \beta < +6^\circ)$ . For low energy ions (where the directionality is determined by microchannel plate anodes and not solid state detectors), the field-of-view is :  $(-80^\circ < \alpha < +80^\circ)$  and  $(-6^\circ < \beta < +6^\circ)$ .

The direction within the ~160 degree field of view is determined for high-energy ions and for electrons with the determination of which solid state detector (SSD) was active. With the high-energy ion and electron segments, there are a total of 12 SSD elements active at any one time. The numbering scheme for these detector elements ranges between 0 and 11, with the even SSD elements corresponding to electrons and the odd SSD elements corresponding to ions. The “0” detector (an electron detector) is the one that looks most closely aligned with the  $-Z(s/c)$  axis, while the “11” detector looks most closely to the  $+Z(s/c)$  axis. In the data that is telemetered to the ground, the directionality of the electrons and ions is represented with a number between 0 and 5. For electrons the directions (0, 1, 2, 3, 4, 5) correspond to SSD’s (0, 2, 4, 6, 8, 10). For high-energy ions the directions (0, 1, 2, 3, 4, 5) correspond to SSD’s (1, 3, 5, 7, 9, 11).

There is a confusing element in the representation of the directionality of low energy ions (time-of-flight only). The directionality is now determined not with the SSD’s but with the microchannel plate anodes. The numbering of the TOF Start-Anodes ranges between 0 and 5. An ion or electron that passes right over Start-Anode “0” (only the ion “stimulates” this start anode) strikes either SSD 10 or SSD 11. Thus, the Start-Anodes 5, 4, 3, 2, 1, and 0 map to SSD’s (0, 1), (2, 3), (4, 5), (6, 7), (8, 9), and (10, 11), respectively. The confusing element is that the Low Energy Ion direction “5” (representing the firing of anode “5”) corresponds roughly (not exactly) to the High Energy Ion direction “0”, and the Low Energy Ion direction “0” corresponds to the High Energy Ion direction “5”. This confusing element exists for historical reasons, and because this representation is how the directionalities are indicated on board the instrument, we believed that even more confusion would be introduced if we made a change within the data generated on the ground.

In FSW6, the high (energy) resolution spectral EDR product (EPS\_HIRES\_SPECTRA) is integrated for  $T*N1$  seconds, where both T and N1 are commandable parameters. The EPS\_HIRES\_SPECTRA data are sent from the spacecraft in high priority telemetry packets. The low (energy) resolution spectral EDR product (EPS\_LORES\_SPECTRA) is integrated for T seconds (high time resolution) and contains rate data as well as the low energy spectra. The EPS\_LORES\_SPECTRA data are sent from the spacecraft in medium priority telemetry packets. The EPS\_SUMMARY\_SPECTRA EDR product contains both high and low energy spectra and is integrated over  $T*N1$  (low time resolution). The EPS\_SUMMARY\_SPECTRA data are sent from the spacecraft in high priority telemetry packets. It provides redundant data and a quick look capability; it may be enabled or disabled by command.

In previous releases, these spectral products were identified by the priority with which the data packets were telemetered by the spacecraft to the ground. In FSW6, this naming convention has been discontinued. The following table clarifies the relationship between the EDR names and the various resolutions and priorities of the three principle products:



| <b>Product</b>      | <b>Energy Resolution</b> | <b>Time Resolution (Integration Time)</b> | <b>Telemetry Priority</b> |
|---------------------|--------------------------|---|---------------------------|
| EPS_HIRES_SPECTRA   | High (36 bins)           | T*N1 (low)                                | High                      |
| EPS_LORES_SPECTRA   | Low (12 bins)            | T (high)                                  | Medium                    |
| EPS_SUMMARY_SPECTRA | Both                     | T*N1 (low)                                | High                      |

New in the FSW6 is the Scan data. In scan mode, EPS varies the energy thresholds integrating hardware rates at each threshold setting (defined in tables). The thresholds are changed three times, and then the base thresholds are restored. A scan is defined as four threshold settings, three offsets and one nominal. At each threshold step, a subset of the hardware rate counters is accumulated for ¼ second. The Scan mode gives EPS the ability to lower its electronics threshold by temporarily suspending the processor operation.

#### **5.2.1.1 Pulse Height Analysis (PHA) Event Data**

PHA events are stored by the EPPS flight software in the EPS High, Medium, or Low priority Science packet, for data prior to FSW6. The following explains how PHA event data is collected for data prior to the FSW6 upload on 8/18/2008. PHA events are distributed among the packet buffers in round-robin fashion: the first detected event is stored into the high-priority packet buffer, the next event is stored in the medium-priority packet buffer, and the last event is stored into the low-priority packet buffer. Please note that there is no individual time tag per PHA event.

Each event allocated to a particular buffer is simply stored into the next slot within the buffer until the buffer fills up. Thereafter, a rotating priority PHA replacement scheme is used in deciding which events may be displaced from the filled buffer. The maximum number of PHA events saved per integration period for a particular packet is shown in the following table:

**Table 7 Maximum PHA Events per Integration**

| EPS Packet Type | Maximum number of PHA events saved during each accumulation interval |
|-----------------|--|
| High Priority   | 10   |
| Medium Priority | 20   |
| Low Priority    | 300  |

Note that a given EPS science packet (which may or may not contain PHA events) is time tagged with one MET time (not per PHA event). PHA events are accumulated within an integration period depending on the priority of the given science packet. Each PHA event is time tagged with the same MET associated with the science packet in which it was contained. Thus, there will be a maximum of 10 High Priority events with the same MET, 20 Medium Priority events with the same MET or 300 Low Priority events with the same MET. A given PHA EDR data file will contain the observations obtained on the same earth day and arranged in time order. Therefore a given PHA EDR data file will contain a

set of N PHA events with the same MET, followed by another set of PHA events with the same MET, etc.

The FSW6 upload created a PHA packet for the express purpose of downloading PHA events. The EPS collects data for  $T \cdot N1$  seconds (where  $T$ =integration time and  $N1$  is the integration time multiplier). If the integration is aborted then  $N1$  will be the actual value instead of the commanded value. Over the  $T \cdot N1$  integration time, EPS saves PHA data in the order that it is seen. Each PHA packet can record a maximum of 934 PHA events. The events in a single PHA packet are time tagged with one MET time.

FSW6 also retired the high, medium, and low priority packets and consequently the capture of PHA events within those packets. The only packet which contains EPS PHA events is the EPS PHA packet and is sent down as a medium priority packet; the file naming convention will reflect that FSW6 PHA EDRs are no longer associated with a priority level.

### 5.2.2 FIPS Data Products

The FIPS portion of the data archive currently consists of two current and 4 retired EDR data products. As with the EPS the data collected in one observation is downloaded at different times and in different packet formats. Therefore, different EDR formats have been developed, each of which presents a different grouping of the data. The following table shows the different FIPS data products and their files. Each data product is identified within the PDS label by a STANDARD\_DATA\_PRODUCT\_ID value (shown in parentheses). Note: a FIPS Flight Software Upload (FSW5) was conducted on Sept 6, 2007 which implemented several changes to the FIPS science packets. This in turn changed the format of the FIPS EDRs. The EDRs prior to FSW5 were regenerated to reflect the updated format. The FSW5 upload also modified the FIPS High Priority Science packet: housekeeping data was no longer being stored in the FIPS High Priority Science Packet. Instead, that housekeeping data was added to the EPPS Status packet, which in turn led to the creation of the EPPS\_LONG\_STATUS EDR. The FIPS\_HI\_HOUSEKEEPING EDR is no longer generated for data collected on or after 9/6/2007.

This was superseded by a FIPS Flight Software Upload (FSW6) conducted on 8/18/2008, henceforth known as the FSW6 upload. This software upload changed the packet formatting such that the Medium Priority FIPS Spectra EDR had to be retired and was replaced by FIPS High Resolution Proton Velocity Distribution EDR. The FIPS SCAN EDR was created to store data from a new instrument packet. The new flight software code was uploaded on 8/18/2008 and implemented on 8/19/2008. Thus, data on and after 8/19/2008 is from the FSW6 load.

Another instrument flight software upload (FSW7) was conducted on 8/18/2009. This software upload enable the creation of Proton PHA events in addition to the existing Heavy Ion PHA events. Both types of PHAs are combined in a single EDR file. The PHA data are also exclusively generated by specific PHA packets. The naming convention for

FSW7 PHA EDRs has been updated to reflect this change. Additionally the FIPS High Resolution Proton Velocity Distribution EDR has been retired due to the FSW7 update.

The table below reflects the changes brought about by each successive FSW upload.

Specific changes to the FIPS EDR formats are described in a NOTE at the start of each FIPS format file.

**Table 8 FIPS EDR Data Products**

| <b>Current Data Products</b>   |  |
|--|--|
| <b>Data Product</b>  | <b>Product Description</b>   |
| FIPS Pulse Height<br>(FIPS_PULSE_HEIGHT)<br>Format updated by FSW5 on<br>9/6/2007  | <ul style="list-style-type: none"> <li>• PDS label file – describes data product and contains pointers to the data file:</li> <li>• PHA Data – contains FIPS Pulse Height Analysis data in binary table format. This data product is generated from either high, medium, or low priority FIPS packets. The priority level will be identified within the PDS label</li> <li>• As of 8/18/2008 the PHA data product is generated from High or Low Priority spectra packets or from FIPS Scan packets. The file naming convention will identify the source packet.</li> </ul> |
| FIPS SCAN<br>(FIPS_SCAN)<br>New FSW6 EDR   | <ul style="list-style-type: none"> <li>• PDS label file – describes data product and contains pointers to the data file:</li> <li>• Data file – contains rate counts sampled at each Deflection System High Voltage (DSHV) step in a FIPS scan.</li> </ul>   |
| <b>Retired Data Products (shown in retired time order)</b>   |  |
| <b>Data Product</b>  | <b>Product Description</b>   |
| High Priority FIPS<br>Housekeeping<br>(FIPS_HI_HOUSEKEEPING)<br>EDR retired by FSW5 on<br>9/6/2007                                   | <ul style="list-style-type: none"> <li>• PDS label file – describes the data product and contains pointers to the data file:</li> <li>• Housekeeping ASCII table file – contains 33 fields of housekeeping data (contained in the high priority science packet).</li> </ul>  |
| Medium Priority<br>FIPS Spectra<br>(FIPS_MED_SPECTRA)<br>EDR retired by FSW6 on<br>8/18/2008   | <ul style="list-style-type: none"> <li>• PDS label file – describes data product and contains pointers to the data file:</li> <li>• Spectra Data file – contains proton velocity distribution, hardware and software rate counters in binary table format. Data and counter values are taken from the Medium Priority Science Packet</li> </ul>  |
| High Priority<br>FIPS Spectra<br>(FIPS_HI_SPECTRA)<br>Format updated by FSW5 on<br>9/6/2007<br>EDR retired by FSW7 on<br>8/18/2009   | <ul style="list-style-type: none"> <li>• PDS label file – describes the data product and contains pointers to the data file:</li> <li>• Spectra Data file – contains spectral and velocity distribution, hardware and software rate counters in binary table format. Data and counter values are taken from the High Priority Science Packet</li> </ul>  |
| FIPS High Resolution Proton<br>Velocity Distribution<br>(FIPS_HIRES_PROTON_V)<br>New FSW6 EDR<br>EDR retired by FSW7 on<br>8/18/2009 | <ul style="list-style-type: none"> <li>• PDS label file – describes data product and contains pointers to the data file:</li> <li>• Data file – Contains a 32 x 32 high resolution proton velocity distribution, integrated over a 10 scan sequence.</li> </ul>  |

Each of these items is explained in detail in the following sections. Much of this information is updated from 'FIPS Data Processing and Instrument Control'. Further details can be found in 'EPPS Instrument Flight Software Specification'. (See Section 2 of this document for full bibliographic information.)

**Table 9 Rate Counters**

| Item | Rate Counter Name | Bits | Derived from                                    |
|------|-------------------|------|---|
| 1    | Start Events      | 10   | Start Events Counter, i2c address 0x67 and 0x68 |
| 2    | Valid Events      | 10   | VE Counter, i2c address 0x6b and 0x6c           |
| 3    | Proton Events     | 10   | H Events Counter, i2c address 0x6d and 0x6e     |
| 4    | Stop Events       | 10   | Stop Events Counter, i2c address 0x69 and 0x6a  |
| 5    | Events Processed  | 10   | EPS internal counter                            |

The rate counters are 32 bit values, which are compressed to 10 bits. The first 3 rate counters listed are retrieved from FIPS at the end of each energy/charge (E/q) step (typically 1 second per step). The Stop Events counter is retrieved periodically and included in the housekeeping data. The fifth, Events Processed, counter is internal to the EPS processor which, when compared with the Valid Event counter, shows how many events have been registered in hardware but not processed in software, due to time limitations. The rate counters are compressed using a 10 bit logarithmic compression code, 5 bits for mantissa and 5 bits for exponent (5/5 compression).

### 5.2.2.1 Mass Distribution and Element Energy Spectra

The **Mass Distribution** is a histogram of events classified by their Mass/charge (M/q). All events are included in this data, both proton and non-proton. The Mass Distribution data object consists of 128 bins of 24 bit counters (compressed to 10 bits using the 5/5 compression). Nominally, these 128 bins span 0.9 AMU to 42 AMU, in a log scale. Bin 0 contains the sum of all events with M/q below the usable range (nominally 0.9 AMU) while bin 127 contains the sum of all events with M/q above the usable range (nominally 42 AMU). This data product is accumulated over a full scan sequence (10 scans; taking typically ~670 s in nominal mode).

To find the bin to increment, the EPPS Flight software uses a lookup table based on the E/q step and the measured TOF value. This lookup table is generated in two parts: First, a table of M/q (in AMU/e) as a function of E/q step and TOF is calculated:

$$M/q = 2 (kU + |V_a|) * TOF^2 / (d^2 * 1040 \text{ ns}^2 \text{ keV} / \text{cm}^2 \text{ AMU})$$

where:

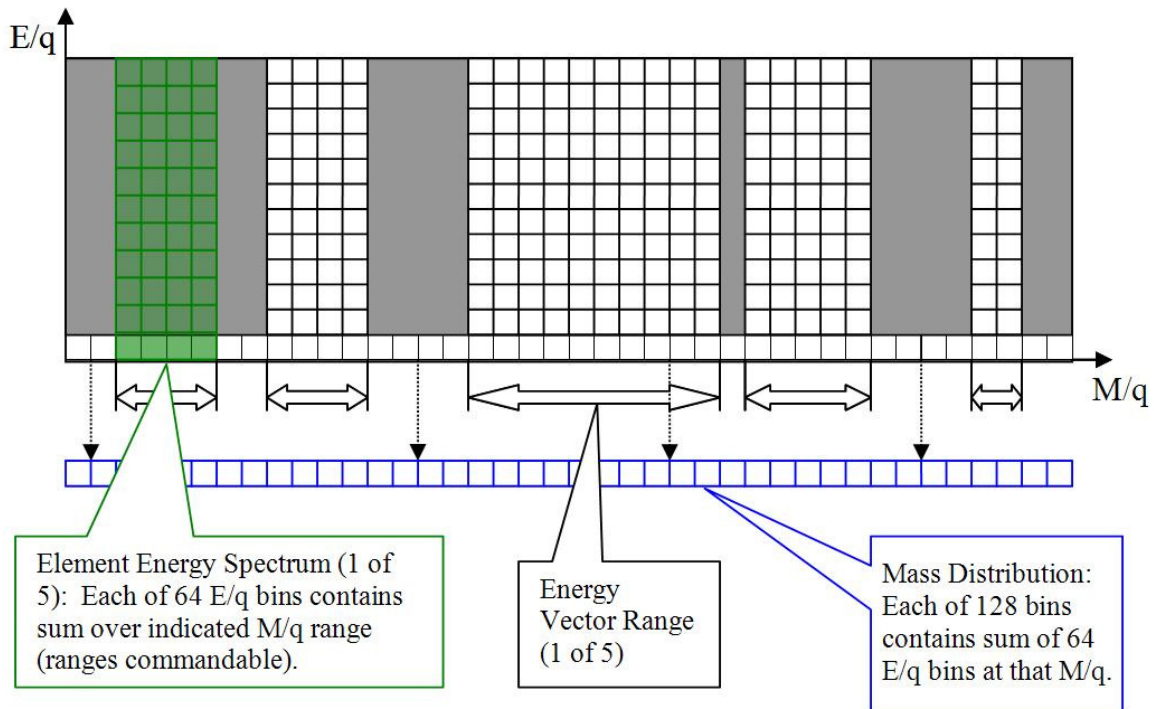
- k = deflection system constant, approx 1.33
- U = deflection system voltage, in kV
- V<sub>a</sub> = post acceleration voltage, in kV
- TOF = the measured Time of Flight, in ns
- d = distance over which TOF is measured, in cm.

Note: This equation does not include a term for the carbon foil scattering and energy loss, which tends to spread the calculated  $M/q$  values for each species making in flight calculations less precise than is possible on the ground.

Second, the  $M/q$  values are binned logarithmically across the  $M/q$  range (nominally 0.9-42 AMU/e):

$$Mq\_bin = ( \log(M/q) - \log(0.9) ) / ( (\log(42) - \log(0.9))/128 )$$

The **Element Energy Spectra** represent the distribution of events over  $E/q$  that fall within a specified  $M/q$  range. There are 5 separate vectors, each corresponding to a different (commandable)  $M/q$  range, called Energy Vector Ranges. These are presented as histograms of 64 bins, each a 24 bit counter, compressed to 10 bits using 5/5 compression. For inclusion in a data packet, the bins for each vector are ordered in ascending order, 0-63, and the 5 vectors are ordered 1 through 5. This data product is accumulated over a full scan sequence (10 scans; typically 670 s in nominal mode).



**Figure 1** Graphical depiction of relation among Element Energy Spectra, the Mass Distribution and the  $E/q - M/q$  measurement space. Note: Not all  $E/q$  or  $M/q$  bins are depicted.

### 5.2.2.2 PHA Event Data

PHA words contain the full-capability measurements of single particle events. Each PHA word contains the TOF,  $E/q$  step, and (X, Y) location of the event on the start MCP. It is accompanied by its associated DSHV step number, a 6-bit value. The LSB of the TOF value is dropped, 11 to 10 bit. The X and Y positions are calculated from the 12 bit

Wedge, Strip, and Zigzag data. First commanded offsets are subtracted from each value then the calculation below is performed:

The 28 bit packet is represented as follows in the following order:

|  |           |
|--|-----------|
| DS voltage step  | [6 bits]  |
| TOF  | [10 bits] |
| $X = \text{INT}(128 * \text{Wedge} / (\text{Wedge} + \text{Strip} + \text{ZigZag}))$ | [6 bits]  |
| $Y = \text{INT}(128 * \text{Strip} / (\text{Wedge} + \text{Strip} + \text{ZigZag}))$ | [6 bits]  |

Since not all PHA words can be telemetered to the ground, a representative sample is transmitted according to a buffered, rotating priority scheme. As events are collected, the flight software stores up to 12 events per deflection system voltage step in a buffer. At the end of the scan, these events are read out in voltage step order, one from each voltage step. Within a voltage step, PHAs are read out in the same order that they were stored. When no PHA exists for a given voltage step, one is read from the next voltage step which has PHAs remaining, until the allowed number of PHAs (quota) for this scan have been selected. The quota is 128 PHAs per scan for High and Medium priority events. The quota for Low priority events is set by ground command, with a maximum of 617 PHA words. This scheme has the effect of downlinking a selection of PHAs which are as evenly distributed across voltage steps as possible, while still telemetering the full quota of PHA words.

High or Medium priority PHA events contain the DS voltage step, TOF, X, and Y values. Low priority PHA events contain the DS voltage step, Wedge, Strip, and ZigZag values. Proton PHA words are not included and thus never included in the data. The 'Valid Event' rate is then used to calculate the appropriate weight of each transmitted PHA word which would reconstruct the distribution of actual valid events.

The PHA events are included as part of the FIPS high, medium, or low science packets. As of FSW6 PHA events are also included as part of the FIPS Scan packet. There is only one MET time tag associated with a science packet, even though it may contain multiple PHA events. Thus, the FIPS PHA EDRs will contain multiple records with the same MET timestamp. The maximum number of PHA events with the same MET timestamp is dependent on the priority level of the PHA event. It is possible to narrow the MET time window associated with a set of PHA events by combination of the E/q step number with the stepping rate. See section 5.1.1 for a description of FIPS stepping rate and note that MET timestamps are for the end of the scan. This priority level is assigned based on the priority of the telemetered science packet containing the PHA event. The maximum number of PHA events contained for a particular packet type is shown in the following table:

Table 10 Maximum PHA Events per Packet Type

| FIPS Packet Type             | Maximum number of PHA events contained in the packet |
|------------------------------|--|
| High Priority                | 64   |
| Medium Priority or FIPS Scan | 128  |

|                  |      |
|------------------|------|
| Low Priority     | 617  |
| Heavy Ion (FSW7) | 617  |
| Proton (FSW7)    | 1169 |

Note that a given FIPS science packet (which may or may not contain PHA events) is time tagged with one MET time. PHA events are accumulated within an integration period depending on the priority of the given science packet. Each PHA event is time tagged with the same MET associated with the science packet in which it was contained. Thus, there will be a maximum of 64 High Priority events with the same MET, 128 Medium Priority events with the same MET or 617 Low Priority events with the same MET. A given PHA EDR data file will contain the observations obtained on the same earth day and arranged in time order. Therefore a given PHA EDR data file will contain a set of N PHA events with the same MET, followed by another set of PHA events with the same MET, etc.

EDR priority designations have been eliminated with the introduction of FSW7. Now there are just 2 types of PHA packets – heavy ion and proton. However, the descriptions given above with regard to the MET time tags and EDR content still apply.

### 5.2.2.3 Velocity Distributions

FIPS is an imaging instrument that views into a region of solid angle that has conical symmetry and is bounded by 2 nested cones, with half angles of ~15 and ~75 degrees. The symmetry axis of the field of view points in the direction of (-0.74324, -0.383558, 0.548158) in spacecraft coordinates. In the back plane of the instrument the field of view is mapped onto a Cartesian (X, Y) coordinate system, with binned elements up to a resolution of 64 x 64. Distributions of the (X, Y) positions for each PHA represent the distributions of the velocity directions of particle events. These distributions are stored as 8 x 8 arrays of counters. The values X/8 and Y/8 are used as the row and column within the velocity distribution matrix to give the bin to be incremented.

#### Proton Velocity Distribution

This velocity distribution is calculated for only Proton events once per scan (typically ~65 s in nominal mode). The first bit in the event packet delivered by FIPS indicates whether it is a proton event.

#### Heavy Ion Velocity Distributions

This set of five velocity distribution arrays are calculated by including all PHA words in the same M/q ranges as those of the Element Energy Spectra. One set of these 5 distributions is produced every scan sequence (10 scans; ~670 s in nominal mode).

### 5.2.3 *EPPS Engineering and Status Data Product*

There is one current and one retired EDR data product containing the engineering and status information for the EPPS instrument – the EPPS Status EDR. This data product consists of an external PDS label file and its pointer to an ASCII table file. The data

product is in ASCII to facilitate the browsing of instrument status parameters with commonly available text readers during mission operations.

Note: a FIPS Flight Software Upload (FSW5) was conducted on Sept 6, 2007 which significantly changed the format of the EPPS Engineering and Status packet. Instead of changing the EPPS Engineering and Status EDR it was decided to create a new EDR, called EPPS\_LONG\_STATUS, to contain the content of the updated Status packet and retire the EPPS\_STATUS EDR after FSW5.

Therefore the EPPS STATUS EDR covers the time period from launch to 9/5/2007. The EPPS\_LONG\_STATUS EDR will contain the engineering and status information for data collected on or after 9/6/2007.

### ***5.3 Data Processing***

#### *5.3.1 Data Processing Level*

There is one EPPS PDS Documentation Archive Volume and one EPPS PDS Data Archive Volume. The data volume will contain level 2 CODMAC(Committee on Data Management and Computation) data products, also known as EDRs. Each product will have a unique file name and conform to the file naming convention in section 6.5. All EDR products will be stored at the Applied Physics Laboratory/Science Operations Center (APL/SOC) during mission operations. Volumes will be electronically transferred to the PDS PPI Node following the procedure in section 5.3.3.

Inputs to the SOC will consist of telemetry in the form of CCSDS packets. Data downlink is telemetered through NASA's Deep Space Network (DSN) managed by the Jet Propulsion Laboratory in Pasadena, CA, and then forwarded to APL. Level 1 CODMAC data (spectra, pulse height analysis, engineering data) is extracted from the telemetry packets and stored online at the SOC. Level 2 CODMAC data (EDRs) is then generated by the 'PIPE-EPPS2EDR' software, which is run automatically at the SOC.

#### *5.3.2 Data Product Generation*

The EPPS EDR files will be produced by the MESSENGER Science Operations Center (SOC) operated jointly by APL and ACT. The 'PIPE-EPPS2EDR' software created by ACT creates the EDR products to the proper PDS labeled format. The EDR data products are made available to the MESSENGER Science Team for initial evaluation and validation. At the end of the evaluation and validation period, the data are organized and stored in the directory structure described in section 6.8 for transmittal to the PPI Node. The transmittal process is described in the following section, Data Flow. An initial release of the documentation volume will accompany the initial release of the data volume. Thereafter, there will be updates to the documentation volume whenever the EPPS team determines that they have a sufficiently improved calibration to warrant a new release. PDS will then provide public access to the data products through its online distribution system. These products will be used for engineering support, direct science analysis, and construction of other science products.



### 5.3.3 *Data Flow*

The MESSENGER SOC operates under the auspices of the MESSENGER Project Scientist to plan data acquisition, generate, and validate data archives. The SOC supports and works with the MOC, the Science Team, instrument scientists, and the PDS.

Figure 2 MESSENGER Data Flow shows the flow of data within the MESSENGER project and out to PDS. The MOC handles raw data flow to and from the MESSENGER spacecraft and the SOC converts the raw telemetry into EDRs. The Science Team validates the EDRs and notifies the SOC if corrections are needed. Documentation, EDRs, and science products are delivered to the PDS Planetary Plasma Interactions (PPI) node. SPICE kernels are delivered to the PDS Navigation and Ancillary Information (NAIF) node. The delivery process is detailed below.

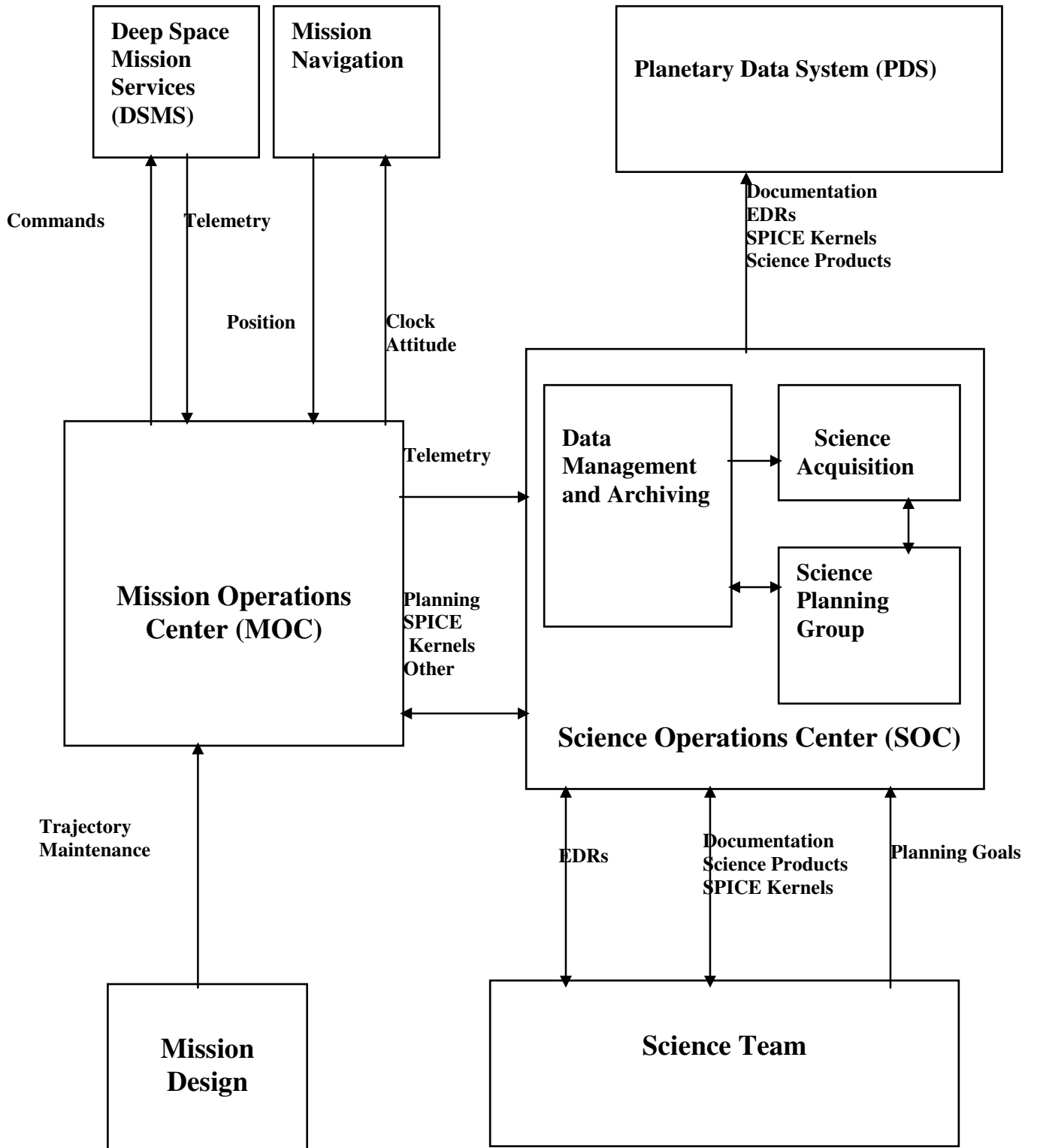


Figure 2 MESSENGER data flow

The MESSENGER SOC will deliver data for the EPPS EDR data volume to the PDS PPI Node in standard product packages. Each package will comprise data and ancillary data files, organized into directory structures consistent with the volume design described in section 6.8. The initial release will also contain the documents and required files for the EPPS documentation volume, organized into directory structures as described in section 6.7. Subsequent releases to the EPPS documentation volume will be at the discretion of the EPPS team and be delivered whenever the EPPS team determines that they have a sufficiently improved calibration to warrant a new release.

The following describes the electronic transfer process of releasing data to PDS for both the data volume and the documentation volume. This process will be implemented for the first PDS delivery. Future data deliveries will be assumed to follow the same process unless otherwise noted in an update of this document. Given the long duration of the mission the project reserves the option of exploring alternate data delivery methods for subsequent deliveries. As such, the method of electronic transfer may change and will be revised accordingly in the SIS. Any changes to the delivery process will be noted in an update to the SIS document and will include the specific dates which will use the new delivery process. The delivery of products to the data volume will follow the schedule in the MESSENGER Data Management and Archiving Plan. The delivery date for updates to the documentation volume will be determined as needed at the discretion of the EPPS team.

In the week prior to the delivery date the directory structure will be compressed into a single "zip archive" file for transmittal to the PDS node. The zip archive preserves the directory structure internally so that it can be recreated after electronic delivery to the PDS node. The zip archive file is transmitted to the PDS node via FTP to an account set up by the receiving node. Also transmitted will be a checksum file created using the MD5 algorithm. This provides an independent method of verifying the integrity of the zip file after it has been sent. Within days of transmittal the PDS node will acknowledge receipt of the archive and checksum file. If acknowledgement is not received, or if problems are reported, the MESSENGER SOC will immediately take corrective action to effect successful transmittal.

After transmittal the PDS node will uncompress the zip archive file and check for data integrity using the checksum file. The node will then perform any additional verification and validation of the data provided and will report any discrepancies or problems to the MESSENGER SOC. It is expected that the node will perform these checks in about two weeks. After inspection has been completed to the satisfaction of the PDS node, the node will issue to the MESSENGER SOC acknowledgement of successful receipt of the data.

Following receipt of a data delivery the PDS node will organize the data into a PDS volume archive structure within its online data system. Newly delivered data will be made available publicly from PDS once accompanying labels and other documentation have been validated.

### 5.3.4 Labeling and Identification

The PDS label conforms to PDS version 3.6 standards. For more information about this standard consult the PDS Standards Reference Document. The label is detached and in a separate PDS label file. The purpose of the PDS label is to describe the data product and provide ancillary information about the data product. There is a PDS label file for every EPPS EDR data file. There is one DATA\_SET\_ID assigned to the EPPS EDR data. The EDRs are further grouped into data products and are identified by the STANDARD\_DATA\_PRODUCT\_ID keyword and the file naming convention, section 6.5. . Example label file content is shown here for every EDR data product. Note that the data is contained within a binary table or ASCII table and the details of the table structure are described by an external ASCII format file (\*.FMT). The fields in each format file are described separately in the Appendix.

#### 5.3.4.1 EPS High Priority Spectra PDS Label

```

PDS_VERSION_ID          = "PDS3"

/**/ FILE FORMAT /**/
FILE_RECORDS            = 287
RECORD_TYPE             = FIXED_LENGTH
RECORD_BYTES           = 1756

/**/ GENERAL DATA DESCRIPTION PARAMETERS /**/
PRODUCT_ID              = "EPSH_S2005134EDR_V1_DAT"
PRODUCT_VERSION_ID     = "V1"
PRODUCT_CREATION_TIME  = 2007-11-12T16:05:31
PRODUCT_TYPE           = "DATA"
STANDARD_DATA_PRODUCT_ID = "EPS_HI_SPECTRA"
SOFTWARE_NAME          = "PIPE-EPPS2EDR"
SOFTWARE_VERSION_ID    = "1.0"
INSTRUMENT_HOST_NAME  = "MESSENGER"
INSTRUMENT_NAME       = "ENERGETIC PARTICLE SPECTROMETER"
INSTRUMENT_ID         = "EPS"
DATA_SET_ID           = "MESS-E/V/H/SW-EPPS-2-EPS-RAWDATA-V1.0"
DATA_SET_NAME = "MESSENGER E/V/H/SW EPPS UNCALIBRATED EPS EDR V1.0"
MISSION_PHASE_NAME    = "EARTH CRUISE"
TARGET_NAME           = "CALIBRATION"
START_TIME            = 2005-05-14T00:04:51
STOP_TIME             = 2005-05-14T23:56:42
SPACECRAFT_CLOCK_START_COUNT = "24516235"
SPACECRAFT_CLOCK_STOP_COUNT = "24602146"
^TABLE                = "EPSH_S2005134EDR_V1.DAT"

OBJECT                  = TABLE
COLUMNS                = 67
INTERCHANGE_FORMAT     = BINARY
ROW_BYTES              = 1756
ROWS                   = 287
DESCRIPTION             = "
    This table contains spectral data collected by the MESSENGER EPS
    instrument in High Priority Mode.
    The complete column definitions are contained in an external file
    found in the LABEL directory of the archive volume.  Additional
    details are contained in the EDR SIS document.
"
^STRUCTURE = "EPSHIGH.FMT"
END_OBJECT              = TABLE
END

```

### 5.3.4.2 EPS High Priority Housekeeping PDS Label

```

PDS_VERSION_ID           = "PDS3"

/** FILE FORMAT */
FILE_RECORDS             = 287
RECORD_TYPE              = FIXED_LENGTH
RECORD_BYTES            = 221

/** GENERAL DATA DESCRIPTION PARAMETERS */
PRODUCT_ID               = "EPSH_H2005134EDR_V1_TAB"
PRODUCT_VERSION_ID       = "V1"
PRODUCT_CREATION_TIME    = 2007-11-12T16:05:40
PRODUCT_TYPE             = "ANCILLARY"
STANDARD_DATA_PRODUCT_ID = "EPS_HI_HOUSEKEEPING"
SOFTWARE_NAME            = "PIPE-EPPS2EDR"
SOFTWARE_VERSION_ID      = "1.0"
INSTRUMENT_HOST_NAME     = "MESSENGER"
INSTRUMENT_NAME          = "ENERGETIC PARTICLE SPECTROMETER"
INSTRUMENT_ID            = "EPS"
DATA_SET_ID              = "MESS-E/V/H/SW-EPPS-2-EPS-RAWDATA-V1.0"
DATA_SET_NAME            = "MESSENGER E/V/H/SW EPPS UNCALIBRATED EPS EDR V1.0"
MISSION_PHASE_NAME       = "EARTH CRUISE"
TARGET_NAME              = "CALIBRATION"
START_TIME               = 2005-05-14T00:04:51
STOP_TIME                 = 2005-05-14T23:56:42
SPACECRAFT_CLOCK_START_COUNT = "24516235"
SPACECRAFT_CLOCK_STOP_COUNT = "24602146"
^TABLE                   = "EPSH_H2005134EDR_V1.TAB"

OBJECT                   = TABLE
COLUMNS                 = 34
INTERCHANGE_FORMAT       = ASCII
ROW_BYTES                = 221
ROWS                     = 287
DESCRIPTION               = "
    This table contains the housekeeping data created by the EPS instrument in
    High Priority Mode. This table is in ASCII format to facilitate the easy
    browsing of instrument parameters.
    The complete column definitions are contained in an external file found in
    the LABEL directory of the archive volume. Additional details are
    contained in the EDR SIS document.
"
^STRUCTURE = "EPSHI_HK.FMT"
END_OBJECT               = TABLE
END

```

### 5.3.4.3 EPS Medium Priority Spectra PDS Label

```

PDS_VERSION_ID           = "PDS3"

/** FILE FORMAT */
FILE_RECORDS             = 2873
RECORD_TYPE              = FIXED_LENGTH
RECORD_BYTES            = 1252

/** GENERAL DATA DESCRIPTION PARAMETERS */
PRODUCT_ID               = "EPSM_S2005134EDR_V1_DAT"
PRODUCT_VERSION_ID       = "V1"
PRODUCT_CREATION_TIME    = 2007-11-12T16:05:49
PRODUCT_TYPE             = "DATA"
STANDARD_DATA_PRODUCT_ID = "EPS_MED_SPECTRA"
SOFTWARE_NAME            = "PIPE-EPPS2EDR"
SOFTWARE_VERSION_ID      = "2.1"
INSTRUMENT_HOST_NAME     = "MESSENGER"
INSTRUMENT_NAME          = "ENERGETIC PARTICLE SPECTROMETER"
INSTRUMENT_ID            = "EPS"

```

```

DATA_SET_ID                = "MESS-E/V/H/SW-EPPS-2-EPS-RAWDATA-V1.0"
DATA_SET_NAME = "MESSENGER E/V/H/SW EPPS UNCALIBRATED EPS EDR V1.0"
MISSION_PHASE_NAME        = "EARTH CRUISE"
TARGET_NAME               = "CALIBRATION"
START_TIME                = 2005-05-14T00:00:09
STOP_TIME                 = 2005-05-14T23:59:31
SPACECRAFT_CLOCK_START_COUNT = "24515953"
SPACECRAFT_CLOCK_STOP_COUNT = "24602315"
^TABLE                    = "EPSM_S2005134EDR_V1.DAT"

OBJECT                     = TABLE
COLUMNS                   = 49
INTERCHANGE_FORMAT        = BINARY
ROW_BYTES                  = 1252
ROWS                       = 2873
DESCRIPTION                = "
    This table contains spectral data collected by the MESSENGER EPS
    instrument in Medium Priority Mode.
    The complete column definitions are contained in an external file
    found in the LABEL directory of the archive volume.  Additional
    details are contained in the EDR SIS document.
"
^STRUCTURE = "EPSMED.FMT"
END_OBJECT                 = TABLE
END

```

#### 5.3.4.4 EPS PHA PDS Label

The format for the EPS High, Medium, Low PHA PDS Labels are identical in terms of the PDS keywords used. In addition, the format of the PHA\_TABLE object is the same for all EPS PHA EDRs. Therefore, only one FORMAT file is used to describe all PHA\_TABLE objects. The file naming convention will distinguish whether the EPS PHA EDR contains high, medium, or low priority PHA data.

After the FSW6 upload, the only packet which may contain EPS PHA events is the EPS PHA packet. There is no longer any association with high, medium or low priority as of FSW6 for EPS PHA EDRs. Section 6.5 File Naming Conventions will explain the designation for N/A priority in the filename.

A sample High Priority PDS label is shown below:

```

PDS_VERSION_ID            = "PDS3"

/**** FILE FORMAT ****/
FILE_RECORDS              = 2870
RECORD_TYPE               = FIXED_LENGTH
RECORD_BYTES              = 36

/**** GENERAL DATA DESCRIPTION PARAMETERS ****/
PRODUCT_ID                = "EPSH_P2005134EDR_V2_DAT"
PRODUCT_VERSION_ID        = "V1"
PRODUCT_CREATION_TIME     = 2008-09-16T17:23:43
PRODUCT_TYPE              = "DATA"
STANDARD_DATA_PRODUCT_ID  = "EPS_PULSE_HEIGHT"
SOFTWARE_NAME              = "PIPE-EPPS2EDR"
SOFTWARE_VERSION_ID       = "2.1"
INSTRUMENT_HOST_NAME      = "MESSENGER"
INSTRUMENT_NAME           = "ENERGETIC PARTICLE SPECTROMETER"
INSTRUMENT_ID             = "EPS"
DATA_SET_ID               = "MESS-E/V/H/SW-EPPS-2-EPS-RAWDATA-V1.0"
DATA_SET_NAME = "MESSENGER E/V/H/SW EPPS UNCALIBRATED EPS EDR V1.0"
MISSION_PHASE_NAME        = "EARTH CRUISE"
TARGET_NAME               = "CALIBRATION"
START_TIME                = 2005-05-14T00:04:51

```

```

STOP_TIME = 2005-05-14T00:04:51
SPACECRAFT_CLOCK_START_COUNT = "24516235"
SPACECRAFT_CLOCK_STOP_COUNT = "24602146"
^TABLE = "EPSH_P2005134EDR_V2.DAT"

OBJECT = TABLE
COLUMNS = 14
INTERCHANGE_FORMAT = BINARY
ROW_BYTES = 36
ROWS = 2870
DESCRIPTION = "
    This table contains the Pulse Height Analysis (PHA) data collected by
    the MESSENGER EPS instrument.
    The complete column definitions are contained in an external file found
    in the LABEL directory of the archive volume. Additional details are
    contained in the EDR SIS document.
"
^STRUCTURE = "EPS_PHA.FMT"
END_OBJECT = TABLE
END

```

### 5.3.4.5 EPS High Resolution Spectra PDS Label

The High Resolution EPS Spectra EDR was created as the result of the FSW6 upload. It stores the high resolution ion and electron spectral data collected by the EPS instrument.

```

PDS_VERSION_ID = "PDS3"

/*** FILE FORMAT ***/
FILE_RECORDS = 96
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 1736

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID = "EPSH_R2008233EDR_V1_DAT"
PRODUCT_VERSION_ID = "V1"
PRODUCT_CREATION_TIME = 2008-09-24T15:57:14
PRODUCT_TYPE = "DATA"
STANDARD_DATA_PRODUCT_ID = "EPS_HIRES_SPECTRA"
SOFTWARE_NAME = "PIPE-EPPS2EDR"
SOFTWARE_VERSION_ID = "2.1"
INSTRUMENT_HOST_NAME = "MESSENGER"
INSTRUMENT_NAME = "ENERGETIC PARTICLE SPECTROMETER"
INSTRUMENT_ID = "EPS"
DATA_SET_ID = "MESS-E/V/H/SW-EPPS-2-EPS-RAWDATA-V1.0"
DATA_SET_NAME = "MESSENGER E/V/H/SW EPPS UNCALIBRATED EPS EDR V1.0"
MISSION_PHASE_NAME = "MERCURY 2 CRUISE"
TARGET_NAME = "CALIBRATION"
START_TIME = 2008-08-20T16:00:21
STOP_TIME = 2008-08-20T23:55:22
SPACECRAFT_CLOCK_START_COUNT = "127735465"
SPACECRAFT_CLOCK_STOP_COUNT = "127763966"
^TABLE = "EPSH_R2008233EDR_V1.DAT"

OBJECT = TABLE
COLUMNS = 15
INTERCHANGE_FORMAT = BINARY
ROW_BYTES = 1736
ROWS = 96
DESCRIPTION = "
    This table contains high-resolution spectra data collected by
    the MESSENGER EPS instrument.
    The complete column definitions are contained in an external file found
    in the LABEL directory of the archive volume. Additional details are
    contained in the EDR SIS document.
"
^STRUCTURE = "EPS_HIRES.FMT"
END_OBJECT = TABLE
END

```

### 5.3.4.6 EPS Low Resolution Spectra PDS Label

The Low Resolution EPS Spectra EDR was created as the result of the FSW6 upload. It stores the low resolution ion and electron spectral data as well as 33 rate counters collected by the EPS instrument.

```

PDS_VERSION_ID          = "PDS3"

/**** FILE FORMAT ****/
FILE_RECORDS            = 29
RECORD_TYPE             = FIXED_LENGTH
RECORD_BYTES           = 1422

/**** GENERAL DATA DESCRIPTION PARAMETERS ****/
PRODUCT_ID              = "EPSL_R2008231EDR_V1_DAT"
PRODUCT_VERSION_ID     = "V1"
PRODUCT_CREATION_TIME   = 2008-09-22T12:00:40
PRODUCT_TYPE           = "DATA"
STANDARD_DATA_PRODUCT_ID = "EPS_LORES_SPECTRA"
SOFTWARE_NAME          = "PIPE-EPPS2EDR"
SOFTWARE_VERSION_ID    = "2.1"
INSTRUMENT_HOST_NAME   = "MESSENGER"
INSTRUMENT_NAME        = "ENERGETIC PARTICLE SPECTROMETER"
INSTRUMENT_ID          = "EPS"
DATA_SET_ID            = "MESS-E/V/H/SW-EPPS-2-EPS-RAWDATA-V1.0"
DATA_SET_NAME          = "MESSENGER E/V/H/SW EPPS UNCALIBRATED EPS EDR V1.0"
MISSION_PHASE_NAME     = "MERCURY 2 CRUISE"
TARGET_NAME            = "CALIBRATION"
START_TIME             = 2008-08-18T23:28:23
STOP_TIME              = 2008-08-18T23:56:23
SPACECRAFT_CLOCK_START_COUNT = "127589546"
SPACECRAFT_CLOCK_STOP_COUNT  = "127591226"
^TABLE                 = "EPSL_R2008231EDR V1.DAT"

OBJECT                  = TABLE
COLUMNS                = 92
INTERCHANGE_FORMAT     = BINARY
ROW_BYTES              = 1422
ROWS                   = 29
DESCRIPTION             = "
    This table contains low-resolution spectra data collected by
    the MESSENGER EPS instrument.
    The complete column definitions are contained in an external file found
    in the LABEL directory of the archive volume. Additional details are
    contained in the EDR SIS document.
"
^STRUCTURE = "EPS_LORES.FMT"
END_OBJECT              = TABLE
END

```

### 5.3.4.7 EPS Summary Spectra PDS Label

The EPS Summary Spectra EDR was created as the result of the FSW6 upload. It contains integrated rates and low resolution spectra collected by the EPS instrument.

```

PDS_VERSION_ID          = "PDS3"

/**** FILE FORMAT ****/
FILE_RECORDS            = 95
RECORD_TYPE             = FIXED_LENGTH
RECORD_BYTES           = 716

/**** GENERAL DATA DESCRIPTION PARAMETERS ****/
PRODUCT_ID              = "EPSS_S2008233EDR_V1_DAT"

```



```

PRODUCT_VERSION_ID           = "V1"
PRODUCT_CREATION_TIME        = 2008-09-24T15:57:25
PRODUCT_TYPE                 = "DATA"
STANDARD_DATA_PRODUCT_ID     = "EPS_SUMMARY_SPECTRA"
SOFTWARE_NAME                 = "PIPE-EPPS2EDR"
SOFTWARE_VERSION_ID          = "2.1"
INSTRUMENT_HOST_NAME         = "MESSENGER"
INSTRUMENT_NAME              = "ENERGETIC PARTICLE SPECTROMETER"
INSTRUMENT_ID                = "EPS"
DATA_SET_ID                  = "MESS-E/V/H/SW-EPPS-2-EPS-RAWDATA-V1.0"
DATA_SET_NAME = "MESSENGER E/V/H/SW EPPS UNCALIBRATED EPS EDR V1.0"
MISSION_PHASE_NAME           = "MERCURY 2 CRUISE"
TARGET_NAME                  = "CALIBRATION"
START_TIME                   = 2008-08-20T16:05:22
STOP_TIME                     = 2008-08-20T23:55:22
SPACECRAFT_CLOCK_START_COUNT = "127735766"
SPACECRAFT_CLOCK_STOP_COUNT  = "127763966"
^TABLE                        = "EPSS_S2008233EDR V1.DAT"

OBJECT                        = TABLE
COLUMNS                      = 48
INTERCHANGE_FORMAT            = BINARY
ROW_BYTES                     = 716
ROWS                           = 95
DESCRIPTION                    = "
    This table contains summary spectra data collected by
    the MESSENGER EPS instrument.
    The complete column definitions are contained in an external file found
    in the LABEL directory of the archive volume. Additional details are
    contained in the EDR SIS document.
"
^STRUCTURE = "EPS_SUM.FMT"
END_OBJECT                      = TABLE
END

```

### 5.3.4.8 EPS Scan PDS Label

The EPS Scan EDR was created as the result of the FSW6 upload. It contains integrated hardware rate for four energy threshold settings. Each threshold setting and integration lasts  $\frac{1}{4}$  second.

```

PDS_VERSION_ID               = "PDS3"

/**** FILE FORMAT ****/
FILE_RECORDS                  = 1
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 388

/**** GENERAL DATA DESCRIPTION PARAMETERS ****/
PRODUCT_ID                    = "EPSS_R2008233EDR_V1_DAT"
PRODUCT_VERSION_ID            = "V1"
PRODUCT_CREATION_TIME         = 2008-09-22T13:00:36
PRODUCT_TYPE                  = "DATA"
STANDARD_DATA_PRODUCT_ID      = "EPS_SCAN_RATES"
SOFTWARE_NAME                  = "PIPE-EPPS2EDR"
SOFTWARE_VERSION_ID           = "2.1"
INSTRUMENT_HOST_NAME          = "MESSENGER"
INSTRUMENT_NAME               = "ENERGETIC PARTICLE SPECTROMETER"
INSTRUMENT_ID                 = "EPS"
DATA_SET_ID                   = "MESS-E/V/H/SW-EPPS-2-EPS-RAWDATA-V1.0"
DATA_SET_NAME = "MESSENGER E/V/H/SW EPPS UNCALIBRATED EPS EDR V1.0"
MISSION_PHASE_NAME            = "MERCURY 2 CRUISE"
TARGET_NAME                   = "CALIBRATION"
START_TIME                     = 2008-08-20T16:05:21
STOP_TIME                      = 2008-08-20T16:05:21
SPACECRAFT_CLOCK_START_COUNT  = "127735765"
SPACECRAFT_CLOCK_STOP_COUNT   = "127735765"
^TABLE                         = "EPSS_R2008233EDR V1.DAT"

OBJECT                        = TABLE

```

```

COLUMNS = 97
INTERCHANGE_FORMAT = BINARY
ROW_BYTES = 388
ROWS = 1
DESCRIPTION = "
    This table contains scan rates collected by the MESSENGER EPS instrument.
    The complete column definitions are contained in an external file found
    in the LABEL directory of the archive volume. Additional details are
    contained in the EDR SIS document.
"
^STRUCTURE = "EPS_SCAN.FMT"
END_OBJECT = TABLE
END

```

The following are example label headers for the FIPS EDR products. As with the EPS EDRs all table structures are defined by external format files. The fields in each format file are defined separately in the Appendix.

### 5.3.4.9 FIPS High Priority Spectra PDS Label

A FSW7 upload was implemented on 8/18/2009 which retired the FIPS High Priority Spectra packet. As a result, the FIPS High Priority Spectra EDR is no longer generated on or after 8/18/2009.

```

PDS_VERSION_ID = "PDS3"

/**** FILE FORMAT ****/
FILE_RECORDS = 149
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 4614

/**** GENERAL DATA DESCRIPTION PARAMETERS ****/
PRODUCT_ID = "FIPH_S2005214EDR_V2_DAT"
PRODUCT_VERSION_ID = "V2"
PRODUCT_CREATION_TIME = 2008-02-22T17:35:53
PRODUCT_TYPE = "DATA"
STANDARD_DATA_PRODUCT_ID = "FIPS_HI_SPECTRA"
SOFTWARE_NAME = "PIPE-EPPS2EDR"
SOFTWARE_VERSION_ID = "2.1"
INSTRUMENT_HOST_NAME = "MESSENGER"
INSTRUMENT_NAME = "FAST IMAGING PLASMA SPECTROMETER"
INSTRUMENT_ID = "FIPS"
DATA_SET_ID = "MESS-E/V/H/SW-EPPS-2-FIPS-RAWDATA-V1.0"
DATA_SET_NAME = "MESSENGER E/V/H/SW EPPS UNCALIBRATED FIPS EDR V1.0"
MISSION_PHASE_NAME = "EARTH FLYBY"
TARGET_NAME = "EARTH"
START_TIME = 2005-08-02T00:00:55
STOP_TIME = 2005-08-02T23:53:36
SPACECRAFT_CLOCK_START_COUNT = "31427999"
SPACECRAFT_CLOCK_STOP_COUNT = "31513960"
^TABLE = "FIPH_S2005214EDR_V2.DAT"

OBJECT = TABLE
COLUMNS = 19
INTERCHANGE_FORMAT = BINARY
ROW_BYTES = 4614
ROWS = 149
DESCRIPTION = "
    This table contains the following data gathered by the Fast Imaging
    Plasma Spectrometer (FIPS) in HIGH priority mode:
        -Proton velocity distribution
    The table also contains hardware and software rate counts accumulated
    over each separate observation.
    The complete column definitions are contained in an external file
    found in the LABEL directory of the archive volume. Additional

```

```

        details are contained in the EDR SIS document.
"
^STRUCTURE = "FIPS_HI.FMT"
END_OBJECT           = TABLE
END

```

### 5.3.4.10 FIPS High Priority Housekeeping PDS Label

A FSW5 upload was implemented on 9/6/2007. The upload moved the housekeeping data from the FIPS High Priority packet to the EPPS Long Status packet. As a result, the FIPS Housekeeping EDR is no longer generated on or after 9/6/2007.

```

PDS_VERSION_ID           = "PDS3"

/**/ FILE FORMAT /**/
FILE_RECORDS             = 149
RECORD_TYPE              = FIXED_LENGTH
RECORD_BYTES            = 216

/**/ GENERAL DATA DESCRIPTION PARAMETERS /**/
PRODUCT_ID               = "FIPH_H2005214EDR_V2_TAB"
PRODUCT_VERSION_ID      = "V2"
PRODUCT_CREATION_TIME   = 2008-02-22T17:35:53
PRODUCT_TYPE            = "ANCILLARY"
STANDARD_DATA_PRODUCT_ID = "FIPS_HI_HOUSEKEEPING"
SOFTWARE_NAME           = "PIPE-EPPS2EDR"
SOFTWARE_VERSION_ID     = "2.0"
INSTRUMENT_HOST_NAME    = "MESSENGER"
INSTRUMENT_NAME        = "FAST IMAGING PLASMA SPECTROMETER"
INSTRUMENT_ID          = "FIPS"
DATA_SET_ID             = "MESS-E/V/H/SW-EPPS-2-FIPS-RAWDATA-V1.0"
DATA_SET_NAME = "MESSENGER E/V/H/SW EPPS UNCALIBRATED FIPS EDR V1.0"
MISSION_PHASE_NAME      = "EARTH FLYBY"
TARGET_NAME             = "EARTH"
START_TIME              = 2005-08-02T00:00:55
STOP_TIME               = 2005-08-02T23:53:36
SPACECRAFT_CLOCK_START_COUNT = "31427999"
SPACECRAFT_CLOCK_STOP_COUNT = "31513960"
^TABLE                  = "FIPH_H2005214EDR_V2.TAB"

OBJECT                   = TABLE
COLUMNS                 = 32
INTERCHANGE_FORMAT      = ASCII
ROW_BYTES               = 216
ROWS                    = 149
DESCRIPTION              = "
        This table contains the housekeeping data created by the FIPS instrument in
        HIGH Priority Mode. The complete column definitions are contained in an
        external file found in the LABEL directory of the archive volume.
        Additional details are contained in the EDR SIS document.
"
^STRUCTURE = "FIPS_HK.FMT"
END_OBJECT           = TABLE
END

```

### 5.3.4.11 FIPS Medium Priority PDS Label

A FSW6 upload was implemented on 8/19/2008. The upload retired the Medium Priority packet and split the contents into two new packets. As a result, the Medium Priority EDR is no longer created after 8/19/2008. Data from the two new packets are contained in the FIPS Scan and FIPS Hi-Res Proton Velocity Distribution EDRs.

```

PDS_VERSION_ID           = "PDS3"

```

```

/**** FILE FORMAT ****/
FILE_RECORDS           = 1337
RECORD_TYPE           = FIXED_LENGTH
RECORD_BYTES          = 1542

/**** GENERAL DATA DESCRIPTION PARAMETERS ****/
PRODUCT_ID            = "FIPM_S2005214EDR_V2_DAT"
PRODUCT_VERSION_ID    = "V2"
PRODUCT_CREATION_TIME = 2008-02-23T00:35:23
PRODUCT_TYPE          = "DATA"
STANDARD_DATA_PRODUCT_ID = "FIPS_MED_SPECTRA"
SOFTWARE_NAME          = "PIPE-EPPS2EDR"
SOFTWARE_VERSION_ID   = "2.0"
INSTRUMENT_HOST_NAME  = "MESSENGER"
INSTRUMENT_NAME       = "FAST IMAGING PLASMA SPECTROMETER"
INSTRUMENT_ID         = "FIPS"
DATA_SET_ID           = "MESS-E/V/H/SW-EPPS-2-FIPS-RAWDATA-V1.0"
DATA_SET_NAME         = "MESSENGER E/V/H/SW EPPS UNCALIBRATED FIPS EDR V1.0"
MISSION_PHASE_NAME    = "EARTH FLYBY"
TARGET_NAME           = "EARTH"
START_TIME            = 2005-08-02T00:01:53
STOP_TIME             = 2005-08-02T23:59:24
SPACECRAFT_CLOCK_START_COUNT = "31428057"
SPACECRAFT_CLOCK_STOP_COUNT = "31514308"
^TABLE                = "FIPM_S2005214EDR_V2.DAT"

OBJECT                = TABLE
COLUMNS              = 8
INTERCHANGE_FORMAT    = BINARY
ROW_BYTES             = 1542
ROWS                  = 1337
DESCRIPTION            = "
    This table contains the following data gathered by the Fast Imaging
    Plasma Spectrometer (FIPS) in MEDIUM priority mode:
    -Proton velocity distribution
    The table also contains hardware and software rate counts accumulated
    over each separate observation.
    The complete column definitions are contained in an external file
    found in the LABEL directory of the archive volume.  Additional
    details are contained in the EDR SIS document.
"
^STRUCTURE = "FIPS_MED.FMT"
END_OBJECT          = TABLE
END

```

### 5.3.4.12 FIPS PHA PDS Label

The format for the FIPS High, Medium, Low PHA PDS Labels are identical in terms of the PDS keywords used. In addition, the format of the PHA\_TABLE object is the same for all FIPS PHA EDRs. Therefore, only one FORMAT file is used to describe all PHA\_TABLE objects. The file naming convention will distinguish whether the FIPS PHA EDR contains high, medium, or low priority PHA data.

After the FSW6 upload, the only packets which may contain PHA events are the high priority, low priority, and scan packets (medium priority packets being retired). The file naming convention will distinguish whether the FIPS PHA EDR contains PHA events extracted from high or low priority, or scan packets. This is detailed in Section 6.5.

After the FSW7 upload, the only packets which may contain PHA events are the Heavy Ion packet and Proton packet (Scan and Low Priority packets being retired). Because of

this the PHA file naming convention is simplified to show the year, day of year, and the fact that the file contains PHA events. This is detailed in Section 6.5.

A sample FSW7 PDS label is shown below:

```

PDS_VERSION_ID          = "PDS3"

/** FILE FORMAT **/
FILE_RECORDS            = 171488
RECORD_TYPE             = FIXED_LENGTH
RECORD_BYTES           = 38

/** GENERAL DATA DESCRIPTION PARAMETERS **/
PRODUCT_ID              = "FIPP_P2009274EDR_V1_DAT"
PRODUCT_VERSION_ID      = "V1"
PRODUCT_CREATION_TIME   = 2009-10-02T11:57:24
PRODUCT_TYPE            = "DATA"
STANDARD_DATA_PRODUCT_ID = "FIPS_PULSE_HEIGHT"
SOFTWARE_NAME           = "PIPE-EPPS2EDR"
SOFTWARE_VERSION_ID     = "2.1"
INSTRUMENT_HOST_NAME    = "MESSENGER"
INSTRUMENT_NAME         = "ENERGETIC PARTICLE AND PLASMA SPECTROMETER"
INSTRUMENT_ID           = "EPPS"
DATA_SET_ID             = "MESS-E/V/H/SW-EPPS-2-FIPS-RAWDATA-V2.0"
DATA_SET_NAME           = "MESSENGER E/V/H/SW EPPS UNCALIBRATED FIPS EDR V2.0"
MISSION_PHASE_NAME      = "MERCURY 3 FLYBY"
TARGET_NAME             = "MERCURY"
START_TIME              = 2009-10-01T19:10:49
STOP_TIME               = 2009-10-01T23:59:28
SPACECRAFT_CLOCK_START_COUNT = "162911715"
SPACECRAFT_CLOCK_STOP_COUNT = "162929034"
^TABLE                  = "FIPP_P2009274EDR_V1.DAT"

OBJECT                  = TABLE
COLUMNS                = 10
INTERCHANGE_FORMAT      = BINARY
ROW_BYTES               = 38
ROWS                    = 171488
DESCRIPTION              = "
    This table contains the Pulse Height Analysis (PHA) data collected by
    the MESSENGER Fast Imaging Plasma Spectrometer (FIPS).
    The complete column definitions are contained in an external file found
    in the LABEL directory of the archive volume. Additional details are
    contained in the EDR SIS document.
"
^STRUCTURE = "FIPS_PHA.FMT"
END_OBJECT              = TABLE
END

```

### 5.3.4.13 FIPS Scan PDS Label

The FIPS Scan EDR was created as the result of the FSW6 upload. It contains FIPS rate counters sampled at each DSHV step in a scan. This EDR has been retired as a result of the FSW7 upload on 8/18/2009 and is no longer generated on or after that date.

```

PDS_VERSION_ID          = "PDS3"

/** FILE FORMAT **/
FILE_RECORDS            = 387
RECORD_TYPE             = FIXED_LENGTH
RECORD_BYTES           = 1286

/** GENERAL DATA DESCRIPTION PARAMETERS **/
PRODUCT_ID              = "FIPS_R2008233EDR_V1_DAT"

```

```

PRODUCT_VERSION_ID           = "V1"
PRODUCT_CREATION_TIME        = 2008-09-22T13:00:23
PRODUCT_TYPE                 = "DATA"
STANDARD_DATA_PRODUCT_ID     = "FIPS_SCAN"
SOFTWARE_NAME                 = "PIPE-EPPS2EDR"
SOFTWARE_VERSION_ID          = "2.1"
INSTRUMENT_HOST_NAME         = "MESSENGER"
INSTRUMENT_NAME              = "FAST IMAGING PLASMA SPECTROMETER"
INSTRUMENT_ID                = "FIPS"
DATA_SET_ID                  = "MESS-E/V/H/SW-EPPS-2-FIPS-RAWDATA-V1.0"
DATA_SET_NAME = "MESSENGER E/V/H/SW EPPS UNCALIBRATED FIPS EDR V1.0"
MISSION_PHASE_NAME           = "MERCURY 2 CRUISE"
TARGET_NAME                  = "CALIBRATION"
START_TIME                   = 2008-08-20T16:02:28
STOP_TIME                     = 2008-08-20T23:59:13
SPACECRAFT_CLOCK_START_COUNT = "127735592"
SPACECRAFT_CLOCK_STOP_COUNT  = "127764197"
^TABLE                        = "FIPS_R2008233EDR V1.DAT"

OBJECT                        = TABLE
COLUMNS                      = 7
INTERCHANGE_FORMAT            = BINARY
ROW_BYTES                     = 1286
ROWS                           = 387
DESCRIPTION                    = "
    This table contains the FIPS rate counts gathered by the Fast Imaging Plasma
    Spectrometer (FIPS) accumulated over each separate observation.
    The complete column definitions are contained in an external file found
    in the LABEL directory of the archive volume. Additional details are
    contained in the EDR SIS document.
"
^STRUCTURE = "FIPS_SCAN.FMT"
END_OBJECT                      = TABLE
END

```

#### **5.3.4.14 FIPS High Resolution Proton Velocity Distribution (HRPVD) PDS Label**

The FIPS HRPVD EDR was created as the result of the FSW6 upload. It contains a 32 x 32 high resolution proton velocity distribution, integrated over a 10 scan sequence. This EDR has been retired as a result of the FSW7 upload on 8/18/2009 and is no longer generated on or after that date.

```

PDS_VERSION_ID               = "PDS3"

/*** FILE FORMAT ***/
FILE_RECORDS                  = 42
RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 4118

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID                    = "FIPS_V2008233EDR_V1_DAT"
PRODUCT_VERSION_ID            = "V1"
PRODUCT_CREATION_TIME         = 2008-09-22T13:00:26
PRODUCT_TYPE                   = "DATA"
STANDARD_DATA_PRODUCT_ID      = "FIPS_HIRES_PROTON_V"
SOFTWARE_NAME                  = "PIPE-EPPS2EDR"
SOFTWARE_VERSION_ID           = "2.1"
INSTRUMENT_HOST_NAME          = "MESSENGER"
INSTRUMENT_NAME                = "FAST IMAGING PLASMA SPECTROMETER"
INSTRUMENT_ID                 = "FIPS"
DATA_SET_ID                    = "MESS-E/V/H/SW-EPPS-2-FIPS-RAWDATA-V1.0"
DATA_SET_NAME = "MESSENGER E/V/H/SW EPPS UNCALIBRATED FIPS EDR V1.0"
MISSION_PHASE_NAME            = "MERCURY 2 CRUISE"
TARGET_NAME                    = "CALIBRATION"
START_TIME                     = 2008-08-20T16:12:30
STOP_TIME                       = 2008-08-20T23:49:12
SPACECRAFT_CLOCK_START_COUNT   = "127736194"
SPACECRAFT_CLOCK_STOP_COUNT    = "127763596"
^TABLE                          = "FIPS_V2008233EDR V1.DAT"

```

```

OBJECT = TABLE
COLUMNS = 38
INTERCHANGE_FORMAT = BINARY
ROW_BYTES = 4118
ROWS = 42
DESCRIPTION = "
    This table contains the high-resolution proton velocity distributions gathered
    by the Fast Imaging Plasma Spectrometer (FIPS) collected over a 10-scan sequence.
    The complete column definitions are contained in an external file found
    in the LABEL directory of the archive volume. Additional details are
    contained in the EDR SIS document.
"
^STRUCTURE = "FIPS_HRPVD.FMT"
END_OBJECT = TABLE
END

```

### 5.3.4.15 EPPS Status PDS Label

The EPPS Status EDR contains the engineering and status data for the EPPS instrument. This EDR is no longer generated on or after 9/6/2007 due to the FSW5 upload; instead use the EPPS\_LONG\_STATUS EDR for data on or after 9/6/2007. The content of the EPPS Status label is shown below:

```

PDS_VERSION_ID = "PDS3"

/**** FILE FORMAT ****/
FILE_RECORDS = 8640
RECORD_TYPE = "FIXED_LENGTH"
RECORD_BYTES = 356

/**** GENERAL DATA DESCRIPTION PARAMETERS ****/
PRODUCT_ID = "EPPS2005121EDR_TAB"
PRODUCT_VERSION_ID = "V1"
PRODUCT_CREATION_TIME = 2006-01-11T14:31:46
PRODUCT_TYPE = "EDR"
STANDARD_DATA_PRODUCT_ID = "EPPS_STATUS"
SOFTWARE_NAME = "PIPE-EPPS2EDR"
SOFTWARE_VERSION_ID = "1.0"
MD5_CHECKSUM = "abc123abc123abc123abc123"
INSTRUMENT_HOST_NAME = "MESSENGER"
INSTRUMENT_NAME = "ENERGETIC PARTICLE AND PLASMA SPECTROMETER"
INSTRUMENT_ID = "EPPS"
DATA_SET_ID = "MESS-EDR-EPPS-STATUS-2-CRUISE-V1.0"
DATA_SET_ID =
    {"MESS-E/V/H/SW-EPPS-2-EPS-RAWDATA-V1.0",
     "MESS-E/V/H/SW-EPPS-2-FIPS-RAWDATA-V1.0"}
MISSION_PHASE_NAME = "EARTH CRUISE"
TARGET_NAME = "CALIBRATION"
START_TIME = 2005-05-01T00:00:02
STOP_TIME = 2005-05-01T23:59:52
SPACECRAFT_CLOCK_START_COUNT = "23392746"
SPACECRAFT_CLOCK_STOP_COUNT = "23479136"
^TABLE = "EPPS2005121EDR_V1.TAB"

OBJECT = TABLE
COLUMNS = 55
INTERCHANGE_FORMAT = BINARY
ROW_BYTES = 356
ROWS = 8640
DESCRIPTION = "
    This table contains housekeeping and status data collected by the
    MESSENGER EPPS instrument.
    The complete column definitions are contained in an external file
    found in the LABEL directory of the archive volume. Additional
    details are contained in the EDR SIS document.
"

```

```

^STRUCTURE = "EPPS_STATUS.FMT"
END_OBJECT      = TABLE
END

```

### 5.3.4.16 EPPS Long Status PDS Label

The EPPS\_LONG\_STATUS EDR contains the engineering and status data for the EPPS instrument as generated by the flight software on and after 9/6/2007 due to the FSW5 upload. The additional columns store housekeeping data that was previously recorded in the EPS/FIPS High Priority Housekeeping EDRs.

```

PDS_VERSION_ID      = "PDS3"

/**** FILE FORMAT ****/
FILE_RECORDS        = 21
RECORD_TYPE         = FIXED_LENGTH
RECORD_BYTES        = 550

/**** GENERAL DATA DESCRIPTION PARAMETERS ****/
PRODUCT_ID          = "ELONG2007348EDR_V1_TAB"
PRODUCT_VERSION_ID  = "V1"
PRODUCT_CREATION_TIME = 2007-12-20T10:00:38
PRODUCT_TYPE        = "ANCILLARY"
STANDARD_DATA_PRODUCT_ID = "EPPS_LONG_STATUS"
SOFTWARE_NAME        = "PIPE-EPPS2EDR"
SOFTWARE_VERSION_ID  = "2.1"
INSTRUMENT_HOST_NAME = "MESSENGER"
INSTRUMENT_NAME      = "ENERGETIC PARTICLE AND PLASMA SPECTROMETER"
INSTRUMENT_ID        = "EPPS"
DATA_SET_ID          =
{ "MESS-E/V/H/SW-EPPS-2-EPS-RAWDATA-V1.0",
  "MESS-E/V/H/SW-EPPS-2-FIPS-RAWDATA-V1.0" }
MISSION_PHASE_NAME   = "MERCURY 1 CRUISE"
TARGET_NAME          = "CALIBRATION"
START_TIME           = 2007-12-14T17:43:38
STOP_TIME            = 2007-12-14T23:43:02
SPACECRAFT_CLOCK_START_COUNT = "106141597"
SPACECRAFT_CLOCK_STOP_COUNT = "106163161"
^TABLE              = "ELONG2007348EDR_V1.TAB"

OBJECT              = TABLE
COLUMNS            = 103
INTERCHANGE_FORMAT  = ASCII
ROW_BYTES           = 550
ROWS                = 21
DESCRIPTION         = "
    This table contains housekeeping and status data collected by the
    MESSENGER EPPS instrument. This EDR is the result of the EPPS
    Flight Software v5 upload in which the updated status packet
    contains additional housekeeping values.
    The complete column definitions are contained in an external file
    found in the LABEL directory of the archive volume. Additional
    details are contained in the EDR SIS document.
"
^STRUCTURE = "EPPS_LONG.FMT"
END_OBJECT      = TABLE
END

```

## 5.4 *Standards Used in Generating Data Products*



#### 5.4.1 PDS Standards

The EPPS EDR data products are constructed according to the data object concepts developed by the PDS. By adopting the PDS format, the data products are consistent in content and organization with other planetary data collections. In the PDS standard, the EDR data file is grouped into objects with PDS labels describing the objects. Each EDR data product consists of two files:

- A data file containing an ASCII or binary table object (the primary data), in fixed field format.
- A label file which serves as a high-level description of the parameters of which correspond to the data file. The label file contains a pointer to an external format file which details the structure of the table object in the data file.

#### 5.4.2 Time Standards

The time fields in the EPPS table objects reference the Mission Elapsed Time (MET). This MET is the spacecraft time in integer seconds that is transmitted to MESSENGER subsystems by the Integrated Electronics Module (IEM). This is referred to by the MESSENGER project as Mission Elapsed Time (MET). MET = 0 is August 3, 2004, at 05:59:16 UTC, which is 1000 seconds prior to the MESSENGER launch. Relativistic effects and circumstances occurring during the mission would result in MET not being a true account of seconds since launch. Following a planned spacecraft clock reset<sup>1</sup> on January 8, 2013, partition numbers (1/, or 2/) were added to product labels to disambiguate MET seconds after the spacecraft clock reset (if partition number is not present, SPICE defaults to partition 1/). For this reason the MESSENGER spacecraft clock coefficients file is archived at the PDS Navigation and Ancillary Information Facility (NAIF) Node. This file is used in conjunction with the leapseconds kernel file in order to calculate the conversion between MET and UTC.

The conversion is easily done through the use of SPICE kernels and the CHRONOS Utility. CHRONOS is a utility included with the SPICE package that is distributed by the PDS NAIF node. The SPICE kernels are files that contain the information needed to perform the conversion. Two SPICE kernels are required. One is the Leapseconds Kernel (LSK) and the other is the MESSENGER Spacecraft Clock Kernel (SCLK). The SCLK file is used by CHRONOS to convert between spacecraft clock time and ephemeris time, while the LSK file is used to convert from ephemeris time to UTC time. The CHRONOS utility is self-documenting and the SPICE package itself contains full documentation on each of the utilities (including CHRONOS) and how they are used.

#### 5.4.3 Coordinate Systems

Table 10 lists the computational assumptions for the geometric and viewing data provided in the PDS label. There are two coordinate systems in use: 1) the celestial reference system used for target and spacecraft position and velocity vectors; and 2) the planetary coordinate system for geometry vectors and target location. The celestial

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<sup>1</sup> See instrument host catalog file in EPPS document volume for more information on MESSENGER spacecraft clock reset.

coordinate system is J2000 (Mean of Earth equator and equinox of J2000). The planetary coordinate system is **planetocentric**.

Different time series data products will be provided corresponding to different coordinate systems. These include: inertial celestial (e.g. J2000), Mercury centered body fixed, Mercury centered magnetospheric, Mercury centered solar wind, and solar orbital (appropriate for cruise). The detailed definition of magnetospheric coordinates depend on the orientation of the Hermetian magnetic dipole and will therefore be updated during the mission.”

### **Table 11 Computational Assumptions**

- <> The mid-point time of observation is used for the geometric element computations.
- <> Label parameters reflect observed, not true, geometry. Therefore, light-time and stellar aberration corrections are used as appropriate.
- <> The inertial reference frame is J2000 (also called EME2000).
- <> Latitudes and longitudes are planetocentric.
- <> The "sub-point" of a body on a target is defined by the surface intercept of the body-to-target-center vector. This is not the closest point on the body to the observer.
- <> Distances are in km, speeds in km/sec, angles, in degrees, angular rates in degrees/sec, unless otherwise noted.
- <> Angle ranges are 0 to 360 degrees for azimuths and local hour angle. Longitudes range from 0 to 360 degrees (positive to the East). Latitudes range from -90 to 90 degrees.

#### *5.4.4 Data Storage Conventions*

The data are organized following PDS standards and stored on hard disk and an SQL (Structured Query Language) relational database for rapid access during mission operations. The MESSENGER SOC will transfer data to PDS via electronic transfer and delivery methods as detailed in section 5.3.3. After verification of the data transfer PDS will provide public access to MESSENGER science data products through its online data distribution system.

### **5.5 Data Validation**

The EPPS EDR data archive volume set will include all data acquired during the MESSENGER mission. The archive validation procedure described in this section applies to data products generated during all post launch phases of the mission. To be clear, there is one and only one documentation volume and one and only one EPPS EDR data archive volume created over the whole mission. Initial releases of both volumes will occur during the first EDR delivery date as stated in the schedule in the MESSENGER

Data Management and Archiving Plan. Updates to the data volume will occur according to the same schedule. Updates to the documentation volume will occur at the discretion of the EPPS team.

PDS standards recommend that all data included in the formal archive be validated through a peer-review process. This process is designed to ensure that both the data and documentation are of sufficient quality to be useful to future generations of scientists. The schedule of PDS data deliveries, however, necessitate some modification of the normal PDS review process since it is impractical to convene a review panel to examine the archive volume for every PDS data delivery. The following describes the modified validation process. The process is presented as several steps, most of which occur in the PDS peer review. This peer review is conducted before any volumes are produced and released to PDS.

The peer review panel consists of members of the EPPS team, members of ACT, the PPI node of PDS, and at least one outside scientist actively working in the field of energetic particles research. The PDS personnel are responsible for validating that the volumes are fully compliant with PDS standards. The instrument team, ACT, and outside reviewer(s) are responsible for verifying the content of the data set, the completeness of the documentation, and the usability of the data in its archive format.

The peer review will validate the documentation and data archive volumes via a two step process. First the panel reviews this document and verifies that the volumes and EDRs produced to this specification will be useful. Next the panel reviews the initial release of the data and documentation volumes to verify that the volumes meet this specification and are acceptable. Once automated production begins, software provided by ACT produce a summary of each data product and software provided by the PPI node verifies that all the files required by PDS are present and the files themselves conform to PDS standards. If an error is detected by either of the above programs, the error is corrected, if possible, before the update to the volume is delivered. Otherwise the correction will occur at the next scheduled delivery date. If an error in a data file is uncorrectable, (i.e. an error in the downlink data file) the error is described in the cumulative errata file that is included in the data archive volume.

The peer review will also validate the EPPS EDR data in a two step process. The first step consists of reviewing a sample data set for compliance with the PDS standards. The sample data set is delivered and reviewed in conjunction with delivery and review of this SIS document. The second step is examination of the data to ensure usability and completeness. The PDS personnel will be responsible for validating that the EDR data set is fully compliant with PDS standards. The instrument team, ACT, and the outside science reviewer(s) will be responsible for verifying the content of the data set, the completeness of the documentation, and the usability of the data in its archive format.

Any deficiencies in the archive data or documentation volumes will be recorded as liens against the product by the review panel. The sample data set is created using software provided by ACT. Once the sample data is validated, and all liens placed against the product or product generation software are resolved, the same software will be used to generate subsequent data products in an automated fashion.

Once automated production begins, the data file content will be spot checked by members of the EPPS team. “Quick look” products generated by software provided by ACT and the EPPS team will be produced routinely and examined by members of the team. In addition, the data will be actively used by team members to perform their analysis. Any discrepancies in the data noted during these activities will be investigated. If the discrepancy is a data error, the response will depend on the source of the error. If the error is in the software producing the data product, the error will be corrected and the data affected will be reproduced, replacing the data file. If there is a correctable error in a data file, the file will be replaced. If an error in a data file is uncorrectable, the error will be described in the cumulative errata file included in the archive volume. The structure of data files and labels will be spot checked by the PPI node for compliance with PDS standards and this SIS.

## **6 Detailed Data Product Specification**

### ***6.1 Data Product Structure and Organization***

The MESSENGER EPPS EDR data products will be archived at the PDS PPI Node. The EDR data set in the data archive volume is intended to store the data in a form closest to the raw telemetry data received from the spacecraft. The automated production and release of EDRs lends itself to the regular release schedule outlined in the MESSENGER Data Management and Archiving Plan. If errors are discovered the data will be replaced with corrected EDRs on the next scheduled delivery date.

Calibration tables and calibration procedures will be required to properly analyze EDRs. These ancillary data will be archived at the PDS PPI Node as part of the EPPS documentation volume. The documentation volume will also be referenced by the EPPS RDR data archive volume. The documentation volume will therefore include both the EPPS EDR SIS and the EPPS RDR SIS in addition to the calibration tables, calibration procedures, and other documents applicable to either data archive volume. A first release of the EPPS documentation volume will accompany the initial release of the EPPS EDR data archive. The initial release of the documentation volume will only contain EDR level documentation and the parameters derived from the ground calibration tests. After the initial release there will be updates whenever the EPPS team determines that they have a sufficiently improved calibration to warrant a new release.

### ***6.2 Handling Errors***

The possibility exists that errors may be introduced into the archive even with validation procedures applied to the archive volumes. An ERRATA report file is maintained to track and document all discovered uncorrectable errors that may occur during the mission. Correctable errors, such as revised EDRs or EDRs that were missing from a previous PDS delivery will be provided at the next scheduled PDS delivery or at the final delivery date (schedule in the MESSENGER Data Management and Archiving Plan). PDS will then replace the outdated files with the revised EDR files in the data directories of the

archive volume. The ERRATA report file is archived in the ROOT directory of the EPPS EDR data volume.

### ***6.3 Data Format Description***

Data is stored in ASCII table format or in binary table format . A detached PDS label file will provide a detailed description of the structure of each table. See section 5.2 for details on which data product contains a binary table or an ASCII table.

### ***6.4 Label and Header Descriptions***

The following are the keyword definitions for the detached PDS label file, which accompanies the instrument data file. The detached PDS label file has the same name as the data file it describes, except for the extension .LBL to distinguish it as a label file.

#### **PDS\_VERSION\_ID**

Represents the version number of the PDS standards documents that is valid when a data product label is created. PDS3 is used for the MESSENGER data products.

#### **FILE\_RECORDS**

Indicates the number of physical file records, including both label records and data records.

#### **RECORD\_TYPE**

Indicates the record format of a file. Note: In the PDS, when record\_type is used in a detached label file it always describes its corresponding detached data file, not the label file itself. The use of record\_type along with other file-related data elements is fully described in the PDS Standards Reference.

#### **RECORD\_BYTES**

Indicates the number of bytes in a physical file record, including record terminators and separators. Note: In the PDS, the use of record\_bytes, along with other file-related data elements is fully described in the Standards Reference.

#### **PRODUCT\_ID**

Represents a permanent, unique identifier assigned to a data product by its producer.

#### **PRODUCT\_CREATION\_TIME**

Defines the UTC system format time when a product was created.

#### **PRODUCT\_VERSION\_ID**

Identifies the version of an individual product within a data set.

Example: 1.0, 2.0, 3.0.

Product\_version\_id will be incremented if a given EDR has to be regenerated and sent to PDS to replace a previously submitted EDR.

#### **PRODUCT\_TYPE**

Identifies the type or category of a product within a data set.

#### **PRODUCT\_TYPE**

Identifies the type or category of a product within a data set.

#### **STANDARD\_DATA\_PRODUCT\_ID**

Used to link an EPPS EDR file to one of the 9 types of EPPS data products defined within the EPPS EDR SIS.

**SOFTWARE\_NAME**

Identifies the data processing software used to convert from spacecraft telemetry into EDR products.

**SOFTWARE\_VERSION\_ID**

Indicates the version of the data processing software used to generate the EDR products from the spacecraft telemetry.

**MD5\_CHECKSUM**

Used to verify the successful electronic transfer of the EDR from the SOC to the PDS-PPI Node.

**INSTRUMENT\_HOST\_NAME**

The full name of the host on which an instrument is based. In this case it is the MESSENGER spacecraft.

**INSTRUMENT\_NAME**

Provides the full name of the instrument.

**INSTRUMENT\_ID**

Provides an abbreviated name or acronym which identifies an instrument.

**DATA\_SET\_ID**

The data\_set\_id element is a unique alphanumeric identifier for a data set or a data product. The data\_set\_id value for a given data set or product is constructed according to flight project naming conventions. There is only one data\_set\_id for the EPPS EDRs.

**MISSION\_PHASE\_NAME**

Provides the commonly used identifier of a mission phase.

**TARGET\_NAME**

The target\_name element identifies a target. The target may be a planet, satellite,ring,region, feature, asteroid or comet.

**START\_TIME**

Provides the date and time of the beginning of an event or observation (whether it be a spacecraft, ground-based, or system event) in UTC system format.

**STOP\_TIME**

Provides the date and time of the end of an observation or event (whether it be a spacecraft, ground-based, or system event) in UTC system format.

**SPACECRAFT\_CLOCK\_START\_COUNT**

Provides the value of the spacecraft clock at the beginning of a time period of interest.

**SPACECRAFT\_CLOCK\_STOP\_COUNT**

Provides the value of the spacecraft clock at the end of a time period of interest.

**^TABLE**

Pointer to the EDR file which contains the data in BINARY table format. The structure of the data file is defined in a referenced format file.

**OBJECT**

Specifies that the EDR is a PDS TABLE object. This object contains its own elements, which are defined below. NOTE: the end of the object definition is always marked with an END\_OBJECT line.

**COLUMNS**

Identifies the number of columns (fields) in the table.

**INTERCHANGE\_FORMAT**

This element specifies that the table is in binary format.

**ROW\_BYTES**

Specifies the number of bytes for each row in the table.

**ROWS**

Identifies the number of rows (records) in the table.

**^STRUCTURE**

This is a pointer to the external file which provides the structure definition for the table object.

The following describes the keywords used to describe the PDS Table Object. These keywords are contained in the FORMAT (.FMT) files for each EDR data product.

**COLUMN\_NUMBER**

Identifies the location of the column within the larger data object (such as a table). For tables consisting of rows ( $I = 1, N$ ) and columns ( $j = 1, M$ ) the column\_number is the  $j$ -th index of any row.

**NAME**

Indicates a literal value representing the common term used to identify an element or object. NOTE: in the PDS data dictionary, name is restricted to 30 characters and must conform to PDS nomenclature standards.

**BYTES**

Specifies the number of bytes allocated for this particular column element.

**DATA\_TYPE**

Specifies the internal representation and/or mathematical properties of the value being stored in this column.

**START\_BYTE**

Identifies the location of the first byte of the particular column, counting from 1.

**ITEMS**

Defines the number of multiple, identical occurrences of a single object. Used mainly in columns containing spectral or histogram data.

**ITEM\_BYTES**

The size in bytes of individual items in a column.  $ITEMS * ITEM\_BYTES$  should equal the value in the BYTES column.

The format file will contain the full text for describing each column of the table. See Appendices for a listing of each field in the individual format files.

## 6.5 File Naming Conventions

The file names developed for PDS data volumes are restricted to a maximum 36 character file name and a 3 character extension name with a period separating the file and extension names. The general form of the EPPS file name for all EDRs except the Status EDR will be "EEEZ\_XYYYYDDDDAAA\_V#.DAT" where:

EEE instrument identifier: represents the EPPS instrument

EPS, EPPS/EPS  
 FIP, EPPS/FIPS

Z specifies whether the packet contains data taken from the high, medium, or low priority science packet  
 H, High Priority  
 M, Medium Priority  
 L, Low Priority

The FSW6 upload removed the EPS PHA association with priority  
 N, indicates N/A association for EPS PHA EDRs

FIPS PHA EDR data can also be extracted from the FIPS Scan packet:  
 S, data from Scan packet

FSW7 FIPS PHA EDR data is only extracted from FIPS PHA packets:  
 P, data from PHA packet (heavy ion or proton)

X specifies whether data contains PHA events, spectra/counts, or Housekeeping data.  
 P, PHA events binary data file  
 S, Spectra binary data file  
 H, Housekeeping ASCII file

NOTE: The FSW6 upload had the effect of retiring several EDRs and adding new ones. In order to keep the EEEZ\_YYYYDDDDAAA\_V#.DAT file naming convention the Z and X characters are used in conjunction to identify the new EDRs:

EPS High Resolution EDR: Z\_X= "H\_R" Ex. "EPSH\_R2008233EDR\_V1.DAT"  
 EPS Low Resolution EDR: Z\_X= "L\_R" Ex. "EPSL\_R2008231EDR V1.DAT"  
 EPS Summary Spectra EDR: Z\_X= "S\_S" Ex. "EPSS\_S2008233EDR V1.DAT"  
 EPS Scan Rates EDR: Z\_X= "S\_R" Ex. "EPSS\_R2008233EDR V1.DAT"  
 FIPS Scan Rates EDR: Z\_X= "S\_R" Ex. "FIPS\_R2008233EDR V1.DAT"  
 FIPS HRPVD EDR: Z\_X= "P\_V" Ex. "FIPS\_V2008233EDR V1.DAT"

YYYY four digit year  
 DDD three digit day of year  
 AAA specifies whether the data product is an EDR or CDR  
 V# Version number. The initial version is "V1". The version number increments to "V2", "V3", etc for each successive version of the EDR product that is produced. A new version of the EDR product may be produced as a result of an error in the product or as a result of errors discovered in the product generation process.  
 .DAT the file extension is dependent on the file type  
 .DAT, Instrument Data in binary table  
 .TAB, Spacecraft data in ASCII table  
 .LBL, Detached PDS label file

Thus, EPSL\_P2006001EDR.dat will contain the all the Low Priority PHA events collected by the EPS sensor on Jan 01, 2006, and is an EDR data product.

The EPPS Status EDR has the naming convention "EPPSYYYYYDDDDAAA\_V#.TAB" where:

EPPS designates the file as the Status EDR file  
 YYYY four digit year  
 DDD three digit day of year  
 AAA specifies whether the product is an EDR or CDR.  
 V# Version number. The initial version is "V1". The version number increments to "V2", "V3", etc for each successive version of the EDR product that is produced. A new version of the EDR product may



be produced as a result of an error in the product or as a result of errors discovered in the product generation process.

and .TAB is the ASCII table containing the status information.

The EPPS Status EDR is no longer generated on or after 9/6/2007 due to the FSW5 upload; instead use the EPPS\_LONG\_STATUS EDR for data on or after 9/6/2007. The EPPS Long Status EDR has the naming convention ELONGYYYYDDDAAA\_V#.TAB where:

ELONG designates the file as the Long Status EDR file  
YYYY four digit year  
DDD three digit day of year  
AAA specifies whether the product is an EDR or CDR  
V# Version number. The initial version is "V1".

.TAB indicates that the data is stored in an ASCII table.

## ***6.6 Archive Volume and File Size***

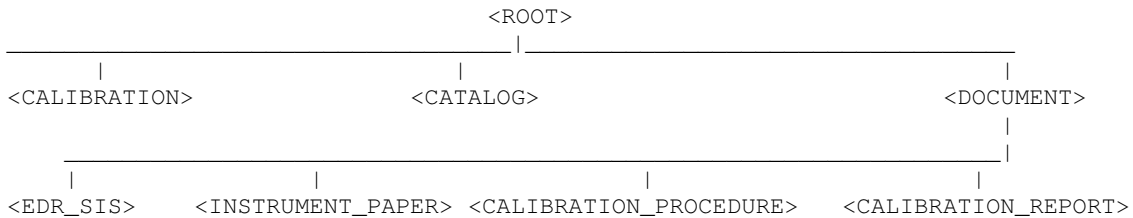
Two archive volumes are created to archive both the EPPS EDR data and the documentation which will be needed to analyze the EDRs. The first volume is the EPPS Documentation Volume. This documentation volume will contain products related to both the EPPS EDR and RDR data archives. The initial release of the documentation volume will contain only EDR level documentation. RDR documents (such as the RDR SIS and dataset catalog) will be added to the volume at the time of initial release of those datasets. Once all of the EPPS data products are designed and released, the documentation volume will contain the following products:

1. All required PDS catalog files for the EDR and RDR archives.
2. The EDR and RDR SIS documents.
3. The SSR instrument paper once copyright permission is obtained. This may not be included in the initial release for copyright reasons.
4. The EPPS calibration report.
5. The EPPS calibration procedures document.
6. Calibration tables.
7. Other information relevant to the RDR archives that would be helpful to users of the EDR archives.
8. Other documents considered useful by the MESSENGER project or the EPPS team.

The second archive volume, designated as the EPPS Data Archive Volume, will contain the EDR data and required files for conforming to PDS volume archive standards. This includes the index files, AAREADME.TXT file, etc. The final EPPS EDR archive volume has a size of approximately 111 GB.

## 6.7 Directory Structure and Contents for EPPS Documentation Volume

The following illustration shows the directory structure overview for the EPPS documentation volume. This volume will be periodically updated as knowledge of the instrument, its calibration, and its operation improve over time. A first release of this volume that includes parameters derived from ground calibration tests will accompany the initial release of the EDR data archive. After initial release there will be updates whenever the EPPS team determines that they have a sufficiently improved calibration to warrant the update. Note that in some deliveries, the products that belong in a particular directory may not yet be available. If a directory has no products in a particular delivery, it will not appear in the archive directory tree. Empty directories will not be delivered.



**Figure 3 Documentation Volume Structure**

### 6.7.1 Directory Contents

#### <ROOT> Directory

This is the top-level volume directory. The following are files contained in the root directory.

**AAREADME.TXT:** General information file. Provides users with an overview of the contents and organization of the associated volume, general instructions for its use, and contact information.

**VOLDESC.CAT:** PDS file containing the VOLUME object. This gives a high-level description of the contents of the volume. Information includes: production date, producer name and institution, volume ID, etc.

**ERRATA.TXT:** Text file for identifying and describing errors and/or anomalies found in the current volume, and possibly previous volumes of a set. Any known errors for the associated volume will be documented in this file.

#### <CALIBRATION> Directory

This will contain the calibration tables needed to analyze the EPPS EDR data. The calibration tables are in ASCII table format and are accompanied by detached PDS labels.

**CALINFO.TXT:** Brief description of the directory contents and naming conventions.

**FIP\*.TAB:** The FIPS energy per charge tables.

**EPPS\_EPS\_EDR2CDR.HTM/PDF:** Describes the conversion of EPPS EDRs to CDRs for the EPS instrument. Document is in HTML and PDF format.

**EPPS\_FIPS\_EDR2CDR.HTM/PDF:** Describes the conversion of EPPS EDRs to CDRs for the FIPS instrument. Document is in HTML and PDF format.

### <CATALOG> Directory

This subdirectory contains the catalog object files for the entire volume. The following files are included in the catalog subdirectory.

**CATINFO.TXT:** Identifies and describes the function of each file in the catalog directory.

**EPPS\*DATASET.CAT:** Describes the general content of the data set for each instrument, as (indicated by the \* text) and includes information about the duration of the mission and the person or group responsible for producing the data.

**INSTRUMENT.CAT:** Describes physical attributes of the EPPS instrument and provides relevant references to published literature.

**INSTHOST.CAT:** Describes the MESSENGER spacecraft.

**MISSION.CAT:** Describes the scientific goals and objectives of the MESSENGER program. It also identifies key people and institutions.

**PERSON.CAT:** Lists and provides contact information for the people involved in the MESSENGER mission, including those involved with EPPS.

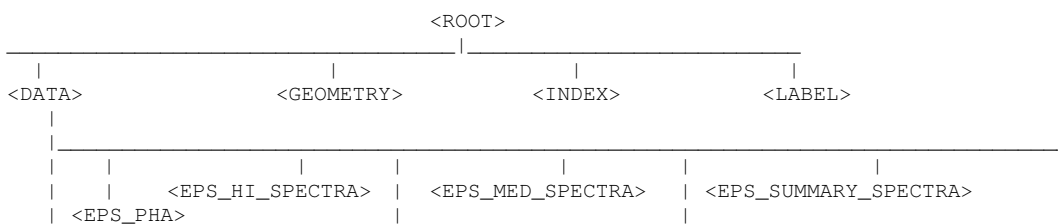
**REF.CAT:** Provides references to scientific papers and other publications of interest to those using the data, both for EPPS and the mission as a whole.

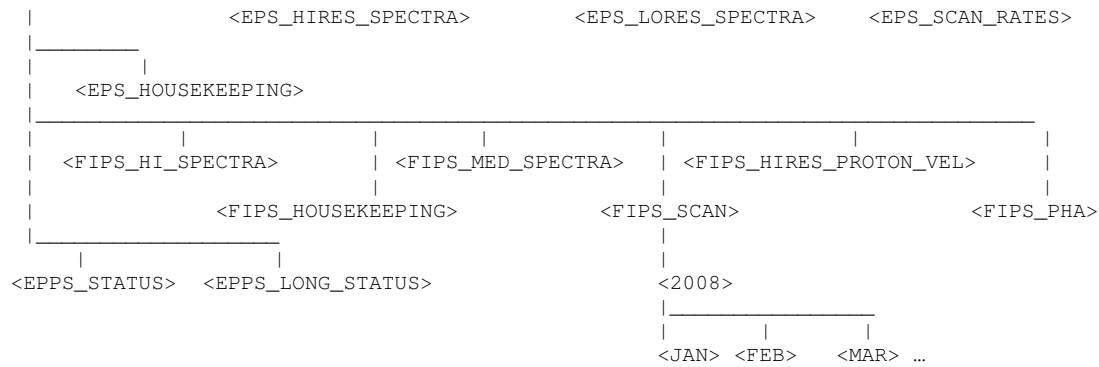
### < DOCUMENT > Directory

This subdirectory contains the documentation that will be needed in order to understand and analyze the EDR and RDR data volumes. The documents will be separated into individual subdirectories according to the document type. The document types are not restricted to the four shown in the graphical depiction of the directory structure. There will be as many document types as needed to categorize each document. The following file is included in the subdirectory.

**DOCINFO.TXT:** Identifies and describes the function of each file in the DOCUMENT directory.

## 6.8 Directory Structure and Contents for EPPS Data Volume





**Figure 4 Data Volume Directory Structure**

### 6.8.1 Directory Contents

#### <ROOT> Directory

This is the top-level directory of a volume. The following are files contained in the root directory.

**AAREADME.TXT** - General information file. Provides users with an overview of the contents and organization of the associated volume, general instructions for its use, and contact information.

**VOLDESC.CAT** - PDS file containing the VOLUME object. This gives a high-level description of the contents of the volume. Information includes: production date, producer name and institution, volume ID, etc.

**ERRATA.TXT** - Text file for identifying and describing errors and/or anomalies found in the current volume, and possibly previous volumes of a set. Any known errors for the associated volume will be documented in this file. This includes revised EDRs meant to replace EDRs in a previous PDS delivery.

#### <DATA> Directory

This top level directory contains the EDR data products. Directly underneath the <DATA> directory are subdirectories corresponding to the standard data products (section 5.2). The directories are further subdivided into YEAR and MONTH directories.

#### <GEOMETRY> Directory

This subdirectory contains information about the files (e.g. SPICE kernels, etc) needed to describe the observation geometry for the data.

**GEOMINFO.TXT** : Identifies and describes the SPICE kernels that a user must have in order to determine observation geometry for the data. The SPICE kernel files are archived with the PDS NAIF node.

#### <INDEX> Directory

This subdirectory contains the indices for all data products on the volume. The following files are contained in the index subdirectory.

**INDEXINFO.TXT** – Identifies and describes the function of each file in the index subdirectory. This includes a description of the structure and contents of each index table in the subdirectory AND usage notes.

**INDEX.TAB** - The EDR index file is organized as a table: there is one entry for each of the data files included in the EPPS data set; the columns contain parameters that describe the observation and instrument and spacecraft parameters. These parameters include state information, such as integration time, spacecraft clock count, time of observation, and instrument modes.

**INDEX.LBL** - Detached PDS label for INDEX.TAB. It contains the INDEX\_TABLE object which identifies and describes the columns of the EPPS index table.

**MD5.TAB** - The MD5 checksum file that contains MD5 hash values for every file in the volume.

**MD5.LBL** - Detached PDS label for MD5.TAB.

### <LABEL> Directory

This subdirectory contains the “label fragments” (i.e., the \*.FMT files) for all data products on the volume. These format files describe the table and data objects which store the data.

## 7 Archive Release Schedule to PDS

The MESSENGER EPPS data and volume archives will be transferred from the SOC to the PDS PPI Node using the electronic transfer process detailed in section 5.3.3. The SPICE kernels will be electronically transferred to the NAIF node. The transfer will take place according to the schedule in the MESSENGER Data Management and Archiving Plan.

### Table 12 PDS Delivery Schedule – REMOVED (refer to MESSENGER Data Management and Archiving Plan)

## 8 Appendices

### 8.1 EPSHIGH.FMT Table Fields

The following are the fields as defined by the EPSHIGH.FMT structure file. This file defines the binary table containing the EPS High Priority spectra data. Archive volume is optimized by defining the table structure once and providing a reference to it in the PDS label file. The fields are numbered according to their column order in the table. Data\_Type refers to the PDS standards data type for a particular column in the table.

The FSW6 upload was done on 8/18/2008 and implemented on 8/19/2008. The software update retired the EPS High Priority Spectra packet. Thus there are no EPS Hi Spectra EDRs on or after 8/19/2008.

**Table 13 EPSHIGH.FMT Fields**

| Start Byte | Length (bytes) | Data Type | Column Name | Summary (see full text for column description) |
|------------|----------------|-----------|-------------|--|
|            |                |           |             |  |

|      |        |                      |                      |   |
|------|--------|----------------------|----------------------|---|
| 1    | 4      | MSB Unsigned Integer | MET                  | Time tag in seconds.  |
| 5    | 4 X 22 | MSB Unsigned Integer | HI_ION_HISTOGRAM_0   | 22 bin high energy ion histogram for ion direction 0.               |
| 93   | 4 X 22 | MSB Unsigned Integer | HI_ION_HISTOGRAM_1   | 22 bin high energy ion histogram for ion direction 1.               |
| 181  | 4 X 22 | MSB Unsigned Integer | HI_ION_HISTOGRAM_2   | 22 bin high energy ion histogram for ion direction 2.               |
| 269  | 4 X 22 | MSB Unsigned Integer | HI_ION_HISTOGRAM_3   | 22 bin high energy ion histogram for ion direction 3.               |
| 357  | 4 X 22 | MSB Unsigned Integer | HI_ION_HISTOGRAM_4   | 22 bin high energy ion histogram for ion direction 4.               |
| 445  | 4 X 22 | MSB Unsigned Integer | HI_ION_HISTOGRAM_5   | 22 bin high energy ion histogram for ion direction 5.               |
| 533  | 4 X 8  | MSB Unsigned Integer | COARSE_E_HISTOGRAM_0 | 8 bin coarse electron histogram for electron direction 0.           |
| 565  | 4 X 8  | MSB Unsigned Integer | COARSE_E_HISTOGRAM_1 | 8 bin coarse electron histogram for electron direction 1.           |
| 597  | 4 X 8  | MSB Unsigned Integer | COARSE_E_HISTOGRAM_2 | 8 bin coarse electron histogram for electron direction 2.           |
| 629  | 4 X 8  | MSB Unsigned Integer | COARSE_E_HISTOGRAM_3 | 8 bin coarse electron histogram for electron direction 3.           |
| 661  | 4 X 8  | MSB Unsigned Integer | COARSE_E_HISTOGRAM_4 | 8 bin coarse electron histogram for electron direction 4.           |
| 693  | 4 X 8  | MSB Unsigned Integer | COARSE_E_HISTOGRAM_5 | 8 bin coarse electron histogram for electron direction 5.           |
| 725  | 4 X 20 | MSB Unsigned Integer | FINE_E_0             | 20 element array of super bin counts for electron direction 0.      |
| 805  | 4 X 20 | MSB Unsigned Integer | FINE_E_1             | 20 element array of super bin counts for electron direction 1.      |
| 885  | 4 X 20 | MSB Unsigned Integer | FINE_E_2             | 20 element array of super bin counts for electron direction 2.      |
| 965  | 4 X 20 | MSB Unsigned Integer | FINE_E_3             | 20 element array of super bin counts for electron direction 3.      |
| 1045 | 4 X 20 | MSB Unsigned Integer | FINE_E_4             | 20 element array of super bin counts for electron direction 4.      |
| 1125 | 4 X 20 | MSB Unsigned Integer | FINE_E_5             | 20 element array of super bin counts for electron direction 5.      |
| 1205 | 4 X 16 | MSB Unsigned Integer | LOW_ION_HISTOGRAM_0  | 16 bin low energy ion histogram for ion microchannel plate anode 0. |
| 1269 | 4 X 16 | MSB Unsigned Integer | LOW_ION_HISTOGRAM_1  | 16 bin low energy ion histogram for ion microchannel plate anode 1. |
| 1333 | 4 X 16 | MSB Unsigned Integer | LOW_ION_HISTOGRAM_2  | 16 bin low energy ion histogram for ion microchannel plate anode 2. |
| 1397 | 4 X 16 | MSB Unsigned Integer | LOW_ION_HISTOGRAM_3  | 16 bin low energy ion histogram for ion microchannel plate anode 3. |
| 1461 | 4 X 16 | MSB Unsigned Integer | LOW_ION_HISTOGRAM_4  | 16 bin low energy ion histogram for ion microchannel plate anode 4. |
| 1525 | 4 X 16 | MSB Unsigned Integer | LOW_ION_HISTOGRAM_5  | 16 bin low energy ion histogram for ion microchannel plate anode 5. |
| 1589 | 4      | MSB Unsigned Integer | FAST_ENERGY_COUNT_0  | One of 12 fast energy hardware counters.                            |
| 1593 | 4      | MSB Unsigned Integer | FAST_ENERGY_COUNT_1  | One of 12 fast energy hardware counters.                            |
| 1597 | 4      | MSB Unsigned Integer | FAST_ENERGY_COUNT_2  | One of 12 fast energy hardware counters.                            |

|      |   |                      |                        |  |
|------|---|----------------------|------------------------|--|
| 1601 | 4 | MSB Unsigned Integer | FAST_ENERGY_COUNT_3    | One of 12 fast energy hardware counters.         |
| 1605 | 4 | MSB Unsigned Integer | FAST_ENERGY_COUNT_4    | One of 12 fast energy hardware counters.         |
| 1609 | 4 | MSB Unsigned Integer | FAST_ENERGY_COUNT_5    | One of 12 fast energy hardware counters.         |
| 1613 | 4 | MSB Unsigned Integer | FAST_ENERGY_COUNT_6    | One of 12 fast energy hardware counters.         |
| 1617 | 4 | MSB Unsigned Integer | FAST_ENERGY_COUNT_7    | One of 12 fast energy hardware counters.         |
| 1621 | 4 | MSB Unsigned Integer | FAST_ENERGY_COUNT_8    | One of 12 fast energy hardware counters.         |
| 1625 | 4 | MSB Unsigned Integer | FAST_ENERGY_COUNT_9    | One of 12 fast energy hardware counters.         |
| 1629 | 4 | MSB Unsigned Integer | FAST_ENERGY_COUNT_10   | One of 12 fast energy hardware counters.         |
| 1633 | 4 | MSB Unsigned Integer | FAST_ENERGY_COUNT_11   | One of 12 fast energy hardware counters.         |
| 1637 | 4 | MSB Unsigned Integer | SHAPED_ENERGY_COUNT_0  | One of 12 shaped energy hardware counters.       |
| 1641 | 4 | MSB Unsigned Integer | SHAPED_ENERGY_COUNT_1  | One of 12 shaped energy hardware counters.       |
| 1645 | 4 | MSB Unsigned Integer | SHAPED_ENERGY_COUNT_2  | One of 12 shaped energy hardware counters.       |
| 1649 | 4 | MSB Unsigned Integer | SHAPED_ENERGY_COUNT_3  | One of 12 shaped energy hardware counters.       |
| 1653 | 4 | MSB Unsigned Integer | SHAPED_ENERGY_COUNT_4  | One of 12 shaped energy hardware counters.       |
| 1657 | 4 | MSB Unsigned Integer | SHAPED_ENERGY_COUNT_5  | One of 12 shaped energy hardware counters.       |
| 1661 | 4 | MSB Unsigned Integer | SHAPED_ENERGY_COUNT_6  | One of 12 shaped energy hardware counters.       |
| 1665 | 4 | MSB Unsigned Integer | SHAPED_ENERGY_COUNT_7  | One of 12 shaped energy hardware counters.       |
| 1669 | 4 | MSB Unsigned Integer | SHAPED_ENERGY_COUNT_8  | One of 12 shaped energy hardware counters.       |
| 1673 | 4 | MSB Unsigned Integer | SHAPED_ENERGY_COUNT_9  | One of 12 shaped energy hardware counters.       |
| 1677 | 4 | MSB Unsigned Integer | SHAPED_ENERGY_COUNT_10 | One of 12 shaped energy hardware counters.       |
| 1681 | 4 | MSB Unsigned Integer | SHAPED_ENERGY_COUNT_11 | One of 12 shaped energy hardware counters.       |
| 1685 | 4 | MSB Unsigned Integer | ANODE_COUNT_0          | Hardware counter for microchannel plate anode 0. |
| 1689 | 4 | MSB Unsigned Integer | ANODE_COUNT_1          | Hardware counter for microchannel plate anode 1. |
| 1693 | 4 | MSB Unsigned Integer | ANODE_COUNT_2          | Hardware counter for microchannel plate anode 2. |
| 1697 | 4 | MSB Unsigned Integer | ANODE_COUNT_3          | Hardware counter for microchannel plate anode 3. |
| 1701 | 4 | MSB Unsigned Integer | ANODE_COUNT_4          | Hardware counter for microchannel plate anode 4. |
| 1705 | 4 | MSB Unsigned Integer | ANODE_COUNT_5          | Hardware counter for microchannel plate anode 5. |
| 1709 | 4 | MSB Unsigned Integer | E_EVENT_COUNT          | Hardware rate counter for electron events.       |

|      |   |                      |                         |  |
|------|---|----------------------|-------------------------|--|
| 1713 | 4 | MSB Unsigned Integer | ION_EVENT_COUNT         | Hardware rate counter for ion events.                        |
| 1717 | 4 | MSB Unsigned Integer | START_COUNT             | Hardware rate counter for microchannel plate start counts.   |
| 1721 | 4 | MSB Unsigned Integer | STOP_COUNT              | Hardware rate counter for microchannel plate stop counts.    |
| 1725 | 4 | MSB Unsigned Integer | VALID_TOF_COUNT         | Hardware rate counter for valid time-of-flight events.       |
| 1729 | 4 | MSB Unsigned Integer | E_PROCESSED_COUNT       | Number of electron events processed.                         |
| 1733 | 4 | MSB Unsigned Integer | HI_ION_PROCESSED_COUNT  | Number of high energy ion events processed.                  |
| 1737 | 4 | MSB Unsigned Integer | LO_ION_PROCESSED_COUNT  | Number of low energy ion events processed.                   |
| 1741 | 4 | MSB Unsigned Integer | PILEUP_E_DISCARD        | Number of electron events discarded due to pileup condition. |
| 1745 | 4 | MSB Unsigned Integer | MULTIPLE_E_HITS_DISCARD | Number of electron events discarded due to multiple hits.    |
| 1749 | 4 | MSB Unsigned Integer | PILEUP_ION_DISCARD      | Number of ion events discarded due to pileup condition.      |
| 1753 | 4 | MSB Unsigned Integer | MULTIPLE_HI_E_DISCARD   | Number of ion events discarded due to multiple hits.         |

### 1. MET

Mission Elapsed Time in seconds at the end of accumulation.

### 2. HI\_ION\_HISTOGRAM\_0

High energy ion histogram for ion direction 0 (SSD detector 1), which is 1 of the 6 ion directions (0 through 5) that define the entire 160 degree field of view of the sensor for high energy ions, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval equal to N1 seconds, where N1 is a multiple of 10 seconds (commonly 300 sec) and set via command. Histogram contains the 22 bins shown in Table 4. In diagnostic mode the first 8 item are ion energy spectral bins, as shown in Table 5, and the rest are zeros.

### 3. HI\_ION\_HISTOGRAM\_1

High energy ion histogram for ion direction 1 (SSD detector 3), which is 1 of the 6 ion directions (0 through 5) that define the entire 160 degree field of view of the sensor for high energy ions, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval equal to N1 seconds, where N1 is a multiple of 10 seconds (commonly 300 sec) and set via command. Histogram contains the 22 bins shown in Table 4. In diagnostic mode the first 8 item are ion energy spectral bins, as shown in Table 5, and the rest are zeros.

### 4. HI\_ION\_HISTOGRAM\_2

High energy ion histogram for ion direction 2 (SSD detector 5), which is 1 of the 6 ion directions (0 through 5) that define the entire 160 degree field of view of the sensor for high energy ions, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval equal to N1 seconds, where N1 is a multiple of 10 seconds (commonly 300 sec) and set via command. Histogram contains the 22 bins shown in Table 4. In diagnostic mode the first 8 item are ion energy spectral bins, as shown in Table 5, and the rest are zeros.

### 5. HI\_ION\_HISTOGRAM\_3

High energy ion histogram for ion direction 3 (SSD detector 7), which is 1 of the 6 ion directions (0 through 5) that define the entire 160 degree field of view of the sensor for high energy ions, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval equal to N1 seconds, where N1 is a multiple of 10 seconds (commonly 300 sec) and set



via command. Histogram contains the 22 bins shown in Table 4.2.4. In diagnostic mode the first 8 item are ion energy spectral bins, as shown in Table 4.2.5, and the rest are zeros.

#### **6. HI\_ION\_HISTOGRAM\_4**

High energy ion histogram for ion direction 4 (SSD detector 9), which is 1 of the 6 ion directions (0 through 5) that define the entire 160 degree field of view of the sensor for high energy ions, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval equal to N1 seconds, where N1 is a multiple of 10 seconds (commonly 300 sec) and set via command. Histogram contains the 22 bins shown in Table 4. In diagnostic mode the first 8 item are ion energy spectral bins, as shown in Table 5, and the rest are zeros.

#### **7. HI\_ION\_HISTOGRAM\_5**

High energy ion histogram for ion direction 5 (SSD detector 11), which is 1 of the 6 ion directions (0 through 5) that define the entire 160 degree field of view of the sensor for high energy ions, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval equal to N1 seconds, where N1 is a multiple of 10 seconds (commonly 300 sec) and set via command. Histogram contains the 22 bins shown in Table 4. In diagnostic mode the first 8 item are ion energy spectral bins, as shown in Table 5, and the rest are zeros.

#### **8. COARSE\_E\_HISTOGRAM\_0**

Electron histogram for electron direction 0 (SSD detector 0), which is 1 of the 6 electron directions (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval of N1 seconds, where N1 is a multiple of 10 seconds (commonly 300 sec) and set via command. Histogram contains the 8 bins shown in Table 2.

#### **9. COARSE\_E\_HISTOGRAM\_1**

Electron histogram for electron direction 1 (SSD detector 2), which is 1 of the 6 electron directions (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval of N1 seconds, where N1 is a multiple of 10 seconds (commonly 300 sec) and set via command. Histogram contains the 8 bins shown in Table 2.

#### **10. COARSE\_E\_HISTOGRAM\_2**

Electron histogram for electron direction 2 (SSD detector 4), which is 1 of the 6 electron directions (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval of N1 seconds, where N1 is a multiple of 10 seconds (commonly 300 sec) and set via command. Histogram contains the 8 bins shown in Table 2.

#### **11. COARSE\_E\_HISTOGRAM\_3**

Electron histogram for electron direction 3 (SSD detector 6), which is 1 of the 6 electron directions (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval of N1 seconds, where N1 is a multiple of 10 seconds (commonly 300 sec) and set via command. Histogram contains the 8 bins shown in Table 2.

#### **12. COARSE\_E\_HISTOGRAM\_4**

Electron histogram for electron direction 4 (SSD detector 8), which is 1 of the 6 electron directions (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval of N1 seconds, where N1 is a multiple of 10 seconds (commonly 300 sec) and set via command. Histogram contains the 8 bins shown in Table 2.

#### **13. COARSE\_E\_HISTOGRAM\_5**

Electron histogram for electron direction 5 (SSD detector 10), which is 1 of the 6 electron directions (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval of N1 seconds, where N1 is a multiple of 10 seconds (commonly 300 sec) and set via command. Histogram contains the 8 bins shown in Table 2.

#### **14. FINE\_E\_0**

A series of “2 super bin counts” for electron direction 0 (SSD detector 0), which is 1 of the 6 electron directions (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). Each super bin is the accumulation of a subset of bin counts in one N1/10 second subinterval. Super bin 0 is the sum of the energy bins 0-3 shown in Table 4.2.2. Super bin 1 is the sum of bins 4-7 shown in Table 2. Each super bin pair is measured once per subinterval for 10 subintervals, making a total of 20 items.

#### **15. FINE\_E\_1**

A series of “2 super bin counts” for electron direction 1 (SSD detector 2), which is 1 of the 6 electron directions (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). Each super bin is the accumulation of a subset of bin counts in one N1/10 second subinterval. Super bin 0 is the sum of the energy bins 0-3 shown in Table 4.2.2. Super bin 1 is the sum of bins 4-7 shown in Table 2. Each super bin pair is measured once per subinterval for 10 subintervals, making a total of 20 items.

#### **16. FINE\_E\_2**

A series of “2 super bin counts” for electron direction 2 (SSD detector 4), which is 1 of the 6 electron directions (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). Each super bin is the accumulation of a subset of bin counts in one N1/10 second subinterval. Super bin 0 is the sum of the energy bins 0-3 shown in Table 4.2.2. Super bin 1 is the sum of bins 4-7 shown in Table 2. Each super bin pair is measured once per subinterval for 10 subintervals, making a total of 20 items.

#### **17. FINE\_E\_3**

A series of “2 super bin counts” for electron direction 3 (SSD detector 6), which is 1 of the 6 electron directions (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). Each super bin is the accumulation of a subset of bin counts in one N1/10 second subinterval. Super bin 0 is the sum of the energy bins 0-3 shown in Table 4.2.2. Super bin 1 is the sum of bins 4-7 shown in Table 2. Each super bin pair is measured once per subinterval for 10 subintervals, making a total of 20 items.

#### **18. FINE\_E\_4**

A series of “2 super bin counts” for electron direction 4 (SSD detector 8), which is 1 of the 6 electron directions (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). Each super bin is the accumulation of a subset of bin counts in one N1/10 second subinterval. Super bin 0 is the sum of the energy bins 0-3 shown in Table 4.2.2. Super bin 1 is the sum of bins 4-7 shown in Table 2. Each super bin pair is measured once per subinterval for 10 subintervals, making a total of 20 items.

#### **19. FINE\_E\_5**

A series of “2 super bin counts” for electron direction 5 (SSD detector 10), which is 1 of the 6 electron directions (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). Each super bin is the accumulation of a subset of bin counts in one N1/10 second subinterval. Super bin 0 is the sum of the energy bins 0-3 shown in Table 4.2.2. Super bin 1 is the sum of bins 4-7 shown in Table 2. Each super bin pair is measured once per subinterval for 10 subintervals, making a total of 20 items.

#### **20. LOW\_ION\_HISTOGRAM\_0**

Low energy ion histogram for ion microchannel plate (MCP) anode 0, which is 1 of the 6 ion anodes (numbered 0 through 5) that read charge coming from the MCP sensor and that define the entire 160 degree

field of view of the sensor for low energy ions, and each representing about 27 degrees out of the entire field of view (Recall that the Low Energy Ion directionality numbering is switched from that used for high energy ions; Section 5.2). This channel is accumulated over a time interval equal to N1 seconds (commonly 300 sec), where N1 is a multiple of 10 seconds and set via command. Histogram contains the 16 bins shown in Table 3. In diagnostic mode these items read zero.

#### **21. LOW\_ION\_HISTOGRAM\_1**

Low energy ion histogram for ion microchannel plate (MCP) anode 1, which is 1 of the 6 ion anodes (numbered 0 through 5) that read charge coming from the MCP sensor and that define the entire 160 degree field of view of the sensor for low energy ions, and each representing about 27 degrees out of the entire field of view (Recall that the Low Energy Ion directionality numbering is switched from that used for high energy ions; Section 5.2). This channel is accumulated over a time interval equal to N1 seconds (commonly 300 sec), where N1 is a multiple of 10 seconds and set via command. Histogram contains the 16 bins shown in Table 3. In diagnostic mode these items read zero.

#### **22. LOW\_ION\_HISTOGRAM\_2**

Low energy ion histogram for ion microchannel plate (MCP) anode 2, which is 1 of the 6 ion anodes (numbered 0 through 5) that read charge coming from the MCP sensor and that define the entire 160 degree field of view of the sensor for low energy ions, and each representing about 27 degrees out of the entire field of view (Recall that the Low Energy Ion directionality numbering is switched from that used for high energy ions; Section 5.2). This channel is accumulated over a time interval equal to N1 seconds (commonly 300 sec), where N1 is a multiple of 10 seconds and set via command. Histogram contains the 16 bins shown in Table 3. In diagnostic mode these items read zero.

#### **23. LOW\_ION\_HISTOGRAM\_3**

Low energy ion histogram for ion microchannel plate (MCP) anode 3, which is 1 of the 6 ion anodes (numbered 0 through 5) that read charge coming from the MCP sensor and that define the entire 160 degree field of view of the sensor for low energy ions, and each representing about 27 degrees out of the entire field of view (Recall that the Low Energy Ion directionality numbering is switched from that used for high energy ions; Section 5.2). This channel is accumulated over a time interval equal to N1 seconds (commonly 300 sec), where N1 is a multiple of 10 seconds and set via command. Histogram contains the 16 bins shown in Table 3. In diagnostic mode these items read zero.

#### **24. LOW\_ION\_HISTOGRAM\_4**

Low energy ion histogram for ion microchannel plate (MCP) anode 4, which is 1 of the 6 ion anodes (numbered 0 through 5) that read charge coming from the MCP sensor and that define the entire 160 degree field of view of the sensor for low energy ions, and each representing about 27 degrees out of the entire field of view (Recall that the Low Energy Ion directionality numbering is switched from that used for high energy ions; Section 5.2). This channel is accumulated over a time interval equal to N1 seconds (commonly 300 sec), where N1 is a multiple of 10 seconds and set via command. Histogram contains the 16 bins shown in Table 3. In diagnostic mode these items read zero.

#### **25. LOW\_ION\_HISTOGRAM\_5**

Low energy ion histogram for ion microchannel plate (MCP) anode 5, which is 1 of the 6 ion anodes (numbered 0 through 5) that read charge coming from the MCP sensor and that define the entire 160 degree field of view of the sensor for low energy ions, and each representing about 27 degrees out of the entire field of view (Recall that the Low Energy Ion directionality numbering is switched from that used for high energy ions; Section 5.2). This channel is accumulated over a time interval equal to N1 seconds (commonly 300 sec), where N1 is a multiple of 10 seconds and set via command. Histogram contains the 16 bins shown in Table 3. In diagnostic mode these items read zero.

#### **26. FAST\_ENERGY\_COUNT\_0**

Fast energy hardware counter from Solid State Detector 0 (electrons), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses used to trigger the baseline measurement of the energy signal. Accumulation period is N1.

**27. FAST\_ENERGY\_COUNT\_1**

Fast energy hardware counter from Solid State Detector 1 (ions), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses used to trigger the baseline measurement of the energy signal. Accumulation period is N1.

**28. FAST\_ENERGY\_COUNT\_2**

Fast energy hardware counter from Solid State Detector 2 (electrons), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses used to trigger the baseline measurement of the energy signal. Accumulation period is N1.

**29. FAST\_ENERGY\_COUNT\_3**

Fast energy hardware counter from Solid State Detector 3 (ions), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses used to trigger the baseline measurement of the energy signal. Accumulation period is N1.

**30. FAST\_ENERGY\_COUNT\_4**

Fast energy hardware counter from Solid State Detector 4 (electrons), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses used to trigger the baseline measurement of the energy signal. Accumulation period is N1.

**31. FAST\_ENERGY\_COUNT\_5**

Fast energy hardware counter from Solid State Detector 5 (ions), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses used to trigger the baseline measurement of the energy signal. Accumulation period is N1.

**32. FAST\_ENERGY\_COUNT\_6**

Fast energy hardware counter from Solid State Detector 6 (electrons), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses used to trigger the baseline measurement of the energy signal. Accumulation period is N1.

**33. FAST\_ENERGY\_COUNT\_7**

Fast energy hardware counter from Solid State Detector 7 (ions), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses used to trigger the baseline measurement of the energy signal. Accumulation period is N1.

**34. FAST\_ENERGY\_COUNT\_8**

Fast energy hardware counter from Solid State Detector 8 (electrons), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses used to trigger the baseline measurement of the energy signal. Accumulation period is N1.

**35. FAST\_ENERGY\_COUNT\_9**

Fast energy hardware counter from Solid State Detector 9 (ions), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses used to trigger the baseline measurement of the energy signal. Accumulation period is N1.

**36. FAST\_ENERGY\_COUNT\_10**

Fast energy hardware counter from Solid State Detector 10 (electrons), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are

electrons and all odd channels are ions. This channel is a count of pulses used to trigger the baseline measurement of the energy signal. Accumulation period is N1.

### **37. FAST\_ENERGY\_COUNT\_11**

Fast energy hardware counter from Solid State Detector 11 (ions), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses used to trigger the baseline measurement of the energy signal. Accumulation period is N1.

### **38. SHAPED\_ENERGY\_COUNT\_0**

Shaped energy hardware counter from Solid State Detector 0 (electrons), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses whose amplitude is used to determine the energy of the particle that generated the pulse. Accumulation period is N1.

### **39. SHAPED\_ENERGY\_COUNT\_1**

Shaped energy hardware counter from Solid State Detector 1 (ions), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses whose amplitude is used to determine the energy of the particle that generated the pulse. Accumulation period is N1.

### **40. SHAPED\_ENERGY\_COUNT\_2**

Shaped energy hardware counter from Solid State Detector 2 (electrons), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses whose amplitude is used to determine the energy of the particle that generated the pulse. Accumulation period is N1.

### **41. SHAPED\_ENERGY\_COUNT\_3**

Shaped energy hardware counter from Solid State Detector 3 (ions), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses whose amplitude is used to determine the energy of the particle that generated the pulse. Accumulation period is N1.

### **42. SHAPED\_ENERGY\_COUNT\_4**

Shaped energy hardware counter from Solid State Detector 4 (electrons) one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses whose amplitude is used to determine the energy of the particle that generated the pulse. Accumulation period is N1.

### **43. SHAPED\_ENERGY\_COUNT\_5**

Shaped energy hardware counter from Solid State Detector 5 (ions), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses whose amplitude is used to determine the energy of the particle that generated the pulse. Accumulation period is N1.

### **44. SHAPED\_ENERGY\_COUNT\_6**

Shaped energy hardware counter from Solid State Detector 6 (electrons), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses whose amplitude is used to determine the energy of the particle that generated the pulse. Accumulation period is N1.

### **45. SHAPED\_ENERGY\_COUNT\_7**

Shaped energy hardware counter from Solid State Detector 7 (ions), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses whose amplitude is used to determine the energy of the particle that generated the pulse. Accumulation period is N1.

**46. SHAPED\_ENERGY\_COUNT\_8**

Shaped energy hardware counter from Solid State Detector 8 (electrons), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses whose amplitude is used to determine the energy of the particle that generated the pulse. Accumulation period is N1.

**47. SHAPED\_ENERGY\_COUNT\_9**

Shaped energy hardware counter from Solid State Detector 9 (ions), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses whose amplitude is used to determine the energy of the particle that generated the pulse. Accumulation period is N1.

**48. SHAPED\_ENERGY\_COUNT\_10**

Shaped energy hardware counter from Solid State Detector 10 (electrons), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses whose amplitude is used to determine the energy of the particle that generated the pulse. Accumulation period is N1.

**49. SHAPED\_ENERGY\_COUNT\_11**

Shaped energy hardware counter from Solid State Detector 11 (ions), one of 12 SSD's (numbered 0-11) that define the 160 degree sensor field of view for both electrons and ions. All even-numbered SSDs are electrons and all odd channels are ions. This channel is a count of pulses whose amplitude is used to determine the energy of the particle that generated the pulse. Accumulation period is N1.

**50. ANODE\_COUNT\_0**

Hardware counter for microchannel plate anode 0 (anodes measure ions only), one of 6 anodes (numbered 0-5) that define the 160-degree sensor field of view for low energy ions. This channel is a count of pulses with amplitudes greater than a discrimination setting. Accumulation period is N1.

**51. ANODE\_COUNT\_1**

Hardware counter for microchannel plate anode 1 (anodes measure ions only), one of 6 anodes (numbered 0-5) that define the 160-degree sensor field of view for low energy ions. This channel is a count of pulses with amplitudes greater than a discrimination setting. Accumulation period is N1.

**52. ANODE\_COUNT\_2**

Hardware counter for microchannel plate anode 2 (anodes measure ions only), one of 6 anodes (numbered 0-5) that define the 160-degree sensor field of view for low energy ions. This channel is a count of pulses with amplitudes greater than a discrimination setting. Accumulation period is N1.

**53. ANODE\_COUNT\_3**

Hardware counter for microchannel plate anode 3 (anodes measure ions only), one of 6 anodes (numbered 0-5) that define the 160-degree sensor field of view for low energy ions. This channel is a count of pulses with amplitudes greater than a discrimination setting. Accumulation period is N1.

**54. ANODE\_COUNT\_4**

Hardware counter for microchannel plate anode 4 (anodes measure ions only), one of 6 anodes (numbered 0-5) that define the 160-degree sensor field of view for low energy ions. This channel is a count of pulses with amplitudes greater than a discrimination setting. Accumulation period is N1.

**55. ANODE\_COUNT\_5**

Hardware counter for microchannel plate anode 5 (anodes measure ions only), one of 6 anodes (numbered 0-5) that define the 160-degree sensor field of view for low energy ions. This channel is a count of pulses with amplitudes greater than a discrimination setting. Accumulation period is N1.

**56. E\_EVENT\_COUNT**

Hardware rate counter for all classified Electron events registered in the fast processing electronics upstream from the Event Processing Computer. Because the Event Processing Computer can process at

most about 5000 events, this counter allows the user to renormalize the processed output rates to retrieve true intensities. Accumulation period is N1.

#### **57. ION\_EVENT\_COUNT**

Hardware rate counter for all classified ion events registered in the fast processing electronics upstream from the Event Processing Computer. Because the Event Processing Computer can process at most about 5000 events, this counter allows the user to renormalize the processed output rates to retrieve true intensities. Accumulation period is N1.

#### **58. START\_COUNT**

Hardware rate counter for all Microchannel Plate Start counts (a sum of counts coming from all 6 MCP anodes) registered in the fast electronics upstream of the Event Processing Computer. This counter helps diagnose sensor operation. Unlike other hardware counters that are 16 bit deep, the Start on board counter is 24 bit deep. However, the data is telemetered in log-compressed form. Accumulation period is N1.

#### **59. STOP\_COUNT**

Hardware rate counter for all Microchannel Plate Stop counts (there is only one stop anode) registered in the fast electronics upstream of the Event Processing Computer. This counter helps diagnose sensor operation. Unlike other hardware counters that are 16 bit deep, the Start on board counter is 24 bit deep. However, the data is telemetered in log-compressed form. Accumulation period is N1.

#### **60. VALID\_TOF\_COUNT**

Hardware rate counter for valid time-of-flight (TOF) events (a combined MCP start pulse and stop pulse that meets certain timing restrictions) registered in the fast electronics upstream of the Event Processing Computer. Unlike other hardware counters that are 16 bit deep, the Start on board counter is 24 bit deep. However, the data is telemetered in log-compressed form. Accumulation period is N1.

#### **61. E\_PROCESSED\_COUNT**

Number of electron events processed by the Event Processing Computer during the accumulation interval. Accumulation period is N1.

#### **62. HI\_ION\_PROCESSED\_COUNT**

Number of high energy ion events processed by the Event Processing Computer during the accumulation interval. Accumulation period is N1.

#### **63. LO\_ION\_PROCESSED\_COUNT**

Number of low energy ion events processed by the Event Processing Computer during the accumulation interval. Accumulation period is N1.

#### **64. PILEUP\_E\_DISCARD**

Number of electron events discarded by the Event Processing Computer due to pileup condition. Accumulation period is N1.

#### **65. MULTIPLE\_E\_HITS\_DISCARD**

Number of electron events discarded by the Event Processing Computer due to multiple electron hits. Accumulation period is N1.

#### **66. PILEUP\_ION\_DISCARD**

Number of high energy ion events discarded by the Event Processing Computer due to pileup condition. Accumulation period is N1.

#### **67. MULTIPLE\_HI\_E\_DISCARD**

Number of high energy ion events discarded by the Event Processing Computer due to multiple ion hits. Accumulation period is N1.

## 8.2 EPSHI\_HK.FMT Table Fields

The following are the fields as defined by the EPSHI\_HK.FMT structure file. This file defines the ASCII table containing the EPS Housekeeping data (taken from EPS High Priority Science Packet). Archive volume is optimized by defining the table structure once and providing a reference to it in the PDS label file. The fields are numbered according to their column order in the table. Data\_Type refers to the PDS standards data type for a particular column in the table.

The FSW6 upload was done on 8/18/2008 and implemented on 8/19/2008. The software update retired the EPS High Priority Spectra packet which also contained the high priority housekeeping data. Thus there are no EPS Housekeeping EDRs on or after 8/19/2008.

**Table 14 EPSHI\_HK.FMT fields**

| Start Byte | Length (bytes) | Data Type     | Column Name       | Summary (see full text for column description) |
|------------|----------------|---------------|-------------------|--|
| 1          | 12             | ASCII_INTEGER | MET               | Mission Elapsed Time in seconds.               |
| 15         | 3              | ASCII_INTEGER | HVPS_SET          | EPS high voltage level setting.                |
| 20         | 3              | ASCII_INTEGER | BIAS_SET          | EPS detector bias level setting.               |
| 25         | 3              | ASCII_INTEGER | TOF_ANODE_0_SET   | Time of flight anode 0 discriminator setting.  |
| 30         | 3              | ASCII_INTEGER | TOF_ANODE_1_SET   | Time of flight anode 1 discriminator setting.  |
| 35         | 3              | ASCII_INTEGER | TOF_ANODE_2_SET   | Time of flight anode 2 discriminator setting.  |
| 40         | 3              | ASCII_INTEGER | TOF_ANODE_3_SET   | Time of flight anode 3 discriminator setting.  |
| 45         | 3              | ASCII_INTEGER | TOF_ANODE_4_SET   | Time of flight anode 4 discriminator setting.  |
| 50         | 3              | ASCII_INTEGER | TOF_ANODE_5_SET   | Time of flight anode 5 discriminator setting.  |
| 55         | 3              | ASCII_INTEGER | TOF_START_CFD     | Time of flight start CFD setting.              |
| 60         | 3              | ASCII_INTEGER | TOF_STOP_CDF      | Time of flight stop CFD setting.               |
| 65         | 3              | ASCII_INTEGER | HEAVY_ION_0_SET   | Heavy Ion 0 discriminator setting.             |
| 70         | 3              | ASCII_INTEGER | HEAVY_ION_1_SET   | Heavy Ion 1 discriminator setting.             |
| 75         | 5              | ASCII_INTEGER | ION_FAST_1_3_5    | Ion fast channels 1,3,5 discriminator setting. |
| 82         | 5              | ASCII_INTEGER | ION_SHAPED_1_3_5  | Ion shaped channels 1,3,5 setting.             |
| 89         | 5              | ASCII_INTEGER | ION_FAST_7_9_11   | Ion fast channels 7,9,11 setting.              |
| 96         | 5              | ASCII_INTEGER | ION_SHAPED_7_9_11 | Ion shaped channels 7,9,11 setting.            |
| 103        | 5              | ASCII_INTEGER | E_FAST_0_2_4      | Electron fast channels 0,2,4 setting.          |
| 110        | 5              | ASCII_INTEGER | E_SHAPED_0_2_4    | Electron shaped channels 0,2,4 setting.        |
| 117        | 5              | ASCII_INTEGER | E_FAST_6_8_10     | Electron fast channels 6,8,10 setting.         |
| 124        | 5              | ASCII_INTEGER | E_SHAPED_6_8_10   | Electron shaped channels 6,8,10 setting.       |
| 131        | 5              | ASCII_INTEGER | CMD_WORD_A        | Integer value of 15-bit command word A.        |
| 138        | 5              | ASCII_INTEGER | CMD_WORD_B        | Integer value of 15-bit command word B.        |
| 145        | 5              | ASCII_INTEGER | EVENT_PARAM_A     | Integer value of 15-bit event parameter A.     |
| 152        | 5              | ASCII_INTEGER | EVENT_PARAM_B     | Integer value of 15-bit event parameter B.     |
| 159        | 5              | ASCII_INTEGER | EVENT_PARAM_C     | Integer value of 15-bit event parameter C.     |
| 166        | 5              | ASCII_INTEGER | HVPS_CLOCK_ADJUST | HVPS clock adjust value.                       |



|     |   |               |                      |                                   |
|-----|---|---------------|----------------------|-----------------------------------|
| 173 | 5 | ASCII_INTEGER | BIAS_CLOCK_ADJUST    | Bias clock adjust value.          |
| 180 | 5 | ASCII_INTEGER | LVPS_CONTROL_WORD    | Echo of the control bit for LVPS. |
| 187 | 5 | ASCII_INTEGER | INVALID_CH_ID_COUNT  | Invalid channel ID count.         |
| 194 | 5 | ASCII_INTEGER | EPS_FIFO_RESET_COUNT | EPS-fifo-reset count.             |
| 201 | 5 | ASCII_INTEGER | I2C_BUS_ERR_COUNT    | I2C Bus error count.              |
| 208 | 5 | ASCII_INTEGER | BUS_READ_VALUE       | Value of most recent bus command. |
| 215 | 5 | ASCII_INTEGER | SPARE                | Spare column, unused.             |

**1. MET**

Mission Elapsed Time in seconds at the end of the accumulation.

**2. HVPS\_SET**

HVPS setting. EPS high voltage level (0-255).

**3. BIAS\_SET**

Bias setting. EPS detector bias level (0-255).

**4. TOF\_ANODE\_0\_SET**

Time of flight start anode 0 discriminator setting (0-255).

**5. TOF\_ANODE\_1\_SET**

Time of flight start anode 1 discriminator setting (0-255).

**6. TOF\_ANODE\_2\_SET**

Time of flight start anode 2 discriminator setting (0-255).

**7. TOF\_ANODE\_3\_SET**

Time of flight start anode 3 discriminator setting (0-255).

**8. TOF\_ANODE\_4\_SET**

Time of flight start anode 4 discriminator setting (0-255).

**9. TOF\_ANODE\_5\_SET**

Time of flight start anode 5 discriminator setting (0-255).

**10. TOF\_START\_CFD**

Time of flight combined Start Constant Fraction Discriminator setting (0-255).

**11. TOF\_STOP\_CFD**

Time of flight combined Stop Constant Fraction Discriminator setting (0-255).

**12. HEAVY\_ION\_0\_SET**

Heavy ion 0 discriminator setting (0-255).

**13. HEAVY\_ION\_1\_SET**

Heavy ion 1 discriminator setting (0-255).

**14. ION\_FAST\_1\_3\_5**

Ion Fast channels, 1,3,5 Discriminator Setting

**15. ION\_SHAPED\_1\_3\_5**

Ion shaped channels 1,3,5 Discriminator Setting

**16. ION\_FAST\_7\_9\_11**

Ion fast channels 7,9,11 Discriminator Setting

**17. ION\_SHAPED\_7\_9\_11**

Ion shaped channels 7,9,11 Discriminator Setting

**18. E\_FAST\_0\_2\_4**

Electron fast channels 0,2,4 Discriminator Setting

**19. E\_SHAPED\_0\_2\_4**

Electron shaped channels 0,2,4 Discriminator Setting

**20. E\_FAST\_6\_8\_10**

Electron fast channels 6,8,10 Discriminator Setting

**21. E\_SHAPED\_6\_8\_10**

Electron shaped channels 6,8,10 Discriminator Setting

## 22. CMD\_WORD\_A

The integer value of the 15-bit Command word A. Description of command word A shown below:

| bit                   | Name                          | Description  | state=1              | state=0      | requires<br>nTOF Master<br>Reset = 0<br>while<br>changing<br>state |
|-----------------------|-------------------------------|--|----------------------|--------------|--|
| <b>Command Word A</b> |                               |  | <i>Default state</i> |              |  |
| 0                     | CMD-0 Ion Power Switch        | Controls whether the large or small ion pixel detector preamps are powered                       | small pixels         | large pixels |  |
| 1                     | CMD-1 Electron Power Switch   | Controls whether the large or small electron pixel detector preamps are powered                  | small pixels         | large pixels |  |
| 2                     | CMD-2 nReset Ion Latchup      | If any of the 6 ion ADC's latchup, they will be powered down automatically. This signal then     | inactive             | active       |  |
| 3                     | CMD-3 nReset Electron Latchup | If any of the 6 electron ADC's latchup, they will be powered down automatically. This            | inactive             | active       |  |
| 4                     | CMD-4 nTOF Master Reset       | Master reset for TOP chip  | inactive             | active       |  |
| 5                     | CMD-5 Half Period             |  | active               | inactive     | YES  |
| 6                     | CMD-6 Tap Select 1            |  | active               | inactive     | YES  |
| 7                     | CMD-7 Tap Select 2            |  | active               | inactive     | YES  |
| 8                     | CMD-8 Exclusion Window        |  | active               | inactive     | YES  |
| 9                     | CMD-9 Disable A0              | Design Change 6-13-02  | active               | inactive     |  |
| 10                    | CMD-10 Disable A1             | Design Change 6-13-02  | active               | inactive     |  |
| 11                    | CMD-11 FIPS +/-5V Power Swt   | enables FIPS +/-5V power   | active               | inactive     |  |
| 12                    | CMD-12 FIPS +/-15V Power Swt  | enables FIPS +/-15V power  | active               | inactive     |  |
| 13                    | CMD-13 EPS Event FIFO Reset   | clears EPS Event FIFO-A  | active               | inactive     |  |
| 14                    | CMD-14 FIPS Reset             | reset entire FIPS sensor electronics.<br>Minimum duration should always be greater than 1 second | active               | inactive     |  |
| 15                    | CMD-15 FIPS Event FIFO Reset  | clears FIPS Event FIFO-B   | active               | inactive     |  |

## 23. CMD\_WORD\_B

The integer value of the 15-bit Command word B. Description of Command Word B shown below:

| bit                   | Name                             | Description                             | state=1              | state=0  | requires<br>nTOF Master<br>Reset = 0<br>while<br>changing<br>state |
|-----------------------|----------------------------------|---|----------------------|----------|--|
| <b>Command Word B</b> |                                  |   | <i>Default state</i> |          |  |
| 0                     | CMD-16 TOF Clock Select          | Selects TOF clock                       | 6 Mhz                | 3 MHz    | YES  |
| 1                     | CMD-17 Enable HV Monitor         | enables HV monitoring circuits          | enabled              | disabled |  |
| 2                     | CMD-18 Enable HV telemetry       | enables HV telemetry functions          | enabled              | disabled |  |
| 3                     | CMD-19 Enable HV / BIAS Supplies | enables HV and BIAS power supply clocks | enabled              | disabled |  |
| 4                     | CMD-20 Disable A2                | Design Change 6-13-02                   | active               | inactive |  |
| 5                     | CMD-21 Disable A3                | Design Change 6-13-02                   | active               | inactive |  |
| 6                     | CMD-22 Disable A4                | Design Change 6-13-02                   | active               | inactive |  |
| 7                     | CMD-23 Disable A5                | Design Change 6-13-02                   | active               | inactive |  |
| 8                     | HV Limit bit-0                   | 8-bit High Voltage Limit                | "1"                  | "0"      |  |
| 9                     | HV Limit bit-1                   |   | "1"                  | "0"      |  |
| 10                    | HV Limit bit-2                   |   | "1"                  | "0"      |  |
| 11                    | HV Limit bit-3                   |   | "1"                  | "0"      |  |
| 12                    | HV Limit bit-4                   |   | "1"                  | "0"      |  |
| 13                    | HV Limit bit-5                   |   | "1"                  | "0"      |  |
| 14                    | HV Limit bit-6                   |   | "1"                  | "0"      |  |
| 15                    | HV Limit bit-7                   |   | "1"                  | "0"      |  |

**24. EVENT\_PARAM\_A**

The integer value of the 15-bit Event parameter A mirror. This parameter contains individual bits that enable/disable energy and ion channels for event processing. Description shown below:

| bit                                 | Name                       | Description                                 | state=1              | state=0  |
|-------------------------------------|----------------------------|---|----------------------|----------|
| <b><i>EPS Event Parameter A</i></b> |                            |   | <i>Default state</i> |          |
| 0                                   | Enable Channel-0           | enables FAST pulses for channel 0           | enabled              | disabled |
| 1                                   | Enable Channel-1           | enables FAST pulses for channel 1           | enabled              | disabled |
| 2                                   | Enable Channel-2           | enables FAST pulses for channel 2           | enabled              | disabled |
| 3                                   | Enable Channel-3           | enables FAST pulses for channel 3           | enabled              | disabled |
| 4                                   | Enable Channel-4           | enables FAST pulses for channel 4           | enabled              | disabled |
| 5                                   | Enable Channel-5           | enables FAST pulses for channel 5           | enabled              | disabled |
| 6                                   | Enable Channel-6           | enables FAST pulses for channel 6           | enabled              | disabled |
| 7                                   | Enable Channel-7           | enables FAST pulses for channel 7           | enabled              | disabled |
| 8                                   | Enable Channel-8           | enables FAST pulses for channel 8           | enabled              | disabled |
| 9                                   | Enable Channel-9           | enables FAST pulses for channel 9           | enabled              | disabled |
| 10                                  | Enable Channel-10          | enables FAST pulses for channel 10          | enabled              | disabled |
| 11                                  | Enable Channel-11          | enables FAST pulses for channel 11          | enabled              | disabled |
| 12                                  | unused                     |   |                      |          |
| 13                                  | FPGA-2 Reset               | reset all of FPGA-2 except commend receiver | enabled              | disabled |
| 14                                  | Enable Min 1400ns Recycles | forces 1400ns min recycles                  | enabled              | disabled |
| 15                                  | Flight Mode                | enables normal Rate Counter port on FPGA-2  | Flight               | Debug    |

**25. EVENT\_PARAM\_B**

The integer value of the 15-bit Event parameter B mirror. This parameter contains two 3-bit code fields that programmably selects the delay taps for energy Fast signals. Description shown below:

| bit                                 | Name                            | Description                                   | state=1              | state=0  |
|-------------------------------------|---------------------------------|---|----------------------|----------|
| <b><i>EPS Event Parameter B</i></b> |                                 |   | <i>Default state</i> |          |
| 0                                   | Delay Tap-1 Code bit-0          | Coincidence Window starting delay tap (0-7)   | "1"                  | "0"      |
| 1                                   | Delay Tap-1 Code bit-1          |   | "1"                  | "0"      |
| 2                                   | Delay Tap-1 Code bit-2          |   | "1"                  | "0"      |
| 3                                   | Delay Tap-2 Code bit-0          | Coincidence Window end delay tap offset       | "1"                  | "0"      |
| 4                                   | Delay Tap-2 Code bit-1          | from starting tap where:                      | "1"                  | "0"      |
| 5                                   | Delay Tap-2 Code bit-2          | <b>[ Tap1 + Tap2 ] &lt; 10</b>                | "1"                  | "0"      |
| 6                                   | Ion Triples Only                | only Ion Triple Coincidence events are passed | enabled              | disabled |
| 7                                   | Lockout Enable                  | Enables 12us lockout circuits                 | enabled              | disabled |
| 8                                   | Diagnostic Mode                 | Enables Diagnostic mode                       | enabled              | disabled |
| 9                                   | Enable EPS Events               | Allows EPS Events                             | enabled              | disabled |
| 10                                  | Enable FIPS Events              | Allows FIPS Events                            | enabled              | disabled |
| 11                                  | Enable Test Port                | Allows Event Stimulus for EPS Events          | enabled              | disabled |
| 12                                  | Enable Multiple START Detection | <b>Design Change 8-31-02 and 12-26-02</b>     | enabled              | disabled |
| 13                                  | Reset EPS FIFO Overflow         | <b>Design Change 9-26-02</b>                  | ON                   | OFF      |
| 14                                  | Reset FIPS FIFO Overflow        | <b>Design Change 9-26-02</b>                  | ON                   | OFF      |
| 15                                  | unused                          |   |                      |          |

**26. EVENT\_PARAM\_C**

The integer value of the 15-bit Event parameter C mirror. This parameter contains one 7-bit field that programmably selects the number of EPS electron events to be discarded per electron event that is placed in the Event FIFO buffer.

| bit                          | Name                           | Description  | state=1              | state=0 |
|------------------------------|--------------------------------|--|----------------------|---------|
| <b>EPS Event Parameter C</b> |                                |  | <i>Default state</i> |         |
| 0                            | Discard Rate bit-0             | 7-bit Discard Rate (0-127d)<br><b>Discard Rate = 0 means no discard</b><br>Discard Rate 1 to 127 means discard this<br>numbers of EPS Electron Events per<br>Electron event that is placed in the FIFO | '1'                  | '0'     |
| 1                            | Discard Rate bit-1             |  | '1'                  | '0'     |
| 2                            | Discard Rate bit-2             |  | '1'                  | '0'     |
| 3                            | Discard Rate bit-3             |  | '1'                  | '0'     |
| 4                            | Discard Rate bit-4             |  | '1'                  | '0'     |
| 5                            | Discard Rate bit-5             |  | '1'                  | '0'     |
| 6                            | Discard Rate bit-6             |  | '1'                  | '0'     |
| 7                            | unused                         |  |                      |         |
| 8                            | unused                         |  |                      |         |
| 9                            | unused                         |  |                      |         |
| 10                           | unused                         |  |                      |         |
| 11                           | unused                         |  |                      |         |
| 12                           | unused                         |  |                      |         |
| 13                           | Enable Invalid Packet ID       | Electron Packets only  | '1'                  | '0'     |
| 14                           | Enable 3 Invalid Packet ID     | Electron Packets only  | '1'                  | '0'     |
| 15                           | Enable Wrong Packet Byte Count | High Energy Ion Packets only   | '1'                  | '0'     |

**27. HVPS\_CLOCK\_ADJUST**

HVPS clock adjust value. Drive for HV supply; since supply does not have a separate “enable” control line, setting this signal to LOW is the method used to quickly disable the supply. Differential 100kHz square-wave signal programmable +/-10% about 100kHz via 256 steps.

**28. BIAS\_CLOCK\_ADJUST**

Bias clock adjust value. Drive for Bias supply; since supply does not have a separate “enable” control line, setting this signal to LOW is the method used to quickly disable the supply. Differential 100kHz square-wave signal programmable +/-10% about 100kHz via 256 steps.

**29. LVPS\_CONTROL\_WORD**

LVPS control word. Echo of the control bit for the LVPS +15V and -15V.

**30. INVALID\_CH\_ID\_COUNT**

Invalid Channel ID count. Accumulation period is N1.

**31. EPS\_FIFO\_RESET\_COUNT**

EPS-fifo-reset count.

**32. I2C\_BUS\_ERR\_COUNT**

I2C Bus error count. Accumulation period is N1.

**33. BUS\_READ\_VALUE**

Value provided by most recent bus read command.

**34. SPARE**

Spare column, unused.

**8.3 EPSMED.FMT Table Fields**

The following are the fields as defined by the EPSMED.FMT structure file. This file defines the binary table containing the EPS Medium Priority spectra data. Archive volume is optimized by defining the table structure once and providing a reference to it in the PDS label file. The fields are numbered according to their column order in the table. Data\_Type refers to the PDS standards data type for a particular column in the table.

The FSW6 upload was done on 8/18/2008 and implemented on 8/19/2008. The software update retired the EPS Medium Priority Spectra packet. Thus there are no EPS Medium Priority EDRs on or after 8/19/2008.

**Table 15 EPSMED.FMT fields**

| Start Byte | Length (bytes) | Data Type            | Column Name          | Summary (see full text for column description)                 |
|------------|----------------|----------------------|----------------------|--|
| 1          | 4              | MSB Unsigned Integer | MET                  | Mission Elapsed Time in seconds.                               |
| 5          | 4 X 12         | MSB Unsigned Integer | HI_ION_HISTOGRAM_0   | 12 bin high energy ion histogram for ion direction 0.          |
| 53         | 4 X 12         | MSB Unsigned Integer | HI_ION_HISTOGRAM_1   | 12 bin high energy ion histogram for ion direction 1.          |
| 101        | 4 X 12         | MSB Unsigned Integer | HI_ION_HISTOGRAM_2   | 12 bin high energy ion histogram for ion direction 2.          |
| 149        | 4 X 12         | MSB Unsigned Integer | HI_ION_HISTOGRAM_3   | 12 bin high energy ion histogram for ion direction 3.          |
| 197        | 4 X 12         | MSB Unsigned Integer | HI_ION_HISTOGRAM_4   | 12 bin high energy ion histogram for ion direction 4.          |
| 245        | 4 X 12         | MSB Unsigned Integer | HI_ION_HISTOGRAM_5   | 12 bin high energy ion histogram for ion direction 5.          |
| 293        | 4 X 8          | MSB Unsigned Integer | COARSE_E_HISTOGRAM_0 | 8 bin coarse electron histogram for electron direction 0.      |
| 325        | 4 X 8          | MSB Unsigned Integer | COARSE_E_HISTOGRAM_1 | 8 bin coarse electron histogram for electron direction 1.      |
| 357        | 4 X 8          | MSB Unsigned Integer | COARSE_E_HISTOGRAM_2 | 8 bin coarse electron histogram for electron direction 2.      |
| 389        | 4 X 8          | MSB Unsigned Integer | COARSE_E_HISTOGRAM_3 | 8 bin coarse electron histogram for electron direction 3.      |
| 421        | 4 X 8          | MSB Unsigned Integer | COARSE_E_HISTOGRAM_4 | 8 bin coarse electron histogram for electron direction 4.      |
| 453        | 4 X 8          | MSB Unsigned Integer | COARSE_E_HISTOGRAM_5 | 8 bin coarse electron histogram for electron direction 5.      |
| 485        | 4 X 20         | MSB Unsigned Integer | FINE_E_0             | 20 element array of super bin counts for electron direction 0. |
| 565        | 4 X 20         | MSB Unsigned Integer | FINE_E_1             | 20 element array of super bin counts for electron direction 1. |
| 645        | 4 X 20         | MSB Unsigned Integer | FINE_E_2             | 20 element array of super bin counts for electron direction 2. |
| 725        | 4 X 20         | MSB Unsigned Integer | FINE_E_3             | 20 element array of super bin counts for electron direction 3. |
| 805        | 4 X 20         | MSB Unsigned Integer | FINE_E_4             | 20 element array of super bin counts for electron direction 4. |

|      |        |                      |                        |  |
|------|--------|----------------------|------------------------|--|
| 885  | 4 X 20 | MSB Unsigned Integer | FINE_E_5               | 20 element array of super bin counts for electron direction 5.     |
| 965  | 4 X 8  | MSB Unsigned Integer | LOW_ION_HISTOGRAM_0    | 8 bin low energy ion histogram for ion microchannel plate anode 0. |
| 997  | 4 X 8  | MSB Unsigned Integer | LOW_ION_HISTOGRAM_1    | 8 bin low energy ion histogram for ion microchannel plate anode 1. |
| 1029 | 4 X 8  | MSB Unsigned Integer | LOW_ION_HISTOGRAM_2    | 8 bin low energy ion histogram for ion microchannel plate anode 2. |
| 1061 | 4 X 8  | MSB Unsigned Integer | LOW_ION_HISTOGRAM_3    | 8 bin low energy ion histogram for ion microchannel plate anode 3. |
| 1093 | 4 X 8  | MSB Unsigned Integer | LOW_ION_HISTOGRAM_4    | 8 bin low energy ion histogram for ion microchannel plate anode 4. |
| 1125 | 4 X 8  | MSB Unsigned Integer | LOW_ION_HISTOGRAM_5    | 8 bin low energy ion histogram for ion microchannel plate anode 5. |
| 1157 | 4      | MSB Unsigned Integer | HW_COUNT_0             | One of 17 hardware counters.                                       |
| 1161 | 4      | MSB Unsigned Integer | HW_COUNT_1             | One of 17 hardware counters.                                       |
| 1165 | 4      | MSB Unsigned Integer | HW_COUNT_2             | One of 17 hardware counters.                                       |
| 1169 | 4      | MSB Unsigned Integer | HW_COUNT_3             | One of 17 hardware counters.                                       |
| 1173 | 4      | MSB Unsigned Integer | HW_COUNT_4             | One of 17 hardware counters.                                       |
| 1177 | 4      | MSB Unsigned Integer | HW_COUNT_5             | One of 17 hardware counters.                                       |
| 1181 | 4      | MSB Unsigned Integer | HW_COUNT_6             | One of 17 hardware counters.                                       |
| 1185 | 4      | MSB Unsigned Integer | HW_COUNT_7             | One of 17 hardware counters.                                       |
| 1189 | 4      | MSB Unsigned Integer | HW_COUNT_8             | One of 17 hardware counters.                                       |
| 1193 | 4      | MSB Unsigned Integer | HW_COUNT_9             | One of 17 hardware counters.                                       |
| 1197 | 4      | MSB Unsigned Integer | HW_COUNT_10            | One of 17 hardware counters.                                       |
| 1201 | 4      | MSB Unsigned Integer | HW_COUNT_11            | One of 17 hardware counters.                                       |
| 1205 | 4      | MSB Unsigned Integer | HW_COUNT_12            | One of 17 hardware counters.                                       |
| 1209 | 4      | MSB Unsigned Integer | HW_COUNT_13            | One of 17 hardware counters.                                       |
| 1213 | 4      | MSB Unsigned Integer | HW_COUNT_14            | One of 17 hardware counters.                                       |
| 1217 | 4      | MSB Unsigned Integer | HW_COUNT_15            | One of 17 hardware counters.                                       |
| 1221 | 4      | MSB Unsigned Integer | HW_COUNT_16            | One of 17 hardware counters.                                       |
| 1225 | 4      | MSB Unsigned Integer | E_PROCESSED_COUNT      | Number of electron events processed.                               |
| 1229 | 4      | MSB Unsigned Integer | HI_ION_PROCESSED_COUNT | Number of high energy ion events processed                         |
| 1233 | 4      | MSB Unsigned Integer | LO_ION_PROCESSED_COUNT | Number of low energy ion events processed.                         |
| 1237 | 4      | MSB Unsigned Integer | PILEUP_E_DISCARD       | Number of electron events discarded due to pileup condition.       |



|      |   |                      |                       |   |
|------|---|----------------------|-----------------------|---|
| 1241 | 4 | MSB Unsigned Integer | MULTIPLE_E_DISCARD    | Number of electron events discarded due to multiple hits.           |
| 1245 | 4 | MSB Unsigned Integer | PILEUP_ION_DISCARD    | Number of high energy ion events discarded due to pileup condition. |
| 1249 | 4 | MSB Unsigned Integer | MULTIPLE_HI_E_DISCARD | Number of high energy ion events discarded due to multiple hits.    |

### 1. MET

Mission elapsed time, in seconds at the end of the accumulation.

### 2. HI\_ION\_HISTOGRAM\_0

High energy ion histogram for ion direction 0 (SSD detector 1), which is 1 of the 6 ion solid state detectors (0 through 5) that define the entire 160 degree field of view of the sensor for high energy ions, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval equal to N2 seconds, where N2 is nominally 30 seconds, but can be changed via command. Histogram contains 12 of the 22 bins shown in Table 4, where the choice of bins is made via ground command. In diagnostic mode the first 8 items are ion energy spectral bins, as shown in Table 5, and the rest are zeros.

### 3. HI\_ION\_HISTOGRAM\_1

High energy ion histogram for ion direction 1 (SSD detector 3), which is 1 of the 6 ion solid state detectors (0 through 5) that define the entire 160 degree field of view of the sensor for high energy ions, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval equal to N2 seconds, where N2 is nominally 30 seconds, but can be changed via command. Histogram contains 12 of the 22 bins shown in Table 4, where the choice of bins is made via ground command. In diagnostic mode the first 8 items are ion energy spectral bins, as shown in Table 5, and the rest are zeros.

### 4. HI\_ION\_HISTOGRAM\_2

High energy ion histogram for ion direction 2 (SSD detector 5), which is 1 of the 6 ion solid state detectors (0 through 5) that define the entire 160 degree field of view of the sensor for high energy ions, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval equal to N2 seconds, where N2 is nominally 30 seconds, but can be changed via command. Histogram contains 12 of the 22 bins shown in Table 4, where the choice of bins is made via ground command. In diagnostic mode the first 8 items are ion energy spectral bins, as shown in Table 5, and the rest are zeros.

### 5. HI\_ION\_HISTOGRAM\_3

High energy ion histogram for ion direction 3 (SSD detector 7), which is 1 of the 6 ion solid state detectors (0 through 5) that define the entire 160 degree field of view of the sensor for high energy ions, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval equal to N2 seconds, where N2 is nominally 30 seconds, but can be changed via command. Histogram contains 12 of the 22 bins shown in Table 4, where the choice of bins is made via ground command. In diagnostic mode the first 8 items are ion energy spectral bins, as shown in Table 5, and the rest are zeros.

### 6. HI\_ION\_HISTOGRAM\_4

High energy ion histogram for ion direction 4 (SSD detector 9), which is 1 of the 6 ion solid state detectors (0 through 5) that define the entire 160 degree field of view of the sensor for high energy ions, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval equal to N2 seconds, where N2 is nominally 30 seconds, but can be changed via command. Histogram contains 12 of the 22 bins shown in Table 4, where the choice of bins is made via ground command. In diagnostic mode the first 8 items are ion energy spectral bins, as shown in Table 5, and the rest are zeros.

### **7. HI\_ION\_HISTOGRAM\_5**

High energy ion histogram for ion direction 5 (SSD detector 11), which is 1 of the 6 ion solid state detectors (0 through 5) that define the entire 160 degree field of view of the sensor for high energy ions, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval equal to  $N_2$  seconds, where  $N_2$  is nominally 30 seconds, but can be changed via command. Histogram contains 12 of the 22 bins shown in Table 4, where the choice of bins is made via ground command. In diagnostic mode the first 8 items are ion energy spectral bins, as shown in Table 5, and the rest are zeros.

### **8. COARSE\_E\_HISTOGRAM\_0**

Electron histogram for electron direction 0 (SSD detector 0), which is 1 of the 6 electron solid-state detectors (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval of  $N_2$  seconds, where  $N_2$  is nominally 30 s but set by ground command. Histogram contains the 8 bins shown in Table 2.

### **9. COARSE\_E\_HISTOGRAM\_1**

Electron histogram for electron direction 1 (SSD detector 2), which is 1 of the 6 electron solid-state detectors (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval of  $N_2$  seconds, where  $N_2$  is nominally 30 s but set by ground command. Histogram contains the 8 bins shown in Table 2.

### **10. COARSE\_E\_HISTOGRAM\_2**

Electron histogram for electron direction 2 (SSD detector 4), which is 1 of the 6 electron solid-state detectors (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval of  $N_2$  seconds, where  $N_2$  is nominally 30 s but set by ground command. Histogram contains the 8 bins shown in Table 2.

### **11. COARSE\_E\_HISTOGRAM\_3**

Electron histogram for electron direction 3 (SSD detector 6), which is 1 of the 6 electron solid-state detectors (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval of  $N_2$  seconds, where  $N_2$  is nominally 30 s but set by ground command. Histogram contains the 8 bins shown in Table 2.

### **12. COARSE\_E\_HISTOGRAM\_4**

Electron histogram for electron direction 4 (SSD detector 8), which is 1 of the 6 electron solid-state detectors (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval of  $N_2$  seconds, where  $N_2$  is nominally 30 s but set by ground command. Histogram contains the 8 bins shown in Table 2.

### **13. COARSE\_E\_HISTOGRAM\_5**

Electron histogram for electron direction 5 (SSD detector 10), which is 1 of the 6 electron solid-state detectors (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). This channel is accumulated over a time interval of  $N_2$  seconds, where  $N_2$  is nominally 30 s but set by ground command. Histogram contains the 8 bins shown in Table 2.

### **14. FINE\_E\_0**

A series of “2 super bin counts” for electron direction 0 (SSD detector 0), which is 1 of the 6 electron solid-state detectors (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). Each super bin is the accumulation of a subset of bin counts in one  $N_2/10$  second subinterval. Super bin 0 is the sum of the

energy bins 0-3 shown in Table 2. Super bin 1 is the sum of bins 4-7 shown in Table 2. Each super bin pair is measured once per subinterval for 10 subintervals, making a total of 20 items.

#### **15. FINE\_E\_1**

A series of “2 super bin counts” for electron direction 1 (SSD detector 2), which is 1 of the 6 electron solid-state detectors (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). Each super bin is the accumulation of a subset of bin counts in one N2/10 second subinterval. Super bin 0 is the sum of the energy bins 0-3 shown in Table 2. Super bin 1 is the sum of bins 4-7 shown in Table 2. Each super bin pair is measured once per subinterval for 10 subintervals, making a total of 20 items.

#### **16. FINE\_E\_2**

A series of “2 super bin counts” for electron direction 2 (SSD detector 4), which is 1 of the 6 electron solid-state detectors (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). Each super bin is the accumulation of a subset of bin counts in one N2/10 second subinterval. Super bin 0 is the sum of the energy bins 0-3 shown in Table 2. Super bin 1 is the sum of bins 4-7 shown in Table 2. Each super bin pair is measured once per subinterval for 10 subintervals, making a total of 20 items.

#### **17. FINE\_E\_3**

A series of “2 super bin counts” for electron direction 3 (SSD detector 6), which is 1 of the 6 electron solid-state detectors (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). Each super bin is the accumulation of a subset of bin counts in one N2/10 second subinterval. Super bin 0 is the sum of the energy bins 0-3 shown in Table 2. Super bin 1 is the sum of bins 4-7 shown in Table 2. Each super bin pair is measured once per subinterval for 10 subintervals, making a total of 20 items.

#### **18. FINE\_E\_4**

A series of “2 super bin counts” for electron direction 4 (SSD detector 8), which is 1 of the 6 electron solid-state detectors (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). Each super bin is the accumulation of a subset of bin counts in one N2/10 second subinterval. Super bin 0 is the sum of the energy bins 0-3 shown in Table 2. Super bin 1 is the sum of bins 4-7 shown in Table 2. Each super bin pair is measured once per subinterval for 10 subintervals, making a total of 20 items.

#### **19. FINE\_E\_5**

A series of “2 super bin counts” for electron direction 5 (SSD detector 10), which is 1 of the 6 electron solid-state detectors (numbered 0 through 5) that define the entire 160 degree field of view of the sensor, and each representing about 27 degrees out of the entire field of view (Section 5.2). Each super bin is the accumulation of a subset of bin counts in one N2/10 second subinterval. Super bin 0 is the sum of the energy bins 0-3 shown in Table 2. Super bin 1 is the sum of bins 4-7 shown in Table 2. Each super bin pair is measured once per subinterval for 10 subintervals, making a total of 20 items.

#### **20. LOW\_ION\_HISTOGRAM\_0**

Low energy ion histogram for ion microchannel plate (MCP) anode 0, which is 1 of the 6 ion anodes (numbered 0 through 5) that read charge coming from the MCP sensor and that define the entire 160 degree field of view of the sensor for low energy ions, and each representing about 27 degrees out of the entire field of view (Recall that the Low Energy Ion directionality numbering is switched from that used for high energy ions; Section 5.2). This channel is accumulated over a time interval equal to N2 seconds, where N2 nominally 30 seconds but set via command. Histogram contains the 8 of the 16 bins shown in Table 3, with the choice of bins set by ground command. In diagnostic mode these items read zero.

#### **21. LOW\_ION\_HISTOGRAM\_1**

Low energy ion histogram for ion microchannel plate (MCP) anode 1, which is 1 of the 6 ion anodes (numbered 0 through 5) that read charge coming from the MCP sensor and that define the entire 160 degree field of view of the sensor for low energy ions, and each representing about 27 degrees out of the entire

field of view (Recall that the Low Energy Ion directionality numbering is switched from that used for high energy ions; Section 5.2). This channel is accumulated over a time interval equal to N2 seconds, where N2 nominally 30 seconds but set via command. Histogram contains the 8 of the 16 bins shown in Table 3, with the choice of bins set by ground command. In diagnostic mode these items read zero.

#### **22. LOW\_ION\_HISTOGRAM\_2**

Low energy ion histogram for ion microchannel plate (MCP) anode 2, which is 1 of the 6 ion anodes (numbered 0 through 5) that read charge coming from the MCP sensor and that define the entire 160 degree field of view of the sensor for low energy ions, and each representing about 27 degrees out of the entire field of view (Recall that the Low Energy Ion directionality numbering is switched from that used for high energy ions; Section 5.2). This channel is accumulated over a time interval equal to N2 seconds, where N2 nominally 30 seconds but set via command. Histogram contains the 8 of the 16 bins shown in Table 3, with the choice of bins set by ground command. In diagnostic mode these items read zero.

#### **23. LOW\_ION\_HISTOGRAM\_3**

Low energy ion histogram for ion microchannel plate (MCP) anode 3, which is 1 of the 6 ion anodes (numbered 0 through 5) that read charge coming from the MCP sensor and that define the entire 160 degree field of view of the sensor for low energy ions, and each representing about 27 degrees out of the entire field of view (Recall that the Low Energy Ion directionality numbering is switched from that used for high energy ions; Section 5.2). This channel is accumulated over a time interval equal to N2 seconds, where N2 nominally 30 seconds but set via command. Histogram contains the 8 of the 16 bins shown in Table 3, with the choice of bins set by ground command. In diagnostic mode these items read zero.

#### **24. LOW\_ION\_HISTOGRAM\_4**

Low energy ion histogram for ion microchannel plate (MCP) anode 4, which is 1 of the 6 ion anodes (numbered 0 through 5) that read charge coming from the MCP sensor and that define the entire 160 degree field of view of the sensor for low energy ions, and each representing about 27 degrees out of the entire field of view (Recall that the Low Energy Ion directionality numbering is switched from that used for high energy ions; Section 5.2). This channel is accumulated over a time interval equal to N2 seconds, where N2 nominally 30 seconds but set via command. Histogram contains the 8 of the 16 bins shown in Table 3, with the choice of bins set by ground command. In diagnostic mode these items read zero.

#### **25. LOW\_ION\_HISTOGRAM\_5**

Low energy ion histogram for ion microchannel plate (MCP) anode 5, which is 1 of the 6 ion anodes (numbered 0 through 5) that read charge coming from the MCP sensor and that define the entire 160 degree field of view of the sensor for low energy ions, and each representing about 27 degrees out of the entire field of view (Recall that the Low Energy Ion directionality numbering is switched from that used for high energy ions; Section 5.2). This channel is accumulated over a time interval equal to N2 seconds, where N2 nominally 30 seconds but set via command. Histogram contains the 8 of the 16 bins shown in Table 3, with the choice of bins set by ground command. In diagnostic mode these items read zero.

#### **26. HW\_COUNT\_0**

One of 17 hardware counters selected by ground command out of a menu of 35 (All 35 are reported with high priority data: See EPSHIGH.FMT items 26 through 60). Nominally this item will contain values for Shaped\_0 counter (EPSHIGH.FMT item 38). Here the counters are accumulated over N2 seconds. An ERRATA file will be provided should the choice for this item be changed.

#### **27. HW\_COUNT\_1**

One of 17 hardware counters selected by ground command out of a menu of 35 (All 35 are reported with high priority data: See EPSHIGH.FMT items 26 through 60). Nominally this item will contain values for Shaped\_1 counter (EPSHIGH.FMT item 39). Here the counters are accumulated over N2 seconds. An ERRATA file will be provided should the choice for this item be changed.

#### **28. HW\_COUNT\_2**

One of 17 hardware counters selected by ground command out of a menu of 35 (All 35 are reported with high priority data: See EPSHIGH.FMT items 26 through 60). Nominally this item will contain values for

Shaped\_2 counter (EPSHIGH.FMT item 40). Here the counters are accumulated over N2 seconds. An ERRATA file will be provided should the choice for this item be changed.

### **29. HW\_COUNT\_3**

One of 17 hardware counters selected by ground command out of a menu of 35 (All 35 are reported with high priority data: See EPSHIGH.FMT items 26 through 60). . Nominally this item will contain values for Shaped\_3 counter (EPSHIGH.FMT item 41). Here the counters are accumulated over N2 seconds. An ERRATA file will be provided should the choice for this item be changed.

### **30. HW\_COUNT\_4**

One of 17 hardware counters selected by ground command out of a menu of 35 (All 35 are reported with high priority data: See EPSHIGH.FMT items 26 through 60). . Nominally this item will contain values for Shaped\_4 counter (EPSHIGH.FMT item 42). Here the counters are accumulated over N2 seconds. An ERRATA file will be provided should the choice for this item be changed.

### **31. HW\_COUNT\_5**

One of 17 hardware counters selected by ground command out of a menu of 35 (All 35 are reported with high priority data: See EPSHIGH.FMT items 26 through 60). . Nominally this item will contain values for Shaped\_5 counter (EPSHIGH.FMT item 44). Here the counters are accumulated over N2 seconds. An ERRATA file will be provided should the choice for this item be changed.

### **32. HW\_COUNT\_6**

One of 17 hardware counters selected by ground command out of a menu of 35 (All 35 are reported with high priority data: See EPSHIGH.FMT items 26 through 60). . Nominally this item will contain values for Shaped\_6 counter (EPSHIGH.FMT item 45). Here the counters are accumulated over N2 seconds. An ERRATA file will be provided should the choice for this item be changed.

### **33. HW\_COUNT\_7**

One of 17 hardware counters selected by ground command out of a menu of 35 (All 35 are reported with high priority data: See EPSHIGH.FMT items 26 through 60). . Nominally this item will contain values for Shaped\_7 counter (EPSHIGH.FMT item 46). Here the counters are accumulated over N2 seconds. An ERRATA file will be provided should the choice for this item be changed.

### **34. HW\_COUNT\_8**

One of 17 hardware counters selected by ground command out of a menu of 35 (All 35 are reported with high priority data: See EPSHIGH.FMT items 26 through 60). . Nominally this item will contain values for Shaped\_8 counter (EPSHIGH.FMT item 47). Here the counters are accumulated over N2 seconds. An ERRATA file will be provided should the choice for this item be changed.

### **35. HW\_COUNT\_9**

One of 17 hardware counters selected by ground command out of a menu of 35 (All 35 are reported with high priority data: See EPSHIGH.FMT items 26 through 60). . Nominally this item will contain values for Shaped\_9 counter (EPSHIGH.FMT item 48). Here the counters are accumulated over N2 seconds. An ERRATA file will be provided should the choice for this item be changed.

### **36. HW\_COUNT\_10**

One of 17 hardware counters selected by ground command out of a menu of 35 (All 35 are reported with high priority data: See EPSHIGH.FMT items 26 through 60). . Nominally this item will contain values for Shaped\_10 counter (EPSHIGH.FMT item 49). Here the counters are accumulated over N2 seconds. An ERRATA file will be provided should the choice for this item be changed.

**37. HW\_COUNT\_11**

One of 17 hardware counters selected by ground command out of a menu of 35 (All 35 are reported with high priority data: See EPSHIGH.FMT items 26 through 60). . Nominally this item will contain values for Shaped\_11 counter (EPSHIGH.FMT item 50). Here the counters are accumulated over N2 seconds. An ERRATA file will be provided should the choice for this item be changed.

**38. HW\_COUNT\_12**

One of 17 hardware counters selected by ground command out of a menu of 35 (All 35 are reported with high priority data: See EPSHIGH.FMT items 26 through 60). . Nominally this item will contain values for E\_EVT\_RT counter (EPSHIGH.FMT item 56). Here the counters are accumulated over N2 seconds. An ERRATA file will be provided should the choice for this item be changed.

**39. HW\_COUNT\_13**

One of 17 hardware counters selected by ground command out of a menu of 35 (All 35 are reported with high priority data: See EPSHIGH.FMT items 26 through 60). . Nominally this item will contain values for ION\_EVT\_RT counter (EPSHIGH.FMT item 57). Here the counters are accumulated over N2 seconds. An ERRATA file will be provided should the choice for this item be changed.

**40. HW\_COUNT\_14**

One of 17 hardware counters selected by ground command out of a menu of 35 (All 35 are reported with high priority data: See EPSHIGH.FMT items 26 through 60). . Nominally this item will contain values for START\_RT counter (EPSHIGH.FMT item 58). Here the counters are accumulated over N2 seconds. An ERRATA file will be provided should the choice for this item be changed.

**41. HW\_COUNT\_15**

One of 17 hardware counters selected by ground command out of a menu of 35 (All 35 are reported with high priority data: See EPSHIGH.FMT items 26 through 60). . Nominally this item will contain values for STOP\_RT counter (EPSHIGH.FMT item 59). Here the counters are accumulated over N2 seconds. An ERRATA file will be provided should the choice for this item be changed.

**42. HW\_COUNT\_16**

One of 17 hardware counters selected by ground command out of a menu of 35 (All 35 are reported with high priority data: See EPSHIGH.FMT items 26 through 60). . Nominally this item will contain values for VALID\_TOF\_RT counter (EPSHIGH.FMT item 60). Here the counters are accumulated over N2 seconds. An ERRATA file will be provided should the choice for this item be changed.

**43. E\_PROCESSED\_COUNT**

Number of electron events processed by the Event Processing Computer during the accumulation interval. Accumulation period is N1.

**44. HI\_ION\_PROCESSED\_COUNT**

Number of high energy ion events processed by the Event Processing Computer during the accumulation interval. Accumulation period is N1.

**45. LO\_ION\_PROCESSED\_COUNT**

Number of low energy ion events processed by the Event Processing Computer during the accumulation interval. Accumulation period is N1.

**46. PILEUP\_E\_DISCARD**

Number of electron events discarded by the Event Processing Computer due to pileup condition. Accumulation period is N1.

**47. MULTIPLE\_E\_DISCARD**

Number of electron events discarded by the Event Processing Computer due to multiple hits.  
Accumulation period is N1.

**48. PILEUP\_ION\_DISCARD**

Number of high energy ion events discarded by the Event Processing Computer due to pileup conditions.  
Accumulation period is N1.

**49. MULTIPLE\_HI\_E\_DISCARD**

Number of high energy ion events discarded by the Event Processing Computer due to multiple hits.  
Accumulation period is N1.

**8.4 EPS\_PHA.FMT Table Fields**

The following are the fields as defined by the EPS\_PHA.FMT structure file. This file defines the binary table containing the EPS Pulse Height Analysis (PHA) event data. The FSW6 upload resulted in changing the EPS PHA data format. It was decided to merge the new format with the previously existing format rather than create an entirely new EDR.

Prior to FSW6 the EPS PHA data could be one of four types: Electron PHA event, Low Energy Ion PHA event, High Energy Ion PHA event, Diagnostic PHA event. After FSW6 there are no separate event types.

There are some common fields for the PHA formats pre and post FSW6, however other fields may be unique. Fields added as a result of FSW6 are INT\_TIME, INT\_TIME\_MULTI, and ENERGY\_BIN. The EPS PHA binary table will contain all the possible fields that may be populated and will include a “Not Applicable” value when appropriate. Archive volume is optimized by defining the table structure once and providing a reference to it in the PDS label file. The fields are numbered according to their column order in the table. Data\_Type refers to the PDS standards data type for a particular column in the table.

**Table 16 EPS\_PHA.FMT Fields**

| Start Byte | Length (bytes) | Data Type            | Column Name     | Summary (see full text for column description)                     |
|------------|----------------|----------------------|-----------------|--|
| 1          | 4              | MSB Unsigned Integer | MET             | Mission Elapsed Time in seconds.                                   |
| 5          | 2              | MSB Unsigned Integer | EVENT_ID        | Identifies PHA event as one of 4 types.                            |
| 7          | 2              | MSB Unsigned Integer | INT_TIME        | Integration time in seconds.                                       |
| 9          | 2              | MSB Unsigned Integer | INT_TIME_MULTI  | Integration time multiplier.                                       |
| 11         | 2              | MSB Unsigned Integer | ENERGY_BIN      | High resolution energy bin number computed by the flight software. |
| 13         | 2              | MSB Unsigned Integer | ION_E_FLAG      | Identifies event as either electron or ion.                        |
| 15         | 4              | MSB Unsigned Integer | ENERGY_PEAK     | PHA value corresponding to the particle energy.                    |
| 19         | 4              | MSB Unsigned Integer | ENERGY_BASELINE | Baseline against which the particle energy is measured.            |
| 23         | 4              | MSB Unsigned Integer | TIME_OF_FLIGHT  | A measure of the particle's velocity.                              |

|    |   |                      |               |   |
|----|---|----------------------|---------------|---|
| 27 | 2 | MSB Unsigned Integer | MULTIPLE_HITS | Flag indicating if more than one detector received a hit. |
| 29 | 2 | MSB Unsigned Integer | HEAVY_DISC_0  | Heavy Ion level 0 discriminator level was triggered.      |
| 31 | 2 | MSB Unsigned Integer | HEAVY_DISC_1  | Heavy Ion level 1 discriminator level was triggered.      |
| 33 | 2 | MSB Unsigned Integer | CHANNEL_NUM   | Indicates the high energy ion or electron channel.        |
| 35 | 2 | MSB Unsigned Integer | START_SEGMENT | Indicates which start anode fired.                        |

### 1. MET

Mission elapsed time in seconds at the end of the accumulation. Corresponds to the MET of the original science packet. Can be used for correlation with the spectra from EPS High Medium Priority Spectra EDRs.

### 2. EVENT\_ID

PHA Event Short ID. There are 4 types: Electron, Low Energy Ion, High Energy Ion, and Diagnostic PHAs. ID =1 Low Energy Ion event, =3 Electron event, =5 High Energy Ion event, =11 Diagnostic Event. =99 (N/A) for FSW6 data.

### 3. INT\_TIME

Integration time in seconds. =0 (NA) for data created prior to FSW6.

### 4. INT\_TIME\_MULTI

Integration time multiplier. = 0 (NA) for data created prior to FSW6.

### 5. ENERGY\_BIN

High Resolution energy bin number computed by the flight software. =99 (NA) for data created prior to FSW6.

### 6. ION\_E\_FLAG

Identifies event as either ion or electron. =0 electron, =1 ion.

### 7. ENERGY\_PEAK

Pulse Height Analysis (PHA) value corresponding to the particle energy. Energy Peak. =0 (NA) for Low Energy Ion PHA.

### 8. ENERGY\_BASELINE

Pulse Height Analysis (PHA) value corresponding to the baseline against which the particle energy is measured. Energy Baseline. = 0 (NA) for Low Energy Ion PHA.

### 9. TIME\_OF\_FLIGHT

Pulse Height Analysis (PHA) value corresponding to the time it takes the particle to pass through the sensor (a measure of the particle's velocity). Time of Flight. =0 (NA) for Electron or Diagnostic PHAs or FSW6 data.

### 10. MULTIPLE\_HITS

A flag that indicates that more than one detector received a hit. = 99 (NA) for Low Energy Ion PHA.

### 11. HEAVY\_DISC\_0

=1 indicates that the pulse height on the STOP microchannel plate (MCP) anode was large enough to fire the heavy ion level 0 discriminator level, a level that is higher than the minimal level set just above the MCP noise. =99 (NA) for Electron or Diagnostic PHAs or FSW6 data.



**12. HEAVY\_DISC\_1**

=11 indicates that the pulse height on the STOP microchannel plate (MCP) anode was large enough to fire the heavy ion level 1 discriminator level, a level that is higher than the minimal level set just above the MCP noise and higher than the “heavy ion level 0” level. =99 (NA) for Electron or Diagnostic PHAs or FSW6 data.

**13. CHANNEL\_NUM**

Indicates the high energy ion or electron channel (0 through 5, indicating directionality within the 160 degree sensor field of view; Section 5.2). = 99 (NA) for Low Energy Ion PHA.

**14. START\_SEGMENT**

Indicates which START anode (0 through 5, indicating directionality within the 160 degree sensor field of view; recall that the Low Energy Ion directionality numbering – anode number --is switched from that used for high energy ions; Section 5.2). Start segment. =99 (NA) for Electron PHAs and for the other types of PHAs if none of the start anodes fired, or for FSW6 data.

**8.5 EPS\_HIRES.FMT Table Fields**

The following are the fields as defined by the EPS\_HIRES.FMT structure file. This file defines the binary table containing the EPS High Resolution Spectra data. This is a new EDR created as a result of the FSW6 upload.

**Table 17 EPS\_HIRES.FMT Fields**

| Start Byte | Length (bytes) | Data Type            | Column Name    | Summary (see full text for column description) |
|------------|----------------|----------------------|----------------|--|
| 1          | 4              | MSB Unsigned Integer | MET            | Time tag in seconds.                           |
| 5          | 2              | MSB Unsigned Integer | INT_TIME       | Integration time in seconds.                   |
| 7          | 2              | MSB Unsigned Integer | INT_TIME_MULTI | Integration time multiplier.                   |
| 9          | 4 X 36         | MSB Unsigned Integer | ION_SPECTRA_0  | Hi-res ion energy spectra, sector 0.           |
| 153        | 4 X 36         | MSB Unsigned Integer | ION_SPECTRA_1  | Hi-res ion energy spectra, sector 1.           |
| 297        | 4 X 36         | MSB Unsigned Integer | ION_SPECTRA_2  | Hi-res ion energy spectra, sector 2.           |
| 441        | 4 X 36         | MSB Unsigned Integer | ION_SPECTRA_3  | Hi-res ion energy spectra, sector 3.           |
| 585        | 4 X 36         | MSB Unsigned Integer | ION_SPECTRA_4  | Hi-res ion energy spectra, sector 4.           |
| 729        | 4 X 36         | MSB Unsigned Integer | ION_SPECTRA_5  | Hi-res ion energy spectra, sector 5.           |
| 873        | 4 X 36         | MSB Unsigned Integer | E_SPECTRA_0    | Hi-res electron energy spectra, sector 0.      |
| 1017       | 4 X 36         | MSB Unsigned Integer | E_SPECTRA_1    | Hi-res electron energy spectra, sector 1.      |
| 1161       | 4 X 36         | MSB Unsigned Integer | E_SPECTRA_2    | Hi-res electron energy spectra, sector 2.      |
| 1305       | 4 X 36         | MSB Unsigned Integer | E_SPECTRA_3    | Hi-res electron energy spectra, sector 3.      |
| 1449       | 4 X 36         | MSB Unsigned Integer | E_SPECTRA_4    | Hi-res electron energy spectra, sector 4.      |
| 1593       | 4 X 36         | MSB Unsigned Integer | E_SPECTRA_5    | Hi-res electron energy spectra, sector 5.      |

**1. MET**

Time tag in seconds.

**2. INT\_TIME**

Integration time in seconds.

**3. INT\_TIME\_MULTI**

Integration time multiplier.

**4. ION\_SPECTRA\_0**

High resolution ion energy spectra, sector 0.

**5. ION\_SPECTRA\_1**

High resolution ion energy spectra, sector 1.

**6. ION\_SPECTRA\_2**

High resolution ion energy spectra, sector 2.

**7. ION\_SPECTRA\_3**

High resolution ion energy spectra, sector 3.

**8. ION\_SPECTRA\_4**

High resolution ion energy spectra, sector 4.

**9. ION\_SPECTRA\_5**

High resolution ion energy spectra, sector 5.

**10. E\_SPECTRA\_0**

High resolution electron energy spectra, sector 0.

**11. E\_SPECTRA\_1**

High resolution electron energy spectra, sector 1.

**12. E\_SPECTRA\_2**

High resolution electron energy spectra, sector 2.

**13. E\_SPECTRA\_3**

High resolution electron energy spectra, sector 3.

**14. E\_SPECTRA\_4**

High resolution electron energy spectra, sector 4.

**15. E\_SPECTRA\_5**

High resolution electron energy spectra, sector 5.

**8.6 EPS\_LORES.FMT Table Fields**

The following are the fields as defined by the EPS\_LORES.FMT structure file. This file defines the binary table containing the EPS Low Resolution Spectra data. This is a new EDR created as a result of the FSW6 upload.

**Table 18 EPS\_LORES.FMT Fields**

| <b>Start Byte</b> | <b>Length (bytes)</b> | <b>Data Type</b>     | <b>Column Name</b> | <b>Summary (see full text for column description)</b>           |
|-------------------|-----------------------|----------------------|--------------------|---|
| 1                 | 4                     | MSB Unsigned Integer | MET                | Time tag in seconds.  |
| 5                 | 2                     | MSB Unsigned Integer | INT_TIME           | Integration time in seconds.                                    |
| 7                 | 4 X 12                | MSB Unsigned Integer | ION_SPECTRA_A_0    | Lo-res ion energy spectra, first int, sector 0.                 |
| 55                | 4 X 12                | MSB Unsigned Integer | ION_SPECTRA_A_1    | Low-resolution ion energy spectra, first integration, sector 1. |
| 103               | 4 X 12                | MSB Unsigned Integer | ION_SPECTRA_A_2    | Low-resolution ion energy spectra, first integration, sector 2. |
| 151               | 4 X 12                | MSB Unsigned Integer | ION_SPECTRA_A_3    | Low-resolution ion energy spectra, first integration, sector 3. |

|     |        |                      |                 |  |
|-----|--------|----------------------|-----------------|--|
| 199 | 4 X 12 | MSB Unsigned Integer | ION_SPECTRA_A_4 | Low-resolution ion energy spectra, first integration, sector 4.          |
| 247 | 4 X 12 | MSB Unsigned Integer | ION_SPECTRA_A_5 | Low-resolution ion energy spectra, first integration, sector 5.          |
| 295 | 4 X 12 | MSB Unsigned Integer | E_SPECTRA_A_0   | Low-resolution electron energy spectra, first integration, sector 0.     |
| 343 | 4 X 12 | MSB Unsigned Integer | E_SPECTRA_A_1   | Low-resolution electron energy spectra, first integration, sector 1.     |
| 391 | 4 X 12 | MSB Unsigned Integer | E_SPECTRA_A_2   | Low-resolution electron energy spectra, first integration, sector 2.     |
| 439 | 4 X 12 | MSB Unsigned Integer | E_SPECTRA_A_3   | Low-resolution electron energy spectra, first integration, sector 3.     |
| 487 | 4 X 12 | MSB Unsigned Integer | E_SPECTRA_A_4   | Low-resolution electron energy spectra, first integration, sector 4.     |
| 535 | 4 X 12 | MSB Unsigned Integer | E_SPECTRA_A_5   | Low-resolution electron energy spectra, first integration, sector 5.     |
| 583 | 4      | MSB Unsigned Integer | HW_FAST_A_0     | Threshold counts of pole-zero shaping circuit, first int, sector 0.      |
| 587 | 4      | MSB Unsigned Integer | HW_FAST_A_1     | Threshold counts of pole-zero shaping circuit, first int, sector 1.      |
| 591 | 4      | MSB Unsigned Integer | HW_FAST_A_2     | Threshold counts of pole-zero shaping circuit, first int, sector 2.      |
| 595 | 4      | MSB Unsigned Integer | HW_FAST_A_3     | Threshold counts of pole-zero shaping circuit, first int, sector 3.      |
| 599 | 4      | MSB Unsigned Integer | HW_FAST_A_4     | Threshold counts of pole-zero shaping circuit, first int, sector 4.      |
| 603 | 4      | MSB Unsigned Integer | HW_FAST_A_5     | Threshold counts of pole-zero shaping circuit, first int, sector 5.      |
| 607 | 4      | MSB Unsigned Integer | HW_FAST_A_6     | Threshold counts of pole-zero shaping circuit, first int, sector 6.      |
| 611 | 4      | MSB Unsigned Integer | HW_FAST_A_7     | Threshold counts of pole-zero shaping circuit, first int, sector 7.      |
| 615 | 4      | MSB Unsigned Integer | HW_FAST_A_8     | Threshold counts of pole-zero shaping circuit, first int, sector 8.      |
| 619 | 4      | MSB Unsigned Integer | HW_FAST_A_9     | Threshold counts of pole-zero shaping circuit, first int, sector 9.      |
| 623 | 4      | MSB Unsigned Integer | HW_FAST_A_10    | Threshold counts of pole-zero shaping circuit, first int, sector 10.     |
| 627 | 4      | MSB Unsigned Integer | HW_FAST_A_11    | Threshold counts of pole-zero shaping circuit, first int, sector 11.     |
| 631 | 4      | MSB Unsigned Integer | HW_SHAPED_A_0   | Threshold counts of 3 pole Gaussian shaping circuit, first int, sector 0 |
| 635 | 4      | MSB Unsigned Integer | HW_SHAPED_A_1   | Threshold counts of 3 pole Gaussian shaping circuit, first int, sector 1 |
| 639 | 4      | MSB Unsigned Integer | HW_SHAPED_A_2   | Threshold counts of 3 pole Gaussian shaping circuit, first int, sector 2 |
| 643 | 4      | MSB Unsigned Integer | HW_SHAPED_A_3   | Threshold counts of 3 pole Gaussian shaping circuit, first int, sector 3 |
| 647 | 4      | MSB Unsigned Integer | HW_SHAPED_A_4   | Threshold counts of 3 pole Gaussian shaping circuit, first int, sector 4 |
| 651 | 4      | MSB Unsigned Integer | HW_SHAPED_A_5   | Threshold counts of 3 pole Gaussian shaping circuit, first int, sector 5 |
| 655 | 4      | MSB Unsigned Integer | HW_SHAPED_A_6   | Threshold counts of 3 pole Gaussian shaping circuit, first int, sector 6 |
| 659 | 4      | MSB Unsigned Integer | HW_SHAPED_A_7   | Threshold counts of 3 pole Gaussian shaping circuit, first int, sector 7 |

|      |        |                      |                 |   |
|------|--------|----------------------|-----------------|---|
| 663  | 4      | MSB Unsigned Integer | HW_SHAPED_A_8   | Threshold counts of 3 pole Gaussian shaping circuit, first int, sector 8  |
| 667  | 4      | MSB Unsigned Integer | HW_SHAPED_A_9   | Threshold counts of 3 pole Gaussian shaping circuit, first int, sector 9  |
| 671  | 4      | MSB Unsigned Integer | HW_SHAPED_A_10  | Threshold counts of 3 pole Gaussian shaping circuit, first int, sector 10 |
| 675  | 4      | MSB Unsigned Integer | HW_SHAPED_A_11  | Threshold counts of 3 pole Gaussian shaping circuit, first int, sector 11 |
| 679  | 4      | MSB Unsigned Integer | HW_ION_EVT_A    | Valid ion events, first int.  |
| 683  | 4      | MSB Unsigned Integer | HW_E_EVT_A      | Valid electron events, first int.   |
| 687  | 4      | MSB Unsigned Integer | SW_ION_PROC_A   | Ions processed, first integration.  |
| 691  | 4      | MSB Unsigned Integer | SW_E_PROC_A     | Electrons processed, first int.   |
| 695  | 4      | MSB Unsigned Integer | SW_ION_PILEUP_A | Ions rejected due to pileup, first int.                                   |
| 699  | 4      | MSB Unsigned Integer | SW_E_PILEUP_A   | Electrons rejected due to pileup, first int.                              |
| 703  | 4      | MSB Unsigned Integer | SW_ION_REJ_A    | Ions rejected due to negative energy, first int.                          |
| 707  | 4      | MSB Unsigned Integer | SW_E_REJ_A      | Electrons rejected due to negative energy, first int.                     |
| 711  | 4      | MSB Unsigned Integer | SW_MULTIHIT_A   | Ion or electron events rejected due to multi-hits, first int.             |
| 715  | 4 X 12 | MSB Unsigned Integer | ION_SPECTRA_B_0 | Low-resolution ion energy spectra, 2nd integration, sector 0.             |
| 763  | 4 X 12 | MSB Unsigned Integer | ION_SPECTRA_B_1 | Low-resolution ion energy spectra, 2nd integration, sector 1.             |
| 811  | 4 X 12 | MSB Unsigned Integer | ION_SPECTRA_B_2 | Low-resolution ion energy spectra, 2nd integration, sector 2.             |
| 859  | 4 X 12 | MSB Unsigned Integer | ION_SPECTRA_B_3 | Low-resolution ion energy spectra, 2nd integration, sector 3.             |
| 907  | 4 X 12 | MSB Unsigned Integer | ION_SPECTRA_B_4 | Low-resolution ion energy spectra, 2nd integration, sector 4.             |
| 955  | 4 X 12 | MSB Unsigned Integer | ION_SPECTRA_B_5 | Low-resolution ion energy spectra, 2nd integration, sector 5.             |
| 1003 | 4 X 12 | MSB Unsigned Integer | E_SPECTRA_B_0   | Low-resolution electron energy spectra, 2nd integration, sector 0.        |
| 1051 | 4 X 12 | MSB Unsigned Integer | E_SPECTRA_B_1   | Low-resolution electron energy spectra, 2nd integration, sector 1.        |
| 1099 | 4 X 12 | MSB Unsigned Integer | E_SPECTRA_B_2   | Low-resolution electron energy spectra, 2nd integration, sector 2.        |
| 1147 | 4 X 12 | MSB Unsigned Integer | E_SPECTRA_B_3   | Low-resolution electron energy spectra, 2nd integration, sector 3.        |
| 1195 | 4 X 12 | MSB Unsigned Integer | E_SPECTRA_B_4   | Low-resolution electron energy spectra, 2nd integration, sector 4.        |
| 1243 | 4 X 12 | MSB Unsigned Integer | E_SPECTRA_B_5   | Low-resolution electron energy spectra, 2nd integration, sector 5.        |
| 1291 | 4      | MSB Unsigned Integer | HW_FAST_B_0     | Threshold counts of pole-zero shaping circuit, 2nd int, sector 0.         |
| 1295 | 4      | MSB Unsigned Integer | HW_FAST_B_1     | Threshold counts of pole-zero shaping circuit, 2nd int, sector 1.         |
| 1299 | 4      | MSB Unsigned Integer | HW_FAST_B_2     | Threshold counts of pole-zero shaping circuit, 2nd int, sector 2.         |
| 1303 | 4      | MSB Unsigned Integer | HW_FAST_B_3     | Threshold counts of pole-zero shaping circuit, 2nd int, sector 3.         |
| 1307 | 4      | MSB Unsigned Integer | HW_FAST_B_4     | Threshold counts of pole-zero shaping circuit, 2nd int, sector 4.         |
| 1311 | 4      | MSB Unsigned Integer | HW_FAST_B_5     | Threshold counts of pole-zero   |

|      |   |                      |                 |  |
|------|---|----------------------|-----------------|--|
|      |   |                      |                 | shaping circuit, 2nd int, sector 5.                                      |
| 1315 | 4 | MSB Unsigned Integer | HW_FAST_B_6     | Threshold counts of pole-zero shaping circuit, 2nd int, sector 6.        |
| 1319 | 4 | MSB Unsigned Integer | HW_FAST_B_7     | Threshold counts of pole-zero shaping circuit, 2nd int, sector 7.        |
| 1323 | 4 | MSB Unsigned Integer | HW_FAST_B_8     | Threshold counts of pole-zero shaping circuit, 2nd int, sector 8.        |
| 1327 | 4 | MSB Unsigned Integer | HW_FAST_B_9     | Threshold counts of pole-zero shaping circuit, 2nd int, sector 9.        |
| 1331 | 4 | MSB Unsigned Integer | HW_FAST_B_10    | Threshold counts of pole-zero shaping circuit, 2nd int, sector 10.       |
| 1335 | 4 | MSB Unsigned Integer | HW_FAST_B_11    | Threshold counts of pole-zero shaping circuit, 2nd int, sector 11.       |
| 1339 | 4 | MSB Unsigned Integer | HW_SHAPED_B_0   | Threshold counts of 3 pole Gaussian shaping circuit, 2nd int, sector 0.  |
| 1343 | 4 | MSB Unsigned Integer | HW_SHAPED_B_1   | Threshold counts of 3 pole Gaussian shaping circuit, 2nd int, sector 1.  |
| 1347 | 4 | MSB Unsigned Integer | HW_SHAPED_B_2   | Threshold counts of 3 pole Gaussian shaping circuit, 2nd int, sector 2.  |
| 1351 | 4 | MSB Unsigned Integer | HW_SHAPED_B_3   | Threshold counts of 3 pole Gaussian shaping circuit, 2nd int, sector 3.  |
| 1355 | 4 | MSB Unsigned Integer | HW_SHAPED_B_4   | Threshold counts of 3 pole Gaussian shaping circuit, 2nd int, sector 4.  |
| 1359 | 4 | MSB Unsigned Integer | HW_SHAPED_B_5   | Threshold counts of 3 pole Gaussian shaping circuit, 2nd int, sector 5.  |
| 1363 | 4 | MSB Unsigned Integer | HW_SHAPED_B_6   | Threshold counts of 3 pole Gaussian shaping circuit, 2nd int, sector 6.  |
| 1367 | 4 | MSB Unsigned Integer | HW_SHAPED_B_7   | Threshold counts of 3 pole Gaussian shaping circuit, 2nd int, sector 7.  |
| 1371 | 4 | MSB Unsigned Integer | HW_SHAPED_B_8   | Threshold counts of 3 pole Gaussian shaping circuit, 2nd int, sector 8.  |
| 1375 | 4 | MSB Unsigned Integer | HW_SHAPED_B_9   | Threshold counts of 3 pole Gaussian shaping circuit, 2nd int, sector 9.  |
| 1379 | 4 | MSB Unsigned Integer | HW_SHAPED_B_10  | Threshold counts of 3 pole Gaussian shaping circuit, 2nd int, sector 10. |
| 1383 | 4 | MSB Unsigned Integer | HW_SHAPED_B_11  | Threshold counts of 3 pole Gaussian shaping circuit, 2nd int, sector 11. |
| 1387 | 4 | MSB Unsigned Integer | HW_ION_EVT_B    | Valid ion events, 2nd int.   |
| 1391 | 4 | MSB Unsigned Integer | HW_E_EVT_B      | Valid electron events, 2nd int.  |
| 1395 | 4 | MSB Unsigned Integer | SW_ION_PROC_B   | Ions processed, counter, 2nd int.  |
| 1399 | 4 | MSB Unsigned Integer | SW_E_PROC_B     | Electrons processed, 2nd int.  |
| 1403 | 4 | MSB Unsigned Integer | SW_ION_PILEUP_B | Ions rejected due to pileup, 2nd int.                                    |
| 1407 | 4 | MSB Unsigned Integer | SW_E_PILEUP_B   | Electrons rejected due to pileup, 2nd int.                               |
| 1411 | 4 | MSB Unsigned Integer | SW_ION_REJ_B    | Ions rejected due to negative energy, 2nd int.                           |
| 1415 | 4 | MSB Unsigned Integer | SW_E_REJ_B      | Electrons rejected due to negative energy, 2nd int.                      |
| 1419 | 4 | MSB Unsigned Integer | SW_MULTIHIT_B   | Ion or electron events rejected due to multi-hits, 2nd int.              |

## 1. MET

Mission elapsed time, in seconds.

## 2. INT\_TIME

Integration time in seconds.

**3. ION\_SPECTRA\_A\_0**

Low-resolution ion energy spectra, first integration, sector 0.

**4. ION\_SPECTRA\_A\_1**

Low-resolution ion energy spectra, first integration, sector 1.

**5. ION\_SPECTRA\_A\_2**

Low-resolution ion energy spectra, first integration, sector 2.

**6. ION\_SPECTRA\_A\_3**

Low-resolution ion energy spectra, first integration, sector 3.

**7. ION\_SPECTRA\_A\_4**

Low-resolution ion energy spectra, first integration, sector 4.

**8. ION\_SPECTRA\_A\_5**

Low-resolution ion energy spectra, first integration, sector 5.

**9. E\_SPECTRA\_A\_0**

Low- resolution electron energy spectra, sector 0.

**10. E\_SPECTRA\_A\_1**

Low- resolution electron energy spectra, sector 1.

**11. E\_SPECTRA\_A\_2**

Low- resolution electron energy spectra, sector 2.

**12. E\_SPECTRA\_A\_3**

Low- resolution electron energy spectra, sector 3.

**13. E\_SPECTRA\_A\_4**

Low- resolution electron energy spectra, sector 4.

**14. E\_SPECTRA\_A\_5**

Low- resolution electron energy spectra, sector 5.

**15. HW\_FAST\_A\_0**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 0, first integration.

**16. HW\_FAST\_A\_1**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 1, first integration.

**17. HW\_FAST\_A\_2**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 2, first integration.

**18. HW\_FAST\_A\_3**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 3, first integration.

**19. HW\_FAST\_A\_4**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 4, first integration.

**20. HW\_FAST\_A\_5**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 5, first integration.

**21. HW\_FAST\_A\_6**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 6, first integration.

**22. HW\_FAST\_A\_7**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 7, first integration.

**23. HW\_FAST\_A\_8**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 8, first integration.

**24. HW\_FAST\_A\_9**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 9, first integration.

**25. HW\_FAST\_A\_10**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 10, first integration.

**26. HW\_FAST\_A\_11**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 11, first integration.

**27. HW\_SHAPED\_A\_0**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 0, first integration.

**28. HW\_SHAPED\_A\_1**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 1, first integration.

**29. HW\_SHAPED\_A\_2**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 2, first integration.

**30. HW\_SHAPED\_A\_3**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 3, first integration.

**31. HW\_SHAPED\_A\_4**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 4, first integration.

**32. HW\_SHAPED\_A\_5**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 5, first integration.

**33. HW\_SHAPED\_A\_6**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 6, first integration.

**34. HW\_SHAPED\_A\_7**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 7, first integration.

**35. HW\_SHAPED\_A\_8**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 8, first integration.

**36. HW\_SHAPED\_A\_9**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 9, first integration.

**37. HW\_SHAPED\_A\_10**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 10, first integration.

**38. HW\_SHAPED\_A\_11**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 11, first integration.

**39. HW\_ION\_EVT\_A**

Counts the occurrence of a valid ion event, as determined by the Field Programmable Gate Array (FPGA)-based valid event logic. The event is counted even if the event information packet is unable to be placed in the First-in, First-out component (FIFO). First integration.

**40. HW\_E\_EVT\_A**

Counts the occurrence of a valid electron event, as determined by the Field Programmable Gate Array (FPGA)-based valid event logic. The event is counted even if the event information packet is unable to be placed in the First-in, First-out component (FIFO). First integration.

**41. SW\_ION\_PROC\_A**

Ions processed; software counter. First integration.

**42. SW\_E\_PROC\_A**

Electrons processed; software counter. First integration.

**43. SW\_ION\_PILEUP\_A**

Ions rejected due to pileup; software counter. First integration.

**44. SW\_E\_PILEUP\_A**

Electrons rejected due to pileup; software counter. First integration.

**45. SW\_ION\_REJ\_A**

Ions rejected due to negative energy; software counter. First integration.

**46. SW\_E\_REJ\_A**

Electrons rejected due to negative energy; software counter. First integration.

**47. SW\_MULTIHIT\_A**



Ion or electron events rejected due to multiple hit; software counter. First integration.

**48. ION\_SPECTRA\_B\_0**

Low-resolution ion energy spectra; second integration; sector 0.

**49. ION\_SPECTRA\_B\_1**

Low-resolution ion energy spectra; second integration; sector 1.

**50. ION\_SPECTRA\_B\_2**

Low-resolution ion energy spectra; second integration; sector 2.

**51. ION\_SPECTRA\_B\_3**

Low-resolution ion energy spectra; second integration; sector 3.

**52. ION\_SPECTRA\_B\_4**

Low-resolution ion energy spectra; second integration; sector 4.

**53. ION\_SPECTRA\_B\_5**

Low-resolution ion energy spectra; second integration; sector 5.

**54. E\_SPECTRA\_B\_0**

Low-resolution electron energy spectra; second integration; sector 0.

**55. E\_SPECTRA\_B\_1**

Low-resolution electron energy spectra; second integration; sector 1.

**56. E\_SPECTRA\_B\_2**

Low-resolution electron energy spectra; second integration; sector 2.

**57. E\_SPECTRA\_B\_3**

Low-resolution electron energy spectra; second integration; sector 3.

**58. E\_SPECTRA\_B\_4**

Low-resolution electron energy spectra; second integration; sector 4.

**59. E\_SPECTRA\_B\_5**

Low-resolution electron energy spectra; second integration; sector 5.

**60. HW\_FAST\_B\_0**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 0, second integration.

**61. HW\_FAST\_B\_1**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 1, second integration.

**62. HW\_FAST\_B\_2**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 2, second integration.

**63. HW\_FAST\_B\_3**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 3, second integration.

**64. HW\_FAST\_B\_4**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 4, second integration.

**65. HW\_FAST\_B\_5**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 5, second integration.

**66. HW\_FAST\_B\_6**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 6, second integration.

**67. HW\_FAST\_B\_7**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 7, second integration.

**68. HW\_FAST\_B\_8**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 8, second integration.

**69. HW\_FAST\_B\_9**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 9, second integration.

**70. HW\_FAST\_B\_10**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 10, second integration.

**71. HW\_FAST\_B\_11**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 11, second integration.

**72. HW\_SHAPED\_B\_0**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 0, second integration.

**73. HW\_SHAPED\_B\_1**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 1, second integration.

**74. HW\_SHAPED\_B\_2**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 2, second integration.

**75. HW\_SHAPED\_B\_3**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 3, second integration.

**76. HW\_SHAPED\_B\_4**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 4, second integration.

**77. HW\_SHAPED\_B\_5**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 5, second integration.

**78. HW\_SHAPED\_B\_6**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 6, second integration.

**79. HW\_SHAPED\_B\_7**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 7, second integration.

**80. HW\_SHAPED\_B\_8**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 8, second integration.

**81. HW\_SHAPED\_B\_9**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 9, second integration.

**82. HW\_SHAPED\_B\_10**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 10, second integration.

**83. HW\_SHAPED\_B\_11**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 11, second integration.

**84. HW\_ION\_EVT\_B**

Counts the occurrence of a valid ion event, as determined by the FPGA-based valid event logic. The event is counted even if the event information packet is unable to be placed in the FIFO. Second integration.

**85. HW\_E\_EVT\_B**

Counts the occurrence of a valid electron event, as determined by the FPGA-based valid event logic. The event is counted even if the event information packet is unable to be placed in the FIFO. Second integration.

**86. SW\_ION\_PROC\_B**

Ions processed, software counter. Second integration.

**87. SW\_E\_PROC\_B**

Electrons processed, software counter. Second integration.

**88. SW\_ION\_PILEUP\_B**

Ions rejected due to pileup, software counter. Second integration.

**89. SW\_E\_PILEUP\_B**

Electrons rejected due to pileup, software counter. Second integration.

**90. SW\_ION\_REJ\_B**

Ions rejected due to negative energy, software counter. Second integration.

**91. SW\_E\_REJ\_B**

Electrons rejected due to negative energy, software counter. Second integration.

**92. SW\_MULTIHIT\_B**

Ion or electron events rejected due to multiple hit, software counter. Second integration.

### 8.7 EPS\_SUM.FMT Table Fields

The following are the fields as defined by the EPS\_SUM.FMT structure file. This file defines the binary table containing the EPS Summary Spectra data. This is a new EDR created as a result of the FSW6 upload.

**Table 19 EPS\_SUM.FMT Fields**

| Start Byte | Length (bytes) | Data Type            | Column Name    | Summary (see full text for column description)                |
|------------|----------------|----------------------|----------------|---|
| 1          | 4              | MSB Unsigned Integer | MET            | Time tag in seconds.  |
| 5          | 2              | MSB Unsigned Integer | INT_TIME       | Integration time in seconds.                                  |
| 7          | 2              | MSB Unsigned Integer | INT_TIME_MULTI | Integration time multiplier.                                  |
| 9          | 4 X 12         | MSB Unsigned Integer | ION_SPECTRA_0  | Lo-res ion energy spectra, sector 0.                          |
| 57         | 4 X 12         | MSB Unsigned Integer | ION_SPECTRA_1  | Lo-res ion energy spectra, sector 1.                          |
| 105        | 4 X 12         | MSB Unsigned Integer | ION_SPECTRA_2  | Lo-res ion energy spectra, sector 2.                          |
| 153        | 4 X 12         | MSB Unsigned Integer | ION_SPECTRA_3  | Lo-res ion energy spectra, sector 3.                          |
| 201        | 4 X 12         | MSB Unsigned Integer | ION_SPECTRA_4  | Lo-res ion energy spectra, sector 4.                          |
| 249        | 4 X 12         | MSB Unsigned Integer | ION_SPECTRA_5  | Lo-res ion energy spectra, sector 5.                          |
| 297        | 4 X 12         | MSB Unsigned Integer | E_SPECTRA_0    | Lo-res electron energy spectra, sector 0.                     |
| 345        | 4 X 12         | MSB Unsigned Integer | E_SPECTRA_1    | Lo-res electron energy spectra, sector 1.                     |
| 393        | 4 X 12         | MSB Unsigned Integer | E_SPECTRA_2    | Lo-res electron energy spectra, sector 2.                     |
| 441        | 4 X 12         | MSB Unsigned Integer | E_SPECTRA_3    | Lo-res electron energy spectra, sector 3.                     |
| 489        | 4 X 12         | MSB Unsigned Integer | E_SPECTRA_4    | Lo-res electron energy spectra, sector 4.                     |
| 537        | 4 X 12         | MSB Unsigned Integer | E_SPECTRA_5    | Lo-res electron energy spectra, sector 5.                     |
| 585        | 4              | MSB Unsigned Integer | HW_FAST_0      | Threshold counts of pole-zero shaping circuit, sector 1.      |
| 589        | 4              | MSB Unsigned Integer | HW_FAST_1      | Threshold counts of pole-zero shaping circuit, sector 2.      |
| 593        | 4              | MSB Unsigned Integer | HW_FAST_2      | Threshold counts of pole-zero shaping circuit, sector 3.      |
| 597        | 4              | MSB Unsigned Integer | HW_FAST_3      | Threshold counts of pole-zero shaping circuit, sector 4.      |
| 601        | 4              | MSB Unsigned Integer | HW_FAST_4      | Threshold counts of pole-zero shaping circuit, sector 5.      |
| 605        | 4              | MSB Unsigned Integer | HW_FAST_5      | Threshold counts of pole-zero shaping circuit, sector 6.      |
| 609        | 4              | MSB Unsigned Integer | HW_FAST_6      | Threshold counts of pole-zero shaping circuit, sector 7.      |
| 613        | 4              | MSB Unsigned Integer | HW_FAST_7      | Threshold counts of pole-zero shaping circuit, sector 8.      |
| 617        | 4              | MSB Unsigned Integer | HW_FAST_8      | Threshold counts of pole-zero shaping circuit, sector 9.      |
| 621        | 4              | MSB Unsigned Integer | HW_FAST_9      | Threshold counts of pole-zero shaping circuit, sector 10.     |
| 625        | 4              | MSB Unsigned Integer | HW_FAST_10     | Threshold counts of pole-zero shaping circuit, sector 10.     |
| 629        | 4              | MSB Unsigned Integer | HW_FAST_11     | Threshold counts of pole-zero shaping circuit, sector 11.     |
| 633        | 4              | MSB Unsigned Integer | HW_SHAPED_0    | Threshold counts of 3 pole Gaussian shaping circuit, sector 0 |
| 637        | 4              | MSB Unsigned Integer | HW_SHAPED_1    | Threshold counts of 3 pole Gaussian shaping circuit, sector 1 |

|     |   |                      |               |  |
|-----|---|----------------------|---------------|--|
| 641 | 4 | MSB Unsigned Integer | HW_SHAPED_2   | Threshold counts of 3 pole Gaussian shaping circuit, sector 2  |
| 645 | 4 | MSB Unsigned Integer | HW_SHAPED_3   | Threshold counts of 3 pole Gaussian shaping circuit, sector 3  |
| 649 | 4 | MSB Unsigned Integer | HW_SHAPED_4   | Threshold counts of 3 pole Gaussian shaping circuit, sector 4  |
| 653 | 4 | MSB Unsigned Integer | HW_SHAPED_5   | Threshold counts of 3 pole Gaussian shaping circuit, sector 5  |
| 657 | 4 | MSB Unsigned Integer | HW_SHAPED_6   | Threshold counts of 3 pole Gaussian shaping circuit, sector 6  |
| 661 | 4 | MSB Unsigned Integer | HW_SHAPED_7   | Threshold counts of 3 pole Gaussian shaping circuit, sector 7  |
| 665 | 4 | MSB Unsigned Integer | HW_SHAPED_8   | Threshold counts of 3 pole Gaussian shaping circuit, sector 8  |
| 669 | 4 | MSB Unsigned Integer | HW_SHAPED_9   | Threshold counts of 3 pole Gaussian shaping circuit, sector 9  |
| 673 | 4 | MSB Unsigned Integer | HW_SHAPED_10  | Threshold counts of 3 pole Gaussian shaping circuit, sector 10 |
| 677 | 4 | MSB Unsigned Integer | HW_SHAPED_11  | Threshold counts of 3 pole Gaussian shaping circuit, sector 11 |
| 681 | 4 | MSB Unsigned Integer | HW_ION_EVT    | Valid ion events.  |
| 685 | 4 | MSB Unsigned Integer | HW_E_EVT      | Valid electron events.   |
| 689 | 4 | MSB Unsigned Integer | SW_ION_PROC   | Ions processed.  |
| 693 | 4 | MSB Unsigned Integer | SW_E_PROC     | Electrons processed.   |
| 697 | 4 | MSB Unsigned Integer | SW_ION_PILEUP | Ions rejected due to pileup.                                   |
| 701 | 4 | MSB Unsigned Integer | SW_E_PILEUP   | Electrons rejected due to pileup.                              |
| 705 | 4 | MSB Unsigned Integer | SW_ION_REJ    | Ions rejected due to negative energy.                          |
| 709 | 4 | MSB Unsigned Integer | SW_E_REJ      | Electrons rejected due to negative energy.                     |
| 713 | 4 | MSB Unsigned Integer | SW_MULTIHIT   | Ion or electron events rejected due to multi-hits.             |

**1. MET**

Time tag in seconds.

**2. INT\_TIME**

Integration time in seconds.

**3. INT\_TIME\_MULTI**

Integration time multiplier.

**4. ION\_SPECTRA\_0**

Low-resolution ion energy spectra, sector 0.

**5. ION\_SPECTRA\_1**

Low-resolution ion energy spectra, sector 1.

**6. ION\_SPECTRA\_2**

Low-resolution ion energy spectra, sector 2.

**7. ION\_SPECTRA\_3**

Low-resolution ion energy spectra, sector 3.

**8. ION\_SPECTRA\_4**

Low-resolution ion energy spectra, sector 4.

**9. ION\_SPECTRA\_5**

Low-resolution ion energy spectra, sector 5.

**10. E\_SPECTRA\_0**

Low-resolution electron energy spectra, sector 0.

**11. E\_SPECTRA\_1**

Low-resolution electron energy spectra, sector 1.

**12. E\_SPECTRA\_2**

Low-resolution electron energy spectra, sector 2.

**13. E\_SPECTRA\_3**

Low-resolution electron energy spectra, sector 3.

**14. E\_SPECTRA\_4**

Low-resolution electron energy spectra, sector 4.

**15. E\_SPECTRA\_5**

Low-resolution electron energy spectra, sector 5.

**16. HW\_FAST\_0**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 0.

**17. HW\_FAST\_1**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 1.

**18. HW\_FAST\_2**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 2.

**19. HW\_FAST\_3**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 3.

**20. HW\_FAST\_4**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 4.

**21. HW\_FAST\_5**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 5.

**22. HW\_FAST\_6**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 6.

**23. HW\_FAST\_7**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 7.

**24. HW\_FAST\_8**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 8.

**25. HW\_FAST\_9**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 9.

**26. HW\_FAST\_10**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 10.

**27. HW\_FAST\_11**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 11.

**28. HW\_SHAPED\_0**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 0.

**29. HW\_SHAPED\_1**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 1.

**30. HW\_SHAPED\_2**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 2.

**31. HW\_SHAPED\_3**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 3.

**32. HW\_SHAPED\_4**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 4.

**33. HW\_SHAPED\_5**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 5.

**34. HW\_SHAPED\_6**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 6.

**35. HW\_SHAPED\_7**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 7.

**36. HW\_SHAPED\_8**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 8.

**37. HW\_SHAPED\_9**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 9.

**38. HW\_SHAPED\_10**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 10.

**39. HW\_SHAPED\_11**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 11.

**40. HW\_ION\_EVT**

Counts the occurrence of a valid ion event, as determined by the Field Programmable Gate Array (FPGA)-based valid event logic. The event is counted even if the event information packet is unable to be placed in the First-in, First-out component (FIFO).

**41. HW\_E\_EVT**

Counts the occurrence of a valid electron event, as determined by the Field Programmable Gate Array (FPGA)-based valid event logic. The event is counted even if the event information packet is unable to be placed in the FIFO.

**42. SW\_ION\_PROC**

Ions processed; software counter.

**43. SW\_E\_PROC**

Electrons processed; software counter.

**44. SW\_ION\_PILEUP**

Ions rejected due to pileup; software counter.

**45. SW\_E\_PILEUP\_A**

Electrons rejected due to pileup; software counter.

**46. SW\_ION\_REJ\_A**

Ions rejected due to negative energy; software counter.

**47. SW\_E\_REJ\_A**

Electrons rejected due to negative energy; software counter.

**48. SW\_MULTIHIT\_A**

Ion or electron events rejected due to multiple hit; software counter.

**8.8 EPS\_SCAN.FMT Table Fields**

The following are the fields as defined by the EPS\_SCAN.FMT structure file. This file defines the binary table containing the EPS Scan data. This is a new EDR created as a result of the FSW6 upload.

**Table 20 EPS\_SCAN.FMT Fields**

| Start Byte | Length (bytes) | Data Type            | Column Name | Summary (see full text for column description)                            |
|------------|----------------|----------------------|-------------|---|
| 1          | 4              | MSB Unsigned Integer | MET         | Time tag in seconds.  |
| 5          | 4              | MSB Unsigned Integer | FAST_A_0    | Threshold counts of pole-zero shaping circuit, first threshold, sector 0. |
| 9          | 4              | MSB Unsigned Integer | FAST_A_1    | Threshold counts of pole-zero shaping                                     |



|     |   |                      |             |  |
|-----|---|----------------------|-------------|--|
|     |   |                      |             | circuit, first threshold, sector 1.  |
| 13  | 4 | MSB Unsigned Integer | FAST_A_2    | Threshold counts of pole-zero shaping circuit, first threshold, sector 2.        |
| 17  | 4 | MSB Unsigned Integer | FAST_A_3    | Threshold counts of pole-zero shaping circuit, first threshold, sector 3.        |
| 21  | 4 | MSB Unsigned Integer | FAST_A_4    | Threshold counts of pole-zero shaping circuit, first threshold, sector 4.        |
| 25  | 4 | MSB Unsigned Integer | FAST_A_5    | Threshold counts of pole-zero shaping circuit, first threshold, sector 5.        |
| 29  | 4 | MSB Unsigned Integer | FAST_A_6    | Threshold counts of pole-zero shaping circuit, first threshold, sector 6.        |
| 33  | 4 | MSB Unsigned Integer | FAST_A_7    | Threshold counts of pole-zero shaping circuit, first threshold, sector 7.        |
| 37  | 4 | MSB Unsigned Integer | FAST_A_8    | Threshold counts of pole-zero shaping circuit, first threshold, sector 8.        |
| 41  | 4 | MSB Unsigned Integer | FAST_A_9    | Threshold counts of pole-zero shaping circuit, first threshold, sector 9.        |
| 45  | 4 | MSB Unsigned Integer | FAST_A_10   | Threshold counts of pole-zero shaping circuit, first threshold, sector 10.       |
| 49  | 4 | MSB Unsigned Integer | FAST_A_11   | Threshold counts of pole-zero shaping circuit, first threshold, sector 11.       |
| 53  | 4 | MSB Unsigned Integer | SHAPED_A_0  | Threshold counts of 3 pole Gaussian shaping circuit, first threshold, sector 0.  |
| 57  | 4 | MSB Unsigned Integer | SHAPED_A_1  | Threshold counts of 3 pole Gaussian shaping circuit, first threshold, sector 1.  |
| 61  | 4 | MSB Unsigned Integer | SHAPED_A_2  | Threshold counts of 3 pole Gaussian shaping circuit, first threshold, sector 2.  |
| 65  | 4 | MSB Unsigned Integer | SHAPED_A_3  | Threshold counts of 3 pole Gaussian shaping circuit, first threshold, sector 3.  |
| 69  | 4 | MSB Unsigned Integer | SHAPED_A_4  | Threshold counts of 3 pole Gaussian shaping circuit, first threshold, sector 4.  |
| 73  | 4 | MSB Unsigned Integer | SHAPED_A_5  | Threshold counts of 3 pole Gaussian shaping circuit, first threshold, sector 5.  |
| 77  | 4 | MSB Unsigned Integer | SHAPED_A_6  | Threshold counts of 3 pole Gaussian shaping circuit, first threshold, sector 6.  |
| 81  | 4 | MSB Unsigned Integer | SHAPED_A_7  | Threshold counts of 3 pole Gaussian shaping circuit, first threshold, sector 7.  |
| 85  | 4 | MSB Unsigned Integer | SHAPED_A_8  | Threshold counts of 3 pole Gaussian shaping circuit, first threshold, sector 8.  |
| 89  | 4 | MSB Unsigned Integer | SHAPED_A_9  | Threshold counts of 3 pole Gaussian shaping circuit, first threshold, sector 9.  |
| 93  | 4 | MSB Unsigned Integer | SHAPED_A_10 | Threshold counts of 3 pole Gaussian shaping circuit, first threshold, sector 10. |
| 97  | 4 | MSB Unsigned Integer | SHAPED_A_11 | Threshold counts of 3 pole Gaussian shaping circuit, first threshold, sector 11. |
| 101 | 4 | MSB Unsigned Integer | FAST_B_0    | Threshold counts of pole-zero shaping circuit, second threshold, sector 0.       |
| 105 | 4 | MSB Unsigned Integer | FAST_B_1    | Threshold counts of pole-zero shaping circuit, second threshold, sector 1.       |
| 109 | 4 | MSB Unsigned Integer | FAST_B_2    | Threshold counts of pole-zero shaping circuit, second threshold, sector 2.       |
| 113 | 4 | MSB Unsigned Integer | FAST_B_3    | Threshold counts of pole-zero shaping circuit, second threshold, sector 3.       |
| 117 | 4 | MSB Unsigned Integer | FAST_B_4    | Threshold counts of pole-zero shaping circuit, second threshold, sector 4.       |
| 121 | 4 | MSB Unsigned Integer | FAST_B_5    | Threshold counts of pole-zero shaping  |

|     |   |                      |             |   |
|-----|---|----------------------|-------------|---|
|     |   |                      |             | circuit, second threshold, sector 5.  |
| 125 | 4 | MSB Unsigned Integer | FAST_B_6    | Threshold counts of pole-zero shaping circuit, second threshold, sector 6.        |
| 129 | 4 | MSB Unsigned Integer | FAST_B_7    | Threshold counts of pole-zero shaping circuit, second threshold, sector 7.        |
| 133 | 4 | MSB Unsigned Integer | FAST_B_8    | Threshold counts of pole-zero shaping circuit, second threshold, sector 8.        |
| 137 | 4 | MSB Unsigned Integer | FAST_B_9    | Threshold counts of pole-zero shaping circuit, second threshold, sector 9.        |
| 141 | 4 | MSB Unsigned Integer | FAST_B_10   | Threshold counts of pole-zero shaping circuit, second threshold, sector 10.       |
| 145 | 4 | MSB Unsigned Integer | FAST_B_11   | Threshold counts of pole-zero shaping circuit, second threshold, sector 11.       |
| 149 | 4 | MSB Unsigned Integer | SHAPED_B_0  | Threshold counts of 3 pole Gaussian shaping circuit, second threshold, sector 0.  |
| 153 | 4 | MSB Unsigned Integer | SHAPED_B_1  | Threshold counts of 3 pole Gaussian shaping circuit, second threshold, sector 1.  |
| 157 | 4 | MSB Unsigned Integer | SHAPED_B_2  | Threshold counts of 3 pole Gaussian shaping circuit, second threshold, sector 2.  |
| 161 | 4 | MSB Unsigned Integer | SHAPED_B_3  | Threshold counts of 3 pole Gaussian shaping circuit, second threshold, sector 3.  |
| 165 | 4 | MSB Unsigned Integer | SHAPED_B_4  | Threshold counts of 3 pole Gaussian shaping circuit, second threshold, sector 4.  |
| 169 | 4 | MSB Unsigned Integer | SHAPED_B_5  | Threshold counts of 3 pole Gaussian shaping circuit, second threshold, sector 5.  |
| 173 | 4 | MSB Unsigned Integer | SHAPED_B_6  | Threshold counts of 3 pole Gaussian shaping circuit, second threshold, sector 6.  |
| 177 | 4 | MSB Unsigned Integer | SHAPED_B_7  | Threshold counts of 3 pole Gaussian shaping circuit, second threshold, sector 7.  |
| 181 | 4 | MSB Unsigned Integer | SHAPED_B_8  | Threshold counts of 3 pole Gaussian shaping circuit, second threshold, sector 8.  |
| 185 | 4 | MSB Unsigned Integer | SHAPED_B_9  | Threshold counts of 3 pole Gaussian shaping circuit, second threshold, sector 9.  |
| 189 | 4 | MSB Unsigned Integer | SHAPED_B_10 | Threshold counts of 3 pole Gaussian shaping circuit, second threshold, sector 10. |
| 193 | 4 | MSB Unsigned Integer | SHAPED_B_11 | Threshold counts of 3 pole Gaussian shaping circuit, second threshold, sector 11. |
| 197 | 4 | MSB Unsigned Integer | FAST_C_0    | Threshold counts of pole-zero shaping circuit, third threshold, sector 0.         |
| 201 | 4 | MSB Unsigned Integer | FAST_C_1    | Threshold counts of pole-zero shaping circuit, third threshold, sector 1.         |
| 205 | 4 | MSB Unsigned Integer | FAST_C_2    | Threshold counts of pole-zero shaping circuit, third threshold, sector 2.         |
| 209 | 4 | MSB Unsigned Integer | FAST_C_3    | Threshold counts of pole-zero shaping circuit, third threshold, sector 3.         |
| 213 | 4 | MSB Unsigned Integer | FAST_C_4    | Threshold counts of pole-zero shaping circuit, third threshold, sector 4.         |
| 217 | 4 | MSB Unsigned Integer | FAST_C_5    | Threshold counts of pole-zero shaping circuit, third threshold, sector 5.         |
| 221 | 4 | MSB Unsigned Integer | FAST_C_6    | Threshold counts of pole-zero shaping circuit, third threshold, sector 6.         |
| 225 | 4 | MSB Unsigned Integer | FAST_C_7    | Threshold counts of pole-zero shaping circuit, third threshold, sector 7.         |
| 229 | 4 | MSB Unsigned Integer | FAST_C_8    | Threshold counts of pole-zero shaping circuit, third threshold, sector 8.         |
| 233 | 4 | MSB Unsigned Integer | FAST_C_9    | Threshold counts of pole-zero shaping   |

|     |   |                      |             |  |
|-----|---|----------------------|-------------|--|
|     |   |                      |             | circuit, third threshold, sector 9.  |
| 237 | 4 | MSB Unsigned Integer | FAST_C_10   | Threshold counts of pole-zero shaping circuit, third threshold, sector 10.       |
| 241 | 4 | MSB Unsigned Integer | FAST_C_11   | Threshold counts of pole-zero shaping circuit, third threshold, sector 11.       |
| 245 | 4 | MSB Unsigned Integer | SHAPED_C_0  | Threshold counts of 3 pole Gaussian shaping circuit, third threshold, sector 0.  |
| 249 | 4 | MSB Unsigned Integer | SHAPED_C_1  | Threshold counts of 3 pole Gaussian shaping circuit, third threshold, sector 1.  |
| 253 | 4 | MSB Unsigned Integer | SHAPED_C_2  | Threshold counts of 3 pole Gaussian shaping circuit, third threshold, sector 2.  |
| 257 | 4 | MSB Unsigned Integer | SHAPED_C_3  | Threshold counts of 3 pole Gaussian shaping circuit, third threshold, sector 3.  |
| 261 | 4 | MSB Unsigned Integer | SHAPED_C_4  | Threshold counts of 3 pole Gaussian shaping circuit, third threshold, sector 4.  |
| 265 | 4 | MSB Unsigned Integer | SHAPED_C_5  | Threshold counts of 3 pole Gaussian shaping circuit, third threshold, sector 5.  |
| 269 | 4 | MSB Unsigned Integer | SHAPED_C_6  | Threshold counts of 3 pole Gaussian shaping circuit, third threshold, sector 6.  |
| 273 | 4 | MSB Unsigned Integer | SHAPED_C_7  | Threshold counts of 3 pole Gaussian shaping circuit, third threshold, sector 7.  |
| 277 | 4 | MSB Unsigned Integer | SHAPED_C_8  | Threshold counts of 3 pole Gaussian shaping circuit, third threshold, sector 8.  |
| 281 | 4 | MSB Unsigned Integer | SHAPED_C_9  | Threshold counts of 3 pole Gaussian shaping circuit, third threshold, sector 9.  |
| 285 | 4 | MSB Unsigned Integer | SHAPED_C_10 | Threshold counts of 3 pole Gaussian shaping circuit, third threshold, sector 10. |
| 289 | 4 | MSB Unsigned Integer | SHAPED_C_11 | Threshold counts of 3 pole Gaussian shaping circuit, third threshold, sector 11. |
| 293 | 4 | MSB Unsigned Integer | FAST_D_0    | Threshold counts of pole-zero shaping circuit, fourth threshold, sector 0.       |
| 297 | 4 | MSB Unsigned Integer | FAST_D_1    | Threshold counts of pole-zero shaping circuit, fourth threshold, sector 1.       |
| 301 | 4 | MSB Unsigned Integer | FAST_D_2    | Threshold counts of pole-zero shaping circuit, fourth threshold, sector 2.       |
| 305 | 4 | MSB Unsigned Integer | FAST_D_3    | Threshold counts of pole-zero shaping circuit, fourth threshold, sector 3.       |
| 309 | 4 | MSB Unsigned Integer | FAST_D_4    | Threshold counts of pole-zero shaping circuit, fourth threshold, sector 4.       |
| 313 | 4 | MSB Unsigned Integer | FAST_D_5    | Threshold counts of pole-zero shaping circuit, fourth threshold, sector 5.       |
| 317 | 4 | MSB Unsigned Integer | FAST_D_6    | Threshold counts of pole-zero shaping circuit, fourth threshold, sector 6.       |
| 321 | 4 | MSB Unsigned Integer | FAST_D_7    | Threshold counts of pole-zero shaping circuit, fourth threshold, sector 7.       |
| 325 | 4 | MSB Unsigned Integer | FAST_D_8    | Threshold counts of pole-zero shaping circuit, fourth threshold, sector 8.       |
| 329 | 4 | MSB Unsigned Integer | FAST_D_9    | Threshold counts of pole-zero shaping circuit, fourth threshold, sector 9.       |
| 333 | 4 | MSB Unsigned Integer | FAST_D_10   | Threshold counts of pole-zero shaping circuit, fourth threshold, sector 10.      |
| 337 | 4 | MSB Unsigned Integer | FAST_D_11   | Threshold counts of pole-zero shaping circuit, fourth threshold, sector 11.      |
| 341 | 4 | MSB Unsigned Integer | SHAPED_D_0  | Threshold counts of 3 pole Gaussian shaping circuit, fourth threshold, sector 0. |
| 345 | 4 | MSB Unsigned Integer | SHAPED_D_1  | Threshold counts of 3 pole Gaussian  |

|     |   |                      |             |   |
|-----|---|----------------------|-------------|---|
|     |   |                      |             | shaping circuit, fourth threshold, sector 1.                                      |
| 349 | 4 | MSB Unsigned Integer | SHAPED_D_2  | Threshold counts of 3 pole Gaussian shaping circuit, fourth threshold, sector 2.  |
| 353 | 4 | MSB Unsigned Integer | SHAPED_D_3  | Threshold counts of 3 pole Gaussian shaping circuit, fourth threshold, sector 3.  |
| 357 | 4 | MSB Unsigned Integer | SHAPED_D_4  | Threshold counts of 3 pole Gaussian shaping circuit, fourth threshold, sector 4.  |
| 361 | 4 | MSB Unsigned Integer | SHAPED_D_5  | Threshold counts of 3 pole Gaussian shaping circuit, fourth threshold, sector 5.  |
| 365 | 4 | MSB Unsigned Integer | SHAPED_D_6  | Threshold counts of 3 pole Gaussian shaping circuit, fourth threshold, sector 6.  |
| 369 | 4 | MSB Unsigned Integer | SHAPED_D_7  | Threshold counts of 3 pole Gaussian shaping circuit, fourth threshold, sector 7.  |
| 373 | 4 | MSB Unsigned Integer | SHAPED_D_8  | Threshold counts of 3 pole Gaussian shaping circuit, fourth threshold, sector 8.  |
| 377 | 4 | MSB Unsigned Integer | SHAPED_D_9  | Threshold counts of 3 pole Gaussian shaping circuit, fourth threshold, sector 9.  |
| 381 | 4 | MSB Unsigned Integer | SHAPED_D_10 | Threshold counts of 3 pole Gaussian shaping circuit, fourth threshold, sector 10. |
| 385 | 4 | MSB Unsigned Integer | SHAPED_D_11 | Threshold counts of 3 pole Gaussian shaping circuit, fourth threshold, sector 11. |

### 1. MET

Mission elapsed time in seconds.

### 2. FAST\_A\_0

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 0, first threshold.

### 3. FAST\_A\_1

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 1, first threshold.

### 4. FAST\_A\_2

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 2, first threshold.

### 5. FAST\_A\_3

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 3, first threshold.

### 6. FAST\_A\_4

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 4, first threshold.

### 7. FAST\_A\_5

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 5, first threshold.

### 8. FAST\_A\_6

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 6, first threshold.

### 9. FAST\_A\_7

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 7, first threshold.

#### **10. FAST\_A\_8**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 8, first threshold.

#### **11. FAST\_A\_9**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 9, first threshold.

#### **12. FAST\_A\_10**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 10, first threshold.

#### **13. FAST\_A\_11**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 11, first threshold.

#### **14. SHAPED\_A\_0**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 0, first threshold.

#### **15. SHAPED\_A\_1**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 1, first threshold.

#### **16. SHAPED\_A\_2**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 2, first threshold.

#### **17. SHAPED\_A\_3**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 3, first threshold.

#### **18. SHAPED\_A\_4**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 4, first threshold.

#### **19. SHAPED\_A\_5**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 5, first threshold.

#### **20. SHAPED\_A\_6**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 6, first threshold.

#### **21. SHAPED\_A\_7**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 7, first threshold.

#### **22. SHAPED\_A\_8**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 8, first threshold.

**23. SHAPED\_A\_9**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 9, first threshold.

**24. SHAPED\_A\_10**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 10, first threshold.

**25. SHAPED\_A\_11**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 11, first threshold.

**26. FAST\_B\_0**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 0, second threshold.

**27. FAST\_B\_1**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 1, second threshold.

**28. FAST\_B\_2**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 2, second threshold.

**29. FAST\_B\_3**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 3, second threshold.

**30. FAST\_B\_4**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 4, second threshold.

**31. FAST\_B\_5**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 5, second threshold.

**32. FAST\_B\_6**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 6, second threshold.

**33. FAST\_B\_7**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 7, second threshold.

**34. FAST\_B\_8**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 8, second threshold.

**35. FAST\_B\_9**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 9, second threshold.

**36. FAST\_B\_10**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 10, second threshold.

**37. FAST\_B\_11**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 11, second threshold.

**38. SHAPED\_B\_0**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 0, second threshold.

**39. SHAPED\_B\_1**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 1, second threshold.

**40. SHAPED\_B\_2**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 2, second threshold.

**41. SHAPED\_B\_3**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 3, second threshold.

**42. SHAPED\_B\_4**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 4, second threshold.

**43. SHAPED\_B\_5**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 5, second threshold.

**44. SHAPED\_B\_6**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 6, second threshold.

**45. SHAPED\_B\_7**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 7, second threshold.

**46. SHAPED\_B\_8**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 8, second threshold.

**47. SHAPED\_B\_9**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 9, second threshold.

**48. SHAPED\_B\_10**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 10, second threshold.

**49. SHAPED\_B\_11**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 11, second threshold.

**50. FAST\_C\_0**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 0, third threshold.

#### **51. FAST\_C\_1**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 1, third threshold.

#### **52. FAST\_C\_2**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 2, third threshold.

#### **53. FAST\_C\_3**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 3, third threshold.

#### **54. FAST\_C\_4**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 4, third threshold.

#### **55. FAST\_C\_5**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 5, third threshold.

#### **56. FAST\_C\_6**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 6, third threshold.

#### **57. FAST\_C\_7**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 7, third threshold.

#### **58. FAST\_C\_8**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 8, third threshold.

#### **59. FAST\_C\_9**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 9, third threshold.

#### **60. FAST\_C\_10**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 10, third threshold.

#### **61. FAST\_C\_11**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 11, third threshold.

#### **62. SHAPED\_C\_0**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 0, third threshold.

#### **63. SHAPED\_C\_1**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 1, third threshold.



**64. SHAPED\_C\_2**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 2, third threshold.

**65. SHAPED\_C\_3**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 3, third threshold.

**66. SHAPED\_C\_4**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 4, third threshold.

**67. SHAPED\_C\_5**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 5, third threshold.

**68. SHAPED\_C\_6**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 6, third threshold.

**69. SHAPED\_C\_7**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 7, third threshold.

**70. SHAPED\_C\_8**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 8, third threshold.

**71. SHAPED\_C\_9**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 9, third threshold.

**72. SHAPED\_C\_10**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 10, third threshold.

**73. SHAPED\_C\_11**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 11, third threshold.

**74. FAST\_D\_0**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 0, fourth threshold.

**75. FAST\_D\_1**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 1, fourth threshold.

**76. FAST\_D\_2**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 2, fourth threshold.

**77. FAST\_D\_3**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 3, fourth threshold.

**78. FAST\_D\_4**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 4, fourth threshold.

**79. FAST\_D\_5**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 5, fourth threshold.

**80. FAST\_D\_6**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 6, fourth threshold.

**81. FAST\_D\_7**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 7, fourth threshold.

**82. FAST\_D\_8**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 8, fourth threshold.

**83. FAST\_D\_9**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 9, fourth threshold.

**84. FAST\_D\_10**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 10, fourth threshold.

**85. FAST\_D\_11**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the pole-zero shaping circuit. Sector 11, fourth threshold.

**86. SHAPED\_D\_0**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 0, fourth threshold.

**87. SHAPED\_D\_1**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 1, fourth threshold.

**88. SHAPED\_D\_2**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 2, fourth threshold.

**89. SHAPED\_D\_3**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 3, fourth threshold.

**90. SHAPED\_D\_4**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 4, fourth threshold.

**91. SHAPED\_D\_5**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 5, fourth threshold.

### **92. SHAPED\_D\_6**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 6, fourth threshold.

### **93. SHAPED\_D\_7**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 7, fourth threshold.

### **94. SHAPED\_D\_8**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 8, fourth threshold.

### **95. SHAPED\_D\_9**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 9, fourth threshold.

### **96. SHAPED\_D\_10**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 10, fourth threshold.

### **97. SHAPED\_D\_11**

Counts the firing of a discriminator when an analog signal exceeds a settable threshold. The discriminator is connected to the output of the 3 pole Gaussian shaping circuit. Sector 11, fourth threshold.

## **8.9 FIPS\_HI.FMT Table Fields**

The following are the fields as defined by the FIPS\_HI.FMT structure file. This file defines the binary table containing the FIPS High Priority data. Archive volume is optimized by defining the table structure once and providing a reference to it in the PDS label file. The fields are numbered according to their column order in the table. Data\_Type refers to the PDS standards data type for a particular column in the table.

The FSW5 upload was implemented on 9/6/2007. As a result the FIPS High Priority EDR format was updated to include two additional columns: FIPS\_SCANTYPE and STOP\_RATE. The values for these two columns are N/A prior to 9/6/2007.

FIPS High Priority EDRs are no longer generated on or after 8/18/2009 due to the FSW7 upload.

**Table 21 FIPS\_HI.FMT Fields**

| <b>Start Byte</b> | <b>Length (bytes)</b> | <b>Data Type</b>     | <b>Column Name</b> | <b>Summary (see full text for column description)</b> |
|-------------------|-----------------------|----------------------|--------------------|---|
| 1                 | 4                     | MSB Unsigned Integer | MET                | Mission Elapsed Time in seconds.                      |
| 5                 | 2                     | MSB Unsigned Integer | FIPS_SCANTYPE      | Indicates FIPS Scan mode.                             |
| 7                 | 4 X 128               | MSB Unsigned Integer | MASS_DIST_HIST     | 128 bin mass distribution histogram.                  |
| 519               | 4 X 64                | MSB Unsigned         | ENERGY_SPECTRA_1   | 64 element energy spectra for                         |

|      |        |                      |                  |   |
|------|--------|----------------------|------------------|---|
|      |        | Integer              |                  | energy vector range 1.  |
| 775  | 4 X 64 | MSB Unsigned Integer | ENERGY_SPECTRA_2 | 64 element energy spectra for energy vector range 2.                                  |
| 1031 | 4 X 64 | MSB Unsigned Integer | ENERGY_SPECTRA_3 | 64 element energy spectra for energy vector range 3.                                  |
| 1287 | 4 X 64 | MSB Unsigned Integer | ENERGY_SPECTRA_4 | 64 element energy spectra for energy vector range 4.                                  |
| 1543 | 4 X 64 | MSB Unsigned Integer | ENERGY_SPECTRA_5 | 64 element energy spectra for energy vector range 5.                                  |
| 1799 | 4 X 64 | MSB Unsigned Integer | HEAVY_ION_DIST_1 | 64 element array of heavy ion velocity distribution values for energy vector range 1. |
| 2055 | 4 X 64 | MSB Unsigned Integer | HEAVY_ION_DIST_2 | 64 element array of heavy ion velocity distribution values for energy vector range 2. |
| 2311 | 4 X 64 | MSB Unsigned Integer | HEAVY_ION_DIST_3 | 64 element array of heavy ion velocity distribution values for energy vector range 3. |
| 2567 | 4 X 64 | MSB Unsigned Integer | HEAVY_ION_DIST_4 | 64 element array of heavy ion velocity distribution values for energy vector range 4. |
| 2823 | 4 X 64 | MSB Unsigned Integer | HEAVY_ION_DIST_5 | 64 element array of heavy ion velocity distribution values for energy vector range 5. |
| 3079 | 4 X 64 | MSB Unsigned Integer | PROTON_V_DIST0   | 64 element array of proton velocity distribution values.                              |
| 3335 | 4 X 64 | MSB Unsigned Integer | START_RATE       | 64 element array of start rate counters.  |
| 3591 | 4 X 64 | MSB Unsigned Integer | STOP_RATE        | 64 element array of stop rate counters.   |
| 3847 | 4 X 64 | MSB Unsigned Integer | VALID_EVT_RATE   | 64 element array of valid event counters.   |
| 4103 | 4 X 64 | MSB Unsigned Integer | PROTON_RATE      | 64 element array of proton rate counters.   |
| 4359 | 4 X 64 | MSB Unsigned Integer | EVT_PROC_RATE    | 64 element array of event processed rate counters.                                    |

### 1. MET

Mission elapsed time in seconds at the end of the accumulation.

### 2. FIPS\_SCANTYPE

Indicates the FIPS Scan Mode. =0 normal scan, =1 high temp scan, =2 burst scan, =3 test scan, =4 Table 4, =5 Table 5, =6 Table 6, =7 Table 7.

### 3. MASS\_DIST\_HIST

Mass distribution histogram consisting of 128 bins. Histogram accumulated over a 10-scan sequence. (Section 5.2.2.2)

### 4. ENERGY\_SPECTRA\_1

A 64-element energy spectrum accumulated over a 10-scan sequence for energy vector range 1. (Section 5.2.2.2)

### 5. ENERGY\_SPECTRA\_2

A 64-element energy spectrum accumulated over a 10-scan sequence for energy vector range 2. (Section 5.2.2.2)

**6. ENERGY\_SPECTRA\_3**

A 64-element energy spectrum accumulated over a 10-scan sequence for energy vector range 3. (Section 5.2.2.2)

**7. ENERGY\_SPECTRA\_4**

A 64-element energy spectrum accumulated over a 10-scan sequence for energy vector range 4. (Section 5.2.2.2)

**8. ENERGY\_SPECTRA\_5**

A 64-element energy spectrum accumulated over a 10-scan sequence for energy vector range 5. (Section 5.2.2.2)

**9. HEAVY\_ION\_DIST\_1**

A 64-element heavy ion velocity distribution accumulated over a 10-scan sequence for energy vector range 1. (Section 5.2.2.4)

**10. HEAVY\_ION\_DIST\_2**

A 64-element heavy ion velocity distribution accumulated over a 10-scan sequence for energy vector range 2. (Section 5.2.2.4)

**11. HEAVY\_ION\_DIST\_3**

A 64-element heavy ion velocity distribution accumulated over a 10-scan sequence for energy vector range 3. (Section 5.2.2.4)

**12. HEAVY\_ION\_DIST\_4**

A 64-element heavy ion velocity distribution accumulated over a 10-scan sequence for energy vector range 4. (Section 5.2.2.4)

**13. HEAVY\_ION\_DIST\_5**

A 64-element heavy ion velocity distribution accumulated over a 10-scan sequence for energy vector range 5. (Section 5.2.2.4)

**14. PROTON\_V\_DIST0**

A 64-element proton velocity distribution function based on the proton events detected during the first 64-step voltage scan of each 10-scan sequence. (Section 5.2.2.4). (See also Section 8.7: FIPS\_MED.FMT, column 2)

**15. START\_RATE**

The start rate counter. Sampled at each of the 64 steps in the 1<sup>st</sup> scan of a 10-scan sequence. (Section 5.2.1.1)

**16. STOP\_RATE**

The stop rate counter. Sampled at each of the 64 steps in the 1<sup>st</sup> scan of a 10-scan sequence. (Section 5.2.1.1)

**17. VALID\_EVT\_RATE**

The valid event rate counter. Sampled at each of the 64 steps in the 1<sup>st</sup> scan of a 10-scan sequence. (Section 5.2.1.1)

**18. PROTON\_RATE**

The proton rate counter. Sampled at each of the 64 steps in the 1<sup>st</sup> scan of a 10-scan sequence. (Section 5.2.1.1)

**19. EVT\_PROC\_RATE**

The events processed rate counter. Sampled at each of the 64 steps in the 1<sup>st</sup> scan of a 10-scan sequence. (Section 5.2.1.1)

### 8.10 FIPS\_HK.FMT Table Fields

The following are the fields as defined by the FIPS\_HK.FMT structure file. This file defines the ASCII table containing the FIPS Housekeeping data (taken from FIPS High Priority Science Packet). Archive volume is optimized by defining the table structure once and providing a reference to it in the PDS label file. The fields are numbered according to their column order in the table. Data\_Type refers to the PDS standards data type for a particular column in the table.

As of the FSW5 upload on 9/6/2007 the data contained in the FIPS housekeeping EDR will be contained in the EPPS\_LONG\_STATUS EDR. As a result the FIPS Housekeeping EDR will no longer be generated on or after 9/6/2007.

Referenced documents:

1. Univ. of Michigan Space Physics Research Lab document 082-0213E, Interface Control Document FIPS to EPS, by Steve Rogacki and Tom LeFever (JHU/APL).
2. JHU/APL document 7389-9041, EPPS Flight Software Specification, version 3, by Horace Malcom.
3. Univ. of Michigan Space Physics Research Lab document 082-0170G, FIPS Data Processing and Instrument Control, by Steve Rogacki and Jim Raines.

See reference (1) for further details unless otherwise noted.

**Table 22 FIPS\_HK.FMT Fields**

| Start Byte | Length (bytes) | Data Type     | Column Name        | Summary (see full text for column description) |
|------------|----------------|---------------|--------------------|--|
| 1          | 12             | ASCII Integer | MET                | Mission Elapsed Time in seconds.               |
| 15         | 5              | ASCII Integer | WEDGE_DIGITIZER    | Wedge digitizer channel.                       |
| 22         | 5              | ASCII Integer | STRIP_DIGITIZER    | Strip digitizer channel.                       |
| 29         | 5              | ASCII Integer | ZIGZAG_DIGITIZER   | Zigzag digitizer channel.                      |
| 36         | 5              | ASCII Integer | FIPS_MON_P15V      | +15 volt monitor.                              |
| 43         | 5              | ASCII Integer | FIPS_MON_N15V      | -15 volt monitor.                              |
| 50         | 5              | ASCII Integer | FIPS_MON_P5V       | +5 volt monitor.                               |
| 57         | 5              | ASCII Integer | FIPS_MON_N5V       | -5 volt monitor.                               |
| 64         | 5              | ASCII Integer | FIPS_MON_P35V      | +3.5 volt monitor.                             |
| 71         | 5              | ASCII Integer | FIPS_MON_P25V      | +2.5 volt monitor.                             |
| 78         | 5              | ASCII Integer | VREF_I2C_TEMP      | Vref I2C temperature.                          |
| 85         | 5              | ASCII Integer | BH_BOT_I2C_TEMP    | BH BOT I2C temperature.                        |
| 92         | 5              | ASCII Integer | BH_TOP_I2C_TEMP    | BH TOP I2C temperature.                        |
| 99         | 5              | ASCII Integer | DS_HV_I2C_TEMP     | DS-HV I2C temperature.                         |
| 106        | 5              | ASCII Integer | MON_MCP_HV         | Micro-channel plate high voltage monitor.      |
| 113        | 5              | ASCII Integer | MON_PA_HV          | Post-acceleration high voltage monitor.        |
| 120        | 5              | ASCII Integer | MON_DS_HV          | Deflection system high voltage monitor.        |
| 127        | 5              | ASCII Integer | FIPS_STATUS        | Integer value of bit flags for FIPS status.    |
| 134        | 1              | ASCII Integer | FIPS_AUTO_SHUTDOWN | Autonomous hi-temperature shutdown flag.       |
| 137        | 1              | ASCII Integer | FIPS_HV_ALARM_SET  | Software HV alarm monitor enable.              |

|     |   |               |                   |  |
|-----|---|---------------|-------------------|--|
| 140 | 3 | ASCII Integer | START_CFD_THLD    | Start constant fraction discriminator (CFD) threshold. |
| 145 | 3 | ASCII Integer | STOP_CFD_THLD     | Stop CFD threshold.                                    |
| 150 | 3 | ASCII Integer | PA_HV_SET         | Post-acceleration high voltage setting.                |
| 155 | 3 | ASCII Integer | MCP_HV_SET        | Micro-channel plate high voltage setting.              |
| 160 | 5 | ASCII Integer | H_EVT_CNTRL_SET   | Proton event control settings.                         |
| 167 | 3 | ASCII Integer | TOF_CNTRL_SET     | Time of flight control settings.                       |
| 172 | 5 | ASCII Integer | FIPS_BH_BOT_TEMP  | Bulkhead bottom temperature.                           |
| 179 | 5 | ASCII Integer | FIPS_BH_TOP_TEMP  | Bulkhead top temperature.                              |
| 186 | 8 | ASCII Integer | STOP_RATE_COUNTER | Stop rate counter.                                     |
| 196 | 5 | ASCII Integer | STOP_RATE_STEP    | Step at which stop rate counter was sampled.           |
| 203 | 5 | ASCII Integer | I2C_READ_ADDR     | Address of last raw I2C read.                          |
| 210 | 5 | ASCII Integer | I2C_READ_VAL      | Value of last raw I2C read.                            |

### 1. MET

Mission elapsed time in seconds at the end of the accumulation.

### 2. WEDGE\_DIGITIZER

The wedge digitizer channel. Taken together with “strip” and “zigzag” channels gives position on stop MCP: See (3) for details.

### 3. STRIP\_DIGITIZER

The strip digitizer channel. Taken together with “wedge” and “zigzag” channels gives position on stop MCP: See (3) for details.

### 4. ZIGZAG\_DIGITIZER

The zigzag digitizer channel. Taken together with “strip” and “wedge” channels gives position on stop MCP : See (3) for details.

### 5. FIPS\_MON\_P15V

FIPS +15 volt monitor

### 6. FIPS\_MON\_N15V

FIPS –15 volt monitor

### 7. FIPS\_MON\_P5V

FIPS +5 volt monitor

### 8. FIPS\_MON\_N5V

FIPS –5 volt monitor

### 9. FIPS\_MON\_P35V

FIPS 3.5 volt monitor

### 10. FIPS\_MON\_P25V

FIPS 2.5 volt monitor

### 11. VREF\_I2C\_TEMP

FIPS Vref I2C temperature

### 12. BH\_BOT\_I2C\_TEMP

FIPS BH BOT I2C temperature

### 13. BH\_TOP\_I2C\_TEMP

FIPS BH TOP I2C temperature

#### 14. DS\_HV\_I2C\_TEMP

FIPS DS-HV I2C temperature

#### 15. MON\_MCP\_HV

Micro-channel plate high voltage (MCP-HV) monitor. Values: 0..16383. Conversion: 219.73 mV/bit.

#### 16. MON\_PA\_HV

Post-acceleration high voltage (PA-HV) monitor. Values: 0..16383. Conversion: -915.53mV/bit.

#### 17. MON\_DS\_HV

Deflection system high voltage monitor. Values: 0..16383. Conversion: 915.53mV/bit.

#### 18. FIPS\_STATUS

FIPS status flag. Describes operational mode, individual HV enable/disable status and more:

**Table 23 FIPS Status Flag Fields**

| Bit No.       | Bit Name                               | Function *=reset state  |   |
|---------------|--|---|---|
| 0-2           | Mode                                   | 000 reset*<br>001 manual<br>010 standby   | 011 maneuver<br>100 single event test                                   |
| 3             | DSHV Enable                            | 0 Deflection System HV Supply Off*<br>1 Supply Enabled  | Note: When read, these bits return the actual HV supply enabled status. |
| 4             | PAHV Enable                            | 0 Post Acceleration HV Supply Off*<br>1 Supply Enabled  |   |
| 5             | MCP HV Enable                          | 0 Micro Channel Plate Supply Off*<br>1 Supply Enabled   |   |
| 6 (read only) | Valid Event                            | when Read:<br>0 no event<br>1 Valid Event detected by TOF and captured  |   |
| 7             | High-Speed Event driver power conserve | 0 – LVDS driver enabled only when transmitting *<br>1 – LVDS driver always enabled  |   |
| 8-10          | TOF Clock Select                       | Set TOF clock:<br>000* 12MHz<br>001 6MHz  | 010 3MHz<br>011 1.5MHz<br>100 750kHz                                    |
| 11            | Retrig Start Delay                     | 0 – non-retrig*<br>1 – retrig, 5us on every start   |   |
| 12            | Event Trigger                          | 0 – Event capture triggered by transmitted event*<br>1 – Event capture triggered by every start pulse, including H events |   |
| 13            | Dump/Ramp                              | 0 – Dump* – peak hold discharge fixed 1us<br>1 – Ramp – variable discharge time, max 9us                                  |   |
| 14            | Peak Hold Enable                       | 0 – disable peak hold (gate off)*<br>1 – Enable peak holds  | Only valid in modes which do not process events.                        |
| 15            | Peak Hold/Track                        | 0 – Peak hold for WSZ*<br>1 – Peak track for WSZ  |   |

#### 19. FIPS\_AUTO\_SHUTDOWN

Clear FIPS autonomous hi-temperature shutdown flag. Allowed values: 0=do not clear (thus enabling autonomous hi-temp. shutdown). 1=clear (thus disabling autonomous hi-temp. shutdown. See (2) for details.

#### 20. FIPS\_HV\_ALARM\_SET



FIPS software HV alarm monitor enable. When enabled a particular HV supply will be disabled if the voltage monitor level for that supply exceeds the commanded value. Allowed values: 0=disable software HV monitoring, 1=enable software HV monitoring. See (2) for details.

### 21. START\_CFD\_THLD

Start constant fraction discriminator (CFD) Threshold. Allowed values: 0..255.

### 22. STOP\_CFD\_THLD

Stop constant fraction discriminator (CFD) Threshold. Allowed values: 0..255.

### 23. PA\_HV\_SET

Post-acceleration high voltage (PA-HV) setting. Allowed values: 0..255. Conversion: -61.5234 V/bit. Not to be set to less than 1/3 of maximum, i.e., essentially allowed values are 82..255.

### 24. MCP\_HV\_SET

Micro-channel plate high voltage (MCP-HV) Setting. Allowed values: 0..255. Conversion: 14.7656 V/bit. Not to be set to less than 1/3 of maximum, i.e., essentially allowed values are 82..255.

### 25. H\_EVT\_CNTRL\_SET

Proton event control settings. Convert back to binary notation to interpret the settings. Bits 0-10 control H threshold. If the TOF for an event is less than (or equal?) to this threshold, the event is classified as a proton. Bits 12-15 control H proportion (decimation): 0000=keep all proton events, 1111=keep 1 in 32768 H events.

### 26. TOF\_CNTRL\_SET

Time of flight control settings. Convert back to binary notation to interpret the bit settings.

**Table 24 TOF Control Settings Fields**

| Bit | TOF chip control pin description |
|-----|----------------------------------|
| 7   | Intb_ext                         |
| 6   | Coreview                         |
| 5   | Srexclwin                        |
| 4   | Tapsel2                          |
| 3   | Tapsel1                          |
| 2   | Fixwin_on                        |
| 1   | Cal_en                           |
| 0   | Half_perb                        |

### 27. FIPS\_BH\_BOT\_TEMP

FIPS bulkhead bottom temperature. Pin #1 on the interface connector. Read by EPPS LVPS board ADC on mux channel 6. Conversion:

$$\text{BH\_BOT\_TEMP}(n, \text{Vp5raw}) := 1 / (2.504819233e-3 + 2.3875387107e-4 * \log((19.99677 * ((304.907e-6 * n) + 2.9136e-3)) / ((0.000610893 * \text{Vp5raw}) + 0.0058375) - ((304.907e-6 * n) + 2.9136e-3))) + 2.8536026677e-6 * \log((19.99677 * ((304.907e-6 * n) + 2.9136e-3)) / ((0.000610893 * \text{Vp5raw}) + 0.0058375) - ((304.907e-6 * n) + 2.9136e-3)))^{*2} + 1.0411088257e-7 * \log((19.99677 * ((304.907e-6 * n) + 2.9136e-3)) / ((0.000610893 * \text{Vp5raw}) + 0.0058375) - ((304.907e-6 * n) + 2.9136e-3)))^{*3} - 273.15$$

Where n is the BH\_BOT\_TEMP value and Vp5raw value is the raw TM item for the +5 V voltage monitor.

### 28. FIPS\_BH\_TOP\_TEMP

FIPS bulkhead top temperature. Pin #2 on the interface connector. Read by EPPS LVPS board ADC on mux channel 8. Conversion:

$$\text{BH\_TOP\_TEMP}(n, \text{Vp5raw}) := 1 / (2.504819233e-3 + 2.3875387107e-4 * \log((20.01703 * ((304.907e-6 * n) + 2.9136e-3)) / ((0.000610893 * \text{Vp5raw}) + 0.0058375) - ((304.907e-6 * n) + 2.9136e-3))) + 2.8536026677e-6 * \log((20.01703 * ((304.907e-6 * n) + 2.9136e-3)) / ((0.000610893 * \text{Vp5raw}) + 0.0058375) - ((304.907e-6 * n) + 2.9136e-3)))^{*2} + 1.0411088257e-7 * \log((20.01703 * ((304.907e-6 * n) + 2.9136e-3)) / ((0.000610893 * \text{Vp5raw}) + 0.0058375) - ((304.907e-6 * n) + 2.9136e-3)))^{*3} - 273.15$$

Where n is the BH\_TOP\_TEMP value and Vp5raw value is the raw TM item for the +5 V voltage monitor.

### 29. STOP\_RATE\_COUNTER

Stop rate counter for one deflection voltage step.

### 30. STOP\_RATE\_STEP

Step at which stop rate counter was sampled.

### 31. I2C\_READ\_ADDR

Address of last raw I2C read from FIPS FPGA.

### 32. I2C\_READ\_VAL

Value of last raw I2C read from FIPS FPGA.

## 8.11 FIPS\_MED.FMT Table Fields

The following are the fields as defined by the FIPS\_MED.FMT structure file. This file defines the binary table containing the FIPS Medium Priority spectra data. Archive volume is optimized by defining the table structure once and providing a reference to it in the PDS label file. The fields are numbered according to their column order in the table. Data\_Type refers to the PDS standards data type for a particular column in the table.

This EDR is retired after the FSW6 upload on 8/18/2008. As a result there are no FIPS Medium EDRs created on or after 8/19/2008.

Referenced documents:

1. Univ. of Michigan Space Physics Research Lab document 082-0213E, Interface Control Document FIPS to EPS, by Steve Rogacki and Tom LeFever (JHU/APL).
2. JHU/APL document 7389-9041, EPPS Flight Software Specification, version 3, by Horace Malcom.
3. Univ. of Michigan Space Physics Research Lab document 082-0170G, FIPS Data Processing and Instrument Control, by Steve Rogacki and Jim Raines.

**Table 25 FIPS\_MED.FMT Fields**

| Start Byte | Length (bytes) | Data Type            | Column Name      | Summary (see full text for column description)           |
|------------|----------------|----------------------|------------------|--|
| 1          | 4              | MSB Unsigned Integer | MET              | Mission Elapsed Time in seconds.                         |
| 5          | 2              | MSB Unsigned Integer | FIPS_SCANTYPE    | Indicates the FIPS scan mode.                            |
| 7          | 4 X 64         | MSB Unsigned Integer | PROTON_V_DIST210 | 64 element array of proton velocity distribution values. |
| 263        | 4 X 64         | MSB Unsigned Integer | START_RATE       | 64 element array of start rate counters.                 |
| 519        | 4 X 64         | MSB Unsigned Integer | STOP_RATE        | 64 element array of stop rate counters.                  |
| 775        | 4 X 64         | MSB Unsigned Integer | VALID_EVT_RATE   | 64 element array of valid event rate counters.           |
| 1031       | 4 X 64         | MSB Unsigned Integer | PROTON_RATE      | 64 element array of proton rate counters.                |

|      |        |                      |               |   |
|------|--------|----------------------|---------------|---|
| 1287 | 4 X 64 | MSB Unsigned Integer | EVT_PROC_RATE | 64 element array of events processed rate counters. |
|------|--------|----------------------|---------------|---|

**1. MET**

Mission elapsed time in seconds at the end of the accumulation.

**2. FIPS\_SCANTYPE**

Indicates the FIPS scan mode. =0 normal scan, =1 high temp scan, =2 burst scan, =3 test scan, =4 table 4, =5 table 5, =6 table 6, =7 table 7.

**3. PROTON\_V\_DIST210**

A 64-element proton velocity distribution accumulated over each of scans 2-10 in the 10 scan sequence. See (1) Section 4.2.1.3 for details. See also Section 8.5 FIPS\_HI.FMT in the EPPS EDR SIS.

**4. START\_RATE**

Start rate counter. See (1) Section 4.2.1.1 for details.

**5. STOP\_RATE**

Stop rate counter. See (1) Section 4.2.1.1 for details.

**6. VALID\_EVT\_RATE**

Valid event rate counter. See (1) Section 4.2.1.1 for details.

**7. PROTON\_RATE**

Proton rate counter. See (1) for details.

**8. EVT\_PROC\_RATE**

Events processed rate counter. See (1) for details.

### ***8.12 FIPS\_PHA.FMT Table Fields***

The following are the fields as defined by the FIPS\_PHA.FMT structure file. This file defines the binary table containing the FIPS Pulse Height Analysis (PHA) event data.

A FSW5 upload was implemented on 9/6/2007. As a result the FIPS PHA EDR format has been updated to include an additional column, FIPS\_SCANTYPE. The values for this column are N/A prior to 9/6/2007.

A FSW7 upload on 8/18/2009 created the FIPS Proton PHA packet. It is necessary to include the proton hardware decimation value in order to analyze proton PHA events but there was a need to keep the same number of columns and byte lengths as in EDRs prior to 8/18/2009. Thus, column 3 now stores either the priority decimation value or the priority level of the PHA data, depending on whether the EDR is pre or post-FSW7.

**Table 26 FIPS\_PHA.FMT Fields**

| Start Byte | Length (bytes) | Data Type            | Column Name   | Summary (see full text for column description) |
|------------|----------------|----------------------|---------------|--|
| 1          | 4              | MSB Unsigned Integer | MET           | Mission Elapsed Time in seconds.               |
| 5          | 2              | MSB Unsigned         | FIPS_SCANTYPE | Indicates the FIPS scan mode and               |

|    |   |                      |                     |  |
|----|---|----------------------|---------------------|--|
|    |   | Integer              |                     | particle type.   |
| 7  | 4 | MSB Unsigned Integer | PRIORITY_DECIMATION | PHA priority level (for pre-FSW7) or proton hardware decimation level (for post-FSW7). |
| 11 | 4 | MSB Unsigned Integer | STEP_NUM            | E/q step number.   |
| 15 | 4 | MSB Unsigned Integer | X                   | Calculated value for FIPS event.   |
| 19 | 4 | MSB Unsigned Integer | Y                   | Calculated value for FIPS event.   |
| 23 | 4 | MSB Unsigned Integer | TIME_OF_FLIGHT      | Time of flight.  |
| 27 | 4 | MSB Unsigned Integer | WEDGE               | Wedge number.  |
| 31 | 4 | MSB Unsigned Integer | STRIP               | Strip number.  |
| 35 | 4 | MSB Unsigned Integer | ZIGZAG              | Zigzag number.   |

### 1. MET

Mission Elapsed Time in seconds at the end of the accumulation. Used for correlation between PHA EDR records and records in the FIPS Spectra file (for High and Medium priority EDRs).

### 2. FIPS\_SCANTYPE

Indicates the FIPS scan mode and particle type. Tables referenced here are one of the eight E/q stepping tables loaded into the instrument. See the EPPS CDR SIS for details on the E/q tables. =0 normal scan heavy ion, =1 high temp scan heavy ion, =2 burst scan heavy ion, =3 test scan heavy ion, =4 table 4 heavy ion, =5 table 5 heavy ion, =6 table 6 heavy ion, =7 table 7 heavy ion, =8 normal scan proton, =9 high temp scan proton, =10 burst scan proton, =11 test scan proton, =12 table 4 proton, =13 table 5 proton, =14 table 6 proton, =15 table 7 proton. =99 NA; the value in all EDRs prior to 9/6/2007.

### 3. PRIORITY\_DECIMATION

Prior to FSW7 this column records the priority level of the PHA data. 0 = High Priority, 1 = Medium priority, 2 = Low priority. After FSW7 this column records the proton hardware decimation level for proton PHAs or =99 for Heavy Ion PHAs.

### 4. STEP\_NUM

E/q Step Number (0-63). Maximum of 64 steps for a given PHA event. Number of steps for a given event may vary from 0-64.

### 5. X

In FSW4, FSW5, and FSW7, X is computed as

$[128*(w+(w-z)/5)/sum]$ , and in FSW6, X is computed as

$[96*(s+(s-z)/5)/sum]$  where

$w = \text{wedge} - \text{wedge\_offset}$

$s = \text{strip} - \text{strip\_offset}$

$z = 14*(\text{zigzag} - \text{zigzag\_offset})/10$

$sum = w+s+z.$

A value of 9999 means X is NA.

### 6. Y

In FSW4, FSW5, and FSW7, Y is computed as

$[128*(s+(s-z)/5)/sum]$ , and in FSW6, Y is computed as

$[100*(s+2*(s-z)/11)/sum]$  where  
 $w = \text{wedge} - \text{wedge\_offset}$   
 $s = \text{strip} - \text{strip\_offset}$   
 $z = 14*(\text{zigzag-zigzag\_offset})/10$   
 $sum = w+s+z.$   
 A value of 9999 means Y is NA.

### 7. TIME\_OF\_FLIGHT

Time of flight.

### 8. WEDGE

Wedge number. =9999 (NA), dependent on the flight software used.

### 9. STRIP

Strip number. =9999 (NA), dependent on the flight software used.

### 10. ZIGZAG

Zigzag number. =9999 (NA), dependent on the flight software used.

## 8.13 FIPS\_SCAN.FMT Table Fields

The following are the fields as defined by the FIPS\_SCAN.FMT structure file. This file defines the binary table containing the FIPS\_Scan data. This is a new EDR created as a result of the FSW6 upload.

FIPS Scan EDRs are no longer generated on or after 8/18/2009 due to the FSW7 upload.

**Table 27 FIPS\_SCAN.FMT Fields**

| Start Byte | Length (bytes) | Data Type            | Column Name    | Summary (see full text for column description) |
|------------|----------------|----------------------|----------------|--|
| 1          | 4              | MSB Unsigned Integer | MET            | Time tag in seconds.                           |
| 5          | 2              | MSB Unsigned Integer | FIPS_SCANTYPE  | Indicates the FIPS Scan Mode.                  |
| 7          | 4 X 64         | MSB Unsigned Integer | START_RATE     | Start rate counter.                            |
| 263        | 4 X 64         | MSB Unsigned Integer | STOP_RATE      | Stop rate counter.                             |
| 519        | 4 X 64         | MSB Unsigned Integer | VALID_EVT_RATE | Valid event rate counter.                      |
| 775        | 4 X 64         | MSB Unsigned Integer | PROTON_RATE    | Proton rate counter.                           |
| 1031       | 4 X 64         | MSB Unsigned Integer | EVT_PROC_RATE  | Events processed rate counter.                 |

### 1. MET

Mission elapsed time in seconds.

### 2. FIPS\_SCANTYPE

Indicates the FIPS Scan Mode. =0 Normal Scan, =1 High temp Scan, =2 Burst Scan, =3 Test Scan, =4 Table 4, =5 Table 5, =6 Table 6, =7 Table 7.

### 3. START\_RATE

Start rate counter sampled at each Deflection System High Voltage (DSHV) step in the scan.

### 4. STOP\_RATE

Stop rate counter sampled at each DSHV step in the scan.

### 5. VALID\_EVT\_RATE

Valid event rate counter sampled at each DSHV step in the scan.

### 6. PROTON\_RATE

Proton rate counter sampled at each DSHV step in the scan.

### 7. EVT\_PROC\_RATE

Events processed rate counter sampled at each DSHV step in the scan.

## 8.14 FIPS\_HRPVD.FMT Table Fields

The following are the fields as defined by the FIPS\_HRPVD.FMT structure file. This file defines the binary table containing the Hi-resolution proton velocity distributions. This is a new EDR created as a result of the FSW6 upload.

FIPS HRPVD EDRs are no longer generated on or after 8/18/2009 due to the FSW7 upload.

**Table 28 FIPS\_HRPVD.FMT Fields**

| Start Byte | Length (bytes) | Data Type            | Column Name   | Summary (see full text for column description)                                 |
|------------|----------------|----------------------|---------------|--|
| 1          | 4              | MSB Unsigned Integer | MET           | Time tag in seconds.   |
| 5          | 2              | MSB Unsigned Integer | FIPS_SCANTYPE | Indicates the FIPS Scan Mode.  |
| 7          | 4 X 32         | MSB Unsigned Integer | PROTONV_L00   | Line 0 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq  |
| 135        | 4 X 32         | MSB Unsigned Integer | PROTONV_L01   | Line 1 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq  |
| 263        | 4 X 32         | MSB Unsigned Integer | PROTONV_L02   | Line 2 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq  |
| 391        | 4 X 32         | MSB Unsigned Integer | PROTONV_L03   | Line 3 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq  |
| 519        | 4 X 32         | MSB Unsigned Integer | PROTONV_L04   | Line 4 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq  |
| 647        | 4 X 32         | MSB Unsigned Integer | PROTONV_L05   | Line 5 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq  |
| 775        | 4 X 32         | MSB Unsigned Integer | PROTONV_L06   | Line 6 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq  |
| 903        | 4 X 32         | MSB Unsigned Integer | PROTONV_L07   | Line 7 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq  |
| 1031       | 4 X 32         | MSB Unsigned Integer | PROTONV_L08   | Line 8 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq  |
| 1159       | 4 X 32         | MSB Unsigned Integer | PROTONV_L09   | Line 9 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq  |
| 1287       | 4 X 32         | MSB Unsigned Integer | PROTONV_L10   | Line 10 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 1415       | 4 X 32         | MSB Unsigned Integer | PROTONV_L11   | Line 11 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 1543       | 4 X 32         | MSB Unsigned Integer | PROTONV_L12   | Line 12 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 1671       | 4 X 32         | MSB Unsigned Integer | PROTONV_L13   | Line 13 of a 32X32 hi-res proton vel   |

|      |        |                      |             |  |
|------|--------|----------------------|-------------|--|
|      |        |                      |             | distribution, integrated over 10 scan seq                                      |
| 1799 | 4 X 32 | MSB Unsigned Integer | PROTONV_L14 | Line 14 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 1927 | 4 X 32 | MSB Unsigned Integer | PROTONV_L15 | Line 15 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 2055 | 4 X 32 | MSB Unsigned Integer | PROTONV_L16 | Line 16 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 2183 | 4 X 32 | MSB Unsigned Integer | PROTONV_L17 | Line 17 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 2311 | 4 X 32 | MSB Unsigned Integer | PROTONV_L18 | Line 18 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 2439 | 4 X 32 | MSB Unsigned Integer | PROTONV_L19 | Line 19 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 2567 | 4 X 32 | MSB Unsigned Integer | PROTONV_L20 | Line 20 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 2695 | 4 X 32 | MSB Unsigned Integer | PROTONV_L21 | Line 21 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 2823 | 4 X 32 | MSB Unsigned Integer | PROTONV_L22 | Line 22 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 2951 | 4 X 32 | MSB Unsigned Integer | PROTONV_L23 | Line 23 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 3079 | 4 X 32 | MSB Unsigned Integer | PROTONV_L24 | Line 24 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 3207 | 4 X 32 | MSB Unsigned Integer | PROTONV_L25 | Line 25 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 3335 | 4 X 32 | MSB Unsigned Integer | PROTONV_L26 | Line 26 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 3463 | 4 X 32 | MSB Unsigned Integer | PROTONV_L27 | Line 27 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 3591 | 4 X 32 | MSB Unsigned Integer | PROTONV_L28 | Line 28 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 3719 | 4 X 32 | MSB Unsigned Integer | PROTONV_L29 | Line 29 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 3847 | 4 X 32 | MSB Unsigned Integer | PROTONV_L30 | Line 30 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 3975 | 4 X 32 | MSB Unsigned Integer | PROTONV_L31 | Line 31 of a 32X32 hi-res proton vel distribution, integrated over 10 scan seq |
| 4103 | 4      | MSB Unsigned Integer | PROTON_L    | Count of protons in left edge of the 32X32 window.                             |
| 4107 | 4      | MSB Unsigned Integer | PROTON_R    | Count of protons in right edge of the 32X32 window.                            |
| 4111 | 4      | MSB Unsigned Integer | PROTON_BOT  | Count of protons in bottom edge of the 32X32 window.                           |
| 4115 | 4      | MSB Unsigned Integer | PROTON_TOP  | Count of protons in top edge of the 32X32 window.                              |

### 1. MET

Mission Elapsed Time in seconds.

### 2. FIPS\_SCANTYPE

Indicates the FIPS Scan Mode. =0 Normal Scan, =1 High Temp Scan, =2 Burst Scan, =3 Test Scan, =4 Table 4, =5 Table 5, =6 Table 6, =7 Table 7.

### 3. PROTONV\_L00

Line 0 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**4. PROTONV\_L01**

Line 1 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**5. PROTONV\_L02**

Line 2 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**6. PROTONV\_L03**

Line 3 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**7. PROTONV\_L04**

Line 4 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**8. PROTONV\_L05**

Line 5 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**9. PROTONV\_L06**

Line 6 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**10. PROTONV\_L07**

Line 7 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**11. PROTONV\_L08**

Line 8 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**12. PROTONV\_L09**

Line 9 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**13. PROTONV\_L10**

Line 10 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**14. PROTONV\_L11**

Line 11 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**15. PROTONV\_L12**

Line 12 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**16. PROTONV\_L13**

Line 13 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**17. PROTONV\_L14**

Line 14 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**18. PROTONV\_L15**

Line 15 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**19. PROTONV\_L16**

Line 16 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**20. PROTONV\_L17**

Line 17 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**21. PROTONV\_L18**

Line 18 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.



**22. PROTONV\_L19**

Line 19 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**23. PROTONV\_L20**

Line 20 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**24. PROTONV\_L21**

Line 21 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**25. PROTONV\_L22**

Line 22 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**26. PROTONV\_L23**

Line 23 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**27. PROTONV\_L24**

Line 24 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**28. PROTONV\_L25**

Line 25 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**29. PROTONV\_L26**

Line 26 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**30. PROTONV\_L27**

Line 27 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**31. PROTONV\_L28**

Line 28 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**32. PROTONV\_L29**

Line 29 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**33. PROTONV\_L30**

Line 30 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**34. PROTONV\_L31**

Line 31 of a 32x32 high-resolution proton velocity distribution, integrated over a 10-scan sequence.

**35. PROTON\_L**

Count of protons off the left edge of the 32x32 window.

**36. PROTON\_R**

Count of protons off the right edge of the 32x32 window.

**37. PROTON\_BOT**

Count of protons off the bottom edge of the 32x32 window.

**38. PROTON\_TOP**

Count of protons off the top edge of the 32x32 window.

### 8.15 EPPS\_STATUS.FMT Table Fields

The following are the fields as defined by the EPPS\_STATUS.FMT structure file. This file defines the ASCII table containing the EPPS engineering status and housekeeping data (taken from the EPPS Status Packet). A FSW5 upload was implemented on 9/6/2007. As a result the EPPS Status EDR will not be generated for data collected by the EPPS instrument on or after 9/6/2007. Instead use the EPPS Long Status EDR.

**Table 29 EPPS\_STATUS.FMT Fields**

| Start Byte | Length (bytes) | Data Type     | Column Name       | Summary (see full text for column description) |
|------------|----------------|---------------|-------------------|--|
| 1          | 12             | ASCII_INTEGER | MET               | Mission Elapsed Time in seconds.               |
| 15         | 5              | ASCII_INTEGER | STATUS_INTERVAL   | Status interval in seconds.                    |
| 22         | 5              | ASCII_INTEGER | FREE_MACRO_BLOCKS | Number of macro blocks free.                   |
| 29         | 5              | ASCII_INTEGER | WATCH_ADDRESS     | Memory watch address.                          |
| 36         | 3              | ASCII_INTEGER | WATCH_MEMORY      | Page number of watched memory.                 |
| 41         | 2 X 1          | ASCII_INTEGER | WATCH_DATA        | 2 element array of watched data values.        |
| 51         | 3              | ASCII_INTEGER | SW_VERSION        | Software version number.                       |
| 56         | 3              | ASCII_INTEGER | ALARM_ID          | Latest alarm ID.                               |
| 61         | 1              | ASCII_INTEGER | ALARM_TYPE        | Type of latest alarm.                          |
| 64         | 3              | ASCII_INTEGER | ALARM_COUNT       | Count of alarms.                               |
| 69         | 3              | ASCII_INTEGER | CMD_EXEC          | Number of commands executed.                   |
| 74         | 3              | ASCII_INTEGER | CMD_REJECT        | Number of commands rejected.                   |
| 79         | 3              | ASCII_INTEGER | MAC_EXEC          | Macro commands executed.                       |
| 84         | 5              | ASCII_INTEGER | MAC_REJECT        | Macro commands rejected.                       |
| 89         | 3              | ASCII_INTEGER | MAC_ID            | ID of most recent macro executed.              |
| 94         | 1              | ASCII_INTEGER | MACRO_LEARN       | Macro learn mode.                              |
| 97         | 1              | ASCII_INTEGER | MONITOR_RESPONSE  | Monitor response.                              |
| 100        | 1              | ASCII_INTEGER | WRITE_ENABLE      | Memory write enable.                           |
| 103        | 2              | ASCII_INTEGER | SPARE             | Spare column.                                  |
| 107        | 5              | ASCII_INTEGER | HVPS_I            | HVPS current.                                  |
| 114        | 5              | ASCII_INTEGER | HVPS_V            | HVPS voltage.                                  |
| 121        | 5              | ASCII_INTEGER | BIAS_I            | Bias current.                                  |
| 128        | 5              | ASCII_INTEGER | BIAS_V            | Bias voltage.                                  |
| 135        | 5              | ASCII_INTEGER | EPS_STATUS_WORD   | Integer value of EPS status word.              |
| 142        | 5              | ASCII_INTEGER | LVPS_P5_V         | +5 volt monitor, mux channel 0.                |
| 149        | 5              | ASCII_INTEGER | LVPS_M5_V         | -5 volt monitor, mux channel 1.                |
| 156        | 5              | ASCII_INTEGER | LVPS_P12_V        | +12 volt monitor, mux channel 2.               |
| 163        | 5              | ASCII_INTEGER | LVPS_M12_V        | -12 volt monitor, mux channel 3.               |
| 170        | 5              | ASCII_INTEGER | LVPS_P5_I         | +5V current.                                   |
| 177        | 5              | ASCII_INTEGER | LVPS_M5_I         | -5V current.                                   |
| 184        | 5              | ASCII_INTEGER | LVPS_P12_I        | +12V current.                                  |
| 191        | 5              | ASCII_INTEGER | LVPS_M12_I        | -12V current.                                  |
| 198        | 5              | ASCII_INTEGER | EPS_TEMP          | EPS temperature.                               |
| 205        | 5              | ASCII_INTEGER | LVPS_TEMP         | LVPS temperature.                              |
| 212        | 5              | ASCII_INTEGER | LVPS_PRIMARY_I    | LVPS primary current monitor.                  |
| 219        | 5              | ASCII_INTEGER | LVPS_SWITCHED_I   | Switched primary current monitor.              |
| 226        | 5              | ASCII_INTEGER | FIPS_P15_V        | +15 volt monitor, FIPS                         |
| 233        | 5              | ASCII_INTEGER | FIPS_M15_V        | -15 volt monitor, FIPS                         |
| 240        | 5              | ASCII_INTEGER | FIPS_P5_V         | +5 volt monitor, FIPS                          |
| 247        | 5              | ASCII_INTEGER | FIPS_M5_V         | -5 volt monitor, FIPS                          |
| 254        | 5              | ASCII_INTEGER | FIPS_P3DOT5_V     | +3.5 volt monitor, FIPS                        |
| 261        | 5              | ASCII_INTEGER | FIPS_P2DOT5_V     | +2.5 volt monitor, FIPS                        |
| 268        | 5              | ASCII_INTEGER | VREF_I2C_TEMP     | Vref I2C temperature.                          |
| 275        | 5              | ASCII_INTEGER | BH_BOT_I2C_TEMP   | BH Bottom I2C temperature.                     |

|     |   |               |                   |  |
|-----|---|---------------|-------------------|--|
| 282 | 5 | ASCII_INTEGER | BH_TOP_I2C_TEMP   | BH Top I2C temperature.                |
| 289 | 5 | ASCII_INTEGER | DSHV_I2C_TEMP     | DS-HV I2C temperature.                 |
| 296 | 5 | ASCII_INTEGER | MCP_HV_MON        | MCP-HV monitor.                        |
| 303 | 5 | ASCII_INTEGER | PA_HV_MON         | PA-HV monitor.                         |
| 310 | 5 | ASCII_INTEGER | DSHV_MON          | DSHV monitor.                          |
| 317 | 5 | ASCII_INTEGER | DSHV_STEP         | Steps at which HV values were sampled. |
| 324 | 5 | ASCII_INTEGER | FIPS_BH_BOT_TEMP  | BH bottom temperature, mux channel 6.  |
| 331 | 5 | ASCII_INTEGER | FIPS_BH_TOP_TEMP  | BH top temperature, mux channel 8.     |
| 338 | 3 | ASCII_INTEGER | SPARE             | Spare column.                          |
| 343 | 5 | ASCII_INTEGER | I2C_READ_CMD_ADDR | I2C read command address.              |
| 350 | 5 | ASCII_INTEGER | I2C_READ_CMD_RES  | I2C read command result.               |

**1. MET**

Mission Elapsed Time in seconds at the end of the accumulation.

**2. STATUS\_INTERVAL**

Status interval in seconds.

**3. FREE\_MACRO\_BLOCKS**

Number of macro blocks free.

**4. WATCH\_ADDRESS**

Memory watch address.

**5. WATCH\_MEMORY**

Watched memory (page number)

**6. WATCH\_DATA**

Watched memory data.

**7. SW\_VERSION**

Software version number.

**8. ALARM\_ID**

Latest alarm ID.

**9. ALARM\_TYPE**

Latest alarm type. =0 persistent, =1 transient.

**10. ALARM\_COUNT**

Count of alarms.

**11. CMD\_EXEC**

Number of commands executed.

**12. CMD\_REJECT**

Number of commands rejected.

**13. MAC\_EXEC**

Macro commands executed.

**14. MAC\_REJECT**

Macro commands rejected.

**15. MAC\_ID**

ID of most recent macro executed.

**16. MACRO\_LEARN**

Macro learn mode. =0 not learning, =1 learning.

**17. MONITOR\_RESPONSE**

Monitor response. =0 disabled, =1 enabled.

**18. WRITE\_ENABLE**

Memory write enable. =0 disabled, =1 enabled.

**19. SPARE**

Spare column.

**20. HVPS\_I**

HVPS current.

**21. HVPS\_V**

HVPS voltage.

**22. BIAS\_I**

Bias current.

**23. BIAS\_V**

Bias voltage.

**24. EPS\_STATUS\_WORD**

EPS status word.

**25. LVPS\_P5\_V**

+5 volt monitor, I2C read of LVPS ADC on mux channel 0.

**26. LVPS\_M5\_V**

-5 volt monitor, I2C read of LVPS ADC on mux channel 1.

**27. LVPS\_P12\_V**

+12 volt monitor, I2C read of LVPS ADC on mux channel 2.

**28. LVPS\_M12\_V**

-12 volt monitor, I2C read of LVPS ADC on mux channel 3.

**29. LVPS\_P5\_I**

+5 current monitor, I2C read of LVPS ADC on mux channel 9.

**30. LVPS\_M5\_I**

-5 current monitor, I2C read of LVPS ADC on mux channel 10.

**31. LVPS\_P12\_I**

+12 current monitor, I2C read of LVPS ADC on mux channel 11.

**32. LVPS\_M12\_I**

-12 current monitor, I2C read of LVPS ADC on mux channel 12.

**33. EPS\_TEMP**

EPS temperature, I2C read of LVPS ADC on mux channel 7.

**34. LVPS\_TEMP**

LVPS temperature, I2C read of VLPS ADC on mux channel 13.

**35. LVPS\_PRIMARY\_I**

Primary current monitor, I2C read of LVPS ADC on mux channel 14.

**36. LVPS\_SWITCHED\_I**

Switched primary current monitor, I2C read of LVPS ADC on mux channel 15.

**37. FIPS\_P15\_V**

FIPS +15 volt monitor.

**38. FIPS\_M15\_V**

FIPS -15 volt monitor.

**39. FIPS\_P5\_V**

FIPS +5 volt monitor.

**40. FIPS\_M5\_V**

FIPS -5 volt monitor.

**41. FIPS\_P3DOT5\_V**

FIPS 3.5 volt monitor.

**42. FIPS\_P2DOT5\_V**

FIPS 2.5 volt monitor.

**43. VREF\_I2C\_TEMP**

FIPS Vref I2C temperature.

**44. BH\_BOT\_I2C\_TEMP**

FIPS BH BOT I2C temperature.

**45. BH\_TOP\_I2C\_TEMP**

FIPS BH TOP I2C temperature.

**46. DSHV\_I2C\_TEMP**

FIPS DS-HV I2C temperature.

**47. MCP\_HV\_MON**

MCP-HV monitor.

**48. PA\_HV\_MON**

PA-HV monitor.

**49. DSHV\_MON**

DSHV Monitor.

**50. DSHV\_STEP**

Steps at which HV values were sampled.

**51. FIPS\_BH\_BOT\_TEMP**

FIPS BH Bottom temperature, I2C read of LVPS ADC on mux channel 6.

**52. FIPS\_BH\_TOP\_TEMP**

FIPS BH Top temperature, I2C read of LVPS ADC on mux channel 8.

**53. SPARE**

Spare column.

**54. I2C\_READ\_CMD\_ADDR**

I2C read command address.

**55. I2C\_READ\_CMD\_RES**

I2C read command result.

**8.16 EPPS\_LONG.FMT Table Fields**

The following are the fields as defined by the EPPS\_LONG.FMT structure file. This file defines the ASCII table containing the EPPS engineering status and housekeeping data taken from the EPPS Status Packet (updated by the version 5 flight software upload). This new EPPS status format contains an additional 48 columns over the old EPPS Status EDR. Refer to the data description following the table for more details on each field.

This EDR is the result of the FSW5 upload on 9/6/2007. For engineering and status data prior to 9/6/2007 use the EPPS Status EDR.

**Table 30 EPPS\_LONG.FMT Fields**

| Start Byte | Length (bytes) | Data Type     | Column Name      | Summary (see full text for column description) |
|------------|----------------|---------------|------------------|--|
| 1          | 12             | ASCII_INTEGER | MET              | Mission Elapsed Time in seconds.               |
| 15         | 5              | ASCII_INTEGER | STATUS_INTERVAL  | Status interval in seconds.                    |
| 22         | 5              | ASCII_INTEGER | MACRO_BLOCKS     | Number of macro blocks free.                   |
| 29         | 5              | ASCII_INTEGER | WATCH_ADDRESS    | Memory watch address.                          |
| 36         | 3              | ASCII_INTEGER | WATCH_MEMORY     | Watched memory.                                |
| 41         | 2 X 3          | ASCII_INTEGER | WATCH_DATA       | Watched memory data.                           |
| 51         | 3              | ASCII_INTEGER | SW_VERSION       | Software version number.                       |
| 56         | 3              | ASCII_INTEGER | ALARM_ID         | Latest alarm ID.                               |
| 61         | 1              | ASCII_INTEGER | ALARM_TYPE       | Latest alarm type.                             |
| 64         | 3              | ASCII_INTEGER | ALARM_COUNT      | Count of alarms.                               |
| 69         | 3              | ASCII_INTEGER | CMD_EXEC         | Number of commands executed.                   |
| 74         | 3              | ASCII_INTEGER | CMD_REJECT       | Number of commands rejected.                   |
| 79         | 3              | ASCII_INTEGER | MAC_EXEC         | Macro commands executed.                       |
| 84         | 3              | ASCII_INTEGER | MAC_REJECT       | Macro commands rejected.                       |
| 89         | 3              | ASCII_INTEGER | MAC_ID           | ID of most recent macro executed.              |
| 94         | 1              | ASCII_INTEGER | MACRO_LEARN      | Macro learn mode.                              |
| 97         | 1              | ASCII_INTEGER | MONITOR_RESPONSE | Monitor response.                              |
| 100        | 1              | ASCII_INTEGER | WRITE_ENABLE     | Memory write enable.                           |
| 103        | 5              | ASCII_INTEGER | LVPS_P5_V        | +5 volt monitor,                               |
| 110        | 5              | ASCII_INTEGER | LVPS_M5_V        | -5 volt monitor,                               |
| 117        | 5              | ASCII_INTEGER | LVPS_P12_V       | +12 volt monitor,                              |
| 124        | 5              | ASCII_INTEGER | LVPS_M12_V       | -12 volt monitor,                              |
| 131        | 5              | ASCII_INTEGER | EPS_TEMP         | EPS temperature                                |
| 138        | 5              | ASCII_INTEGER | FIPS_BH_TOP_TEMP | FIPS BH Top temperature                        |
| 145        | 5              | ASCII_INTEGER | LVPS_P5_I        | +5 current monitor.                            |
| 152        | 5              | ASCII_INTEGER | LVPS_M5_I        | -5 current monitor.                            |
| 159        | 5              | ASCII_INTEGER | LVPS_P12_I       | +12 current monitor.                           |
| 166        | 5              | ASCII_INTEGER | LVPS_M12_I       | -12 current monitor.                           |
| 173        | 5              | ASCII_INTEGER | LVPS_TEMP        | LVPS temperature                               |
| 180        | 5              | ASCII_INTEGER | LVPS_PRIMARY_I   | Primary current monitor                        |
| 187        | 1              | ASCII_INTEGER | FIPS_15V_PWR     | FIPS +15 volt Power enable                     |
| 190        | 1              | ASCII_INTEGER | FIPS_5V_PWR      | FIPS +5 volt Power enable                      |
| 193        | 2              | ASCII_INTEGER | EPS_START1       | EPS start anode enable A0                      |

|     |   |               |                      |   |
|-----|---|---------------|----------------------|---|
| 197 | 2 | ASCII_INTEGER | EPS_TOF_MODE         | EPS TOF mode                            |
| 201 | 1 | ASCII_INTEGER | EPS_ELEC_PIX_SIZE    | EPS elec pix size                       |
| 204 | 1 | ASCII_INTEGER | EPS_ION_PIX_SIZE     | EPS ion pix size                        |
| 207 | 2 | ASCII_INTEGER | EPS_HV_LIMIT         | EPS HV limit                            |
| 211 | 2 | ASCII_INTEGER | EPS_START2           | EPS start anode enable A2-A5            |
| 215 | 1 | ASCII_INTEGER | EPS_HV_CLKS          | EPS HV clcks enable                     |
| 218 | 1 | ASCII_INTEGER | EPS_HV_ADC           | EPS HV ADC enable                       |
| 221 | 1 | ASCII_INTEGER | EPS_HV_MON           | EPS HV mon enable                       |
| 224 | 1 | ASCII_INTEGER | EPS_TOF_CLK          | EPS TOF clk                             |
| 227 | 1 | ASCII_INTEGER | EPS_FLIGHT_MODE      | EPS flight mode                         |
| 230 | 4 | ASCII_INTEGER | EPS_SSD_CHAN         | EPS SSD channels                        |
| 236 | 1 | ASCII_INTEGER | EPS_MULTI_DET        | EPS multi start/stop detection          |
| 239 | 1 | ASCII_INTEGER | EPS_STIM_PORT        | EPS stim port enable                    |
| 242 | 1 | ASCII_INTEGER | FIPS_FIFO            | Stores the value of the FIPS FIFO.      |
| 245 | 1 | ASCII_INTEGER | EPS_FIFO             | EPS FIFO enable                         |
| 248 | 1 | ASCII_INTEGER | EPS_DIAG_MODE        | EPS diagnostic mode enable              |
| 251 | 1 | ASCII_INTEGER | EPS_12US_LOCKOUT     | EPS 12us lockout enable                 |
| 254 | 1 | ASCII_INTEGER | EPS_ION_TRIPLE       | EPS ion triple events only              |
| 257 | 1 | ASCII_INTEGER | EPS_COIN_STOP        | EPS coincidence stop window             |
| 260 | 1 | ASCII_INTEGER | EPS_COIN_START       | EPS coincidence start window            |
| 263 | 1 | ASCII_INTEGER | EPS_TEST_MODES       | EPS test modes                          |
| 266 | 2 | ASCII_INTEGER | EPS_ELEC_DECIMATION  | EPS electron decimation                 |
| 270 | 5 | ASCII_INTEGER | HVPS_I               | HVPS current.                           |
| 277 | 5 | ASCII_INTEGER | HVPS_V               | HVPS voltage.                           |
| 284 | 5 | ASCII_INTEGER | BIAS_I               | Bias current.                           |
| 291 | 5 | ASCII_INTEGER | BIAS_V               | Bias voltage.                           |
| 298 | 5 | ASCII_INTEGER | EPS_STATUS_WORD      | EPS status word.                        |
| 305 | 5 | ASCII_INTEGER | HVPS_SET             | HVPS setting.                           |
| 312 | 5 | ASCII_INTEGER | BIAS_SET             | Bias setting.                           |
| 319 | 5 | ASCII_INTEGER | EPS_ION_FAST_1_3_5   | Ion fast channels 1,3,5.                |
| 326 | 5 | ASCII_INTEGER | EPS_ION_SHPD_1_3_5   | Ion shaped channels 1,3,5.              |
| 333 | 5 | ASCII_INTEGER | EPS_ION_FAST_7_9_11  | Ion fast channels 7,9,11.               |
| 340 | 5 | ASCII_INTEGER | EPS_ION_SHPD_7_9_11  | Ion shaped channels 7,9,11.             |
| 347 | 5 | ASCII_INTEGER | EPS_ELEC_FAST_0_2_4  | Electron fast channels 0,2,4.           |
| 354 | 5 | ASCII_INTEGER | EPS_ELEC_SPHD_0_2_4  | Electron shaped channels 0,2,4.         |
| 361 | 5 | ASCII_INTEGER | EPS_ELEC_FAST_6_8_10 | Electron fast channels 6,8,10.          |
| 368 | 5 | ASCII_INTEGER | EPS_ELEC_SHPD_6_8_10 | Electron shaped channels 6,8,10.        |
| 375 | 5 | ASCII_INTEGER | EPS_BIAS_CLOCK_ADJ   | Bias clock adjust value.                |
| 382 | 5 | ASCII_INTEGER | I2C_ERRORS           | I2C bus error count.                    |
| 389 | 5 | ASCII_INTEGER | EPS_BUS_READ_VALUE   | Most recent bus read command.           |
| 396 | 5 | ASCII_INTEGER | FIPS_WEDGE           | Wedge digitizer channel.                |
| 403 | 5 | ASCII_INTEGER | FIPS_STRIP           | Strip digitizer channel.                |
| 410 | 5 | ASCII_INTEGER | FIPS_ZIGZAG          | Zigzag digitizer channel.               |
| 417 | 5 | ASCII_INTEGER | FIPS_P15_V           | FIPS +15V monitor.                      |
| 424 | 5 | ASCII_INTEGER | FIPS_M15_V           | FIPS -15V monitor.                      |
| 431 | 5 | ASCII_INTEGER | FIPS_P5_V            | FIPS +5V monitor.                       |
| 438 | 5 | ASCII_INTEGER | FIPS_M5_V            | FIPS -5V monitor.                       |
| 445 | 5 | ASCII_INTEGER | FIPS_3DOT5_V         | FIPS +3.5V monitor.                     |
| 452 | 5 | ASCII_INTEGER | FIPS_2DOT5_V         | FIPS +2.5V monitor.                     |
| 459 | 5 | ASCII_INTEGER | V_REF_T              | FIPS Vref I2C temperature.              |
| 466 | 5 | ASCII_INTEGER | BH_TOP_I2C_T         | FIPS bulkhead top temperature from I2C. |
| 473 | 5 | ASCII_INTEGER | DSHV_I2C_T           | FIPS DSHV temperature from I2C.         |
| 480 | 5 | ASCII_INTEGER | MCP_HV_MON           | MCPHV monitor.                          |
| 487 | 5 | ASCII_INTEGER | PA_HV_MON            | PAHV monitor.                           |
| 494 | 5 | ASCII_INTEGER | DSHV_MON             | DSHV monitor.                           |

|     |   |               |                     |  |
|-----|---|---------------|---------------------|--|
| 501 | 5 | ASCII_INTEGER | DSHV_STEP           | Steps at which HV values were sampled. |
| 508 | 1 | ASCII_INTEGER | FIPS_PEAKHOLD_TRACK | FIPS peak hold/track.                  |
| 511 | 1 | ASCII_INTEGER | FIPS_PEAKHOLD       | FIPS peak hold.                        |
| 514 | 1 | ASCII_INTEGER | FIPS_DUMPRAMP       | FIPS dump/ramp.                        |
| 517 | 1 | ASCII_INTEGER | FIPS_EVENTTRIG      | FIPS event trigger.                    |
| 520 | 1 | ASCII_INTEGER | FIPS_RETRIG         | FIPS retrigger start dealy.            |
| 523 | 1 | ASCII_INTEGER | FIPS_TOFCLOCK       | FIPS time of flight clock select.      |
| 526 | 1 | ASCII_INTEGER | FIPS_HIGHSPEED      | FIPS LVDS power mode.                  |
| 529 | 1 | ASCII_INTEGER | FIPS_VALIDEVENT     | FIPS valid event.                      |
| 532 | 1 | ASCII_INTEGER | FIPS_MCPHV          | FIPS MCPHV enable.                     |
| 535 | 1 | ASCII_INTEGER | FIPS_PAHV           | FIPS PAHV enable.                      |
| 538 | 1 | ASCII_INTEGER | FIPS_DSHV           | FIPS DSHV enable.                      |
| 541 | 1 | ASCII_INTEGER | FIPS_STAT_MODE      | FIPS mode.                             |
| 544 | 1 | ASCII_INTEGER | PAHVTRIPPED         | PAHV autonomous shutdown flag.         |
| 547 | 1 | ASCII_INTEGER | MCPHVTRIPPED        | MCPHV autonomous shutdown flag.        |

**1. MET**

Mission Elapsed Time in seconds.

**2. STATUS\_INTERVAL**

Status interval in seconds.

**3. FREE\_MACRO\_BLOCKS**

Number of macro blocks free.

**4. WATCH\_ADDRESS**

Memory watch address.

**5. WATCH\_MEMORY**

Watched memory (page number)

**6. WATCH\_DATA**

Watched memory data.

**7. SW\_VERSION**

Software version number.

**8. ALARM\_ID**

Latest alarm ID.

**9. ALARM\_TYPE**

Latest alarm type. =0 persistent, =1 transient.

**10. ALARM\_COUNT**

Count of alarms.

**11. CMD\_EXEC**

Number of commands executed.

**12. CMD\_REJECT**

Number of commands rejected.

**13. MAC\_EXEC**

Macro commands executed.

**14. MAC\_REJECT**



Macro commands rejected.

**15. MAC\_ID**

ID of most recent macro executed.

**16. MACRO\_LEARN**

Macro learn mode. =0 not learning, =1 learning.

**17. MONITOR\_RESPONSE**

Monitor response. =0 disabled, =1 enabled.

**18. WRITE\_ENABLE**

Memory write enable. =0 disabled, =1 enabled.

**19. LVPS\_P5\_V**

+5 volt monitor.

**20. LVPS\_M5\_V**

-5 volt monitor.

**21. LVPS\_P12\_V**

+12 volt monitor.

**22. LVPS\_M12\_V**

-12 volt monitor.

**23. EPS\_TEMP**

EPS temperature.

**24. FIPS\_BH\_TOP\_TEMP**

FIPS BH Top temperature.

**25. LVPS\_P5\_I**

+5 current.

**26. LVPS\_M5\_I**

-5 current monitor.

**27. LVPS\_P12\_I**

+12 current monitor.

**28. LVPS\_M12\_I**

-12 current monitor.

**29. LVPS\_TEMP**

LVPS temperature,

**30. LVPS\_PRIMARY\_I**

Primary current monitor,

**31. FIPS\_15\_V\_PWR**

FIPS +15v Power enable =0 off, =1 on.

**32. FIPS\_5\_V\_PWR**

FIPS +5v Power enable. =0 off, =1 on.

**33. EPS\_START1**

EPS\_Start\_Anode\_Enable:A0, A1:Enable=1.

**34. EPS\_TOF\_MODE**

EPS\_TOF\_MODE:half period, tap\_sel1,tap\_sel2.

**35. EPS\_ELEC\_PIX\_SIZE**

EPS\_Elec\_Pix\_Size: large=0, small=1.

**36. EPS\_ION\_PIX\_SIZE**

EPS\_Ion\_Pix\_Size: large=0, small=1.

**37. EPS\_HV\_LIMIT**

EPS\_HV\_Limit (8 bit signed voltage limit).

**38. EPS\_START2**

EPS\_Start\_Anode\_Enable:A2-A5:Enable=1.

**39. EPS\_HV\_CLKS**

EPS\_HV\_Clks\_Enable: Enable=1.

**40. EPS\_HV\_ADC**

EPS\_HV\_ADC\_Enable: Enable=1.

**41. EPS\_HV\_MON**

EPS\_HV\_Mon\_Enable: Enable=1.

**42. EPS\_TOF\_CLK**

EPS\_TOF\_Clk: 6MHz=1, 3MHz=0.

**43. EPS\_FLIGHT\_MODE**

EPS\_Flight\_Mode: Flight=1, Ground\_test=0.

**44. EPS\_SSD\_CHAN**

EPS\_SSD\_Channels: 12 bit field for each SSD: enable=1.

**45. EPS\_MULTI\_DET**

EPS\_Multi\_start/stop\_Detection: Enable=1.

**46. EPS\_STIM\_PORT**

EPS\_Stim\_Port\_Enable: Enable=1.

**47. FIPS\_FIFO**

Stores the status of the FIPS event FIFO.

=0 FIPS events disabled, =1 FIPS events enabled in FIPS FIFO of EPU.

**48. EPS\_FIFO**

EPS\_FIFO\_Enable: Enable=1.

**49. EPS\_DIAG\_MODE**

EPS\_Diagnostic\_Mode\_Enable: Enable=1

**50. EPS\_12US\_LOCKOUT**

EPS\_12us\_Lockout\_Enable: Enable=1.

**51. EPS\_ION\_TRIPLE**

EPS\_Ion\_Triple\_Events\_only: Enable=1.

**52. EPS\_COIN\_STOP**

EPS\_Coincidence\_Stop\_window: 3 bit delay tap code.

**53. EPS\_COIN\_START**

EPS\_Coincidence\_Start\_window: 3 bit delay tap code.

**54. EPS\_TEST\_MODES**

EPS\_Test\_Modes: Enable=1.

**55. EPS\_ELEC\_DECIMATION**

EPS\_Electron\_Decimation: 7 bit discard rate.

**56. HVPS\_I**

HVPS current.

**57. HVPS\_V**

HVPS voltage.

**58. BIAS\_I**

Bias current.

**59. BIAS\_V**

Bias voltage.

**60. EPS\_STATUS\_WORD**

EPS status word.

**61. HVPS\_SET**

HVPS setting.

**62. BIAS\_SET**

Bias Setting.

**63. EPS\_ION\_FAST\_1\_3\_5**

Ion fast channels 1,3,5.

**64. EPS\_ION\_SHPD\_1\_3\_5**

Ion shaped channels 1,3,5.

**65. EPS\_ION\_FAST\_7\_9\_11**

Ion fast channels 7,9,11.

**66. EPS\_ION\_SHPD\_7\_9\_11**

Ion shaped channels 7,9,11.

**67. EPS\_ELEC\_FAST\_0\_2\_4**

Electron fast channels 0,2,4.

**68. EPS\_ELEC\_SHPD\_0\_2\_4**

Electron shaped channels 0,2,4.

**69. EPS\_ELEC\_FAST\_6\_8\_10**

Electron fast channels 6,8,10.

**70. EPS\_ELEC\_SHPD\_6\_8\_10**

Electron shaped channels 6,8,10.

**71. EPS\_BIAS\_CLOCK\_ADJ**

Bias clock adjust value.

**72. I2C\_ERRORS**

I2C bus error count.

**73. EPS\_BUS\_READ\_VALUE**

Value provided by most recent bus command.

**74. FIPS\_WEDGE**

Wedge digitizer channel.

**75. FIPS\_STRIP**

Strip digitizer channel.

**76. FIPS\_ZIGZAG**

Zigzag digitizer channel.

**77. FIPS\_P15\_V**

FIPS +15V monitor,

**78. FIPS\_M15\_V**

FIPS -15V monitor.

**79. FIPS\_P5\_V**

FIPS +5V monitor.

**80. FIPS\_M5\_V**

FIPS -5V monitor.

**81. FIPS\_3DOT5\_V**

FIPS +3.5V monitor.

**82. FIPS\_2DOT5\_V**

FIPS +2.5V monitor.

**83. V\_REF\_T**

FIPS Vref I2C temperature.

**84. BH\_TOP\_I2C\_T**

FIPS bulk head top temperature (read via I2C).

**85. DSHV\_I2C\_T**

FIPS DSHV temperature (read via I2C).

**86. MCP\_HV\_MON**

MCPHV monitor.

**87. PA\_HV\_MON**

PAHV monitor.

**88. DSHV\_MON**

DSHV monitor.

**89. DSHV\_STEP**

Steps at which HV values were sampled.

**90. FIPS\_PEAKHOLD\_TRACK**

FIPS Peak Hold/Track. =0 Peak hold for WSZ. =1 Peak track for WSZ.

**91. FIPS\_PEAKHOLD**

FIPS Peak Hold. =0 Disable =1 Enable.

**92. FIPS\_DUMPRAMP**

FIPS Dump/Ramp. =0 Dump, =1 Ramp.

**93. FIPS\_EVENTTRIG**

FIPS Event Trigger. =0 Transmit, =1 Start.

**94. FIPS\_RETRIG**

FIPS Retrigger start delay. =0 Non-retrig, =1 Retrig.

**95. FIPS\_TOFCLOCK**

FIPS Time of Flight Clock Select:  
=0 12MHz, =1 6MHz, =2 3MHz, =3 1.5MHz, =4 750kHz.

**96. FIPS\_HIGHSPEED**

FIPS LVDS Power mode. =0 Transmit, =1 Always.

**97. FIPS\_VALIDEVENT**

FIPS Valid Event. =0 No event, =1 Valid event.

**98. FIPS\_MCPHV**

FIPS MCPHV enable =0 off, =1 on.

**99. FIPS\_PAHV**

FIPS PAHV enable. =0 off, =1 on.

**100.FIPS\_DSHV**

FIPS DSHV enable. =0 off, =1 on.

**101.FIPS\_STAT\_MODE**

FIPS mode =0 reset, =1 manual, =2 standby, =3 maneuver, =4 single.

**102.PAHVTRIPPED**

FIPS autonomous shutdown flag for PAHV shutdown. =0 OK, =1 shutdown.

**103.MCPHVTRIPPED**

FIPS autonomous shutdown flag for MCPHV shutdown. =0 OK, =1 shutdown.

***8.17 SPICE Kernel Files Used in MESSENGER Data Products***

The following SPICE kernel files will be used to compute the UTC time and any geometric quantities found in the PDS labels. Kernel files will be generated throughout the mission with a filenaming convention specified by the MESSENGER project.

**\*.bsp:**

MESSENGER spacecraft ephemeris file. Also known as the Planetary Spacecraft Ephemeris Kernel (SPK) file.

**\*.bc:**

Messenger spacecraft orientation file. Also known as the Attitude C-Kernel (CK) file.

**\*.tf:**

MESSENGER reference frame file. Also known as the Frames Kernel. Contains the MESSENGER spacecraft, science instrument, and communications antennae frame definitions.

**\*.ti:**

MESSENGER instrument kernel (I-kernel). Contains references to mounting alignment, operation modes, and timing as well as internal and field of view geometry for the EPPS.

**\*.tsc:**

MESSENGER spacecraft clock coefficients file. Also known as the Spacecraft Clock Kernel (SCLK) file.

**\*.tpc:**

Planetary constants file. Also known as the Planetary Constants Kernel (PcK) file.

**\*.tls:**

NAIF leapseconds kernel file. Used in conjunction with the SCLK kernel to convert between Universal Time Coordinated (UTC) and MESSENGER Mission Elapsed Time (MET). Also called the Leap Seconds Kernel (LSK) file.

### 8.18 CODMAC/NASA Definition of Processing Levels

**Table 31 CODMAC/NASA Definition of processing levels for science data sets**

| CODMAC Level | Proc. Type       | Data Processing Level Description  |
|--------------|------------------|--|
| 1            | Raw Data         | Telemetry data stream as received at the ground station, with science and engineering data embedded. Corresponds to NASA packet data.  |
| 2            | Edited Data      | Instrument science data (e.g. raw voltages, counts) at full resolution, time ordered, with duplicates and transmission errors removed. Referred to in the MESSENGER program as Experiment Data Records (EDRs). Corresponds to NASA Level 0 data.   |
| 3            | Calibrated Data  | Edited data that are still in units produced by instrument, but have transformed (e.g. calibrated, rearranged) in a reversible manner and packaged with needed ancillary and auxiliary data (e.g. radiances with calibration equations applied). Referred to in the MESSENGER Program as Calibrated Data Records (CDRs). In some cases these also qualify as derived data products (DDRs). Corresponds to NASA Level 1A. |
| 4            | Resampled data   | Irreversibly transformed (e.g. resampled, remapped, calibrated) values of the instrument measurements (e.g. radiances, magnetic field strength). Referred to in the MESSENGER program as either derived data products (DDPs) or derived analysis products (DAPs). Corresponds to NASA Level 1B.  |
| 5            | Derived Data     | Derived results such as maps, reports, graphics, etc.<br>Corresponds to NASA Levels 2 through 5  |
| 6            | Ancillary Data   | Non-Science data needed to generate calibrated or resampled data sets. Consists of instrument gains, offsets; pointing information for scan platforms, etc.  |
| 7            | Corrective Data  | Other science data needed to interpret space-borne data sets. May include ground based data observations such as soil type or ocean buoy measurements of wind drift.   |
| 8            | User Description | Description of why the data were required, any peculiarities associated with the data sets, and enough documentation to allow secondary user to extract information from the data.   |

The above is based on the national research council committee on data management and computation (CODMAC) data levels.

**8.19 MESSENGER Glossary and Acronym List**

|                  |   |
|------------------|---|
| <b>ACT</b>       | Applied Coherent Technology Corporation   |
| <b>ADC</b>       | Analog-to-Digital Converter   |
| <b>AMU</b>       | Atomic Mass Unit  |
| <b>APL</b>       | The Johns Hopkins university Applied Physics Laboratory   |
| <b>ASCII</b>     | American Standard Code for Information Interchange  |
| <b>BH</b>        | Bulk Head   |
| <b>CCSDS</b>     | Consultative Committee for Space Data Systems   |
| <b>CDR</b>       | Calibrated Data Record  |
| <b>CK</b>        | Attitude C-Kernel (SPICE)   |
| <b>CODMAC</b>    | Committee on Data Management and Computation  |
| <b>Co-I</b>      | Co-Investigator   |
| <b>DAP</b>       | Derived Analysis Products   |
| <b>DDP</b>       | Derived Data Products   |
| <b>DN</b>        | Digital number, the raw telemetry count   |
| <b>DPU</b>       | Data Processing Unit  |
| <b>DSHV</b>      | Deflection System High Voltage  |
| <b>DSN</b>       | Deep Space Network  |
| <b>EDR</b>       | Experiment Data Records   |
| <b>EPPS</b>      | Energetic Particle and Plasma Spectrometer  |
| <b>EPS</b>       | Energetic Particle Spectrometer   |
| <b>ESA</b>       | Electrostatic Analyzer  |
| <b>ET</b>        | Ephemeris Time  |
| <b>FIFO</b>      | First In, First out. An electronic component that stores and retrieves information following a first-in-first-out discipline. |
| <b>FIPS</b>      | Fast Imaging Plasma Spectrometer  |
| <b>FOV</b>       | Field-of-View   |
| <b>FSW</b>       | Flight Software   |
| <b>FTP</b>       | File Transfer protocol  |
| <b>GC</b>        | Geochemistry Group  |
| <b>GP</b>        | Geophysics Group  |
| <b>GRNS</b>      | Gamma-ray and Neutron Spectrometer  |
| <b>GRS</b>       | Gamma-ray Spectrometer  |
| <b>GSFC</b>      | Goddard Space Flight Center   |
| <b>HV</b>        | High Voltage  |
| <b>HVPS</b>      | High Voltage Power Supply   |
| <b>I&amp;T</b>   | Integration and Test  |
| <b>I2C</b>       | Inter-Integrated Circuit  |
| <b>JPL</b>       | Jet Propulsion Laboratory   |
| <b>IEM</b>       | Integrated Electronic Module  |
| <b>LSB</b>       | Least Significant Bit   |
| <b>LSK</b>       | Leapseconds Kernel (SPICE)  |
| <b>LVPS</b>      | Low Voltage Power Supply  |
| <b>MAG</b>       | Magnetometer  |
| <b>MASCS</b>     | Mercury Atmospheric and Surface Composition Spectrometer  |
| <b>MCP</b>       | Micro-channel Plate   |
| <b>MCPHV</b>     | Micro-channel Plate High Voltage  |
| <b>MDIS</b>      | Mercury Dual Imaging System   |
| <b>MESSENGER</b> | Mercury, Surface, Space ENvironment, GEochemistry, and Ranging  |
| <b>MET</b>       | Mission Elapsed Time  |
| <b>MLA</b>       | Mercury Laser Altimeter   |
| <b>NAIF</b>      | Navigation and Ancillary Information Facility   |
| <b>NASA</b>      | National Aeronautics and Space Administration   |
| <b>NS</b>        | Neutron Spectrometer  |
| <b>PAHV</b>      | Post Acceleration High Voltage  |
| <b>PCK</b>       | Planetary Constant Kernel (SPICE)   |
| <b>PDS</b>       | Planetary Data System   |
| <b>PHA</b>       | Pulse Height Analysis   |
| <b>PPI</b>       | Planetary Plasma Interactions PDS Node  |
| <b>RDR</b>       | Reduced Data Record   |



|              |  |
|--------------|--|
| <b>SCLK</b>  | Space Clock Kernel (SPICE)   |
| <b>SOC</b>   | Science Operations Center  |
| <b>SPICE</b> | Spacecraft, Planet, Instrument, C-matrix Events, refers to the kernel files and NAIF software used to generate viewing geometry. |
| <b>SPK</b>   | Spacecraft and Planets Kernel (SPICE)  |
| <b>SQL</b>   | Structured Query Language  |
| <b>SSD</b>   | Solid-State Detector   |
| <b>SSR</b>   | Space Sciences Review  |
| <b>TOF</b>   | Time of Flight   |
| <b>UTC</b>   | Coordinated Universal Time   |
| <b>XRS</b>   | X-Ray Spectrometer   |