MESSENGER Software Interface Specification for the Gamma Ray Spectrometer Experiment Data Record

Version 4.8

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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.

Patrick Peplowski, MESSENGER GRNS Scientist, has reviewed and approved this document.

Susan Slavney, PDS Geosciences Node Representative, has reviewed and approved this document.

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

Change Log

<table>
<thead>
<tr>
<th>DATE</th>
<th>SECTIONS CHANGED</th>
<th>REASON FOR CHANGE</th>
<th>REVISION</th>
</tr>
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<tr>
<td>6/2/11</td>
<td>N/A</td>
<td>Add change log.</td>
<td>4.2</td>
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<tr>
<td>6/2/11</td>
<td>1.4, 1.5.4.3</td>
<td>Describe 9/2/10 GRS FSW update for fast neutron detection, updated GRS shield sensor product, and associated label change.</td>
<td>4.2</td>
</tr>
<tr>
<td>6/2/11</td>
<td>1.17, 1.18, 1.19</td>
<td>Add note that original GRS_SHIELD format applies to products before 9/17/10. Add format information for GRS_SHIELD_2 products starting 9/17/10.</td>
<td>4.2</td>
</tr>
<tr>
<td>6/2/11</td>
<td>Appendix/format descriptions</td>
<td>Change “periherm” to “apoherm” in orbit start time descriptions</td>
<td>4.2</td>
</tr>
<tr>
<td>6/10/11</td>
<td>Document Review</td>
<td>Replaced signature page with document review information per agreement with PDS</td>
<td>4.3</td>
</tr>
<tr>
<td>5/25/12</td>
<td>Applicable Documents, Archive release schedule</td>
<td>Change “Data Management and Science Analysis Plan” to “Data Management and Archiving Plan” and update references. Replace archive release schedule table with reference to Data Management and Archiving Plan.</td>
<td>4.4</td>
</tr>
<tr>
<td>9/26/13</td>
<td>1.3, 1.4, 1.5.4.4, 1.20</td>
<td>Describe 25/2/13 GRS FSW update to optimize neutron detection, updated GRS shield sensor products, and associated label changes.</td>
<td>4.5</td>
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<tr>
<td>11/14/13</td>
<td>1.4, 1.5.4.4, 1.20</td>
<td>Edits resulting from review of new shield sensor products.</td>
<td>4.6</td>
</tr>
<tr>
<td>7/7/15</td>
<td>5.4.3,6.4, 6.5</td>
<td>Note use of clock partitions in time tags in product labels following January 8, 2013 S/C clock reset. Update reference to PDS file naming standard (was 27.3 now 36.3). Update GRS EDR data archive volume estimate for mission. Make correction to document style heading 1 so that all 8 document sections are present (not just one section).</td>
<td>4.7</td>
</tr>
<tr>
<td>7/13/15</td>
<td>Table of Contents, 5.1,</td>
<td>Updated with minor formatting corrections</td>
<td>4.8</td>
</tr>
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1 Purpose and Scope of Document

1.1 Purpose
This Software Interface Specification (SIS) document provides users of the Mercury: Surface, Space Environment, Geochemistry and Ranging (MESSENGER) Gamma Ray Spectrometer (GRS) data products with a basic description of the GRS instrument and Experiment Data Records (EDRs). The GRS EDR data products are deliverables to the Planetary Data System (PDS) and the scientific community that it supports. This document is both an EDR data product SIS and an EDR archive volume SIS. Note that the Gamma Ray and Neutron Spectrometer (NS) instruments are generally referred to together as the Gamma Ray and Neutron Spectrometer (GRNS) instrument. However they are two separate sensors, each with its own Event Processing Unit (EPU), and the data products are described within the specific Software Interface Specification (SIS) of each sensor.

1.2 Scope
This SIS document is of a limited scope due to the EDRs being of a very low processing level. It does not provide a description or understanding of the GRS instrument or its EDRs at a detailed level. It is not intended for general use by data analysts outside of the MESSENGER project and it is not intended for the typical science user to access the EDRs routinely. Rather, it is mainly useful as an input to producing the Calibrated Data Record (CDR) and Reduced Data Record (RDR) products. There is a separate PDS data archive for the CDR and RDR products, and these products are described by a separate SIS document.

2 Applicable Documents
The Messenger GRS EDR SIS is responsive to the following Documents:

- Appendix 7 to the discovery program Plan; Program Level Requirement for the MESSENGER Discovery project; June 20, 2001.

3 Relationships with Other Interfaces
The GRS EDR data products are stored on Hard Disk and in a SQL (Structured Query Language) relational database for rapid mission access during mission operations. The data products are electronically transferred to the PDS Geosciences Node according to the delivery schedule in the MESSENGER Data Management and Archiving Plan. The data in the EDR files themselves are stored in PDS binary table objects with the exception of the GRS Status, Software Counter, and Command Echo EDRs. These three EDRs consist of data stored in PDS ASCII table objects.
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 MERcury Surface, Space ENvironment, GEmochemistry, and Ranging (MESSENGER) mission is designed to orbit Mercury following one Earth flyby, two of Venus, and three of Mercury. It launched in August 2004 and achieved orbit insertion around Mercury on 18 March 2011. Initial data collection began during the three flybys of Mercury and consists primarily of global mapping and measurements of the surface, atmosphere, and magnetosphere composition. The nominal one-Earth-year long mission ended on 17 March 2012. This was immediately followed by the start of a one-year-long extended mission. MESSENGER is currently in a two-year-long second and final extended mission. MESSENGER orbital observations provide data to answer questions about the nature and composition of Mercury’s crust, tectonic history, structure of the atmosphere/magnetosphere, and the nature of the polar caps.

The Gamma Ray Spectrometer (GRS) instrument onboard the MESSENGER spacecraft is designed to observe the spectrum of gamma rays emitted from Mercury’s surface in the energy range from 0.1 MeV to 10 MeV. Gamma rays are produced either directly from radioactive decay (of K, Th, U) or indirectly when activated by the cosmic ray background. The relatively low absorption rate of these gamma rays allows the estimation of the surface composition to depths of ~10’s of cm, depending on the energy of the gamma ray.

The GRS primarily consists of a high-purity Germanium (HPGe) cylinder surrounded by a shield of borated plastic scintillator, BC-454. The HPGe cylinder is suspended within the shield by Kevlar strings inside three nested gold-coated cans. This is done to provide thermal isolation for operation at cryogenic temperature. When a gamma ray interacts with the bulk HPGe, a charge is generated. The electric charge is amplified, measured, and then digitally converted into one of 16,384 channels, or bins. After a specified amount of time, a histogram is produced, which shows the distribution of events (number of strikes) as a function of energy (channel number). Because of the low count rates usually encountered, accumulation times of minutes to hours are normal. The raw science data product (HPGe Raw EDR, section 5.2) is the counts in each of the 16384 bins after this accumulation period. This histogram is counted as one gamma ray spectrum.

The HPGe required a mechanical cryocooler to maintain the required ~90K temperatures in order to detect gamma rays. The cryocooler failed on 15 June, 2012 after approximately 9,000 hours of operation. This exceeded the expected 8,000 hour lifetime of the cooler. Following the cooler failure, new flight software was uploaded to the GRS on 25 February 2013 for the purpose of optimizing the instrument for neutron and charged particle measurements with the BC-454 shield. These changes included the addition of a high time cadence measure of the local particle flux, which is useful for characterizing the charged particle environment near Mercury.

The GRS uses the plastic scintillator as a shield against detection of cosmic rays. In a scintillator, the interaction of the gamma ray results in a brief fluorescence, with an intensity proportional to the energy. The light pulse is amplified by a photo-multiplier tube and then buffered, shaped and digitized from the
HPGe. The shield scintillator has a much lower energy resolution than the HPGe, so detected events in the shield (SHIELD EDR, section 5.2) are binned to only 1024 channels by the EPU.

If events are found to occur in both detectors within some short time interval (of order microseconds), a coincidence condition is flagged. This may have been caused by a single high-energy particle (cosmic ray) depositing energy in both detectors as it passed through, or by secondary photons created after an initial gamma ray or neutron interaction, or by two independent events occurring simultaneously (false coincidence or “accidental”). In any case, the energies measured cannot be related to the initial event without additional interpretation. A separate spectrum (HPGe AC EDR, section 5.2) is maintained to accumulate the anti-coincidence HPGe events (eliminating those background events likely due to cosmic rays).

The 25 February 2013 flight software upload included the addition of a new data product, called “shield count rate”. This product measures the total count rate at high time cadence (10 ms) in order to provide new insights into the charged particle environment around Mercury, particularly the energetic electron events. The total count rate on the detector is measured every 10 ms and stored in a 16,384 channel long array. For short integration periods, this array is too large and the remaining values are set to zero. When a data integration period would require more than 16,384 channels, the values past this length aren’t stored.

The GRS data rate is driven by the integration time for the HPGe raw and anticoincidence spectra, since these EDRs constitute by far the largest amount of data. Since the orbital gamma-ray flux is low, the smallest integration times are determined by surface mapping spatial resolution and thermal electronics energy smearing at the lowest altitudes. Assumption of a reasonable 60-second integration time at low altitudes and correspondingly larger integration times at higher altitudes yields an estimated data rate of 13 Mbits per earth day. Further information on the GRS instrument can be found in the MESSENGER instrument paper.

5.2 Data Product Overview

There are ten EDR data products produced by the GRS instrument. A single EDR data file contains the observations with a time tag corresponding to a given Earth day. They are as follows:

<table>
<thead>
<tr>
<th>Data Product</th>
<th>Product Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPGE RAW</td>
<td>• Detached PDS label file</td>
</tr>
<tr>
<td></td>
<td>• Spectra data file – HPGe raw data in binary table.</td>
</tr>
<tr>
<td>HPGE AC</td>
<td>• Detached PDS label file</td>
</tr>
<tr>
<td></td>
<td>• Spectra data file – HPGe anti-coincident data in binary table.</td>
</tr>
<tr>
<td>SHIELD</td>
<td>• Detached PDS label file</td>
</tr>
<tr>
<td></td>
<td>• Spectra data file – SHIELD data in binary table.</td>
</tr>
<tr>
<td>SHIELD (SH2)</td>
<td>• Detached PDS label file</td>
</tr>
<tr>
<td></td>
<td>• Spectra data file – SH2 data in binary table.</td>
</tr>
<tr>
<td>SHIELD COUNT RATE (SCR)</td>
<td>• Detached PDS label file</td>
</tr>
<tr>
<td></td>
<td>• Count rate data file – SCR data in binary table.</td>
</tr>
<tr>
<td>MICROPHONICS</td>
<td>• Detached PDS label file</td>
</tr>
</tbody>
</table>
The detached (separate) PDS label file describes the content of the data file. The label file defines the start time and end of the records in the data file (start time is the UTC time tag of the first record in the data file, and end time is the UTC time tag of the last record in the data file), product creation time, etc.

The “science” data - HPGE_RAW, HPGE_AC, SHIELD, MICROPHONICS - are contained in data files where the data are arranged in binary tables. The first three are spectra described in Sec. 5.3.4. The Microphonics data are binned time series of fluctuations generated electronically that are associated with cryocooler vibrations. When fed through an acoustic speaker, they sound very much like cooler vibrations; hence the term “microphonics”. The microphonics data are used to help determine if the cooler is developing vibration problems, such as bearing noise.

The GRS flight software (FSW) was changed on September 17, 2010 to incorporate fast neutron detection in the GRS shield sensor. Measurement of the fast-neutron flux near the GRS is needed to reduce the uncertainty in the spacecraft contribution to important elemental lines in the GRS gamma-ray spectrum. The previous shield spectrum data product (Column 9 in the GRS_SHIELD.FMT file) was a full 1024 bins and extended well beyond the region of interest. This data product was subdivided into several new data products related to the measurement of thermal and fast neutrons. The first half (512 bins) is devoted to a buffer of raw events (up to 126 raw events plus an 8-word header), where each raw event contains full resolution information on each interaction that meets on-board requirements for candidate neutrons. The remaining available 512 bins contain five spectral data products that result from on-board binning of the raw events that meet selected criteria:

- Shield All Events Spectrum (128 bins)
- Shield Thermal Events Spectrum (128 bins)
- HPGe Thermal Events Spectrum (64 bins)
- Shield Fast Events Spectrum (128 bins)
- HPGe Fast Events Spectrum (64 bins)

The GRS_SHIELD_2.FMT file describes the content of the GRS_SHIELD EDR for data taken after the September 17, 2010 FSW update (see Appendix 8.4 for more description on this format file). The GRS_SHIELD.FMT file describes the content of GRS_SHIELD EDRs before the FSW update (see Appendix 8.3 for more description on this format file).
The four Thermal and Fast Events Spectra are all obtained using coincidence events with the HPGe detector in the 478-keV region of the HPGe spectrum. The 478-keV region contains the gamma-ray emitted in a thermal neutron capture reaction with $^{10}\text{B}$ present in the borated-plastic shield. It was found that the spectra of these coincidence events best isolated the neutron signal, while minimizing the gamma-ray background, but it is not certain what fraction of these events are actually neutrons or gamma-rays. The buffer of unbinned raw events (up to 126 events per accumulation period) allows for enhanced analysis techniques, which if successfully developed may help to reduce these uncertainties. The two Thermal Events Spectra contain events within a narrow $\pm 0.1\mu s$ coincidence window and likely represent mostly thermal neutrons. The two Fast Events Spectra contain events with positive coincidence times $> 0.1\mu s$ and likely represent mostly fast neutrons. The two 64-bin Thermal and Fast Events HPGe Spectra provide the corresponding 478-keV HPGe peak along with sufficient background channels on either side of the peak to allow background subtraction, while the two 128-bin Thermal and Fast Events Spectra contain the corresponding shield spectrum.

The GRS flight software (FSW) was changed on 25 February 2013 to improve neutron detection capability in the Shield data product as well as to add a new “shield count rate” EDR. This product measures the total count rate at high time cadence (10 ms) in order to provide new insights into the charged particle environment around Mercury, particularly the energetic electron events. The total count rate on the detector is measured every 10 ms and stored in a 16,384 channel long array. For short integration periods, this array is too large and the remaining values are set to zero. When a data integration period would require more than 16,384 channels, the values past this length are stored in the final channel. The first approximately 50 entries of the shield count rate product are always zero, and reflect the 0.5-second-long interval at the beginning of the accumulation period during which the GRS electronics busy performing other tasks and are unable to processes the total shield count rates.

The SW_COUNTER EDR contains the data from the software event counters and associated data in an ASCII table, where event data are accumulated independent of energy. Similarly, the information for STATUS EDR is also contained in ASCII tables. Status data monitors many engineering parameters, such as voltages, currents, temperatures, and modes, in raw units. The data are contained in ASCII tables to allow the instrument engineer to immediately view the data in commercial-off-the-shelf spreadsheet or document viewing applications. This allows the instrument engineer to easily evaluate the instrument and generate simple trending plots.

The FPGA_ADC EDR is stored in binary tables to facilitate extraction of bit counters which contain information about the state of the instrument. This data stores many parameters associated with the Analog-to-Digital converter (ADC) event processing in the associated Field-Programmable Gate Array (FPGA).

The Command Echo EDR contains the time-tagged list of commands executed by the GRS instrument. It also records the success level of each command.

### 5.3 Data Processing

#### 5.3.1 Data Processing Level

There is one EDR archive volume for the GRS instrument. The data volume contains level 2 CODMAC data products or EDRs. Each product has a unique file name and conforms to the file naming convention in section 6.4. All EDR products are stored at the Applied Physics Laboratory/Science Operations Center (APL/SOC) during mission operations. In addition to the sensor spectral data products, scientific
and engineering-housekeeping data are sampled by the GRS at a rate independent of the spectra sampling rate. The data volume is electronically transferred to the PDS Geosciences Node following the procedure in section 5.3.3.

5.3.2 Data Product Generation

The Gamma-Ray Spectrometer EDR files are produced by the MESSENGER Science Operations Center (SOC) operated jointly by APL and ACT. 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. Inputs to the SOC consist of telemetry in the form of CCSDS packets. Level-1 GRS raw spectral and engineering data is then broken out of the data stream and stored online at the SOC. The ‘PIPE-GRS2EDR’ software packages the Level 1 CODMAC data to the PDS formats defined in this SIS (section 5.3.4 and Appendices). The resulting files are designated as Level 2 CODMAC data or EDRs. 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 6.6 for transmittal to the Geosciences Node. The transmittal process is described in section 5.3.3.

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 Mission Operations Center (MOC), the Science Team, instrument scientists, and the PDS.

The SOC is located at John’s Hopkins University/Applied Physics Lab (JHU/APL). The Data Flow diagram in figure 1 shows the general flow of data within the MESSENGER project and data flow to the 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 and EDRs are delivered to the PDS Geosciences Node. SPICE kernels are delivered to the PDS Navigation and Ancillary Information (NAIF) node.

The MESSENGER SOC delivers data for the GRS EDR data volume to the PDS Geosciences Node in standard product packages. Each package comprises data and files organized into directory structures consistent with the volume design described in section 6.6.

The following describes the electronic transfer process of releasing data to PDS. In the weeks prior to the delivery date the directory structure is 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 is 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 acknowledges receipt of the archive and checksum file. If acknowledgement is not received, or if problems are reported, the MESSENGER SOC immediately takes corrective action to effect successful transmittal.

After transmittal the PDS node uncompressed the zip archive file and checks for data integrity using the checksum file. The node performs any additional verification and validation of the data provided and reports any discrepancies or problems to the MESSENGER SOC. It is expected that the node performs these checks in about two weeks. After inspection has been completed to the satisfaction of the PDS node, the node issues to the MESSENGER SOC acknowledgement of successful receipt of the data. Following receipt of a data delivery the PDS node organizes the data into a PDS archive volume
structure within its online data system. Newly delivered data are made available publicly from PDS once accompanying labels and other documentation have been validated.
Figure 1. MESSENGER data flow
5.3.4 Labeling and Identification

For every EDR data file there exists a detached PDS label file. Detached means that the label file is separate from the data file, as opposed to being in the header portion of the data file. The following are examples of the detached PDS label file for each of the GRS EDRs. Details about the label format are specified later in section 6.3.

Each PDS label file will contain a pointer to an external format file. This format file describes the table structure of the EDR data file. Details for each format file are found in the Appendices.

5.3.4.1 HPGe Raw Spectra PDS Label

```
PDS_VERSION_ID = "PDS3"

/*** FILE FORMAT ***/
FILE_RECORDS = 287
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 32792

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID = "GRS_RAW2004316ZZZ_DAT"
PRODUCT_VERSION_ID = "V1"
PRODUCT_CREATION_TIME = 2006-03-13T22:03:3
PRODUCT_TYPE = "DATA"
STANDARD_DATA_PRODUCT_ID = "GRS_HPGE_RAW_SPECTRA"
SOFTWARE_NAME = "PIPE-GRS2EDR"
SOFTWARE_VERSION_ID = "1.0"
INSTRUMENT_HOST_NAME = "MESSENGER"
INSTRUMENT_NAME = "GAMMA RAY SPECTROMETER"
INSTRUMENT_ID = "GRS"
DETECTOR_ID = "HPGE"
DATA_SET_ID = "MESS-E/V/H-GRNS-2-GRS-RAWDATA-V1.0"
MISSION_PHASE_NAME = "EARTH CRUISE"
TARGET_NAME = "CALIBRATION"
START_TIME = 2004-11-11 00:00:27.000
STOP_TIME = 2004-11-11 23:49:27.000
SPACECRAFT_CLOCK_START_COUNT = 8618421
SPACECRAFT_CLOCK_STOP_COUNT = 8704161
^TABLE = "GRS_RAW2004316ZZZ.DAT"
OBJECT = TABLE
COLUMNS = 10
INTERCHANGE_FORMAT = BINARY
ROWS = 287
ROW_BYTES = 32792
DESCRIPTION = "This table contains one set of raw spectra collected from the high purity Germanium (HPGe) detector, MESSENGER Gamma Ray Spectrometer (GRS). A set is defined as all data with MET timestamps corresponding to a given Earth day. 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 = "GRS_HPGE_RAW.FMT"
END_OBJECT = TABLE
END
```
5.3.4.2 HPGe AC Spectra PDS Label

```
PDS_VERSION_ID = "PDS3"

/*** FILE FORMAT ***/
FILE_RECORDS = 199
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 32792

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID = "GRS_ANC2004316ZZZ_DAT"
PRODUCT_VERSION_ID = "V1"
PRODUCT_CREATION_TIME = 2006-03-13T21:05:5
PRODUCT_TYPE = "DATA"
STANDARD_DATA_PRODUCT_ID = "GRS_HPGE_AC_SPECTRA"
SOFTWARE_NAME = "PIPE-GRS2EDR"
SOFTWARE_VERSION_ID = "1.0"
INSTRUMENT_HOST_NAME = "MESSENGER"
INSTRUMENT_NAME = "GAMMA RAY SPECTROMETER"
INSTRUMENT_ID = "GRS"
DETECTOR_ID = "HPGE"
DATA_SET_ID = "MESS-E/V/H-GRNS-2-GRS-RAWDATA-V1.0"
MISSION_PHASE_NAME = "EARTH CRUISE"
TARGET_NAME = "CALIBRATION"
START_TIME = 2004-11-11 01:28:27.000
STOP_TIME = 2004-11-11 23:49:27.000
SPACECRAFT_CLOCK_START_COUNT = 8623701
SPACECRAFT_CLOCK_STOP_COUNT = 8704161
^TABLE = "GRS_ANC2004316ZZZ.DAT"
OBJECT = TABLE
COLUMNS = 10
INTERCHANGE_FORMAT = BINARY
ROWS = 199
ROW_BYTES = 32792
DESCRIPTION = "This table contains one set of Anti-Coincident (AC) spectra collected from the high purity Germanium (HPGe) detector, MESSENGER Gamma Ray Spectrometer (GRS). A set is defined as all data with MET timestamps corresponding to a given Earth day. 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 = "GRS_HPGE_AC.FMT"
END_OBJECT = TABLE
END
```

5.3.4.3 Shield Spectra PDS Label

The sample PDS label below has a STANDARD_DATA_PRODUCT_ID used for Shield EDRs created prior to the FSW update on September 17, 2010. EDRs created from data after the FSW update have a STANDARD_DATA_PRODUCT_ID = “GRS_SHIELD_SPECTRA_2” and refer to the table structure defined in “GRS_SHIELD_2.FMT”.

```
PDS_VERSION_ID = "PDS3"

/*** FILE FORMAT ***/
FILE_RECORDS = 216
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 2070

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
```
PRODUCT_ID = "GRS_SHI2004314ZZZ_DAT"
PRODUCT_VERSION_ID = "V1"
PRODUCT_CREATION_TIME = 2006-03-13T22:16:57
PRODUCT_TYPE = "DATA"
STANDARD_DATA_PRODUCT_ID = "GRS_SHIELD_SPECTRA"
SOFTWARE_NAME = "PIPE-GRS2EDR"
SOFTWARE_VERSION_ID = "1.0"
INSTRUMENT_HOST_NAME = "MESSENGER"
INSTRUMENT_NAME = "GAMMA RAY SPECTROMETER"
INSTRUMENT_ID = "GRS"
DETECTOR_ID = "SHIELD"
DATA_SET_ID = "MESS-E/V/H-GRNS-2-GRS-RAWDATA-V1.0"
MISSION_PHASE_NAME = "EARTH CRUISE"
TARGET_NAME = "CALIBRATION"
START_TIME = 2004-11-09 06:02:19.000
STOP_TIME = 2004-11-09 23:57:19.000
SPACECRAFT_CLOCK_START_COUNT = 8467334
SPACECRAFT_CLOCK_STOP_COUNT = 8531834

OBJECT = TABLE
COLUMNS = 9
INTERCHANGE_FORMAT = BINARY
ROWS = 216
ROW_BYTES = 2070
DESCRIPTION = "This table contains one set of raw spectra collected from the SHIELD detector, MESSENGER Gamma Ray Spectrometer (GRS). A set is defined as all data with MET timestamps corresponding to a given Earth day. 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 = "GRS_SHIELD.FMT"
END_OBJECT = TABLE
END

5.3.4.4 Shield Count Rate PDS Label

FILE_FORMAT = "PDS3"

FILE_RECORDS = 990
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 32792

PRODUCT_ID = "GRS_SCR2013244ZZZ_DAT"
PRODUCT_VERSION_ID = "V1"
PRODUCT_CREATION_TIME = 2013-11-13T22:34
PRODUCT_TYPE = "DATA"
STANDARD_DATA_PRODUCT_ID = "GRS_SHIELD_COUNTER"
SOFTWARE_NAME = "PIPE-GRS2EDR"
SOFTWARE_VERSION_ID = "1.1"
INSTRUMENT_HOST_NAME = "MESSENGER"
INSTRUMENT_NAME = "GAMMA RAY SPECTROMETER"
INSTRUMENT_ID = "GRS"
DETECTOR_ID = "ACS"
DATA_SET_ID = "MESS-E/V/H-GRNS-2-GRS-RAWDATA-V1.0"
MISSION_PHASE_NAME = "MERCURY ORBIT YEAR 3"
TARGET_NAME = "MERCURY"
START_TIME = 2013-09-01T00:00:01.000
STOP_TIME = 2013-09-01T23:30:21.000
SPACECRAFT_CLOCK_START_COUNT = "2/20317601"
SPACECRAFT_CLOCK_STOP_COUNT = "2/20402221"
^TABLE = "GRS_SCR2013244ZZZ.DAT"
This table contains one set of high-time-resolution count rate measurements in the GRS anti-coincidence shield. Each entry contains a 16384-channel-long array that is populated with values corresponding to the total number of events registered by the GRS Anti-Coincidence Shield (ACS) in 10-ms-long increments. When the accumulation period is insufficient to populate all 16384 channels, the remaining entries are assigned values of zero. When the number of measurements exceeds 16384, the last channel records the sum of all subsequent events. A set is defined as all data with MET timestamps corresponding to a given day.

This table contains the parameters and spectra associated with one set of raw microphonics time series collected by the MESSENGER Gamma Ray Spectrometer (GRS). A set is defined as all data with MET timestamps corresponding to a given Earth day. 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.
5.3.4.6 Software Counter PDS Label

PDS_VERSION_ID = "PDS3"

/// **FILE FORMAT**///
FILE_RECORDS = 72
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 355

/// **GENERAL DATA DESCRIPTION PARAMETERS**///
PRODUCT_ID = "GRS_SWC2004319ZZZ_TAB"
PRODUCT_VERSION_ID = "V1"
PRODUCT_CREATION_TIME = 2006-03-09T15:03:3
PRODUCT_TYPE = "ANCILLARY"
STANDARD_DATA_PRODUCT_ID = "GRS_SOFTWARE_RATE_COUNTERS"
SOFTWARE_NAME = "PIPE-GRS2EDR"
SOFTWARE_VERSION_ID = "1.0"
INSTRUMENT_HOST_NAME = "MESSENGER"
INSTRUMENT_NAME = "GAMMA RAY SPECTROMETER"
INSTRUMENT_ID = "GRS"
DATA_SET_ID = "MESS-E/V/H-GRNS-2-GRS-RAWDATA-V1.0"
MISSION_PHASE_NAME = "EARTH CRUISE"
TARGET_NAME = "CALIBRATION"
START_TIME = 2004-11-14 00:09:29.000
STOP_TIME = 2004-11-14 23:49:29.000
SPACECRAFT_CLOCK_START_COUNT = 8878161
SPACECRAFT_CLOCK_STOP_COUNT = 8963361
^TABLE = "GRS_SWC2004319ZZZ.TAB"
OBJECT = TABLE
COLUMNS = 30
INTERCHANGE_FORMAT = ASCII
ROWS = 72
ROW_BYTES = 355
DESCRIPTION = "This table contains one set of software rate counter telemetry information gathered by the MESSENGER Gamma-Ray Spectrometer (GRS). A set is defined as all data with MET timestamps corresponding to a given Earth day. 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 = "GRS_SWC.FMT"
END_OBJECT = TABLE

5.3.4.7 Status PDS Label

PDS_VERSION_ID = "PDS3"

/// **FILE FORMAT**///
FILE_RECORDS = 1079
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 1127

/// **GENERAL DATA DESCRIPTION PARAMETERS**///
PRODUCT_ID = "GRS_STA2005175ZZZ_TAB"
PRODUCT_VERSION_ID = "V1"
PRODUCT_CREATION_TIME = 2006-03-09T15:19:58
PRODUCT_TYPE = "ANCILLARY"
STANDARD_DATA_PRODUCT_ID = "GRS_STATUS"
SOFTWARE_NAME = "PIPE-GRS2EDR"
SOFTWARE_VERSION_ID = "1.0"
This table contains one set of status telemetry information gathered by the MESSENGER Gamma-Ray Spectrometer (GRS). A set is defined as all data with MET timestamps corresponding to a given Earth day. 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.

This table contains one set of FPGA ADC diagnostic information gathered by the MESSENGER Gamma-Ray Spectrometer (GRS). A set is defined as all data with MET timestamps corresponding to a given Earth day. 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.
with MET timestamps corresponding to a given Earth day.
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.

5.3.4.9 Command Echo PDS Label

PDS_VERSION_ID = "PDS3"

/*** FILE FORMAT ***/
FILE_RECORDS = 8
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 125

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID = "GRS_CMD2004320ZZZ_DAT"
PRODUCT_VERSION_ID = "V1"
PRODUCT_CREATION_TIME = 2008-12-05T19:42:49
PRODUCT_TYPE = "ANCILLARY"
STANDARD_DATA_PRODUCT_ID = "GRS_COMMAND_ECHO"
SOFTWARE_NAME = "PIPE-GRS2EDR"
SOFTWARE_VERSION_ID = "1.0"
INSTRUMENT_HOST_NAME = "MESSENGER"
INSTRUMENT_NAME = "GAMMA RAY SPECTROMETER"
INSTRUMENT_ID = "GRS"
DATA_SET_ID = "MESS-E/V/H-GRNS-2-GRS-RAWDATA-V1.0"
MISSION_PHASE_NAME = "EARTH CRUISE"
TARGET_NAME = "CALIBRATION"
START_TIME = 2004-11-15 06:25:10.000
STOP_TIME = 2004-11-15 18:55:01.000
SPACECRAFT_CLOCK_START_COUNT = 8987101
SPACECRAFT_CLOCK_STOP_COUNT = 9032092
^TABLE = "GRS_CMD2004320ZZZ.DAT"

OBJECT = TABLE
COLUMNS = 7
INTERCHANGE_FORMAT = ASCII
ROW_BYTES = 125
ROWS = 8
DESCRIPTION = "This table contains one set of the commands executed by the MESSENGER Gamma-Ray Spectrometer (GRS). A set is defined as all data with MET timestamps corresponding to a given Earth day. 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 = "GRS_CMDECHO.FMT"
END_OBJECT = TABLE
END

5.4 Standards used in Generating Data Products

5.4.1 PDS Standards

The GRS 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 the following:
• A data file containing an ASCII or binary table object, in fixed field format. ASCII table objects are additionally in comma separated value (CSV) format. This makes the ASCII data extremely easy to read by many commercial off-the-shelf programs. See section 5.2 for a listing of the data products and whether the data is contained in an ASCII or binary table object.

• A label file, which is a high-level description of the parameters that 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 Coordinate Systems
SPICE kernels are archived at the PDS NAIF node. Coordinate systems are included in the CDR-RDR-DAP SIS document.

5.4.3 Time Standards
The MET field in the GRS EDR tables matches 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 reset1 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.

5.4.4 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 transfers data to PDS via electronic transfer and delivery methods as detailed in section 5.3.3. After verification of the data transfer PDS provides public access to MESSENGER science data products through its online data distribution system.

5.5 Data Validation
The GRS EDR data products are validated by the GRS Instrument scientist for science content and for compliance with PDS archive standards [MESSENGER Data Management and Archiving Plan].

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1 See instrument host catalog file in GRS EDR volume catalog directory for more information on MESSENGER spacecraft clock reset.
6 Detailed Data Product Specification

6.1 Data Product Structure and Organization

The MESSENGER GRS data set is archived at the PDS Geosciences node as a data archive volume. The GRS EDR products in the data archive volume store the data in a form closest to the raw telemetry data received from the spacecraft. There is only one GRS EDR data archive volume which was created at the first delivery to PDS. Subsequent deliveries to PDS update this data volume. If errors are discovered the data is replaced with corrected EDRs on the next scheduled delivery date.

The EDRs are organized in the data archive volume according to the structure defined in section 6.6. First there is the top level <DATA> directory. Then subsequent directories are organized into folders by year. In each year folder there are directories organized by month. The PDS START_TIME keyword in the EDR is used to determine the year and month directory in which the EDR is placed.

6.2 Data Format Description

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

6.3 Label and Header Descriptions

The following are the keyword definitions for the detached PDS label 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. The keywords are listed in the order in which they appear in the example PDS labels in Section 5.3.4.

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. The FIXED_LENGTH value is used for the table object in the MESSENGER GRS EDR data products.

RECORD_BYTES
The number of bytes in a physical file record, including record terminators and separators.

PRODUCT_ID
The product_id data element represents a permanent, unique identifier assigned to a data product by its producer. See also: source_product_id.
Note: In the PDS, the value assigned to product_id must be unique within its data set.

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

PRODUCT_VERSION_ID
Identifies the version of an individual product within a data set.
Example: V1, V2, V3
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.

STANDARD_DATA_PRODUCT_ID
Used to link a GRS EDR file to one of the 10 types of GRS data products defined within the GRS EDR SIS.

SOFTWARE_NAME
Identifies the data processing software used to generate the EDR products.

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

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
The full, unabbreviated name of the instrument: Gamma-Ray Spectrometer.

INSTRUMENT_ID
An abbreviated name or acronym which identifies an instrument (i.e. GRS).

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 GRS EDRs.

MISSION_PHASE_NAME
Provides the commonly used identifier of a mission phase.

TARGET_NAME
The target of the observation

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
Mission Elapsed Time (MET) corresponding to the first record in the data table.

SPACECRAFT_CLOCK_STOP_COUNT
Mission Elapsed Time (MET) corresponding to the last record in the data table.

^TABLE
Pointer to the external data file which contains the table object.

OBJECT = TABLE
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
Specifies the format of the table.
ROWS
Number of rows in the table.

ROWgetBytes
Number of bytes for each row in the table.

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

6.3.1 Table Object Keyword Definitions

The following describes the keywords used to define the PDS table object:

OBJECT = COLUMN
Identifies this as a column in the table object.

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 the column object.

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. Ex. For the HPGe_Raw EDR it is used to describe that the Gamma-Ray spectra contains 16384 bins.

ITEM_BYTES
Represents the size in bytes of an individual item.

6.4 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 GRS data products use a 17.3 file naming convention – 17 character base name and 3 character extension. The general form of the file name is "GRS_ZZZYYYYYDDDDWWW.XXX", where:

- GRS - instrument identifier: represents the GRS instrument
- ZZZ - The data product name:
  - RAW - HPGe Raw spectrum
  - ANC - HPGE Anti-coincident spectrum
  - SHI - SHIELD spectrum
  - SCR - SHIELD count rate
  - MID - Microphonics spectrum
  - SWC - Software rate counter
  - STA - Status telemetry
  - ADC - FPGA ADC
  - CMD - Command Echo
The four digit year corresponding to the start time of the first record in the EDR data file.

The three digit day of year corresponding to the start time of the first record in the EDR data file.

Reserved 3 character string to use during the course of the mission as necessary to identify "special" data products. Nominal data products will be identified with 'ZZZ'.

The file extension. The detached PDS label file has the extension 'LBL', the binary table file has the extension 'DAT', and the ASCII table file has the extension 'TAB'.

6.5 Archive Volume and File Size
The final GRS EDR archive volume has a size of approximately 62 GB.

6.6 Directory Structure and Contents
The following illustration shows the directory structure overview for the GRS EDR Data Archive Volume. This volume contains the GRS EDR data products, supporting documentation, and any additional files required for the volume to be compliant with PDS standards. The content of the volume is expected to be updated with each periodic EDR release. Revised EDRs will have an incremented version number in the PDS label.

Directory Structure Overview

```
<ROOT>
  
  |<LABEL>  |<INDEX>  |<CATALOG>  |<DOCUMENT>|<DATA>
  
  |<2004>  |<2005>  |<2006>  |<2007>|
  
  |<JANUARY> <FEBRUARY> ...|
```

6.7 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.

**<DOCUMENT> Directory**
This subdirectory contains the documentation that is needed in order to understand and analyze the EDR data products. Files are stored in PDF and ASCII format.

DOCINFO.TXT – Identifies and describes the function of each file in the DOCUMENT directory.
<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.

DATASET.CAT: Describes the general content of the dataset and includes information about the duration of the mission and the person or group responsible for producing the data.

GRS_INST.CAT: Describes physical attributes of the GRS instrument and provides relevant references to published literature.

INSTRUMENT_HOST.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 with the GRS instrument on the MESSENGER mission.

REF.CAT: Contains the reference objects. These reference additional documents that may be useful to the person using the MLA EDR.

<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 a row for each observation on the volume; the columns contain parameters that describe the observation and instrument and spacecraft parameters.

INDEX.LBL - Detached PDS label for INDEX.TAB. It contains the INDEX_TABLE object which identifies and describes the columns of the GRS index table.

< LABEL > Directory
This subdirectory contains the format files for each of the different EDR product types. The format file describes the structure of the PDS Binary (or ASCII) table object in the EDR data file.

<Data Directory
This is the top level of the directory in which the EDRs are contained. The data directories are organized by year (YYYY) followed by month. The EDRs reside in the month folders. The START_TIME of the EDR is used to determine the year and month in which the EDR will be placed.

7 Archive Release Schedule to PDS
The MESSENGER GRS EDR archive is transferred from the SOC to the PDS Geosciences Node using the electronic transfer process detailed in section 5.3.3. The transfer follows the schedule in the MESSENGER Data Management and Archiving Plan.
8 Appendices

8.1 GRS_HPG_E_RAW.FMT

Below is a table that shows the structure of the binary table containing the HPGE Raw Spectra data. Following this is the actual content of the format file itself.

<table>
<thead>
<tr>
<th>Start Byte</th>
<th>Length (bytes)</th>
<th>Data Type</th>
<th>Column Name</th>
<th>Summary (see format file text for full description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>MSB Unsigned Integer</td>
<td>MET</td>
<td>Mission Elapsed Time in seconds.</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>MSB Unsigned Integer</td>
<td>ACCUM_TIME</td>
<td>Accumulation time, in seconds.</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td>MSB Unsigned Integer</td>
<td>MIDPOINT_MET</td>
<td>MET at the midpoint of the observation.</td>
</tr>
<tr>
<td>13</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>ORBIT_NUMBER</td>
<td>Unique consecutive integer identifying a given orbit of MESSENGER around Mercury.</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>START_BIN</td>
<td>Start bin of the detector.</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>NUMBER_OF_BINS</td>
<td>Number of bins in the raw spectra.</td>
</tr>
<tr>
<td>19</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>GRS_PRIORITY_LEVEL</td>
<td>Priority assigned to the downloaded science packet.</td>
</tr>
<tr>
<td>21</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>MISSING_DATA_PACKETS</td>
<td>Indicates whether any of the 16 packets which make up an observation are missing.</td>
</tr>
<tr>
<td>23</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>BAD_DATA_FLAG</td>
<td>Bit-string bad data flag.</td>
</tr>
<tr>
<td>25</td>
<td>2 X 16384</td>
<td>MSB Unsigned Integer</td>
<td>HPGE_RAW</td>
<td>Raw spectra, 16384 bins.</td>
</tr>
</tbody>
</table>

OBJECT = COLUMN
NAME = MET
COLUMN_NUMBER = 1
BYTES = 4
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 1
DESCRIPTION = "Mission elapsed time, in seconds, corresponding to the start of the accumulation period for the spectra."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = ACCUM_TIME
COLUMN_NUMBER = 2
BYTES = 4
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 5
DESCRIPTION = "Accumulation time, in seconds, of the HPGe detector."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = MIDPOINT_MET
COLUMN_NUMBER = 3
BYTES = 4
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 9
DESCRIPTION = "The mission elapsed time at the midpoint of the observation. Defined as: MET at the start of the observation + (ACCUM_TIME / 2)."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = ORBIT_NUMBER
COLUMN_NUMBER = 4
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 13
DESCRIPTION = "Orbit number is a unique identifier for a given orbit of the MESSENGER spacecraft around Mercury. Orbit number is defined as starting at aphelion and is calculated using the MET value and the appropriate SPICE kernels. Orbit numbering does not start until MESSENGER performs the Mercury orbit insertion. Until that time the value for orbit number is 0."
**END_OBJECT** = COLUMN

**OBJECT** = COLUMN
**NAME** = START_BIN
**COLUMN_NUMBER** = 5
**BYTES** = 2
**DATA_TYPE** = MSB_UNSIGNED_INTEGER
**START_BYTE** = 15
**DESCRIPTION** = "Start Bin of the HPGe detector."

**END_OBJECT** = COLUMN

**OBJECT** = COLUMN
**NAME** = NUMBER_OF_BINS
**COLUMN_NUMBER** = 6
**BYTES** = 2
**DATA_TYPE** = MSB_UNSIGNED_INTEGER
**START_BYTE** = 17
**DESCRIPTION** = "Number of bins in the raw spectra."

**END_OBJECT** = COLUMN

**OBJECT** = COLUMN
**NAME** = GRS_PRIORITY_LEVEL
**COLUMN_NUMBER** = 7
**BYTES** = 2
**DATA_TYPE** = MSB_UNSIGNED_INTEGER
**START_BYTE** = 19
**DESCRIPTION** = "Indicates the type of priority assigned to the science packet. The priority level is tied to the ApID of the packet. Priority level varies from 0-3, 0 being highest and 3 being lowest priority."

**END_OBJECT** = COLUMN

**OBJECT** = COLUMN
**NAME** = MISSING_DATA_PACKETS
**COLUMN_NUMBER** = 8
**BYTES** = 2
**DATA_TYPE** = MSB_UNSIGNED_INTEGER
**START_BYTE** = 21
**DESCRIPTION** = "The value represents a 16-bit binary number where each bit indicates whether an HPGe Raw telemetry packet is missing from the EDR. Each HPGe Raw EDR consists of information extracted from 16 telemetry packets in a complete observation. The least significant bit is a flag corresponding to the first of 16 packets and the most significant bit is a flag corresponding to the 16th packet. A bit value of 1 indicates that a given packet is missing from the EDR. For example, a value of 0 in this column indicates that the spectra from all 16 packets have been downloaded and included in the HPGE_RAW spectra for this EDR. A value of 3 indicates that the spectra information from the first and second packets are missing and therefore spectral bins 0-2047 should be discounted from analysis of the HPGE_RAW spectra."

**END_OBJECT** = COLUMN

**OBJECT** = COLUMN
**NAME** = BAD_DATA_FLAG
**COLUMN_NUMBER** = 9
**BYTES** = 2
**DATA_TYPE** = MSB_UNSIGNED_INTEGER
**START_BYTE** = 23
**DESCRIPTION** = "Intended for use as a bit-string bad data flag to indicate specific problems associated with the data. Values are expected to be assigned to specific bits as problems are identified during the course of the mission. Currently no values have been assigned and will default to a value of zero."

**END_OBJECT** = COLUMN

**OBJECT** = COLUMN
**NAME** = HPGE_RAW
**COLUMN_NUMBER** = 10
**BYTES** = 32768
**DATA_TYPE** = MSB_UNSIGNED_INTEGER
**START_BYTE** = 25
**ITEMS** = 16384
**ITEM_BYTES** = 2
**DESCRIPTION** = "Raw spectra accumulated by the HPGe detector. Contains the counts in each of the 16384 bins after 1 accumulation period."

**END_OBJECT** = COLUMN
8.2 **GRS_HPGE_AC.FMT**

Below is a table that shows the structure of the binary table containing the HPGE Anti-Coincident Spectra data. Following this is the actual content of the format file itself.

<table>
<thead>
<tr>
<th>Start Byte</th>
<th>Length (bytes)</th>
<th>Data Type</th>
<th>Column Name</th>
<th>Summary (see format file text for full description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>MSB Unsigned Integer</td>
<td>MET</td>
<td>Mission Elapsed Time in seconds.</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>MSB Unsigned Integer</td>
<td>ACCUM_TIME</td>
<td>Accumulation time, in seconds.</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td>MSB Unsigned Integer</td>
<td>MIDPOINT_MIDPOINT</td>
<td>MET at the midpoint of the observation.</td>
</tr>
<tr>
<td>13</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>ORBIT_NUMBER</td>
<td>Unique consecutive integer identifying a given orbit of MESSENGER around Mercury.</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>START_BIN</td>
<td>Start bin of the detector.</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>NUMBER_OF_BINS</td>
<td>Number of bins in the raw spectra.</td>
</tr>
<tr>
<td>19</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>GRS_PRIORITY_LEVEL</td>
<td>Priority assigned to the downloaded science packet.</td>
</tr>
<tr>
<td>21</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>MISSING_DATA_PACKETS</td>
<td>Indicates whether any of the 16 packets which make up an observation are missing.</td>
</tr>
<tr>
<td>23</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>BAD_DATA_FLAG</td>
<td>Bit-string bad data flag.</td>
</tr>
<tr>
<td>25</td>
<td>2 X 16384</td>
<td>MSB Unsigned Integer</td>
<td>HPGE_AC</td>
<td>Anti-coincident spectra, 16384 bins.</td>
</tr>
</tbody>
</table>

**OBJECT** = COLUMN

NAME = MET
COLUMN_NUMBER = 1
BYTES = 4
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 1

DESCRIPTION = "Mission elapsed time, in seconds, corresponding to the start of the accumulation period for the spectra."

END_OBJECT = COLUMN

**OBJECT** = COLUMN

NAME = ACCUM_TIME
COLUMN_NUMBER = 2
BYTES = 4
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 5

DESCRIPTION = "Accumulation time, in seconds, of the HPGe detector."

END_OBJECT = COLUMN

**OBJECT** = COLUMN

NAME = MIDPOINT_MIDPOINT
COLUMN_NUMBER = 3
BYTES = 4
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 9

DESCRIPTION = "The mission elapsed time at the midpoint of the observation. Defined as: MET at the start of the observation + (ACCUM_TIME / 2)."

END_OBJECT = COLUMN

**OBJECT** = COLUMN

NAME = ORBIT_NUMBER
COLUMN_NUMBER = 4
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 13

DESCRIPTION = "Orbit number is a unique identifier for a given orbit of the MESSENGER spacecraft around Mercury. Orbit number is defined as starting at apoherm and is calculated using the MET value and the appropriate SPICE kernels. Orbit numbering does not start until MESSENGER performs the Mercury orbit insertion. Until that time the value for orbit number is 0."

END_OBJECT = COLUMN

**OBJECT** = COLUMN

NAME = START_BIN
COLUMN_NUMBER = 5
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 15
DESCRIPTION = "Start Bin of the HPGe detector."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = NUMBER_OF_BINS
COLUMN_NUMBER = 6
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 17
DESCRIPTION = "Number of bins in the raw spectra."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = GRS_PRIORITY_LEVEL
COLUMN_NUMBER = 7
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 19
DESCRIPTION = "Indicates the type of priority assigned to the science packet. The priority level is tied to the ApID of the packet. Priority level varies from 0-3, 0 being highest and 3 being lowest priority."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = MISSING_DATA_PACKETS
COLUMN_NUMBER = 8
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 21
DESCRIPTION = "The value represents a 16-bit binary number where each bit indicates whether an HPGe Raw telemetry packet is missing from the EDR. Each HPGe Raw EDR consists of information extracted from 16 telemetry packets in a complete observation. The least significant bit is a flag corresponding to the first of 16 packets and the most significant bit is a flag corresponding to the 16th packet. A bit value of 1 indicates that a given packet is missing from the EDR. For example, a value of 0 in this column indicates that the spectra from all 16 packets have been downloaded and included in the HPGE_RAW spectra for this EDR. A value of 3 indicates that the spectra information from the first and second packets are missing and therefore spectral bins 0-2047 should be discounted from analysis of the HPGE_RAW spectra."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = BAD_DATA_FLAG
COLUMN_NUMBER = 9
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 23
DESCRIPTION = "Intended for use as a bit-string bad data flag to indicate specific problems associated with the data. Values are expected to be assigned to specific bits as problems are identified during the course of the mission. Currently no values have been assigned and will default to a value of zero."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HPGE_AC
COLUMN_NUMBER = 10
BYTES = 32768
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 25
ITEMS = 16384
ITEM_BYTES = 2
DESCRIPTION = "Anti-coincident (AC) spectra accumulated by the HPGe detector. Contains the counts in each of the 16384 bins after 1 accumulation period."
END_OBJECT = COLUMN
8.3 **GRS_SHIELD.FMT**

Below is a table that shows the structure of the binary table containing the Shield Spectra data for data taken before the FSW update on September 17, 2010. Following this is the actual content of the format file itself.

<table>
<thead>
<tr>
<th>Start Byte</th>
<th>Length (bytes)</th>
<th>Data Type</th>
<th>Column Name</th>
<th>Summary (see format file text for full description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>MSB Unsigned Integer</td>
<td>MET</td>
<td>Mission Elapsed Time in seconds.</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>MSB Unsigned Integer</td>
<td>ACCUM_TIME</td>
<td>Accumulation time, in seconds.</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td>MSB Unsigned Integer</td>
<td>MIDPOINT_MET</td>
<td>MET at the midpoint of the observation.</td>
</tr>
<tr>
<td>13</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>ORBIT_NUMBER</td>
<td>Unique consecutive integer identifying a given orbit of MESSENGER around Mercury</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>START_BIN</td>
<td>Start bin of the detector.</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>NUMBER_OF_BINS</td>
<td>Number of bins in the raw spectra.</td>
</tr>
<tr>
<td>19</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>GRS_PRIORITY_LEVEL</td>
<td>Priority assigned to the downloaded science packet.</td>
</tr>
<tr>
<td>21</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>BAD_DATA_FLAG</td>
<td>Bit-string bad data flag.</td>
</tr>
<tr>
<td>25</td>
<td>2 X 1024</td>
<td>MSB Unsigned Integer</td>
<td>SHIELD</td>
<td>Shield spectra, 1024 bins.</td>
</tr>
</tbody>
</table>

```
OBJECT = COLUMN
  NAME = MET
  COLUMN_NUMBER = 1
  BYTES = 4
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 1
  DESCRIPTION = "Mission elapsed time, in seconds, corresponding to the
  start of the accumulation period for the spectra."
END_OBJECT = COLUMN

OBJECT = COLUMN
  NAME = ACCUM_TIME
  COLUMN_NUMBER = 2
  BYTES = 4
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 5
  DESCRIPTION = "Accumulation time, in seconds, of the HPGe detector."
END_OBJECT = COLUMN

OBJECT = COLUMN
  NAME = MIDPOINT_MET
  COLUMN_NUMBER = 3
  BYTES = 4
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 9
  DESCRIPTION = "The mission elapsed time at the midpoint of the
  observation. Defined as:
  MET at the start of the observation + (ACCUM_TIME / 2)."
END_OBJECT = COLUMN

OBJECT = COLUMN
  NAME = ORBIT_NUMBER
  COLUMN_NUMBER = 4
  BYTES = 2
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 13
  DESCRIPTION = "Orbit number is a unique identifier for a given orbit of
  the MESSENGER spacecraft around Mercury. Orbit number is defined as
  starting at apoherm and is calculated using the MET value and the
  appropriate SPICE kernels. Orbit numbering does not start until MESSENGER
  performs the Mercury orbit insertion. Until that time the value for orbit
  number is 0."
END_OBJECT = COLUMN

OBJECT = COLUMN
  NAME = START_BIN
  COLUMN_NUMBER = 5
  BYTES = 2
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 15
  DESCRIPTION = "Start Bin of the Shield detector."
```
8.4  **GRS_SHIELD_2.FMT**

Below is a table that shows the structure of the binary table containing the Shield Spectra data for data taken after the FSW update on September 17, 2010. Following this is the actual content of the format file itself.

<table>
<thead>
<tr>
<th>Start Byte</th>
<th>Length (bytes)</th>
<th>Data Type</th>
<th>Column Name</th>
<th>Summary (see format file text for full description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>MSB Unsigned Integer</td>
<td>MET</td>
<td>Mission Elapsed Time in seconds.</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>MSB Unsigned Integer</td>
<td>ACCUM_TIME</td>
<td>Accumulation time, in seconds.</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td>MSB Unsigned Integer</td>
<td>MIDPOINT_MET</td>
<td>MET at the midpoint of the observation.</td>
</tr>
<tr>
<td>13</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>ORBIT_NUMBER</td>
<td>Unique consecutive integer identifying a given orbit of MESSENGER around Mercury.</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>START_BIN</td>
<td>Start bin of the detector.</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>NUMBER_OF_BINS</td>
<td>Number of bins in the raw spectra.</td>
</tr>
<tr>
<td>19</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>GRS_PRIORITY_LEVEL</td>
<td>Priority assigned to the downloaded science packet.</td>
</tr>
<tr>
<td>21</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>BAD_DATA_FLAG</td>
<td>Bit-string bad data flag.</td>
</tr>
<tr>
<td>25</td>
<td>2 X 1024</td>
<td>MSB Unsigned Integer</td>
<td>SHIELD</td>
<td>Contains a set of data values as defined by the Appendix Shield_2 Content description.</td>
</tr>
<tr>
<td>NAME</td>
<td>MET</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>-------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BYTES</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>MSB_UNSIGNED_INTEGER</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>START_BYTE</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;Mission elapsed time, in seconds, corresponding to the start of the accumulation period for the spectra.&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>ACCUM_TIME</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>2</td>
</tr>
<tr>
<td>BYTES</td>
<td>4</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>MSB_UNSIGNED_INTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>5</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;Accumulation time, in seconds, of the HPGe detector.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>MIDPOINT_MET</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>3</td>
</tr>
<tr>
<td>BYTES</td>
<td>4</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>MSB_UNSIGNED_INTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>9</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;The mission elapsed time at the midpoint of the observation. Defined as: MET at the start of the observation + (ACCUM_TIME / 2).&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>ORBIT_NUMBER</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>4</td>
</tr>
<tr>
<td>BYTES</td>
<td>2</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>MSB_UNSIGNED_INTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>13</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;Orbit number is a unique identifier for a given orbit of the MESSENGER spacecraft around Mercury. Orbit number is defined as starting at apoherm and is calculated using the MET value and the appropriate SPICE kernels. Orbit numbering does not start until MESSENGER performs the Mercury orbit insertion. Until that time the value for orbit number is 0.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>START_BIN</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>5</td>
</tr>
<tr>
<td>BYTES</td>
<td>2</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>MSB_UNSIGNED_INTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>15</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;Start Bin of the Shield detector.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>NUMBER_OF_BINS</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>6</td>
</tr>
<tr>
<td>BYTES</td>
<td>2</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>MSB_UNSIGNED_INTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>17</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;Number of bins in the raw spectra.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>GRS_PRIORITY_LEVEL</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>7</td>
</tr>
<tr>
<td>BYTES</td>
<td>2</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>MSB_UNSIGNED_INTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>19</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;Indicates the type of priority assigned to the science packet. The priority level is tied to the ApID of the packet. Priority level varies from 0-3, 0 being highest and 3 being lowest priority.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>BAD_DATA_FLAG</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>8</td>
</tr>
</tbody>
</table>
8.5 **SHIELD_2 Content Description**

This describes the individual items in column 9 of the GRS_SHIELD_2.FMT file. This applies for GRS Shield EDRs created after the FSW update completed on September 17, 2010. Each item consists of a 2-byte MSB_UNSIGNED_INTEGER.

**Item 0**

Raw Bytes: The number of bytes in the raw event buffer, up to a maximum of 1024 bytes. The number of events in the raw event buffer is (Raw Bytes-16)/8. The number of raw events in the buffer will range from 0 to 126. Note that there must be at least one event in the buffer before the event buffer header will be generated.

**Item 1**

Raw Events: This value contains a count of the total number of raw events detected. This is not limited by the length of the buffer. This counter will rollover if the count exceeds 65535.

**Item 2**

ZCT Thermal Neutron Min: Window parameter that sets the minimum acceptable time difference between shield and HpGe triggers for an event to be considered a thermal neutron. Units are 100 ns/tick. Parameter is inclusive, i.e., values equal to this parameter are accepted.

**Item 3**

ZCT Thermal Neutron Max: Window parameter that sets the maximum acceptable time difference between shield and HpGe triggers for an event to be considered a thermal neutron. Units are 100 ns/tick. Parameter is exclusive, i.e., values equal to this parameter are rejected.

**Item 4**

ZCT Fast Neutron Min: Window parameter that sets the minimum acceptable time difference between shield and HpGe triggers for an event to be considered a fast neutron. Units are 100 ns/tick. Parameter is inclusive, i.e., values equal to this parameter are accepted.

**Item 5**
ZCT Fast Neutron Max: Window parameter that sets the maximum time difference between shield and HpGe triggers for an event to be considered a fast neutron. Units are 100 ns/tick. Parameter is exclusive, i.e., values equal to this parameter are rejected.

Item 6
Shield Right Shifts (Raw): The number of right shifts (divide by 2s) that are applied to raw shield pulse heights prior to binning in the Shield All Events spectrum. Possible values are 2 or 3. A value of two effectively increases the binning resolution but decreases the dynamic range (maximum binned energy).

Item 7
Shield Right Shifts (Neutron): The number of right shifts (divide by 2s) that are applied to raw shield pulse heights prior to binning in either the Shield Thermal Events spectrum or the Shield Fast Events spectrum. Possible values are 2 or 3. A value of two effectively increases the binning resolution but decreases the dynamic range (maximum binned energy).

Items 8-511 consist of data values describing each raw event in the buffer, up to a maximum of 126 events. For example, Items 8,9,10,11 are data values describing event 1 as described below. Items 12,13,14,15 are data values describing event 2 and have the same definitions as the corresponding Items 8,9,10,11 below. And so on. The data values are 0 for events greater than the total number of events as reported in Item 0.

The data values for each event will be described using Items 8,9,10,11:

Item 8
ADC Shield Min: Minimum value of shield bipolar pulse for each candidate neutron event. This value indicates the peak amplitude of the negative lobe. The total pulse height is the peak-to-peak amplitude of the bipolar pulse.

Item 9
ADC Shield Max: Maximum value of shield bipolar pulse for each candidate neutron event. This value indicates the peak amplitude of the positive lobe. The total pulse height is the peak-to-peak amplitude of the bipolar pulse.

Item 10
ADC HPGe Peak-to-peak: HpGe detector total pulse height for each candidate neutron event.

Item 11
Zero-crossing Time: Time difference between shield and HpGe signal triggers for each candidate neutron event based on their respective zero-crossing times. Units are 100 ns/tick.

Items 512-639 contain the Shield All Events Spectrum.
Shield All Events Spectrum: A 128-bin spectrum containing all interaction types in the shield detector with deposited energy less than approximately 1.5 MeV.

Items 640-767 contain the Shield Thermal Events Spectrum.
Shield Thermal Events Spectrum: A 128-bin spectrum containing only those shield events in prompt coincidence with 478-keV energy depositions in the HpGe detector.

Items 768-831 contain the HpGe Thermal Events Spectrum.
HpGe Thermal Events Spectrum: A 64-bin spectrum containing only those HpGe events that fall within the 478-keV energy window and that are in prompt coincidence with the shield detector.

Items 832-959 contain the Shield Fast Events Spectrum.
Shield Fast Events Spectrum: A 128-bin spectrum containing only those shield events in delayed coincidence with 478-keV energy depositions in the HpGe detector.

Items 960-1023 contain the HPGE Fast Events Spectrum.
HpGe Fast Events Spectrum: A 64-bin spectrum containing only those HpGe events that fall within the 478-keV energy window and that are in delayed coincidence with the shield detector.

8.6 GRS_SCR.FMT

Below is a table that shows the structure of the binary table containing the Shield Count Rate data. Following this is the actual content of the format file itself.

<table>
<thead>
<tr>
<th>Start Byte</th>
<th>Length (bytes)</th>
<th>Data Type</th>
<th>Column Name</th>
<th>Summary (see format file text for full description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>MSB Unsigned Integer</td>
<td>MET</td>
<td>Mission elapsed time, in seconds, corresponding to the start of the accumulation period for the spectra.</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>MSB Unsigned Integer</td>
<td>ACCUM_TIME</td>
<td>Accumulation time, in seconds, of the anti-coincidence shield detector.</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td>MSB Unsigned Integer</td>
<td>MIDPOINT_MET</td>
<td>The mission elapsed time at the midpoint of the observation. Defined as: MET at the start of the observation + (ACCUM_TIME / 2).</td>
</tr>
<tr>
<td>13</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>ORBIT_NUMBER</td>
<td>Unique consecutive integer identifying a given orbit of MESSENGER around Mercury.</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>START_BIN</td>
<td>The bin containing first shield counter (starting from zero). Nominally is zero.</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>NUMBER_OF_BINS</td>
<td>Number of bins in each science packet.</td>
</tr>
<tr>
<td>19</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>GRS_PRIORITY_LEVEL</td>
<td>Indicates the type of priority assigned to the science packet. The priority level is tied to the ApID of the packet. Priority level varies from 0-3, 0 being highest and 3 being lowest priority.</td>
</tr>
<tr>
<td>21</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>MISSING_DATA_PACKETS</td>
<td>The value represents a 16-bit binary number where each bit indicates whether a shield count rate telemetry packet is missing from the EDR (1=missing).</td>
</tr>
<tr>
<td>23</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>BAD_DATA_FLAG</td>
<td>Intended for use as a bit-string bad data flag to indicate specific problems associated with the data. Values are expected to be assigned to specific bits as problems are identified during the course of the mission. Currently no values have been assigned and will default to a value of zero.</td>
</tr>
<tr>
<td>25</td>
<td>2 X 16384</td>
<td>MSB Unsigned Integer</td>
<td>SHIELD_COUNT_SPECTRA</td>
<td>High-time-resolution counter of the total event rate in the shield detector. Counter operates at a 10-ms cadence for the duration of the accumulation period, resulting in a series of measurements that populate the 16384 channel spectra. When fewer than 16384 channels are required, the remainder are set to zero. When more than 16384 channels are required, the last channel represents the sum of all measurements made after the array is filled. For all cases, the first approximately fifty channels are zero due to signal processing deadtime in the GRS electronics. The use of a 16384-channel array is the result of a flight software change to retask a defunct GRS packet into a shield rate counter.</td>
</tr>
</tbody>
</table>
without changing the format of the packet itself.

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>= COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>MET</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>1</td>
</tr>
<tr>
<td>BYTES</td>
<td>4</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>MSB_UNSIGNEDINTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>1</td>
</tr>
<tr>
<td>DESCRIPTION = &quot;Mission elapsed time, in seconds, corresponding to the start of the accumulation period for the spectra.&quot;</td>
<td></td>
</tr>
</tbody>
</table>

END_OBJECT = COLUMN

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>= COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>ACCUM_TIME</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>2</td>
</tr>
<tr>
<td>BYTES</td>
<td>4</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>MSB_UNSIGNEDINTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>5</td>
</tr>
<tr>
<td>DESCRIPTION = &quot;Accumulation time, in seconds, of the anti-coincidence shield detector.&quot;</td>
<td></td>
</tr>
</tbody>
</table>

END_OBJECT = COLUMN

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>= COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>MIDPOINT_MET</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>3</td>
</tr>
<tr>
<td>BYTES</td>
<td>4</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>MSB_UNSIGNEDINTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>9</td>
</tr>
<tr>
<td>DESCRIPTION = &quot;The mission elapsed time at the midpoint of the observation. Defined as: MET at the start of the observation + (ACCUM_TIME / 2).&quot;</td>
<td></td>
</tr>
</tbody>
</table>

END_OBJECT = COLUMN

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>= COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>ORBIT_NUM</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>4</td>
</tr>
<tr>
<td>BYTES</td>
<td>2</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>MSB_UNSIGNEDINTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>13</td>
</tr>
<tr>
<td>DESCRIPTION = &quot;Orbit number is a unique identifier for a given orbit of the MESSENGER spacecraft around Mercury. Orbit number is defined as starting at apoherm and is calculated using the MET value and the appropriate SPICE kernels. Orbit numbering does not start until MESSENGER performs the Mercury orbit insertion. Until that time the value for orbit number is 0.&quot;</td>
<td></td>
</tr>
</tbody>
</table>

END_OBJECT = COLUMN

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>= COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>START_BIN</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>5</td>
</tr>
<tr>
<td>BYTES</td>
<td>2</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>MSB_UNSIGNEDINTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>15</td>
</tr>
<tr>
<td>DESCRIPTION = &quot;The bin containing first shield counter (starting from zero). Nominally is zero.&quot;</td>
<td></td>
</tr>
</tbody>
</table>

END_OBJECT = COLUMN

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>= COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>NUMBER_OF_BINS</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>6</td>
</tr>
<tr>
<td>BYTES</td>
<td>2</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>MSB_UNSIGNEDINTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>17</td>
</tr>
<tr>
<td>DESCRIPTION = &quot;Number of bins in each science packet.&quot;</td>
<td></td>
</tr>
</tbody>
</table>

END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = GRS_PRIORITY_LEVEL
COLUMN_NUMBER = 7
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 19
DESCRIPTION = "Indicates the type of priority assigned to the science packet. The priority level is tied to the ApID of the packet. Priority level varies from 0-3, 0 being highest and 3 being lowest priority."
END_OBJECT

OBJECT = COLUMN
NAME = MISSING_DATA_PACKETS
COLUMN_NUMBER = 8
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 21
DESCRIPTION = "The value represents a 16-bit binary number where each bit indicates whether a shield count rate telemetry packet is missing from the EDR. Each GRS_SCR EDR consists of information extracted from 16 telemetry packets in a complete observation. The least significant bit is a flag corresponding to the first of 16 packets and the most significant bit is a flag corresponding to the 16th packet. A bit value of 1 indicates that a given packet is missing from the EDR. For example, a value of 0 in this column indicates that the spectra from all 16 packets have been downloaded and included in the count rate spectra for this EDR. A value of 3 indicates that the count rate information from the first and second packets are missing and therefore channels 0-2047 should be discounted from analysis of the GRS_SCR spectra. A value of three or greater would indicate the EDR contains no valid data, since the count rates are only contained in the first 2000 channels."
END_OBJECT

OBJECT = COLUMN
NAME = BAD_DATA_FLAG
COLUMN_NUMBER = 9
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 23
DESCRIPTION = "Intended for use as a bit-string bad data flag to indicate specific problems associated with the data. Values are expected to be assigned to specific bits as problems are identified during the course of the mission. Currently no values have been assigned and will default to a value of zero."
END_OBJECT

OBJECT = COLUMN
NAME = SHIELD_COUNT_SPECTRA
COLUMN_NUMBER = 10
BYTES = 32768
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 25
ITEMS = 16384
ITEM_BYTES = 2
DESCRIPTION = "High-time-resolution counter of the total event rate in the shield detector. Counter operates at a 10-ms cadence for the duration of the accumulation period, resulting in a series of measurements that populate the 16384 channel spectra. When fewer than 16384 channels are required, the remainder are set to zero. When more than 16384 channels are required, the last channel represents the sum of all measurements made after the array is filled. For all cases, the first approximately fifty channels are zero due to signal processing deadtime in the GRS electronics. The use of a 16384-channel array is the result of a flight software change to retask a defunct GRS packet into a shield rate counter without changing the format of the packet itself."
END_OBJECT
8.7 **GRS_MICRO.FMT**

Below is a table that shows the structure of the binary table containing the Microphonics data. Following this is the actual content of the format file itself.

<table>
<thead>
<tr>
<th>Start Byte</th>
<th>Length (bytes)</th>
<th>Data Type</th>
<th>Column Name</th>
<th>Summary (see format file text for full description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>MSB Unsigned Integer</td>
<td>MET</td>
<td>Mission Elapsed Time in seconds.</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>ORBIT_NUMBER</td>
<td>Unique consecutive integer identifying a given orbit of MESSENGER around Mercury.</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>START_BIN</td>
<td>Start bin of the detector.</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>NUMBER_OF_BINS</td>
<td>Number of bins in the raw spectra.</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>BAD_DATA_FLAG</td>
<td>Bit-string bad data flag.</td>
</tr>
<tr>
<td>13</td>
<td>2 X 32768</td>
<td>MSB Integer</td>
<td>MICROPHONICS</td>
<td>Microphonics time series, 32768 bins.</td>
</tr>
</tbody>
</table>

```plaintext
OBJECT        = COLUMN
                 NAME     = MET
                 COLUMN_NUMBER  = 1
                 BYTES          = 4
                 DATA_TYPE      = MSB_UNSIGNED_INTEGER
                 START_BYTE     = 1
                 DESCRIPTION = "Mission elapsed time, in seconds, corresponding to the start of the accumulation period for the spectra."

END_OBJECT    = COLUMN

OBJECT        = COLUMN
                 NAME     = ORBIT_NUM
                 COLUMN_NUMBER  = 2
                 BYTES          = 2
                 DATA_TYPE      = MSB_UNSIGNED_INTEGER
                 START_BYTE     = 5
                 DESCRIPTION = "Orbit number is a unique identifier for a given orbit of the MESSENGER spacecraft around Mercury. Orbit number is defined as starting at apoherm and is calculated using the MET value and the appropriate SPICE kernels. Orbit numbering does not start until MESSENGER performs the Mercury orbit insertion. Until that time the value for orbit number is 0."

END_OBJECT    = COLUMN

OBJECT        = COLUMN
                 NAME     = START_BIN
                 COLUMN_NUMBER  = 3
                 BYTES          = 2
                 DATA_TYPE      = MSB_UNSIGNED_INTEGER
                 START_BYTE     = 7
                 DESCRIPTION = "Start Bin of the Microphonics detector."

END_OBJECT    = COLUMN

OBJECT        = COLUMN
                 NAME     = NUMBER_OF_BINS
                 COLUMN_NUMBER  = 4
                 BYTES          = 2
                 DATA_TYPE      = MSB_UNSIGNED_INTEGER
                 START_BYTE     = 9
                 DESCRIPTION = "Number of bins in the raw spectra."

END_OBJECT    = COLUMN

OBJECT        = COLUMN
                 NAME     = BAD_DATA_FLAG
                 COLUMN_NUMBER  = 5
                 BYTES          = 2
                 DATA_TYPE      = MSB_UNSIGNED_INTEGER
                 START_BYTE     = 11
                 DESCRIPTION = "Intended for use as a bit-string bad data flag to indicate specific problems associated with the data. Values are expected to be assigned to specific bits as problems are identified during the course of the mission. Currently no values have been assigned and will default to a value of zero."

END_OBJECT    = COLUMN
```

- 39 -
OBJECT        = COLUMN
NAME           = MICROPHONICS
COLUMN_NUMBER  = 6
BYTES          = 65536
DATA_TYPE      = MSB_INTEGER
START_BYTE     = 13
ITEMS          = 32768
ITEM_BYTES     = 2
DESCRIPTION    = "One sample measurement of microphonics times series
accumulated by ADC from microphonics detector."
END_OBJECT     = COLUMN
8.8 *GRS_SWC_FMT*

Below is a table that shows the structure of the ASCII table containing the Software Rate Counters data. The ASCII table is both fixed-width and comma delimited. Note that in PDS ASCII table format, the Start Byte has to take into account the comma delimiter and empty spaces. Following this is the actual content of the format file itself.

<table>
<thead>
<tr>
<th>Start Byte</th>
<th>Length (bytes)</th>
<th>Data Type</th>
<th>Column Name</th>
<th>Summary (see format file text for full description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>ASCII Integer</td>
<td>MET</td>
<td>Mission Elapsed Time in seconds.</td>
</tr>
<tr>
<td>13</td>
<td>5</td>
<td>ASCII Integer</td>
<td>ORBIT_NUMBER</td>
<td>Unique consecutive integer identifying a given orbit of MESSENGER around Mercury.</td>
</tr>
<tr>
<td>20</td>
<td>10</td>
<td>ASCII Integer</td>
<td>HPGE_RAW_EVENTS</td>
<td>Counter for HPGe Raw events.</td>
</tr>
<tr>
<td>32</td>
<td>10</td>
<td>ASCII Integer</td>
<td>SHIELD_RAW_EVENTS</td>
<td>Count for SHIELD raw events.</td>
</tr>
<tr>
<td>44</td>
<td>10</td>
<td>ASCII Integer</td>
<td>ACCUMULATED_DEAD_TIME</td>
<td>Count for accumulated dead time.</td>
</tr>
<tr>
<td>56</td>
<td>10</td>
<td>ASCII Integer</td>
<td>HPGE_CHARGE_RESETS</td>
<td>Number of HPGe charge resets.</td>
</tr>
<tr>
<td>68</td>
<td>10</td>
<td>ASCII Integer</td>
<td>SHIELD_CHARGE_RESETS</td>
<td>Number of SHIELD charge resets.</td>
</tr>
<tr>
<td>80</td>
<td>10</td>
<td>ASCII Integer</td>
<td>ACCUMULATION_TIME</td>
<td>Accumulation time for software counters.</td>
</tr>
<tr>
<td>92</td>
<td>10</td>
<td>ASCII Integer</td>
<td>ALL_EVENTS</td>
<td>All events counter.</td>
</tr>
<tr>
<td>104</td>
<td>10</td>
<td>ASCII Integer</td>
<td>ALL_CH0_CH1_EVENTS</td>
<td>All channel 0 and 1 events.</td>
</tr>
<tr>
<td>116</td>
<td>10</td>
<td>ASCII Integer</td>
<td>ALL_CH0_EVENTS</td>
<td>All single channel 0 events.</td>
</tr>
<tr>
<td>128</td>
<td>10</td>
<td>ASCII Integer</td>
<td>ALL_CH1_EVENTS</td>
<td>All single channel 1 events.</td>
</tr>
<tr>
<td>140</td>
<td>10</td>
<td>ASCII Integer</td>
<td>INVALID_SINGLE_CH0</td>
<td>Channel 0 out-of-range events.</td>
</tr>
<tr>
<td>152</td>
<td>10</td>
<td>ASCII Integer</td>
<td>INVALID_SINGLE_CH1</td>
<td>Channel 1 out-of-range events.</td>
</tr>
<tr>
<td>164</td>
<td>10</td>
<td>ASCII Integer</td>
<td>INVALID_COINCIDENT_CH0</td>
<td>Channel 0 out-of-range coincidence events.</td>
</tr>
<tr>
<td>176</td>
<td>10</td>
<td>ASCII Integer</td>
<td>INVALID_COINCIDENT_CH1</td>
<td>Channel 1 out-of-range coincidence events.</td>
</tr>
<tr>
<td>188</td>
<td>10</td>
<td>ASCII Integer</td>
<td>VALID_SINGLE_CH0</td>
<td>Single channel 0 valid events.</td>
</tr>
<tr>
<td>200</td>
<td>10</td>
<td>ASCII Integer</td>
<td>VALID_COINCIDENT_CH0</td>
<td>Coincidence channel 0 valid events.</td>
</tr>
<tr>
<td>212</td>
<td>10</td>
<td>ASCII Integer</td>
<td>VALID_SINGLE_CH1</td>
<td>Single channel 1 valid events.</td>
</tr>
<tr>
<td>224</td>
<td>10</td>
<td>ASCII Integer</td>
<td>VALID_COINCIDENT_CH1</td>
<td>Coincidence channel 1 valid events.</td>
</tr>
<tr>
<td>236</td>
<td>10</td>
<td>ASCII Integer</td>
<td>ALL_VALID_COINCIDENT</td>
<td>All valid coincidence events.</td>
</tr>
<tr>
<td>248</td>
<td>10</td>
<td>ASCII Integer</td>
<td>INVALID_PULSER_EVENTS</td>
<td>Channel 0 inverted events.</td>
</tr>
<tr>
<td>260</td>
<td>10</td>
<td>ASCII Integer</td>
<td>CH0_PILEUP_REJECT</td>
<td>Channel 0 pileup rejected events.</td>
</tr>
<tr>
<td>272</td>
<td>10</td>
<td>ASCII Integer</td>
<td>FIFO_FULL_COUNT</td>
<td>Hardware FIFO full flag tested for all events.</td>
</tr>
<tr>
<td>284</td>
<td>10</td>
<td>ASCII Integer</td>
<td>PULSER_ENERGY_SUM</td>
<td>Pulser energy sum.</td>
</tr>
<tr>
<td>296</td>
<td>10</td>
<td>ASCII Integer</td>
<td>PULSER_ENERGY_SUM2</td>
<td>Pulser energy sum squared.</td>
</tr>
<tr>
<td>308</td>
<td>10</td>
<td>ASCII Integer</td>
<td>PULSER_EVENTS</td>
<td>Number of valid pulser events.</td>
</tr>
<tr>
<td>320</td>
<td>10</td>
<td>ASCII Integer</td>
<td>INVALID_PULSER_EVENTS</td>
<td>Out-of-range pulser events.</td>
</tr>
<tr>
<td>332</td>
<td>10</td>
<td>ASCII Integer</td>
<td>NEUTRON_EVENTS</td>
<td>Coincidence events meeting neutron criterion.</td>
</tr>
<tr>
<td>344</td>
<td>10</td>
<td>ASCII Integer</td>
<td>PULSER_OFFSET</td>
<td>Pulser energy offset.</td>
</tr>
</tbody>
</table>

**OBJECT** = COLUMN
**NAME** = MET
**COLUMN_NUMBER** = 1
**BYTES** = 10
**DATA_TYPE** = ASCII_INTEGER
**START_BYTE** = 1
**DESCRIPTION** = "Mission elapsed time in seconds."

**END_OBJECT** = COLUMN

**OBJECT** = COLUMN
**NAME** = ORBIT_NUMBER
**COLUMN_NUMBER** = 2
**BYTES** = 5
**DATA_TYPE** = ASCII_INTEGER
**START_BYTE** = 13
**DESCRIPTION** = "Orbit number is a unique identifier for a given orbit of the MESSENGER spacecraft around Mercury. Orbit number is defined as starting at apoherm and is calculated using the MET value and the appropriate SPICE kernels. Orbit numbering does not start until MESSENGER..."
performs the Mercury orbit insertion. Until that time the value for orbit number is 0."

END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HPGE_RAW_EVENTS
COLUMN_NUMBER = 3
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 20
DESCRIPTION = "Counter of HPGe Raw events."

END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = SHIELD_RAW_EVENTS
COLUMN_NUMBER = 4
BYTES = 10
DATA_TYPE = ASCII=Integer
START_BYTE = 32
DESCRIPTION = "Counter for SHIELD raw events."

END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = ACCUMULATED_DEAD_TIME
COLUMN_NUMBER = 5
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 44
DESCRIPTION = "Counter for accumulated dead time."

END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HPGE_CHARGE_RESETS
COLUMN_NUMBER = 6
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 56
DESCRIPTION = "Number of HPGe charge resets."

END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = SHIELD_CHARGE_RESETS
COLUMN_NUMBER = 7
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 68
DESCRIPTION = "Number of SHIELD charge resets."

END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = ACCUMULATION_TIME
COLUMN_NUMBER = 8
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 80
DESCRIPTION = "Accumulation time for software counters."

END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = ALL_EVENTS
COLUMN_NUMBER = 9
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 92
DESCRIPTION = "All events counter."

END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = ALL_CH0_CH1_EVENTS
COLUMN_NUMBER = 10
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 104
DESCRIPTION = "All channel 0 and channel 1 events. Excludes inverted Channel 0, Pileups, and Pulser events."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = ALL_CH0_EVENTS
COLUMN_NUMBER  = 11
BYTES          = 10
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 116
DESCRIPTION    = "All single Channel 0 events - either singlet or fails crossing time criterion."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = ALL_CH1_EVENTS
COLUMN_NUMBER  = 12
BYTES          = 10
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 128
DESCRIPTION    = "All single Channel 1 events - either singlet or fails crossing time criterion."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = INVALID_SINGLE_CH0
COLUMN_NUMBER  = 13
BYTES          = 10
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 140
DESCRIPTION    = "Single channel 0 out-of-range events."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = INVALID_SINGLE_CH1
COLUMN_NUMBER  = 14
BYTES          = 10
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 152
DESCRIPTION    = "Single channel 1 out-of-range events."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = INVALID_COINCIDENT_CH0
COLUMN_NUMBER  = 15
BYTES          = 10
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 164
DESCRIPTION    = "Channel 0 out-of-range coincidence events."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = INVALID_COINCIDENT_CH1
COLUMN_NUMBER  = 16
BYTES          = 10
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 176
DESCRIPTION    = "Channel 1 out-of-range coincidence events."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = VALID_SINGLE_CH0
COLUMN_NUMBER  = 17
BYTES          = 10
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 188
DESCRIPTION    = "Single channel 0 valid events only."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = VALID_COINCIDENT_CH0
COLUMN_NUMBER  = 18
BYTES          = 10
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 200
DESCRIPTION    = "Coincidence channel 0 valid events."
END_OBJECT    = COLUMN
OBJECT = COLUMN
NAME = VALID_SINGLE_CH1
COLUMN_NUMBER = 19
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 212
DESCRIPTION = "Single channel 1 valid events only."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = VALID_COINCIDENT_CH1
COLUMN_NUMBER = 20
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 224
DESCRIPTION = "Coincidence channel 1 valid events."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = ALL_VALID_COINCIDENT
COLUMN_NUMBER = 21
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 236
DESCRIPTION = "All valid coincidence events - both Channel 0 and Channel 1 valid."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = INVERTED_CH0
COLUMN_NUMBER = 22
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 248
DESCRIPTION = "Channel 0 events flagged 'inverted' by the hardware."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = CH0_PILEUP_REJECT
COLUMN_NUMBER = 23
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 260
DESCRIPTION = "Channel 0 pileup rejected events. Only if pileup rejection is enabled."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = FIFO_FULL_COUNT
COLUMN_NUMBER = 24
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 272
DESCRIPTION = "Hardware FIFO full flag tested for all events. Number of events for which First-In-First-Out buffer is full."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = PULSER_ENERGY_SUM
COLUMN_NUMBER = 25
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 284
DESCRIPTION = "Pulser energy sum. Summation of (Pulser Energy - Offset)."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = PULSER_ENERGY_SUM2
COLUMN_NUMBER = 26
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 296
DESCRIPTION = "Pulser energy sum squared. Summation of square of
GRS EDR SIS, V4.8 Revision date: July 13, 2015

(Pulser Energy - Offset)."

END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = PULSER_EVENTS
COLUMN_NUMBER = 27
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 308
DESCRIPTION = "Number of valid pulser events."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = INVALID_PULSER_EVENTS
COLUMN_NUMBER = 28
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 320
DESCRIPTION = "Out-of-range pulser events."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = NEUTRON_EVENTS
COLUMN_NUMBER = 29
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 332
DESCRIPTION = "Coincidence events that meet neutron criterion."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = PULSER_OFFSET
COLUMN_NUMBER = 30
BYTES = 10
DATA_TYPE = ASCII_INTEGER
START_BYTE = 344
DESCRIPTION = "Pulser energy offset used to form PULSER_ENERGY_SUM and PULSER_ENERGY_SUM2."
END_OBJECT = COLUMN

8.9 GRS_STATUS.FMT

Below is a table that shows the structure of the ASCII table containing the Status data. The ASCII table is both fixed-width and comma delimited. Note that in PDS ASCII table format, the Start Byte has to take into account the comma delimiter and empty spaces. Following this is the actual content of the format file itself.

<table>
<thead>
<tr>
<th>Start Byte</th>
<th>Length (bytes)</th>
<th>Data Type</th>
<th>Column Name</th>
<th>Summary (see format file text for full description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12</td>
<td>ASCII Integer</td>
<td>MET</td>
<td>Mission Elapsed Time in seconds.</td>
</tr>
<tr>
<td>15</td>
<td>6</td>
<td>ASCII Integer</td>
<td>ORBIT_NUMBER</td>
<td>Unique consecutive integer identifying a given orbit of MESSENGER around Mercury</td>
</tr>
<tr>
<td>23</td>
<td>6</td>
<td>ASCII Integer</td>
<td>LVPS_PLUS5V</td>
<td>LVPS +5 volt monitor</td>
</tr>
<tr>
<td>31</td>
<td>6</td>
<td>ASCII Integer</td>
<td>LVPS_NEG5V</td>
<td>LVPS -5 volt monitor</td>
</tr>
<tr>
<td>39</td>
<td>6</td>
<td>ASCII Integer</td>
<td>LVPS_PLUS12V</td>
<td>LVPS +12 volt monitor</td>
</tr>
<tr>
<td>47</td>
<td>6</td>
<td>ASCII Integer</td>
<td>LVPS_NEG12V</td>
<td>LVPS -12 volt monitor</td>
</tr>
<tr>
<td>55</td>
<td>6</td>
<td>ASCII Integer</td>
<td>LVPS_EXT_C1</td>
<td>Unused</td>
</tr>
<tr>
<td>63</td>
<td>6</td>
<td>ASCII Integer</td>
<td>LVPS_EXT_C2</td>
<td>Unused</td>
</tr>
<tr>
<td>71</td>
<td>6</td>
<td>ASCII Integer</td>
<td>LVPS_EXT_C3</td>
<td>Unused</td>
</tr>
<tr>
<td>79</td>
<td>6</td>
<td>ASCII Integer</td>
<td>LVPS_EXT_C4</td>
<td>Unused</td>
</tr>
<tr>
<td>87</td>
<td>6</td>
<td>ASCII Integer</td>
<td>LVPS_EXT_C5</td>
<td>Unused</td>
</tr>
<tr>
<td>95</td>
<td>6</td>
<td>ASCII Integer</td>
<td>LVPS_PLUS5V_1</td>
<td>LVPS +5V current</td>
</tr>
<tr>
<td>103</td>
<td>6</td>
<td>ASCII Integer</td>
<td>LVPS_NEG5V_1</td>
<td>LVPS -5V current</td>
</tr>
<tr>
<td>111</td>
<td>6</td>
<td>ASCII Integer</td>
<td>LVPS_PLUS12V_1</td>
<td>LVPS +12V current</td>
</tr>
<tr>
<td>119</td>
<td>6</td>
<td>ASCII Integer</td>
<td>LVPS_NEG12V_1</td>
<td>LVPS -12V current</td>
</tr>
<tr>
<td>127</td>
<td>6</td>
<td>ASCII Integer</td>
<td>LVPS_TEMP</td>
<td>LVPS Temperature</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ASCII Integer</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---------------</td>
<td>--------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>135</td>
<td>6</td>
<td>LVPS_PRI_I</td>
<td>LVPS Primary Current</td>
<td></td>
</tr>
<tr>
<td>143</td>
<td>6</td>
<td>OP_HEATER_CURRENT</td>
<td>Op-heater Current</td>
<td></td>
</tr>
<tr>
<td>151</td>
<td>6</td>
<td>HVPS TEMP</td>
<td>HVPS Temperature</td>
<td></td>
</tr>
<tr>
<td>159</td>
<td>6</td>
<td>HVPS VOLT</td>
<td>HVPS Voltage</td>
<td></td>
</tr>
<tr>
<td>167</td>
<td>6</td>
<td>HVPS REF_VOLT</td>
<td>HVPS Reference Voltage</td>
<td></td>
</tr>
<tr>
<td>175</td>
<td>6</td>
<td>HPGE_TEMP_1</td>
<td>HPGE Detector Temperature 1</td>
<td></td>
</tr>
<tr>
<td>183</td>
<td>6</td>
<td>HPGE_TEMP_2</td>
<td>HPGE Detector Temperature 2</td>
<td></td>
</tr>
<tr>
<td>191</td>
<td>6</td>
<td>HPGE_DET_LEAK</td>
<td>HPGE Detector Leakage current</td>
<td></td>
</tr>
<tr>
<td>199</td>
<td>6</td>
<td>HVPS TEMP</td>
<td>HVPS Temperature</td>
<td></td>
</tr>
<tr>
<td>207</td>
<td>6</td>
<td>PREAMP_TEMP</td>
<td>PreAmp Temperature</td>
<td></td>
</tr>
<tr>
<td>215</td>
<td>6</td>
<td>SHAPER_TEMP</td>
<td>Shaper Temperature</td>
<td></td>
</tr>
<tr>
<td>223</td>
<td>6</td>
<td>AD_TEMP</td>
<td>AD Temperature</td>
<td></td>
</tr>
<tr>
<td>231</td>
<td>6</td>
<td>HV_MONITOR</td>
<td>HV Monitor</td>
<td></td>
</tr>
<tr>
<td>239</td>
<td>6</td>
<td>REF_2_5V</td>
<td>2.5V reference ADC counts</td>
<td></td>
</tr>
<tr>
<td>247</td>
<td>6</td>
<td>REF_2_5V_DIV2</td>
<td>2.5V reference / 2 ADC counts.</td>
<td></td>
</tr>
<tr>
<td>255</td>
<td>6</td>
<td>REF_2_5V_DIV3</td>
<td>2.5V reference / 3 ADC counts.</td>
<td></td>
</tr>
<tr>
<td>263</td>
<td>6</td>
<td>CONTROL_BOARD_TEMP</td>
<td>Controller board temperature.</td>
<td></td>
</tr>
<tr>
<td>271</td>
<td>6</td>
<td>ANNEAL_PRI_VOLT</td>
<td>Anneal primary voltage.</td>
<td></td>
</tr>
<tr>
<td>279</td>
<td>6</td>
<td>COOLER_PRI_VOLT</td>
<td>Cooler primary voltage.</td>
<td></td>
</tr>
<tr>
<td>287</td>
<td>6</td>
<td>ANNEAL_SEC_I</td>
<td>Anneal secondary current.</td>
<td></td>
</tr>
<tr>
<td>295</td>
<td>6</td>
<td>COOLER_SEC_I</td>
<td>Cooler secondary current.</td>
<td></td>
</tr>
<tr>
<td>303</td>
<td>6</td>
<td>COOLER_PRI_I</td>
<td>Cooler primary current.</td>
<td></td>
</tr>
<tr>
<td>311</td>
<td>6</td>
<td>ANNEAL_PRI_I</td>
<td>Anneal primary current.</td>
<td></td>
</tr>
<tr>
<td>319</td>
<td>6</td>
<td>COOLERPOWER_BOARD_TEMP</td>
<td>Cooler power board temperature.</td>
<td></td>
</tr>
<tr>
<td>327</td>
<td>6</td>
<td>STATOR_TEMP</td>
<td>Stator temperature</td>
<td></td>
</tr>
<tr>
<td>335</td>
<td>6</td>
<td>HVAC_HEATER</td>
<td>Heater register.</td>
<td></td>
</tr>
<tr>
<td>343</td>
<td>6</td>
<td>HVAC_RELAY</td>
<td>Relay register.</td>
<td></td>
</tr>
<tr>
<td>351</td>
<td>6</td>
<td>HVAC_HEATER_POWER_LEVEL</td>
<td>Heater power level.</td>
<td></td>
</tr>
<tr>
<td>359</td>
<td>6</td>
<td>ANNEAL_MAX_VALID_TEMP</td>
<td>Anneal max valid temp reading limit.</td>
<td></td>
</tr>
<tr>
<td>367</td>
<td>6</td>
<td>ANNEAL_UPPER_TEMP</td>
<td>Anneal upper temp limit.</td>
<td></td>
</tr>
<tr>
<td>375</td>
<td>6</td>
<td>ANNEAL_LOWER_TEMP</td>
<td>Anneal lower temp limit.</td>
<td></td>
</tr>
<tr>
<td>383</td>
<td>6</td>
<td>ANNEAL_MIN_VALID_TEMP</td>
<td>Anneal min valid temp reading limit.</td>
<td></td>
</tr>
<tr>
<td>391</td>
<td>6</td>
<td>HVAC_COOLER_PWR</td>
<td>Cooler set point.</td>
<td></td>
</tr>
<tr>
<td>399</td>
<td>6</td>
<td>HPGE_HVPS_CMD</td>
<td>HPGe HVPS command.</td>
<td></td>
</tr>
<tr>
<td>407</td>
<td>1</td>
<td>CMD_HPGE_HV_ENABLE</td>
<td>Commanded HPGE HV enabled.</td>
<td></td>
</tr>
<tr>
<td>410</td>
<td>1</td>
<td>CMD_SHIELD_HV_ENABLE</td>
<td>Commanded Shield HV enabled.</td>
<td></td>
</tr>
<tr>
<td>413</td>
<td>1</td>
<td>COOLER_HEATER_STATE</td>
<td>Cooler Op-heater state.</td>
<td></td>
</tr>
<tr>
<td>416</td>
<td>1</td>
<td>COOLER_THERMOSTAT</td>
<td>Cooler thermostat enabled.</td>
<td></td>
</tr>
<tr>
<td>419</td>
<td>1</td>
<td>HPGE_HV_TEMP_OK</td>
<td>HPGe temp in range for HV.</td>
<td></td>
</tr>
<tr>
<td>422</td>
<td>1</td>
<td>HPGE_TEMP1_ENABLE</td>
<td>HPGe Temp1 sensor enabled.</td>
<td></td>
</tr>
<tr>
<td>425</td>
<td>1</td>
<td>HPGE_TEMP2_ENABLE</td>
<td>HPGe Temp2 sensor enabled.</td>
<td></td>
</tr>
<tr>
<td>428</td>
<td>1</td>
<td>HPGE_PILEUP_REJ_ENABLE</td>
<td>Pileup rejection enabled.</td>
<td></td>
</tr>
<tr>
<td>431</td>
<td>1</td>
<td>CMD_SCIENCE_MODE</td>
<td>Commanded to event classification.</td>
<td></td>
</tr>
<tr>
<td>434</td>
<td>1</td>
<td>COOLER_ENABLE</td>
<td>Cooler enabled.</td>
<td></td>
</tr>
<tr>
<td>437</td>
<td>1</td>
<td>COOLER_PL_ENABLE</td>
<td>Cooler Pl control enabled.</td>
<td></td>
</tr>
<tr>
<td>440</td>
<td>1</td>
<td>COOLER_TEMP_OK</td>
<td>Cooler temperature in range.</td>
<td></td>
</tr>
<tr>
<td>443</td>
<td>1</td>
<td>HPGE_HTR_COOLER_OVERRIDE</td>
<td>Allow anneal heater and cooler.</td>
<td></td>
</tr>
<tr>
<td>446</td>
<td>1</td>
<td>HPGE_HTR_WATCHDOG</td>
<td>Anneal heater watchdog enabled.</td>
<td></td>
</tr>
<tr>
<td>449</td>
<td>1</td>
<td>PULSER_SPECTRUM_ENABLE</td>
<td>Include pulser events in spectrum.</td>
<td></td>
</tr>
<tr>
<td>452</td>
<td>1</td>
<td>CMD_SCIENCE_PURGE</td>
<td>Purge science at end of accumulation.</td>
<td></td>
</tr>
<tr>
<td>455</td>
<td>1</td>
<td>CMD_UPDATE_MODE</td>
<td>Immediate update of periods.</td>
<td></td>
</tr>
<tr>
<td>458</td>
<td>1</td>
<td>IN_SCIENCE_MODE</td>
<td>In an accumulation/reporting cycle.</td>
<td></td>
</tr>
<tr>
<td>461</td>
<td>1</td>
<td>PREPARE_SCIENCE_DATA</td>
<td>Prepare to ship latest accumulation.</td>
<td></td>
</tr>
<tr>
<td>464</td>
<td>1</td>
<td>WATCHDOG_STARTED</td>
<td>Main watchdog enabled.</td>
<td></td>
</tr>
<tr>
<td>467</td>
<td>3</td>
<td>MINOR_SW_VERSION</td>
<td>Minor software version.</td>
<td></td>
</tr>
<tr>
<td>472</td>
<td>6</td>
<td>HPGE_TEMP_DELTA_MAX</td>
<td>Maximum diode sensor difference.</td>
<td></td>
</tr>
<tr>
<td>480</td>
<td>6</td>
<td>HPGE_TEMP_LOW_ON</td>
<td>Maximum temp to turn on HPGe HV.</td>
<td></td>
</tr>
<tr>
<td>488</td>
<td>6</td>
<td>HPGE_TEMP_HIGH_OFF</td>
<td>Temperature to turn off HPGe HV.</td>
<td></td>
</tr>
<tr>
<td>496</td>
<td>6</td>
<td>HPGE_HV_BIAS_THRESH</td>
<td>HPGe bias current safing threshold.</td>
<td></td>
</tr>
<tr>
<td>504</td>
<td>6</td>
<td>HPGE_HV_BIAS_CHECK</td>
<td>Min HPGe HV to check bias.</td>
<td></td>
</tr>
<tr>
<td>512</td>
<td>6</td>
<td>HPGE_CRITICAL_BIAS</td>
<td>HPGe critical bias condition.</td>
<td></td>
</tr>
<tr>
<td>520</td>
<td>6</td>
<td>HPGE_CRT_BIAS_MAX_HV</td>
<td>HPGe critical bias max HV.</td>
<td></td>
</tr>
<tr>
<td>528</td>
<td>6</td>
<td>HPGE_LVL1_SAF RETRIES</td>
<td>HPGe level 1 safing retries.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>536</td>
<td>6</td>
<td>ASCII Integer</td>
<td>HPGE_LVL1_WAIT_TIME</td>
<td></td>
</tr>
<tr>
<td>544</td>
<td>6</td>
<td>ASCII Integer</td>
<td>SHIELD_HV_RATE_THRESH</td>
<td></td>
</tr>
<tr>
<td>552</td>
<td>6</td>
<td>ASCII Integer</td>
<td>SHIELD_LVL1_SAF_RETIES</td>
<td></td>
</tr>
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<td>560</td>
<td>6</td>
<td>ASCII Integer</td>
<td>SHIELD_LVL1_WAIT_TIME</td>
<td></td>
</tr>
<tr>
<td>568</td>
<td>6</td>
<td>ASCII Integer</td>
<td>COOLER_OP_HEATER_LOW_LIMIT</td>
<td></td>
</tr>
<tr>
<td>576</td>
<td>6</td>
<td>ASCII Integer</td>
<td>COOLER_OP_HEATER_HIGH_LIMIT</td>
<td></td>
</tr>
<tr>
<td>584</td>
<td>6</td>
<td>ASCII Integer</td>
<td>HPGE_PILEUP_OFFSET</td>
<td></td>
</tr>
<tr>
<td>592</td>
<td>6</td>
<td>ASCII Integer</td>
<td>HPGE_PILEUP_HALF_WIDTH</td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>6</td>
<td>ASCII Integer</td>
<td>EVENT_COIN_OFFSET</td>
<td></td>
</tr>
<tr>
<td>608</td>
<td>6</td>
<td>ASCII Integer</td>
<td>EVENT_COIN_HALF_WIDTH</td>
<td></td>
</tr>
<tr>
<td>616</td>
<td>6</td>
<td>ASCII Integer</td>
<td>NEUTRON_CHO_MIN_E</td>
<td></td>
</tr>
<tr>
<td>624</td>
<td>6</td>
<td>ASCII Integer</td>
<td>NEUTRON_CHO_MAX_E</td>
<td></td>
</tr>
<tr>
<td>632</td>
<td>6</td>
<td>ASCII Integer</td>
<td>NEUTRON_CH1_MIN_E</td>
<td></td>
</tr>
<tr>
<td>640</td>
<td>6</td>
<td>ASCII Integer</td>
<td>NEUTRON_CH1_MAX_E</td>
<td></td>
</tr>
<tr>
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<td>6</td>
<td>ASCII Integer</td>
<td>PULSER_CHO_MIN_VALID</td>
<td></td>
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<tr>
<td>656</td>
<td>6</td>
<td>ASCII Integer</td>
<td>PULSER_CHO_MAX_VALID</td>
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<td>ASCII Integer</td>
<td>PULSER_OFFSET</td>
<td></td>
</tr>
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<td>672</td>
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<td>ASCII Integer</td>
<td>PULSER_SHIFT</td>
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<td>680</td>
<td>3</td>
<td>ASCII Integer</td>
<td>CONFIG_CHANGED</td>
<td></td>
</tr>
<tr>
<td>685</td>
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<td>ASCII Integer</td>
<td>DIAG_PACKETS_DROPPED</td>
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</tr>
<tr>
<td>690</td>
<td>1</td>
<td>ASCII Integer</td>
<td>LVPS_I2C_12V</td>
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</tr>
<tr>
<td>693</td>
<td>1</td>
<td>ASCII Integer</td>
<td>LVPS_I2C_EXT_PR_1</td>
<td></td>
</tr>
<tr>
<td>696</td>
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<td>891</td>
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<td>OUTPUT_HVPS_EVENT_SAFE</td>
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<td>LAST_OPCODE</td>
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<td>ASCII Integer</td>
<td>SHLD_HV_UNCHANGED_TICKS</td>
<td></td>
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<td>927</td>
<td>6</td>
<td>ASCII Integer</td>
<td>COOLER_TEMP_SETPOINT</td>
<td></td>
</tr>
<tr>
<td>935</td>
<td>6</td>
<td>ASCII Integer</td>
<td>COOLER_POWER</td>
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</tr>
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<table>
<thead>
<tr>
<th>ASCII Integer</th>
<th>COLUMN</th>
<th>DESCRIPTION</th>
</tr>
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<tbody>
<tr>
<td>6</td>
<td>COOLER_PI_PROP</td>
<td>Cooler PI proportional gain.</td>
</tr>
<tr>
<td>6</td>
<td>COOLER_PI_INTEGRAL</td>
<td>Cooler PI integral gain.</td>
</tr>
<tr>
<td>6</td>
<td>COOLER_PI_OFFSET</td>
<td>Cooler PI offset for output.</td>
</tr>
<tr>
<td>6</td>
<td>COOLER_PI_MAX_ERR</td>
<td>PI max error to enable integration.</td>
</tr>
<tr>
<td>6</td>
<td>ACCUM_TIME_LEFT</td>
<td>Time left in current accumulation.</td>
</tr>
<tr>
<td>6</td>
<td>CMD_REPORT_PERIOD</td>
<td>Commanded reporting period.</td>
</tr>
<tr>
<td>6</td>
<td>CMD_ACCUM_TIME</td>
<td>Commanded accumulation time.</td>
</tr>
<tr>
<td>6</td>
<td>CMD_SHIP_MODE</td>
<td>Commanded science ship selection.</td>
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<tr>
<td>6</td>
<td>A2D_SHIP_MODE</td>
<td>Microphonics ship mode.</td>
</tr>
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<td>6</td>
<td>SCIENCE_PRIORITY</td>
<td>Base value for science ApIDs.</td>
</tr>
<tr>
<td>6</td>
<td>STATUS_INTERVAL</td>
<td>Status interval (seconds).</td>
</tr>
<tr>
<td>6</td>
<td>MACRO_FREE_BLOCKS</td>
<td>Free blocks for macros.</td>
</tr>
<tr>
<td>6</td>
<td>TLM_VOLUME</td>
<td>Telemetry volume (kB).</td>
</tr>
<tr>
<td>6</td>
<td>WATCH_ADDR</td>
<td>Debug watch address.</td>
</tr>
<tr>
<td>6</td>
<td>WATCH_MEM</td>
<td>Debug watch page.</td>
</tr>
<tr>
<td>3</td>
<td>WATCH_BYTE1</td>
<td>Debug watch byte 1.</td>
</tr>
<tr>
<td>3</td>
<td>WATCH_BYTE2</td>
<td>Debug watch byte 2.</td>
</tr>
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<td>3</td>
<td>SW_VERSION</td>
<td>Major software version.</td>
</tr>
<tr>
<td>3</td>
<td>ALARM_ID</td>
<td>Last alarm ID.</td>
</tr>
<tr>
<td>6</td>
<td>ALARM_COUNT</td>
<td>Total alarm count.</td>
</tr>
<tr>
<td>3</td>
<td>CMD_EXECUTED</td>
<td>Number of commands executed.</td>
</tr>
<tr>
<td>3</td>
<td>CMD_REJECTED</td>
<td>Number of commands rejected.</td>
</tr>
<tr>
<td>3</td>
<td>MACRO_CMD_EXEC</td>
<td>Macro commands executed.</td>
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<tr>
<td>3</td>
<td>MACRO_CMD_REJECT</td>
<td>Macro commands rejected.</td>
</tr>
<tr>
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<td>MACRO_ID</td>
<td>Last macro ID.</td>
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<td>MACRO_LEARN</td>
<td>Macro learning mode.</td>
</tr>
<tr>
<td>1</td>
<td>MEM_WRITE_ENABLE</td>
<td>Memory writing enabled.</td>
</tr>
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<td>1</td>
<td>MON_RESPONSE</td>
<td>Monitor response.</td>
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**OBJECT** = COLUMN
**NAME** = MET
**COLUMN_NUMBER** = 1
**BYTES** = 12
**DATA_TYPE** = ASCII_INTEGER
**START_BYTE** = 1
**DESCRIPTION** = "Mission Elapsed Time in seconds."

**END_OBJECT** = COLUMN

**OBJECT** = COLUMN
**NAME** = ORBIT_NUMBER
**COLUMN_NUMBER** = 2
**BYTES** = 6
**DATA_TYPE** = ASCII_INTEGER
**START_BYTE** = 15
**DESCRIPTION** = "Orbit number is a unique identifier for a given orbit of the MESSENGER spacecraft around Mercury. Orbit number is defined as starting at apoherm and is calculated using the MET value and the appropriate SPICE kernels. Orbit numbering does not start until MESSENGER performs the Mercury orbit insertion. Until that time the value for orbit number is 0."

**END_OBJECT** = COLUMN

**OBJECT** = COLUMN
**NAME** = LVPS_PLUS5V
**COLUMN_NUMBER** = 3
**BYTES** = 6
**DATA_TYPE** = ASCII_INTEGER
**START_BYTE** = 23
**DESCRIPTION** = "LVPS +5 volt monitor."

**END_OBJECT** = COLUMN

**OBJECT** = COLUMN
**NAME** = LVPS_NEG5V
**COLUMN_NUMBER** = 4
**BYTES** = 6
**DATA_TYPE** = ASCII_INTEGER
**START_BYTE** = 31
**DESCRIPTION** = "LVPS -5 volt monitor."
END_OBJECT     = COLUMN

OBJECT        = COLUMN
NAME           = LVPS_PLUS12V
COLUMN_NUMBER  = 5
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 39
DESCRIPTION    = "LVPS +12 volt monitor."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = LVPS_NEG12V
COLUMN_NUMBER  = 6
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 47
DESCRIPTION    = "LVPS -12 volt monitor."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = LVPS_EXT_C1
COLUMN_NUMBER  = 7
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 55
DESCRIPTION    = "Unused."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = LVPS_EXT_C2
COLUMN_NUMBER  = 8
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 63
DESCRIPTION    = "Unused."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = LVPS_EXT_C3
COLUMN_NUMBER  = 9
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 71
DESCRIPTION    = "Unused."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = LVPS_EXT_C4
COLUMN_NUMBER  = 10
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 79
DESCRIPTION    = "Unused."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = LVPS_EXT_C5
COLUMN_NUMBER  = 11
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 87
DESCRIPTION    = "Unused."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = LVPS_PLUS5V_I
COLUMN_NUMBER  = 12
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 95
DESCRIPTION    = "LVPS +5V current."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME = LVPS_NEG5V_I
COLUMN_NUMBER = 13
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 103
DESCRIPTION = "LVPS -5V current."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = LVPS_PLUS12V_I
COLUMN_NUMBER = 14
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 111
DESCRIPTION = "LVPS +12V current."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = LVPS_NEG12V_I
COLUMN_NUMBER = 15
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 119
DESCRIPTION = "LVPS -12V current."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = LVPS_TEMP
COLUMN_NUMBER = 16
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 127
DESCRIPTION = "LVPS Temperature."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = LVPS_PRI_I
COLUMN_NUMBER = 17
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 135
DESCRIPTION = "LVPS Primary Current."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = OP_HEATER_CURRENT
COLUMN_NUMBER = 18
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 143
DESCRIPTION = "Op-Heater Current."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HVPS_TEMP
COLUMN_NUMBER = 19
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 151
DESCRIPTION = "HVPS Temperature."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HVPS_VOLT
COLUMN_NUMBER = 20
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 159
DESCRIPTION = "HVPS Voltage."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HVPS_REF_VOLT
COLUMN_NUMBER = 21
BYTES = 6
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<thead>
<tr>
<th>NAME</th>
<th>COLUMN_NUMBER</th>
<th>BYTES</th>
<th>DATA_TYPE</th>
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<th>DESCRIPTION</th>
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<td>HPGE_TEMP_1</td>
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<td>ASCII_INTEGER</td>
<td>167</td>
<td>&quot;HVPS Reference Voltage.&quot;</td>
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<td>HPGE_TEMP_2</td>
<td>23</td>
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<td>ASCII_INTEGER</td>
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<td>&quot;ADC0 Channel 0, HPGE Detector Temperature 1.&quot;</td>
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<td>HPGE_DET_LEAK</td>
<td>24</td>
<td>6</td>
<td>ASCII_INTEGER</td>
<td>183</td>
<td>&quot;ADC0 Channel 1, HPGE Detector Temperature 2.&quot;</td>
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<td>HVPS_TEMP</td>
<td>25</td>
<td>6</td>
<td>ASCII_INTEGER</td>
<td>199</td>
<td>&quot;ADC0 Channel 3, HVPS Temperature.&quot;</td>
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<tr>
<td>PREAMP_TEMP</td>
<td>26</td>
<td>6</td>
<td>ASCII_INTEGER</td>
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<td>&quot;ADC0 Channel 4, Pre Amp Temperature.&quot;</td>
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<td>SHAPER_TEMP</td>
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<td>ASCII_INTEGER</td>
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<td>&quot;ADC0 Channel 5, Shaper Temperature.&quot;</td>
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<td>&quot;ADC0 Channel 6, AD Temperature.&quot;</td>
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<td>HV_MONITOR</td>
<td>29</td>
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<td>ASCII_INTEGER</td>
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<td>&quot;ADC0 Channel 7, HV Monitor.&quot;</td>
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END_OBJECT   = COLUMN

OBJECT   = COLUMN
    NAME    = REF_2_5V
    COLUMN_NUMBER = 30
    BYTES    = 6
    DATA_TYPE = ASCII_INTEGER
    START_BYTE = 239
    DESCRIPTION = "ADC0 Channel 8, 2.5V reference counts."
END_OBJECT   = COLUMN

OBJECT   = COLUMN
    NAME    = REF_2_5V_DIV2
    COLUMN_NUMBER = 31
    BYTES    = 6
    DATA_TYPE = ASCII_INTEGER
    START_BYTE = 247
    DESCRIPTION = "ADC0 Channel 9, 2.5V reference counts divided by 2."
END_OBJECT   = COLUMN

OBJECT   = COLUMN
    NAME    = REF_2_5V_DIV3
    COLUMN_NUMBER = 32
    BYTES    = 6
    DATA_TYPE = ASCII_INTEGER
    START_BYTE = 255
    DESCRIPTION = "ADC0 Channel A, 2.5V reference counts divided by 3."
END_OBJECT   = COLUMN

OBJECT   = COLUMN
    NAME    = CONTROL_BOARD_TEMP
    COLUMN_NUMBER = 33
    BYTES    = 6
    DATA_TYPE = ASCII_INTEGER
    START_BYTE = 263
    DESCRIPTION = "ADC0 Channel B, Controller Board temperature."
END_OBJECT   = COLUMN

OBJECT   = COLUMN
    NAME    = ANNEAL_PRI_VOLT
    COLUMN_NUMBER = 34
    BYTES    = 6
    DATA_TYPE = ASCII_INTEGER
    START_BYTE = 271
    DESCRIPTION = "ADC1 Channel 0, Anneal primary voltage."
END_OBJECT   = COLUMN

OBJECT   = COLUMN
    NAME    = COOLER_PRI_VOLT
    COLUMN_NUMBER = 35
    BYTES    = 6
    DATA_TYPE = ASCII_INTEGER
    START_BYTE = 279
    DESCRIPTION = "ADC1 Channel 1, Cooler primary voltage."
END_OBJECT   = COLUMN

OBJECT   = COLUMN
    NAME    = ANNEAL_SEC_I
    COLUMN_NUMBER = 36
    BYTES    = 6
    DATA_TYPE = ASCII_INTEGER
    START_BYTE = 287
    DESCRIPTION = "ADC1 Channel 2, Anneal secondary current."
END_OBJECT   = COLUMN

OBJECT   = COLUMN
    NAME    = COOLER_SEC_I
    COLUMN_NUMBER = 37
    BYTES    = 6
    DATA_TYPE = ASCII_INTEGER
    START_BYTE = 295
    DESCRIPTION = "ADC1 Channel 3, Cooler secondary current."
END_OBJECT   = COLUMN

OBJECT   = COLUMN
NAME = COOLER_PRI_I
COLUMN_NUMBER = 38
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 303
DESCRIPTION = "ADC1 Channel 4, Cooler primary current."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = ANNEAL_PRI_I
COLUMN_NUMBER = 39
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 311
DESCRIPTION = "ADC1 Channel 5, Anneal primary current."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = COOLER_POWER_BOARD_TEMP
COLUMN_NUMBER = 40
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 319
DESCRIPTION = "ADC1 Channel 6, Cooler power board temperature."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = STATOR_TEMP
COLUMN_NUMBER = 41
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 327
DESCRIPTION = "ADC1 Channel 7, Stator temperature."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HVAC_HEATER
COLUMN_NUMBER = 42
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 335
DESCRIPTION = "Heater bit register. Bits that define states of anneal heaters."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HVAC_RELAY
COLUMN_NUMBER = 43
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 343
DESCRIPTION = "Relay bit register. Bits that define states of anneal heater relay circuits."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HVAC_HEATER_POWER_LEVEL
COLUMN_NUMBER = 44
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 351
DESCRIPTION = "Heater power level."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = ANNEAL_MAX_VALID_TEMP
COLUMN_NUMBER = 45
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 359
DESCRIPTION = "Anneal max valid temp reading limit."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = ANNEAL_UPPER_TEMP
COLUMN_NUMBER = 46
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 367
DESCRIPTION = "Anneal upper temp limit."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = ANNEAL_LOWER_TEMP
COLUMN_NUMBER = 47
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 375
DESCRIPTION = "Anneal lower temp limit."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = ANNEAL_MIN_VALID_TEMP
COLUMN_NUMBER = 48
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 383
DESCRIPTION = "Anneal min valid temp reading limit."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HVAC_COOLER_PWR
COLUMN_NUMBER = 49
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 391
DESCRIPTION = "DAC0 Cooler set point."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HPGE_HVPS_CMD
COLUMN_NUMBER = 50
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 399
DESCRIPTION = "DAC1: HPGe HVPS high voltage value commanded (not actual value)."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = CMD_HPGE_HV_ENABLE
COLUMN_NUMBER = 51
BYTES = 1
DATA_TYPE = ASCII_INTEGER
START_BYTE = 407
DESCRIPTION = "Commanded HPGe HV enabled."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = CMD_SHIELD_HV_ENABLE
COLUMN_NUMBER = 52
BYTES = 1
DATA_TYPE = ASCII_INTEGER
START_BYTE = 410
DESCRIPTION = "Commanded Shield HV enabled."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = COOLER_HEATER_STATE
COLUMN_NUMBER = 53
BYTES = 1
DATA_TYPE = ASCII_INTEGER
START_BYTE = 413
DESCRIPTION = "Cooler Op-heater state."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = COOLER_THERMOSTAT
COLUMN_NUMBER = 54
BYTES = 1
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 416
DESCRIPTION    = "Cooler thermostat enabled."
END_OBJECT    = COLUMN

OBJECT       = COLUMN
NAME          = HPGE_HV_TEMP_OK
COLUMN_NUMBER = 55
BYTES         = 1
DATA_TYPE     = ASCII_INTEGER
START_BYTE    = 419
DESCRIPTION   = "HPGe temp in range for HV."
END_OBJECT    = COLUMN

OBJECT       = COLUMN
NAME          = HPGE_TEMP1_ENABLE
COLUMN_NUMBER = 56
BYTES         = 1
DATA_TYPE     = ASCII_INTEGER
START_BYTE    = 422
DESCRIPTION   = "HPGe Temp1 sensor enabled."
END_OBJECT    = COLUMN

OBJECT       = COLUMN
NAME          = HPGE_TEMP2_ENABLE
COLUMN_NUMBER = 57
BYTES         = 1
DATA_TYPE     = ASCII_INTEGER
START_BYTE    = 425
DESCRIPTION   = "HPGe Temp2 sensor enabled."
END_OBJECT    = COLUMN

OBJECT       = COLUMN
NAME          = HPGE_PILEUP_REJ_ENABLE
COLUMN_NUMBER = 58
BYTES         = 1
DATA_TYPE     = ASCII_INTEGER
START_BYTE    = 428
DESCRIPTION   = "Pileup rejection enabled."
END_OBJECT    = COLUMN

OBJECT       = COLUMN
NAME          = CMD_SCIENCE_MODE
COLUMN_NUMBER = 59
BYTES         = 1
DATA_TYPE     = ASCII_INTEGER
START_BYTE    = 431
DESCRIPTION   = "Commanded to event classification."
END_OBJECT    = COLUMN

OBJECT       = COLUMN
NAME          = COOLER_ENABLE
COLUMN_NUMBER = 60
BYTES         = 1
DATA_TYPE     = ASCII_INTEGER
START_BYTE    = 434
DESCRIPTION   = "Cooler enabled."
END_OBJECT    = COLUMN

OBJECT       = COLUMN
NAME          = COOLER_PI_ENABLE
COLUMN_NUMBER = 61
BYTES         = 1
DATA_TYPE     = ASCII_INTEGER
START_BYTE    = 437
DESCRIPTION   = "Cooler PI (Proportional Integral) loop control enabled."
END_OBJECT    = COLUMN

OBJECT       = COLUMN
NAME          = COOLER_TEMP_OK
COLUMN_NUMBER = 62
BYTES         = 1
DATA_TYPE     = ASCII_INTEGER
START_BYTE    = 440
DESCRIPTION   = "Cooler temperature in range for operation."
END_OBJECT    = COLUMN
OBJECT        = COLUMN
NAME           = HPGE_HTR_COOLER_OVERRIDE
COLUMN_NUMBER  = 63
BYTES          = 1
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 443
DESCRIPTION    = "Allow anneal heater and cooler."
END_OBJECT    = COLUMN
OBJECT        = COLUMN
NAME           = HPGE_HTR_WATCHDOG
COLUMN_NUMBER  = 64
BYTES          = 1
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 446
DESCRIPTION    = "Anneal heater watchdog enabled."
END_OBJECT    = COLUMN
OBJECT        = COLUMN
NAME           = PULSER_SPECTRUM_ENABLE
COLUMN_NUMBER  = 65
BYTES          = 1
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 449
DESCRIPTION    = "Include pulser events in spectrum."
END_OBJECT    = COLUMN
OBJECT        = COLUMN
NAME           = CMD_SCIENCE_PURGE
COLUMN_NUMBER  = 66
BYTES          = 1
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 452
DESCRIPTION    = "Purge science at end of accumulation."
END_OBJECT    = COLUMN
OBJECT        = COLUMN
NAME           = CMD_UPDATE_MODE
COLUMN_NUMBER  = 67
BYTES          = 1
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 455
DESCRIPTION    = "Mode for immediate update of periods after command sent
to change accumulation period (rather than delayed until end of period)."
END_OBJECT    = COLUMN
OBJECT        = COLUMN
NAME           = IN_SCIENCE_MODE
COLUMN_NUMBER  = 68
BYTES          = 1
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 458
DESCRIPTION    = "In an accumulation/reporting cycle."
END_OBJECT    = COLUMN
OBJECT        = COLUMN
NAME           = PREPARE_SCIENCE_DATA
COLUMN_NUMBER  = 69
BYTES          = 1
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 461
DESCRIPTION    = "Prepare to ship latest accumulation."
END_OBJECT    = COLUMN
OBJECT        = COLUMN
NAME           = WATCHDOG_STARTED
COLUMN_NUMBER  = 70
BYTES          = 1
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 464
DESCRIPTION    = "Main watchdog enabled."
END_OBJECT    = COLUMN
OBJECT = COLUMN
NAME = MINOR_SW_VERSION
COLUMN_NUMBER = 71
BYTES = 3
DATA_TYPE = ASCII_INTEGER
START_BYTE = 467
DESCRIPTION = "Minor software version."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HPGE_TEMP_DELTA_MAX
COLUMN_NUMBER = 72
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 472
DESCRIPTION = "Maximum diode sensor temperature difference allowed (before safe mode enabled)."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HPGE_TEMP_LOW_ON
COLUMN_NUMBER = 73
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 480
DESCRIPTION = "Maximum temperature to turn on HPGe HV."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HPGE_TEMP_HIGH_OFF
COLUMN_NUMBER = 74
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 488
DESCRIPTION = "Temperature to turn off HPGe HV."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HPGE_HV_BIAS_THRESH
COLUMN_NUMBER = 75
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 496
DESCRIPTION = "HPGe bias current safing threshold."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HPGE_HV_BIAS_CHECK
COLUMN_NUMBER = 76
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 504
DESCRIPTION = "Min HPGe HV to check bias."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HPGE_CRITICAL_BIAS
COLUMN_NUMBER = 77
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 512
DESCRIPTION = "HPGe critical bias condition."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HPGE_CRIT_BIAS_MAX_HV
COLUMN_NUMBER = 78
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 520
DESCRIPTION = "HPGe critical bias max HV."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HPGE_LVL1_SAF_RETRIES
COLUMN_NUMBER  = 79
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 528
DESCRIPTION    = "HPGe level 1 safing retries."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = HPGE_LVL1_WAIT_TIME
COLUMN_NUMBER  = 80
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 536
DESCRIPTION    = "HPGe level 1 wait time (minutes)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = SHIELD_HV_RATE_THRESH
COLUMN_NUMBER  = 81
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 544
DESCRIPTION    = "Shield event rate safing threshold."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = SHIELD_LVL1_SAF_RETRIES
COLUMN_NUMBER  = 82
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 552
DESCRIPTION    = "Shield level 1 safing retries."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = SHIELD_LVL1_WAIT_TIME
COLUMN_NUMBER  = 83
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 560
DESCRIPTION    = "Shield level 1 wait time (minutes)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = COOLER_OP_HEATER_LOW_LIMIT
COLUMN_NUMBER  = 84
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 568
DESCRIPTION    = "Cooler op heater lower limit."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = COOLER_OP_HEATER_HIGH_LIMIT
COLUMN_NUMBER  = 85
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 576
DESCRIPTION    = "Cooler op heater upper limit."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = HPGE_PILEUP_OFFSET
COLUMN_NUMBER  = 86
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 584
DESCRIPTION    = "Offset for pileup rejection window."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = HPGE_PILEUP_HALF_WIDTH
COLUMN_NUMBER  = 87
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER

START_BYTE     = 592
DESCRIPTION    = "Time half-width (before or after pulse zero crossing) for pulse pileup rejection."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = EVENT_COIN_OFFSET
COLUMN_NUMBER  = 88
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 600
DESCRIPTION    = "Offset for event coincidence window."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = EVENT_COIN_HALF_WIDTH
COLUMN_NUMBER  = 89
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 608
DESCRIPTION    = "Time half-width (before or after pulse zero crossing) for coincidence."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = NEUTRON_CH0_MIN_E
COLUMN_NUMBER  = 90
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 616
DESCRIPTION    = "Neutron event Channel 0 minimum energy."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = NEUTRON_CH0_MAX_E
COLUMN_NUMBER  = 91
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 624
DESCRIPTION    = "Neutron event Channel 0 maximum energy."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = NEUTRON_CH1_MIN_E
COLUMN_NUMBER  = 92
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 632
DESCRIPTION    = "Neutron event Channel 1 minimum energy."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = NEUTRON_CH1_MAX_E
COLUMN_NUMBER  = 93
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 640
DESCRIPTION    = "Neutron event Channel 1 maximum energy."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = PULSER_CH0_MIN_VALID
COLUMN_NUMBER  = 94
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 648
DESCRIPTION    = "Valid pulser minimum energy."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = PULSER_CH0_MAX_VALID
COLUMN_NUMBER  = 95
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 656
DESCRIPTION = "Valid pulser maximum energy."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = PULSER_OFFSET
COLUMN_NUMBER = 96
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 664
DESCRIPTION = "Pulse height offset for computing pulser height-variation statistics."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = PULSER_SHIFT
COLUMN_NUMBER = 97
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 672
DESCRIPTION = "Shift pulser energy for spectrum."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = CONFIG_CHANGED
COLUMN_NUMBER = 98
BYTES = 3
DATA_TYPE = ASCII_INTEGER
START_BYTE = 680
DESCRIPTION = "Configuration changed during accumulation."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = DIAG_PACKETS_DROPPED
COLUMN_NUMBER = 99
BYTES = 3
DATA_TYPE = ASCII_INTEGER
START_BYTE = 685
DESCRIPTION = "Number of diagnostic packets dropped."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = LVPS_I2C_12V
COLUMN_NUMBER = 100
BYTES = 1
DATA_TYPE = ASCII_INTEGER
START_BYTE = 690
DESCRIPTION = "LVPS 12V enabled."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = LVPS_I2C_EXT_PR_1
COLUMN_NUMBER = 101
BYTES = 1
DATA_TYPE = ASCII_INTEGER
START_BYTE = 693
DESCRIPTION = "LVPS External Primary 1 enabled."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = LVPS_I2C_EXT_PR_2
COLUMN_NUMBER = 102
BYTES = 1
DATA_TYPE = ASCII_INTEGER
START_BYTE = 696
DESCRIPTION = "LVPS External Primary 2 enabled."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HVPS_I2C_HV1_ENABLE
COLUMN_NUMBER = 103
BYTES = 1
DATA_TYPE = ASCII_INTEGER
START_BYTE = 699
DESCRIPTION = "HVPS (Shield) HV enabled."
END_OBJECT = COLUMN
<table>
<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>HVPS_I2C_HV2_ENABLE</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>104</td>
</tr>
<tr>
<td>BYTES</td>
<td>1</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>ASCII_INTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>702</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;Unused.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>HVPS_I2C_MUX_ENABLE</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>105</td>
</tr>
<tr>
<td>BYTES</td>
<td>1</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>ASCII_INTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>705</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;Enables/disables ADC MUX on HVPS board to provide HVPS housekeeping data.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>HVPS_I2C_REF_ENABLE</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>106</td>
</tr>
<tr>
<td>BYTES</td>
<td>1</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>ASCII_INTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>708</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;Enables/disables use of reference HV on HVPS board to set/regulate HPGe HV.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
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</thead>
<tbody>
<tr>
<td>NAME</td>
<td>HVPS_I2C_HV_CMD</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>107</td>
</tr>
<tr>
<td>BYTES</td>
<td>6</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>ASCII_INTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>711</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;HVPS I2C (Shield) HV Command.&quot;</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
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</thead>
<tbody>
<tr>
<td>NAME</td>
<td>HW_CH0_1SEC</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>108</td>
</tr>
<tr>
<td>BYTES</td>
<td>6</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>ASCII_INTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>719</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;Hardware channel 0 1-second event total.&quot;</td>
</tr>
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<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>HW_CH1_1SEC</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>109</td>
</tr>
<tr>
<td>BYTES</td>
<td>6</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>ASCII_INTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>727</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;Hardware channel 1 1-second event total.&quot;</td>
</tr>
</tbody>
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<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>HW_DEAD_TIME_1SEC</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>110</td>
</tr>
<tr>
<td>BYTES</td>
<td>6</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>ASCII_INTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>735</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;Hardware dead time 1-second event total.&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>COLUMN</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAME</td>
<td>HPGE_CHRG_RSET_1SEC</td>
</tr>
<tr>
<td>COLUMN_NUMBER</td>
<td>111</td>
</tr>
<tr>
<td>BYTES</td>
<td>6</td>
</tr>
<tr>
<td>DATA_TYPE</td>
<td>ASCII_INTEGER</td>
</tr>
<tr>
<td>START_BYTE</td>
<td>743</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>&quot;Hardware HPGe charge reset 1-second total.&quot;</td>
</tr>
</tbody>
</table>
OBJECT       = COLUMN
NAME         = SHLD_CHRG_RSET_1SEC
COLUMN_NUMBER = 112
BYTES        = 6
DATA_TYPE    = ASCII_INTEGER
START_BYTE   = 751
DESCRIPTION  = "Hardware Shield charge reset 1-second total."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
NAME         = CH0_LATCHES_DETECTED
COLUMN_NUMBER = 113
BYTES        = 3
DATA_TYPE    = ASCII_INTEGER
START_BYTE   = 759
DESCRIPTION  = "Number of Channel 0 latches detected (reset at boot time only)."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
NAME         = CH1_LATCHES_DETECTED
COLUMN_NUMBER = 114
BYTES        = 3
DATA_TYPE    = ASCII_INTEGER
START_BYTE   = 764
DESCRIPTION  = "Number of Channel 1 latches detected (reset at boot time only)."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
NAME         = CMD_HPGE_MAX_HV
COLUMN_NUMBER = 115
BYTES        = 6
DATA_TYPE    = ASCII_INTEGER
START_BYTE   = 769
DESCRIPTION  = "Commanded HPGe max HV level."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
NAME         = CMD_SHIELD_MAX_HV
COLUMN_NUMBER = 116
BYTES        = 6
DATA_TYPE    = ASCII_INTEGER
START_BYTE   = 777
DESCRIPTION  = "Commanded Shield max HV level."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
NAME         = CMD_HPGE_HV
COLUMN_NUMBER = 117
BYTES        = 6
DATA_TYPE    = ASCII_INTEGER
START_BYTE   = 785
DESCRIPTION  = "Commanded HPGe HV level."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
NAME         = CMD_SHIELD_HV
COLUMN_NUMBER = 118
BYTES        = 6
DATA_TYPE    = ASCII_INTEGER
START_BYTE   = 793
DESCRIPTION  = "Commanded Shield HV level."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
NAME         = CALIB_AVG_DET_TEMP
COLUMN_NUMBER = 119
BYTES        = 6
DATA_TYPE    = ASCII_INTEGER
START_BYTE   = 801
DESCRIPTION  = "Calibrated, averaged detector temperature."
END_OBJECT   = COLUMN

OBJECT       = COLUMN

- 62 -
NAME = HPGE_GOAL_HV_ENABLED
COLUMN_NUMBER = 120
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 809
DESCRIPTION = "HPGe goal HV if HV enabled."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HPGE_GOAL_TEMP_SAFE
COLUMN_NUMBER = 121
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 817
DESCRIPTION = "HPGe goal HV if temperature safe."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = RAMP_2_HPGE_HV_B
COLUMN_NUMBER = 122
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 825
DESCRIPTION = "Implements ramp to HPGE_HV_B value."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HPGE_HV_A_BIAS_SAFE
COLUMN_NUMBER = 123
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 833
DESCRIPTION = "HPGE_HV_A HV if bias current safe."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HPGE_HV_TEMP_CYCLE
COLUMN_NUMBER = 124
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 841
DESCRIPTION = "Transitions to or from safe temperature."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HPGE_HV_SAFING_LVL
COLUMN_NUMBER = 125
BYTES = 3
DATA_TYPE = ASCII_INTEGER
START_BYTE = 849
DESCRIPTION = "Current safing level."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HPGE_HV_SAFING_CYC
COLUMN_NUMBER = 126
BYTES = 3
DATA_TYPE = ASCII_INTEGER
START_BYTE = 854
DESCRIPTION = "Times increased safing levels."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = HPGE_HV_UNCHANGED_TICKS
COLUMN_NUMBER = 127
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 859
DESCRIPTION = "Seconds at current HPGe HV."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = SHLD_GOAL_HV_ENABLED
COLUMN_NUMBER = 128
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 867
DESCRIPTION = "Shield goal HV if HV enabled."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = SHLD_GOAL_EVENT_SAFE
COLUMN_NUMBER = 129
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 875
DESCRIPTION = "Shield goal HV if event rate safe."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = RAMP_2_SHLD_HV_B
COLUMN_NUMBER = 130
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 883
DESCRIPTION = "Implements ramp to SHIELD_HV_B value."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = OUTPUT_HVPS_EVENT_SAFE
COLUMN_NUMBER = 131
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 891
DESCRIPTION = "Output to HVPS if event rate safe."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = SHLD_HV_STATE
COLUMN_NUMBER = 132
BYTES = 3
DATA_TYPE = ASCII_INTEGER
START_BYTE = 899
DESCRIPTION = "Not used."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = SHLD_HV_SAFING_LVL
COLUMN_NUMBER = 133
BYTES = 3
DATA_TYPE = ASCII_INTEGER
START_BYTE = 904
DESCRIPTION = "Current safing level."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = SHLD_HV_SAFING_CYC
COLUMN_NUMBER = 134
BYTES = 3
DATA_TYPE = ASCII_INTEGER
START_BYTE = 909
DESCRIPTION = "Number of times safing level was increased."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = LAST_OPCODE
COLUMN_NUMBER = 135
BYTES = 3
DATA_TYPE = ASCII_INTEGER
START_BYTE = 914
DESCRIPTION = "Last command opcode received."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = SHLD_HV_UNCHANGED_TICKS
COLUMN_NUMBER = 136
BYTES = 6
DATA_TYPE = ASCII_INTEGER
START_BYTE = 919
DESCRIPTION = "Seconds at current HPGe HV."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = COOLER_TEMP_SETPOINT
COLUMN_NUMBER  = 137
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 927
DESCRIPTION    = "Cooler temperature set point."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = COOLER_POWER
COLUMN_NUMBER  = 138
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 935
DESCRIPTION    = "Cooler power (manual or PI control)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = COOLER_PI_PROP
COLUMN_NUMBER  = 139
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 943
DESCRIPTION    = "Cooler PI (Proportional Integral) loop proportional
        gain (*256)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = COOLER_PI_INTEGRAL
COLUMN_NUMBER  = 140
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 951
DESCRIPTION    = "Cooler PI (Proportional Integral) loop integral gain
        (*256)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = COOLER_PI_OFFSET
COLUMN_NUMBER  = 141
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 959
DESCRIPTION    = "Cooler PI (Proportional Integral) loop offset for
        output."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = COOLER_PI_MAX_ERR
COLUMN_NUMBER  = 142
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 967
DESCRIPTION    = "PI loop max error to enable integration."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = ACCUM_TIME_LEFT
COLUMN_NUMBER  = 143
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 975
DESCRIPTION    = "Time left in current accumulation."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = CMD_REPORT_PERIOD
COLUMN_NUMBER  = 144
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 983
DESCRIPTION    = "Commanded reporting period."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = CMD_ACCUM_TIME
COLUMN_NUMBER  = 145
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 991
DESCRIPTION    = "Commanded accumulation time."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = CMD_SHIP_MODE
COLUMN_NUMBER  = 146
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 999
DESCRIPTION    = "Commanded science ship mode."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = A2D_SHIP_MODE
COLUMN_NUMBER  = 147
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 1007
DESCRIPTION    = "Microphonics ship mode (compressed)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = SCIENCE_PRIORITY
COLUMN_NUMBER  = 148
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 1015
DESCRIPTION    = "Base value for science ApIDs."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = STATUS_INTERVAL
COLUMN_NUMBER  = 149
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 1023
DESCRIPTION    = "Status interval (seconds). Defines interval at which
status is reported. Not an accumulation interval. All status fields are
stationary values."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = MACRO_FREE_BLOCKS
COLUMN_NUMBER  = 150
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 1031
DESCRIPTION    = "Free blocks for macros."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = TLM_VOLUME
COLUMN_NUMBER  = 151
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 1039
DESCRIPTION    = "Telemetry volume (kB)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME           = WATCH_ADDR
COLUMN_NUMBER  = 152
BYTES          = 6
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 1047
DESCRIPTION    = "Debug watch address."
END_OBJECT    = COLUMN
OBJECT     = COLUMN
NAME        = WATCH_MEM
COLUMN_NUMBER = 153
BYTES       = 6
DATA_TYPE   = ASCII_INTEGER
START_BYTE  = 1055
DESCRIPTION = "Debug watch page."
END_OBJECT  = COLUMN

OBJECT     = COLUMN
NAME        = WATCH_BYTE1
COLUMN_NUMBER = 154
BYTES       = 3
DATA_TYPE   = ASCII_INTEGER
START_BYTE  = 1063
DESCRIPTION = "Debug watch byte 1."
END_OBJECT  = COLUMN

OBJECT     = COLUMN
NAME        = WATCH_BYTE2
COLUMN_NUMBER = 155
BYTES       = 3
DATA_TYPE   = ASCII_INTEGER
START_BYTE  = 1068
DESCRIPTION = "Debug watch byte 2."
END_OBJECT  = COLUMN

OBJECT     = COLUMN
NAME        = SW_VERSION
COLUMN_NUMBER = 156
BYTES       = 3
DATA_TYPE   = ASCII_INTEGER
START_BYTE  = 1073
DESCRIPTION = "Major software version."
END_OBJECT  = COLUMN

OBJECT     = COLUMN
NAME        = ALARM_ID
COLUMN_NUMBER = 157
BYTES       = 3
DATA_TYPE   = ASCII_INTEGER
START_BYTE  = 1078
DESCRIPTION = "Last alarm ID."
END_OBJECT  = COLUMN

OBJECT     = COLUMN
NAME        = ALARM_COUNT
COLUMN_NUMBER = 158
BYTES       = 6
DATA_TYPE   = ASCII_INTEGER
START_BYTE  = 1083
DESCRIPTION = "Total alarm count (can be reset by command)."
END_OBJECT  = COLUMN

OBJECT     = COLUMN
NAME        = ALARM_TYPE
COLUMN_NUMBER = 159
BYTES       = 1
DATA_TYPE   = ASCII_INTEGER
START_BYTE  = 1091
DESCRIPTION = "Last alarm type."
END_OBJECT  = COLUMN

OBJECT     = COLUMN
NAME        = CMD_EXECUTED
COLUMN_NUMBER = 160
BYTES       = 3
DATA_TYPE   = ASCII_INTEGER
START_BYTE  = 1094
DESCRIPTION = "Number of commands executed (can be reset by command)."
END_OBJECT  = COLUMN

OBJECT     = COLUMN
NAME        = CMD_REJECTED
8.10 GRS_FPGA.FMT

Below is a table that shows the structure of the binary table containing the FPGA/ADC Diagnostic data. Following this is the actual content of the format file itself.

<table>
<thead>
<tr>
<th>Start Byte</th>
<th>Length (bytes)</th>
<th>Data Type</th>
<th>Column Name</th>
<th>Summary (see format file text for full description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>MSB Unsigned Integer</td>
<td>MET</td>
<td>Mission Elapsed Time in seconds.</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>MSB Unsigned Integer</td>
<td>ORBIT_NUMBER</td>
<td>Unique consecutive integer identifying a given orbit of MESSENGER around Mercury</td>
</tr>
<tr>
<td>Object</td>
<td>Column Number</td>
<td>Bytes</td>
<td>Data Type</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>---------------</td>
<td>-------</td>
<td>-----------</td>
<td>-------------</td>
</tr>
<tr>
<td>POWER_REGISTER</td>
<td>3</td>
<td>2</td>
<td>MSB_BIT_STRING</td>
<td>A two-byte integer containing information in individual bit fields. See format file text for full description.</td>
</tr>
<tr>
<td>TAP_REGISTER</td>
<td>2</td>
<td>2</td>
<td>MSB_BIT_STRING</td>
<td>A two-byte integer containing information in individual bit fields. See format file text for full description.</td>
</tr>
<tr>
<td>CH0_TRIGGER_THRESHOLD</td>
<td>3</td>
<td>2</td>
<td>MSB_INTEGER</td>
<td>Channel 0 trigger threshold.</td>
</tr>
<tr>
<td>CH1_TRIGGER_THRESHOLD</td>
<td>4</td>
<td>2</td>
<td>MSB_INTEGER</td>
<td>Channel 1 trigger threshold.</td>
</tr>
<tr>
<td>CH0_WINDOW</td>
<td>5</td>
<td>2</td>
<td>MSB_INTEGER</td>
<td>Channel 0 processing window.</td>
</tr>
<tr>
<td>CH1_WINDOW</td>
<td>6</td>
<td>2</td>
<td>MSB_INTEGER</td>
<td>Channel 1 processing window.</td>
</tr>
<tr>
<td>SETTLE_ADC</td>
<td>7</td>
<td>2</td>
<td>MSB_UNSIGNED_INTEGER</td>
<td>Settling time.</td>
</tr>
<tr>
<td>DITHER_SETTLE_ADC</td>
<td>8</td>
<td>2</td>
<td>MSB_UNSIGNED_INTEGER</td>
<td>Dither settling time.</td>
</tr>
<tr>
<td>DITHER_DAC_CMD</td>
<td>9</td>
<td>2</td>
<td>MSB_UNSIGNED_INTEGER</td>
<td>Dither DAC command.</td>
</tr>
<tr>
<td>GAIN_DAC_CMD</td>
<td>10</td>
<td>2</td>
<td>MSB_UNSIGNED_INTEGER</td>
<td>Gain DAC command.</td>
</tr>
<tr>
<td>STATUS_REGISTER</td>
<td>11</td>
<td>2</td>
<td>MSB_BIT_STRING</td>
<td>A two-byte integer containing information in individual bit fields. See format file text for full description.</td>
</tr>
<tr>
<td>TRIGGER_PER_SEC_CH0</td>
<td>12</td>
<td>2</td>
<td>MSB_UNSIGNED_INTEGER</td>
<td>Channel 0 triggers per second.</td>
</tr>
<tr>
<td>EVENT_MAX_CH0</td>
<td>13</td>
<td>2</td>
<td>MSB_INTEGER</td>
<td>Channel 0 event max.</td>
</tr>
<tr>
<td>EVENT_MIN_CH0</td>
<td>14</td>
<td>2</td>
<td>MSB_INTEGER</td>
<td>Channel 0 event min.</td>
</tr>
<tr>
<td>EVENT_PEAK_CH0</td>
<td>15</td>
<td>2</td>
<td>MSB_INTEGER</td>
<td>Channel 0 event peak.</td>
</tr>
<tr>
<td>TRIGGER_PER_SEC_CH1</td>
<td>16</td>
<td>2</td>
<td>MSB_UNSIGNED_INTEGER</td>
<td>Channel 1 triggers per second.</td>
</tr>
<tr>
<td>EVENT_MAX_CH1</td>
<td>17</td>
<td>2</td>
<td>MSB_INTEGER</td>
<td>Channel 1 event max.</td>
</tr>
<tr>
<td>EVENT_MIN_CH1</td>
<td>18</td>
<td>2</td>
<td>MSB_INTEGER</td>
<td>Channel 1 event min.</td>
</tr>
<tr>
<td>EVENT_PEAK_CH1</td>
<td>19</td>
<td>2</td>
<td>MSB_INTEGER</td>
<td>Channel 1 event peak.</td>
</tr>
<tr>
<td>DELTA_PEAK_TIME</td>
<td>20</td>
<td>2</td>
<td>MSB_INTEGER</td>
<td>Time of channel 0 peak – time of channel 1 peak.</td>
</tr>
<tr>
<td>DEAD_TIME_ADC</td>
<td>21</td>
<td>2</td>
<td>MSB_UNSIGNED_INTEGER</td>
<td>Dead time per second.</td>
</tr>
<tr>
<td>Q_RESET_ADC</td>
<td>22</td>
<td>2</td>
<td>MSB_UNSIGNED_INTEGER</td>
<td>Channel 0 charge resets per second.</td>
</tr>
<tr>
<td>PMT_RESET_ADC</td>
<td>23</td>
<td>2</td>
<td>MSB_UNSIGNED_INTEGER</td>
<td>Channel 1 charge resets per second.</td>
</tr>
<tr>
<td>CH0_ADC_TEST_PORT</td>
<td>24</td>
<td>2</td>
<td>MSB_INTEGER</td>
<td>Channel 0 ADC test port.</td>
</tr>
<tr>
<td>CH1_ADC_TEST_PORT</td>
<td>25</td>
<td>2</td>
<td>MSB_INTEGER</td>
<td>Channel 1 ADC test port.</td>
</tr>
<tr>
<td>CH2_ADC_TEST_PORT</td>
<td>26</td>
<td>2</td>
<td>MSB_INTEGER</td>
<td>Channel 2 ADC test port.</td>
</tr>
<tr>
<td>TEST_PULSE_REGISTER</td>
<td>27</td>
<td>2</td>
<td>MSB_BIT_STRING</td>
<td>A two-byte integer containing information in individual bit fields. See format file text for full description.</td>
</tr>
<tr>
<td>DELTA_CH0_MAX_MIN</td>
<td>28</td>
<td>2</td>
<td>MSB_UNSIGNED_INTEGER</td>
<td>Time between Channel 0 max and min.</td>
</tr>
<tr>
<td>DIAGNOSTIC_ADC</td>
<td>29</td>
<td>2</td>
<td>MSB_UNSIGNED_INTEGER</td>
<td>Diagnostic register.</td>
</tr>
</tbody>
</table>
START_BYTE     = 7
DESCRIPTION    = "The 2-byte integer contains the following bit fields:"

OBJECT     = BIT_COLUMN
NAME           = CH1_LATCHUP
BIT_DATA_TYPE  = MSB_UNSIGNED_INTEGER
START_BIT      = 1
BITS           = 1
DESCRIPTION    = "ADC Channel 1 latchup. =0 no latchup. =1 latchup"
END_OBJECT = BIT_COLUMN

OBJECT     = BIT_COLUMN
NAME           = CH0_LATCHUP
BIT_DATA_TYPE  = MSB_UNSIGNED_INTEGER
START_BIT      = 2
BITS           = 1
DESCRIPTION    = "ADC Channel 0 latchup. =0 no latchup. =1 latchup"
END_OBJECT = BIT_COLUMN

OBJECT     = BIT_COLUMN
NAME           = PWR_CH1_INVERTED_ADC
BIT_DATA_TYPE  = MSB_UNSIGNED_INTEGER
START_BIT      = 3
BITS           = 1
DESCRIPTION    = "Channel 1 inverted power. =0 not inverted, =1 inverted."
END_OBJECT = BIT_COLUMN

OBJECT     = BIT_COLUMN
NAME           = PWR_CH0_INVERTED_ADC
BIT_DATA_TYPE  = MSB_UNSIGNED_INTEGER
START_BIT      = 4
BITS           = 1
DESCRIPTION    = "Channel 0 inverted power. =0 not inverted, =1 inverted."
END_OBJECT = BIT_COLUMN

OBJECT     = BIT_COLUMN
NAME           = FPGA_RESET_ADC
BIT_DATA_TYPE  = MSB_UNSIGNED_INTEGER
START_BIT      = 8
BITS           = 1
DESCRIPTION    = "Always reads 0. Write a 1 to reset FPGA."
END_OBJECT = BIT_COLUMN

OBJECT     = BIT_COLUMN
NAME           = ADC_CH2_CLOCK
BIT_DATA_TYPE  = MSB_UNSIGNED_INTEGER
START_BIT      = 9
BITS           = 1
DESCRIPTION    = "ADC Channel 2 clock. =0 off, =1 on."
END_OBJECT = BIT_COLUMN

OBJECT     = BIT_COLUMN
NAME           = ADC_CH1_CLOCK
BIT_DATA_TYPE  = MSB UNSIGNED_INTEGER
START_BIT      = 10
BITS           = 1
DESCRIPTION    = "ADC Channel 1 clock. =0 off, =1 on."
END_OBJECT = BIT_COLUMN

OBJECT     = BIT_COLUMN
NAME           = ADC_CH0_CLOCK
BIT_DATA_TYPE  = MSB UNSIGNED_INTEGER
START_BIT      = 11
BITS           = 1
DESCRIPTION    = "ADC Channel 0 clock. =0 off, =1 on."
END_OBJECT = BIT_COLUMN

OBJECT     = BIT_COLUMN
NAME           = CH1_2_ADC_POWER
BIT_DATA_TYPE  = MSB UNSIGNED_INTEGER
START_BIT      = 12
BITS           = 1
DESCRIPTION    = "Channel 1,2 ADC power. =0 power on, =1 power off"
END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
NAME = CH1_RESET_LATCHUP
BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BIT = 13
BITS = 1
DESCRIPTION = "Channel 1,2 reset latchup. =0 normal, =1 reset latchup"

END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
NAME = CH0_ADC_POWER
BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BIT = 14
BITS = 1
DESCRIPTION = "Channel 0 ADC Power, =0 power on, =1 power off."

END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
NAME = CH0_RESET_LATCHUP
BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BIT = 15
BITS = 1
DESCRIPTION = "Channel 0 reset latchup, =0 normal, =1 reset latchup"

END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
NAME = POWER_SLEEP_ADC
BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BIT = 16
BITS = 1
DESCRIPTION = "=0 normal operation, =1 sleep mode."

END_OBJECT = BIT_COLUMN

END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = TAP_REGISTER
COLUMN_NUMBER = 4
BYTES = 2
DATA_TYPE = MSB_BIT_STRING
START_BYTE = 9
DESCRIPTION = "The 2-byte integer contains the following bit fields:

OBJECT = BIT_COLUMN
NAME = USE_ZC_OR_MAX_FOR_COIN
BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BIT = 3
BITS = 1
DESCRIPTION = "=0 use zc0-zc1 for coincidence. =1 use max0-max1 for coincidence."

END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
NAME = CH0_PREFILTER_FLAG
BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BIT = 4
BITS = 1
DESCRIPTION = "Channel 0 prefilter flag. =0 bypass input filter, =1 prefilter channel 0."

END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
NAME = DITHER_MODE_SETTING
BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BIT = 5
BITS = 1
DESCRIPTION = "Dither mode. =0 Immediate dither, =1 synchronized dither."

END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
NAME = CH1_SETTLE_RETRIG
BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER

- 71 -
START_BIT = 6
BITS = 1
DESCRIPTION = "Settling retriggered by Channel 1 trigger.
-0 true, -1 false"
END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
NAME = CH1_Q_RESET_DISABLE_ADC
BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BIT = 7
BITS = 1
DESCRIPTION = "Channel 1 charge reset does disable triggers.
-0 false, -1 true"
END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
NAME = CH0_Q_RESET_DISABLE_ADC
BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BIT = 8
BITS = 1
DESCRIPTION = "Channel 0 charge reset does disable triggers.
-0 false, -1 true"
END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
NAME = TAP_CH1_ADC
BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BIT = 9
BITS = 4
DESCRIPTION = "Channel 1 trigger tap."
END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
NAME = TAP_CH0_ADC
BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BIT = 13
BITS = 4
DESCRIPTION = "Channel 0 trigger tap."
END_OBJECT = BIT_COLUMN

END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = CH0_TRIGGER_THRESHOLD
COLUMN_NUMBER = 5
BYTES = 2
DATA_TYPE = MSB_INTEGER
START_BYTE = 11
DESCRIPTION = "Channel 0 trigger threshold."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = CH1_TRIGGER_THRESHOLD
COLUMN_NUMBER = 6
BYTES = 2
DATA_TYPE = MSB_INTEGER
START_BYTE = 13
DESCRIPTION = "Channel 1 trigger threshold."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = CH0_WINDOW
COLUMN_NUMBER = 7
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 15
DESCRIPTION = "Channel 0 processing window."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = CH1_WINDOW
COLUMN_NUMBER = 8
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 17
### Description

"Channel 1 processing window."

### Column: Settled_ADC

- **Name:** SETTLE_ADC
- **Column Number:** 9
- **Bytes:** 2
- **Data Type:** MSB_UNSIGNED_INTEGER
- **Start Byte:** 19
- **Description:** "Settling time."

### Column: Dither_Settled_ADC

- **Name:** DITHER_SETTLE_ADC
- **Column Number:** 10
- **Bytes:** 2
- **Data Type:** MSB_UNSIGNED_INTEGER
- **Start Byte:** 21
- **Description:** "Dither settling time."

### Column: Dither_DAC.Cmd

- **Name:** DITHER_DAC_CMD
- **Column Number:** 11
- **Bytes:** 2
- **Data Type:** MSB_UNSIGNED_INTEGER
- **Start Byte:** 23
- **Description:** "Dither DAC command."

### Column: Gain_DAC.Cmd

- **Name:** GAIN_DAC_CMD
- **Column Number:** 12
- **Bytes:** 2
- **Data Type:** MSB_UNSIGNED_INTEGER
- **Start Byte:** 25
- **Description:** "Gain DAC command."

### Column: Status_Register

- **Name:** STATUS_REGISTER
- **Column Number:** 13
- **Bytes:** 2
- **Data Type:** MSB_BIT_STRING
- **Start Byte:** 27
- **Description:** "This 2-byte integer contains the following bit fields:

#### Event Pending

- **Name:** EVENT_PENDING
- **Bit Data Type:** MSB_UNSIGNED_INTEGER
- **Start Bit:** 1
- **Bits:** 1
- **Description:** "0 No events pending. 1 Event pending in FIFO."

#### Reset_FIFO_ADC

- **Name:** RESET_FIFO_ADC
- **Bit Data Type:** MSB_UNSIGNED_INTEGER
- **Start Bit:** 2
- **Bits:** 1
- **Description:** "Always reads 0. Write a 1 to reset buffer pointer logic."

#### CH1_IN_RANGE

- **Name:** CH1_IN_RANGE
- **Bit Data Type:** MSB_UNSIGNED_INTEGER
- **Start Bit:** 11
- **Bits:** 1
- **Description:** "0 Channel 1 in range, 1 channel 1 out of range."

#### CH1_EVENT_FLAG

- **Name:** CH1_EVENT_FLAG
- **Bit Data Type:** MSB_UNSIGNED_INTEGER
START_BIT = 12
BITS = 1
DESCRIPTION = "=0 No channel 1 event occurred, =1 channel 1 event occurred."
END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
NAME = TEST_PULSE
BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BIT = 13
BITS = 1
DESCRIPTION = "=0 Not a test pulse event, =1 Test pulse event."
END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
NAME = CH0_INVERTED_PULSE
BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BIT = 14
BITS = 1
DESCRIPTION = "=0 Channel 0 is not an inverted pulse. =1 Inverted Channel 0 pulse event."
END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
NAME = CH0_IN_RANGE
BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BIT = 15
BITS = 1
DESCRIPTION = "=0 Channel 0 in range. =1 Channel 0 out of range."
END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
NAME = CH0_EV
ENT_FLAG
BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BIT = 16
BITS = 1
DESCRIPTION = "=0 No channel 0 event occurred, =1 channel 0 event occurred."
END_OBJECT = BIT_COLUMN

OBJECT = COLUMN
NAME = TRIGGER_PER_SEC_CH0
COLUMN_NUMBER = 14
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 29
DESCRIPTION = "Channel 0 number of triggers per second."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = EVENT_MAX_CH0
COLUMN_NUMBER = 15
BYTES = 2
DATA_TYPE = MSB_INTEGER
START_BYTE = 31
DESCRIPTION = "Channel 0 event max."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = EVENT_MIN_CH0
COLUMN_NUMBER = 16
BYTES = 2
DATA_TYPE = MSB_INTEGER
START_BYTE = 33
DESCRIPTION = "Channel 0 event min."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = EVENT_PEAK_CH0
COLUMN_NUMBER = 17
BYTES = 2
DATA_TYPE = MSB_INTEGER
START_BYTE = 35
DESCRIPTION = "Channel 0 event peak."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = TRIGGER_PER_SEC_CH1
COLUMN_NUMBER = 18
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 37
DESCRIPTION = "Channel 1 number of triggers per second."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = EVENT_MAX_CH1
COLUMN_NUMBER = 19
BYTES = 2
DATA_TYPE = MSB_INTEGER
START_BYTE = 39
DESCRIPTION = "Channel 1 event max."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = EVENT_MIN_CH1
COLUMN_NUMBER = 20
BYTES = 2
DATA_TYPE = MSB_INTEGER
START_BYTE = 41
DESCRIPTION = "Channel 1 event min."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = EVENT_PEAK_CH1
COLUMN_NUMBER = 21
BYTES = 2
DATA_TYPE = MSB_INTEGER
START_BYTE = 43
DESCRIPTION = "Channel 1 event peak."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = DELTA_PEAK_TIME
COLUMN_NUMBER = 22
BYTES = 2
DATA_TYPE = MSB_INTEGER
START_BYTE = 45
DESCRIPTION = "Time of channel 0 peak - time of channel 1 peak (100 ns lsb)."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = DEAD_TIME_ADC
COLUMN_NUMBER = 23
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 47
DESCRIPTION = "Dead time per second. (16 microseconds lsb)"
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = Q_RESET_ADC
COLUMN_NUMBER = 24
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 49
DESCRIPTION = "Channel 0 (Ge) charge resets per second."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = PMT_RESET_ADC
COLUMN_NUMBER = 25
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 51
DESCRIPTION = "Channel 1 (PMT) charge resets per second."
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = CH0_ADC_TEST_PORT
COLUMN_NUMBER = 26
BYTES = 2
DATA_TYPE = MSB_INTEGER
START_BYTE = 53
DESCRIPTION = "Channel 0 ADC test port. HPGe raw data for debugging."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = CH1_ADC_TEST_PORT
COLUMN_NUMBER = 27
BYTES = 2
DATA_TYPE = MSB_INTEGER
START_BYTE = 55
DESCRIPTION = "Channel 1 ADC test port. Shield raw data for debugging."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = CH2_ADC_TEST_PORT
COLUMN_NUMBER = 28
BYTES = 2
DATA_TYPE = MSB_INTEGER
START_BYTE = 57
DESCRIPTION = "Channel 2 ADC test port. Microphonics raw data (actual time series data)."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = TEST_PULSE_REGISTER
COLUMN_NUMBER = 29
BYTES = 2
DATA_TYPE = MSB_BIT_STRING
START_BYTE = 59
DESCRIPTION = "This 2-byte integer contains the following bit fields:"

OBJECT = BIT_COLUMN
NAME = TEST_PLS_AUTO_CYC
BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BIT = 15
BITS = 1
DESCRIPTION = "Setting this bit will generate a 7.8 Hz pulse."
END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
NAME = TEST_PLS_FIRE_ADC
BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BIT = 16
BITS = 1
DESCRIPTION = "Any writing to this register will generate a 64 microsecond active low pulse."
END_OBJECT = BIT_COLUMN

OBJECT = COLUMN
NAME = DELTA_CH0_MAX_MIN
COLUMN_NUMBER = 30
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 61
DESCRIPTION = "Time between Channel 0 max and Channel 0 min."
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = DIAGNOSTIC_ADC
COLUMN_NUMBER = 31
BYTES = 2
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 63
DESCRIPTION = "Diagnostic register."
END_OBJECT = COLUMN
8.11 GRS_CMDECHO.FMT

Below is a table that shows the structure of the ASCII table containing the Command Echo data. The ASCII table is both fixed-width and comma delimited. Note that in PDS ASCII table format, the Start Byte has to take into account the comma delimiter and empty spaces. Following this is the actual content of the format file itself.

<table>
<thead>
<tr>
<th>Start Byte</th>
<th>Length (bytes)</th>
<th>Data Type</th>
<th>Column Name</th>
<th>Summary (see format file text for full description)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12</td>
<td>ASCII Integer</td>
<td>MET</td>
<td>Mission Elapsed Time in seconds.</td>
</tr>
<tr>
<td>15</td>
<td>19</td>
<td>CHARACTER</td>
<td>CMD_UTC_TIME</td>
<td>UTC time derived from MET using SPICE kernels</td>
</tr>
<tr>
<td>37</td>
<td>3</td>
<td>CHARACTER</td>
<td>MACRO_FLAG</td>
<td>Identifies command echo as a single command or part of a command macro.</td>
</tr>
<tr>
<td>43</td>
<td>3</td>
<td>ASCII Integer</td>
<td>CMD_RESULT</td>
<td>Indicates level of success for the command.</td>
</tr>
<tr>
<td>49</td>
<td>4</td>
<td>CHARACTER</td>
<td>CMD_OPCODE</td>
<td>Command opcode expressed as a hexadecimal string</td>
</tr>
<tr>
<td>57</td>
<td>40</td>
<td>CHARACTER</td>
<td>CMD_OPCODE_STRING</td>
<td>Hex command translated to a string mnemonic.</td>
</tr>
<tr>
<td>101</td>
<td>22</td>
<td>CHARACTER</td>
<td>CMD_ARG_PARAMETERS</td>
<td>Up to the first 10 command arguments.</td>
</tr>
</tbody>
</table>

```
OBJECT    = COLUMN
NAME      = MET
COLUMN_NUMBER  = 1
BYTES     = 12
DATA_TYPE = ASCII_INTEGER
START_BYTE = 1
DESCRIPTION = "Mission Elapsed Time in seconds."
END_OBJECT = COLUMN

OBJECT    = COLUMN
NAME      = CMD_UTC_TIME
COLUMN_NUMBER = 2
BYTES     = 19
DATA_TYPE = CHARACTER
START_BYTE = 15
DESCRIPTION = "UTC time in YYYY-MM-DDTHH:MM:SS format derived from the MET using SPICE kernels."
END_OBJECT = COLUMN

OBJECT    = COLUMN
NAME      = MACRO_FLAG
COLUMN_NUMBER = 3
BYTES     = 3
DATA_TYPE = CHARACTER
START_BYTE = 37
DESCRIPTION = "Identifies the command echo as a single command (CMD) or part of a command macro (MAC)."
END_OBJECT = COLUMN

OBJECT    = COLUMN
NAME      = CMD_RESULT
COLUMN_NUMBER = 4
BYTES     = 3
DATA_TYPE = ASCII_INTEGER
START_BYTE = 43
DESCRIPTION = "Indicates the level of success for the command. The success level is command dependent and is described for each separate command in the GRS Flight Software Document."
END_OBJECT = COLUMN

OBJECT    = COLUMN
NAME      = CMD_OPCODE
COLUMN_NUMBER = 5
BYTES     = 4
DATA_TYPE = CHARACTER
START_BYTE = 49
DESCRIPTION = "The command opcode expressed as a hexadecimal string."
```
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME          = CMD_OPCODE_STRING
   COLUMN_NUMBER = 6
   BYTES        = 40
   DATA_TYPE    = CHARACTER
   START_BYTE   = 57
   DESCRIPTION  = "The hex command translated into a string mnemonic.
                  A hex command without an associated string map is set to
                  UNDEFINED_CMD_STRING."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME          = CMD_ARG_PARAMETERS
   COLUMN_NUMBER = 7
   BYTES        = 22
   DATA_TYPE    = CHARACTER
   START_BYTE   = 101
   DESCRIPTION  = "The command echo packet returns up to the first 10
                  command arguments. Most commands contain less than 10. The
                  arguments are represented by a single hex string. The decoding of
                  the hex string is command dependent and described for each separate
                  command in the GRS Flight Software Document."
END_OBJECT    = COLUMN

8.12 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. SPICE kernel files will be archived with the PDS
NAIF node.

*.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 GRS instrument.

*.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.

### 8.13 CODMAC/NASA Definition of Processing Levels

<table>
<thead>
<tr>
<th>CODMAC Level</th>
<th>Proc. Type</th>
<th>Data Processing Level Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Raw Data</td>
<td>Telemetry data stream as received at the ground station, with science and engineering data embedded. Corresponds to NASA packet data.</td>
</tr>
<tr>
<td>2</td>
<td>Edited Data</td>
<td>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.</td>
</tr>
<tr>
<td>3</td>
<td>Calibrated Data</td>
<td>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.</td>
</tr>
<tr>
<td>4</td>
<td>Resampled data</td>
<td>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.</td>
</tr>
<tr>
<td>5</td>
<td>Derived Data</td>
<td>Derived results such as maps, reports, graphics, etc. Corresponds to NASA Levels 2 through 5</td>
</tr>
<tr>
<td>6</td>
<td>Ancillary Data</td>
<td>Non-Science data needed to generate calibrated or resampled data sets. Consists of instrument gains, offsets; pointing information for scan platforms, etc.</td>
</tr>
<tr>
<td>7</td>
<td>Corrective Data</td>
<td>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.</td>
</tr>
<tr>
<td>8</td>
<td>User Description</td>
<td>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.</td>
</tr>
</tbody>
</table>

The above is based on the national research council committee on data management and computation (CODMAC) data levels.

### 8.14 MESSENGER Acronym List

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACT</td>
<td>Applied Coherent Technology Corporation</td>
</tr>
<tr>
<td>ADC</td>
<td>Analog-to-Digital Converter</td>
</tr>
<tr>
<td>AM</td>
<td>Atmosphere and Magnetosphere Group</td>
</tr>
<tr>
<td>ApID</td>
<td>Application Identifier code for telemetry packet type</td>
</tr>
<tr>
<td>APL</td>
<td>The Johns Hopkins university Applied Physics Laboratory</td>
</tr>
<tr>
<td>ASCII</td>
<td>American Standard Code for Information Interchange</td>
</tr>
<tr>
<td>CCD</td>
<td>Charged-Coupled Device</td>
</tr>
<tr>
<td>CCSDS</td>
<td>Consultative Committee for Space Data Systems</td>
</tr>
<tr>
<td>CDR</td>
<td>Calibrated Data Record</td>
</tr>
<tr>
<td>CK</td>
<td>C- Kernel (SPICE)</td>
</tr>
<tr>
<td>CODMAC</td>
<td>Committee on Data Management and Computation</td>
</tr>
<tr>
<td>CO-I</td>
<td>Co-Investigator</td>
</tr>
<tr>
<td>DAC</td>
<td>Digital-to-Analog converter.</td>
</tr>
<tr>
<td>DSMS</td>
<td>Deep Space Mission Services</td>
</tr>
<tr>
<td>DPU</td>
<td>Data Processing Unit</td>
</tr>
<tr>
<td>EDR</td>
<td>Experiment Data Records</td>
</tr>
<tr>
<td>EK</td>
<td>Event Kernel</td>
</tr>
<tr>
<td>EPPS</td>
<td>Energetic Particle and Plasma Spectrometer</td>
</tr>
<tr>
<td>EPU</td>
<td>Event Processing Unit</td>
</tr>
<tr>
<td>ET</td>
<td>Ephemeris Time</td>
</tr>
<tr>
<td>FIPS</td>
<td>Fast Imaging Plasma Spectrometer</td>
</tr>
<tr>
<td>FITS</td>
<td>Flexible Image Transport System</td>
</tr>
<tr>
<td>FOV</td>
<td>Field-of-View</td>
</tr>
<tr>
<td>FPA</td>
<td>Focal Plane Assembly</td>
</tr>
<tr>
<td>FPGA</td>
<td>Field Programmable Gate Array</td>
</tr>
<tr>
<td>FTP</td>
<td>File Transfer protocol</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GC</td>
<td>Geochemistry Group</td>
</tr>
<tr>
<td>GP</td>
<td>Geophysics Group</td>
</tr>
<tr>
<td>GRNS</td>
<td>Gamma-ray and Neutron Spectrometer</td>
</tr>
<tr>
<td>GSFC</td>
<td>Goddard Space Flight Center</td>
</tr>
<tr>
<td>HPGe</td>
<td>High-Purity Germanium (HPGe) detector on the GRS instrument.</td>
</tr>
<tr>
<td>HVAC</td>
<td>High Voltage, Annealing, and Cooling</td>
</tr>
<tr>
<td>HVPS</td>
<td>High Voltage Power Supply</td>
</tr>
<tr>
<td>HV</td>
<td>High Voltage</td>
</tr>
<tr>
<td>I&amp;T</td>
<td>Integration and Test</td>
</tr>
<tr>
<td>I2C</td>
<td>Inter-Integrated Circuit</td>
</tr>
<tr>
<td>IEM</td>
<td>Integrated Electronic Module</td>
</tr>
<tr>
<td>IK</td>
<td>Instrument Measurement Kernel (SPICE)</td>
</tr>
<tr>
<td>LSK</td>
<td>Leapseconds Kernel (SPICE)</td>
</tr>
<tr>
<td>LVPS</td>
<td>Low Voltage Power Supply</td>
</tr>
<tr>
<td>MAG</td>
<td>Magnetometer</td>
</tr>
<tr>
<td>MASCs</td>
<td>Mercury Atmospheric and Surface Composition Spectrometer</td>
</tr>
<tr>
<td>MDIS</td>
<td>Mercury Dual Imaging System</td>
</tr>
<tr>
<td>MESSENGER</td>
<td>MErcury, Surface, Space ENvironment, Geochemistry, and Ranging</td>
</tr>
<tr>
<td>MET</td>
<td>Mission Elapsed Time</td>
</tr>
<tr>
<td>MLA</td>
<td>Mercury Laser Altimeter</td>
</tr>
<tr>
<td>MOC</td>
<td>Mission Operations Center</td>
</tr>
<tr>
<td>NAIF</td>
<td>Navigation and Ancillary Information Facility</td>
</tr>
<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
</tr>
<tr>
<td>PCK</td>
<td>Planetary Constant Kernel (SPICE)</td>
</tr>
<tr>
<td>PDS</td>
<td>Planetary Data System</td>
</tr>
<tr>
<td>PI</td>
<td>Proportional Integral (automated control loop)</td>
</tr>
<tr>
<td>RDR</td>
<td>Reduced Data Record</td>
</tr>
<tr>
<td>SCLK</td>
<td>Space Clock Kernel (SPICE)</td>
</tr>
<tr>
<td>SCR</td>
<td>Shield Count Rate</td>
</tr>
<tr>
<td>SIS</td>
<td>Software Interface Specification</td>
</tr>
<tr>
<td>SOC</td>
<td>MESSENGER Science Operations Center</td>
</tr>
<tr>
<td>SPICE</td>
<td>Spacecraft, Planet, Instrument, C-matrix Events</td>
</tr>
<tr>
<td>SPK</td>
<td>Spacecraft and Planets Kernel (SPICE)</td>
</tr>
<tr>
<td>SQL</td>
<td>Structured Query Language</td>
</tr>
<tr>
<td>UTC</td>
<td>Coordinated Universal Time</td>
</tr>
<tr>
<td>XRS</td>
<td>X-Ray Spectrometer</td>
</tr>
</tbody>
</table>