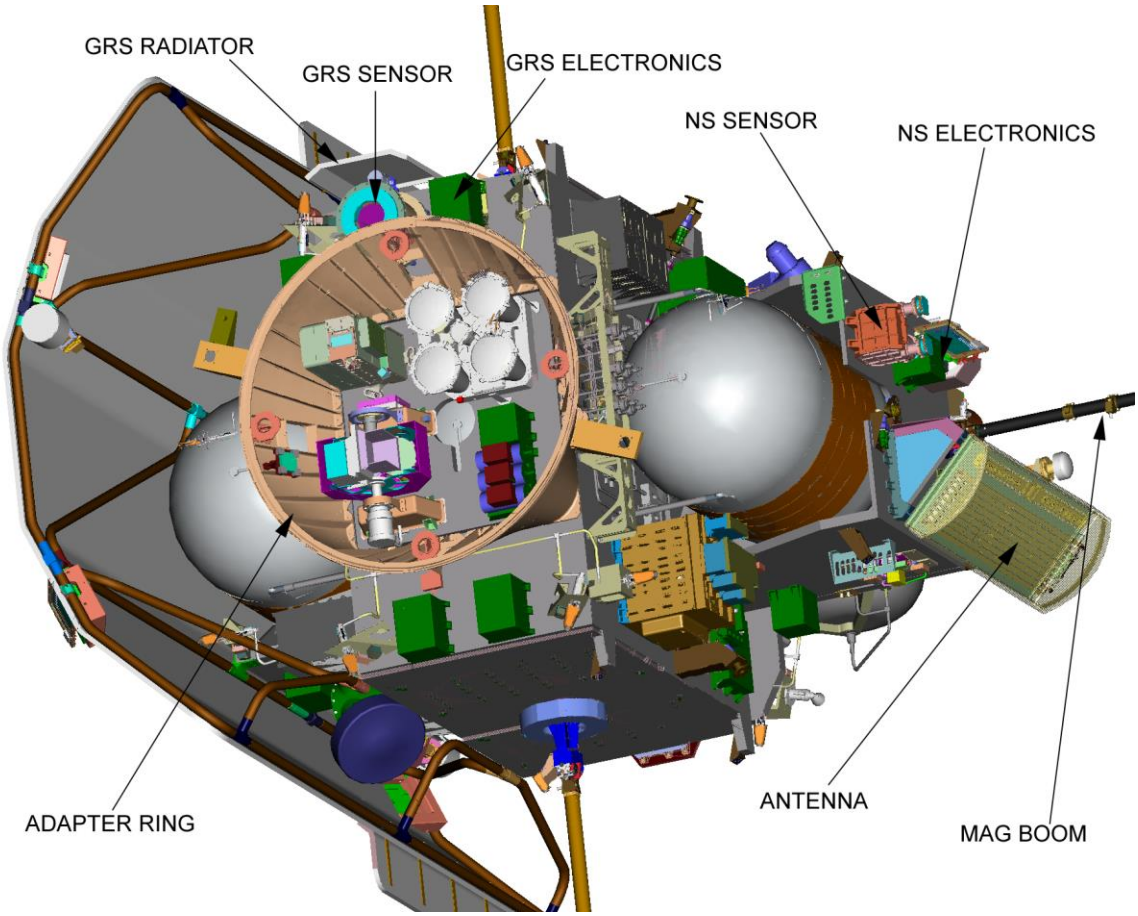
MESSENGER Software Interface Specification for the Gamma Ray Spectrometer Experiment Data Record



Version 4.8

Prepared by
Raymond Espiritu
Erick Malaret
Pierluigi Guasqui
Applied Coherent Technology Corporation
112 Elden St, Suite K
Herndon, VA 22304
http://www.actgate.com

Patrick Peplowski
Johns Hopkins University Applied Physics Laboratory
11100 Johns Hopkins Road
Laurel, MD 20723

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

DATE	SECTIONS CHANGED	REASON FOR CHANGE	REVISION
6/2/11	N/A	Add change log.	4.2
6/2/11	1.4, 1.5.4.3	Describe 9/2/10 GRS FSW update for fast neutron detection, updated GRS shield sensor product, and associated label change.	4.2
6/2/11	1.17, 1.18, 1.19	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.	4.2
6/2/11	Appendix/format descriptions	Change “periherm” to “apoherm” in orbit start time descriptions	4.2
6/10/11	Document Review	Replaced signature page with document review information per agreement with PDS	4.3
5/25/12	Applicable Documents, Archive release schedule	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.	4.4
9/26/13	1.3, 1.4, 1.5.4.4, 1.20	Describe 25/2/13 GRS FSW update to optimize neutron detection, updated GRS shield sensor products, and associated label changes.	4.5
11/14/13	1.4, 1.5.4.4, 1.20	Edits resulting from review of new shield sensor products.	4.6
7/7/15	5.4.3,6.4, 6.5	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).	4.7
7/13/15	Table of Contents, 5.1,	Updated with minor formatting corrections	4.8

	5.4.1, 6.5		

Table of Contents

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:

- Planetary Data System (PDS) Standards Reference, February 27, 2009, Version 3.8. JPL D-7669, Part-2.
- Planetary Data System Archive Preparation Guide, April 1, 2010, Version 1.4, JPL D-31224.
- GRS Flight Software Specification, Draft Dec. 15, 2003.
- MESSENGER Data Management and Archiving Plan. The Johns Hopkins University, APL. Document ID number 7384-9019.
- MESSENGER Mercury: Surface, Space Environment, Geochemistry, Ranging; A mission to Orbit and Explore the Planet Mercury, Concept Study, March 1999. Document ID number FG632/99-0479.
- Appendix 7 to the discovery program Plan; Program Level Requirement for the MESSENGER Discovery project; June 20, 2001.
- The MESSENGER Gamma-Ray and Neutron Spectrometer, Space Science Reviews 131, 339-391, 2007.

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, GEochemistry, 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 (2^{14}) 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:

Data Product	Product Description
HPGE RAW	• Detached PDS label file • Spectra data file – HPGe raw data in binary table.
HPGE AC	• Detached PDS label file • Spectra data file – HPGe anti-coincident data in binary table.
SHIELD	• Detached PDS label file • Spectra data file – SHIELD data in binary table.
SHIELD (SH2)	• Detached PDS label file • Spectra data file – SH2 data in binary table.
SHIELD COUNT RATE (SCR)	• Detached PDS label file • Count rate data file – SCR data in binary table.
MICROPHONICS	• Detached PDS label file

	• Time series data file – Microphonics data in binary table.
SW COUNTER	• Detached PDS label file • ASCII table file – software rate counter data.
STATUS	• Detached PDS label file • ASCII table file – critical state information provided by GRS status packet
FPGA ADC	• Detached PDS label file. • Diagnostic information stored in binary table.
COMMAND ECHO	• Detached PDS label file. • ASCII table file – Contains commands executed by GRS.

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}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 ± 0.1μs coincidence window and likely represent mostly thermal neutrons. The two Fast Events Spectra contain events with positive coincidence times > 0.1μs 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 uncompresses 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.

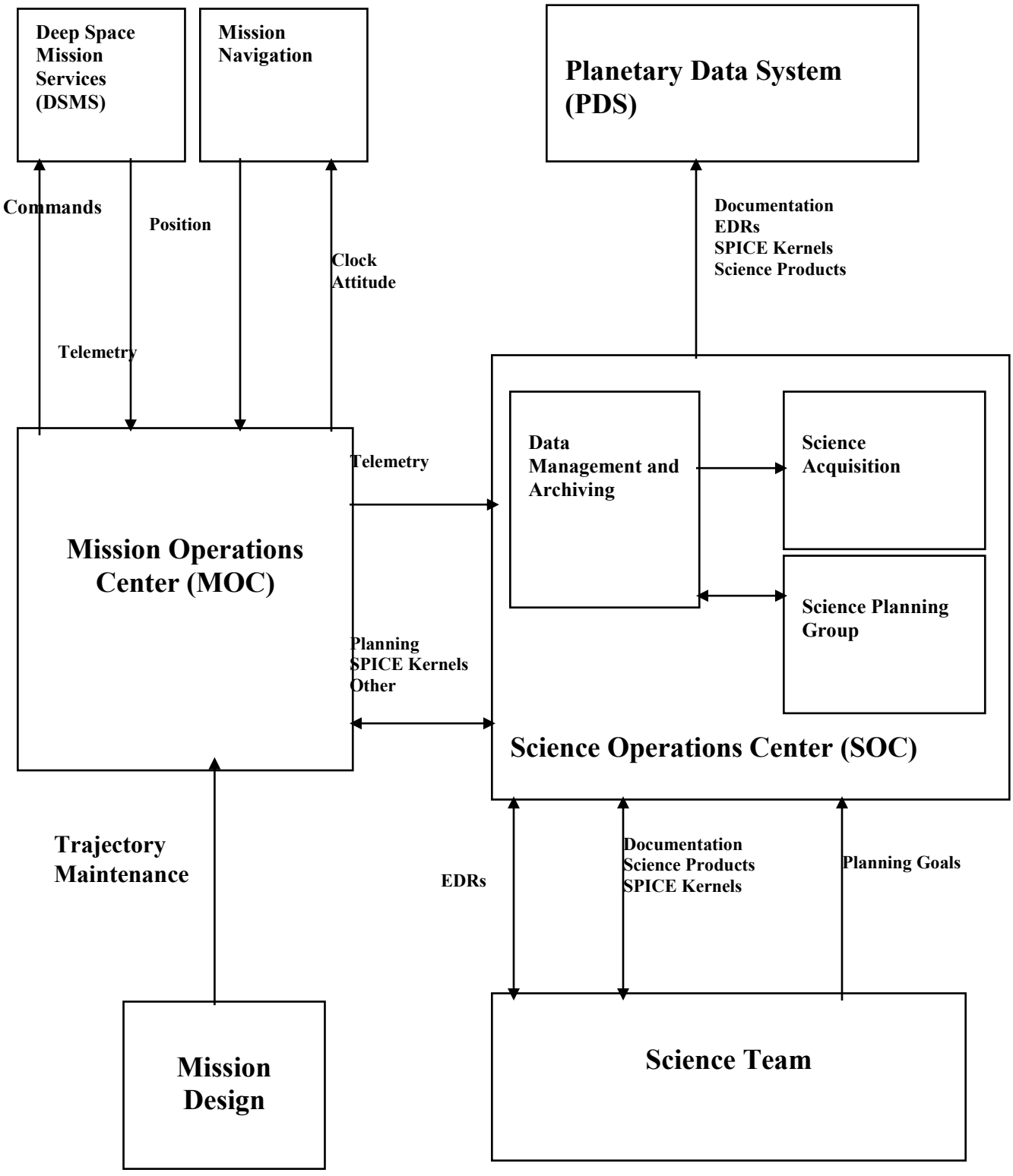


Figure 1. MESSENGER data flow

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
^TABLE                          = "GRS_SHI2004314ZZZ.DAT"

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

```
PDS_VERSION_ID                  = "PDS3"

/*** FILE FORMAT ***/
FILE_RECORDS                    = 990
RECORD_TYPE                     = FIXED_LENGTH
RECORD_BYTES                    = 32792

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID                      = "GRS_SCR2013244ZZZ_DAT"
PRODUCT_VERSION_ID              = "V1"
PRODUCT_CREATION_TIME           = 2013-11-13T20:22:34
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"
```

```
OBJECT                          = TABLE
COLUMNS                         = 10
INTERCHANGE_FORMAT              = BINARY
ROWS                            = 990
ROW_BYTES                       = 32792
DESCRIPTION                     = "
    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."

^STRUCTURE                      = "GRS_SCR.FMT"
END_OBJECT                      = TABLE
END
```

5.3.4.5 Microphonics Time Series PDS Label

```
PDS_VERSION_ID                  = "PDS3"

/*** FILE FORMAT ***/
RECORD_TYPE                     = FIXED_LENGTH
RECORD_BYTES                    = 65548
FILE_RECORDS                    = 7

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID                      = "GRS_MID2004315ZZZ_DAT"
PRODUCT_VERSION_ID              = "V1"
PRODUCT_CREATION_TIME           = 2006-03-03T16:01:1
PRODUCT_TYPE                    = "DATA"
STANDARD_DATA_PRODUCT_ID        = "GRS_MICROPHONICS"
SOFTWARE_NAME                   = "PIPE-GRS2EDR"
SOFTWARE_VERSION_ID             = "1.0"
INSTRUMENT_HOST_NAME            = "MESSENGER"
INSTRUMENT_NAME                 = "GAMMA RAY SPECTROMETER"
INSTRUMENT_ID                   = "GRS"
DETECTOR_ID                     = "MICROPHONICS"
DATA_SET_ID                     = "MESS-E/V/H-GRNS-2-GRS-RAWDATA-V1.0"
MISSION_PHASE_NAME              = "EARTH CRUISE"
TARGET_NAME                     = "CALIBRATION"
START_TIME                      = 2004-11-10 16:22:59.000
STOP_TIME                       = 2004-11-10 23:47:13.000
SPACECRAFT_CLOCK_START_COUNT    = 8590973
SPACECRAFT_CLOCK_STOP_COUNT     = 8617627
^TABLE                          = "GRS_MID2004315ZZZ.DAT"

OBJECT                          = TABLE
COLUMNS                         = 6
INTERCHANGE_FORMAT              = BINARY
ROWS                            = 7
ROW_BYTES                       = 65548
DESCRIPTION    = "
    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.
"
^STRUCTURE                      = "GRS_MICRO.FMT"
END_OBJECT                      = TABLE
```

```
END
```

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
END
```

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"
```

```
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"
ISSION_PHASE_NAME              = "EARTH CRUISE"
TARGET_NAME                    = "CALIBRATION"
START_TIME                     = 2005-06-24 06:01:20.000
STOP_TIME                      = 2005-06-24 23:59:20.000
SPACECRAFT_CLOCK_START_COUNT   = 28080024
SPACECRAFT_CLOCK_STOP_COUNT    = 28144704
^TABLE                         = "GRS_STA2005175ZZZ.TAB"

OBJECT                         = TABLE
   COLUMNS                     = 167
   INTERCHANGE_FORMAT          = ASCII
   ROWS                        = 1079
   ROW_BYTES                   = 1127
   DESCRIPTION                 = "
    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.
"
^STRUCTURE                     = "GRS_STATUS.FMT"
END_OBJECT                     = TABLE
END
```

5.3.4.8 FPGA ADC PDS Label

```
PDS_VERSION_ID                 = "PDS3"

/*** FILE FORMAT ***/
FILE_RECORDS                   = 7213
RECORD_TYPE                    = FIXED_LENGTH
RECORD_BYTES                   = 64

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID                     = "GRS_ADC2004320ZZZ_DAT"
PRODUCT_VERSION_ID             = "V1"
PRODUCT_CREATION_TIME          = 2006-03-09T04:52:26
PRODUCT_TYPE                   = "ANCILLARY"
STANDARD_DATA_PRODUCT_ID       = "GRS_FPGA_ADC"
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 16:54:50.000
STOP_TIME                      = 2004-11-15 18:55:02.000
SPACECRAFT_CLOCK_START_COUNT   = 9024881
SPACECRAFT_CLOCK_STOP_COUNT    = 9032093
^TABLE                         = "GRS_ADC2004320ZZZ.DAT"

OBJECT                         = TABLE
COLUMNS                        = 31
INTERCHANGE_FORMAT             = BINARY
ROWS                           = 7213
ROW_BYTES                      = 64
DESCRIPTION                    = "
   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.
"
^STRUCTURE                     = "GRS_FPGA.FMT"
END_OBJECT                     = TABLE
END
```

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 reset[1] 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].

[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.

ROW_BYTES
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_ZZZYYYYDDDWWW.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
```

YYYY	The four digit year corresponding to the start time of the first record in the EDR data file.
DDD	The three digit day of year corresponding to the start time of the first record in the EDR data file.
WWW	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'.
.XXX	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'.

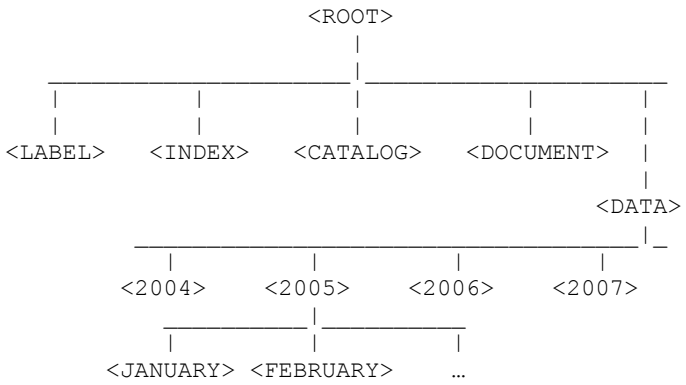
6.5 Archive Volume and File Size

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



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> - 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_HPGE_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.

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

```
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 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.

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

```
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 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.

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

```
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."
```

```
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           = BAD_DATA_FLAG
   COLUMN_NUMBER  = 8
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 21
   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           = SHIELD
   COLUMN_NUMBER  = 9
   BYTES          = 2048
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 23
   ITEMS          = 1024
   ITEM_BYTES     = 2
   DESCRIPTION    = "Spectra of light pulses produced from interaction of a
   gamma ray with the plastic scintillator shield. Contains the counts in each
   of the 1024 bins after 1 accumulation period."
END_OBJECT    = COLUMN
```

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.

Start Byte	Length (bytes)	Data Type	Column Name	Summary (see format file text for full description)
1	4	MSB Unsigned Integer	MET	Mission Elapsed Time in seconds.
5	4	MSB Unsigned Integer	ACCUM_TIME	Accumulation time, in seconds.
9	4	MSB Unsigned Integer	MIDPOINT_MET	MET at the midpoint of the observation.
13	2	MSB Unsigned Integer	ORBIT_NUMBER	Unique consecutive integer identifying a given orbit of MESSENGER around Mercury
15	2	MSB Unsigned Integer	START_BIN	Start bin of the detector.
17	2	MSB Unsigned Integer	NUMBER_OF_BINS	Number of bins in the raw spectra.
19	2	MSB Unsigned Integer	GRS_PRIORITY_LEVEL	Priority assigned to the downloaded science packet.
21	2	MSB Unsigned Integer	BAD_DATA_FLAG	Bit-string bad data flag.
25	2 X 1024	MSB Unsigned Integer	SHIELD	Contains a set of data values as defined by the Appendix Shield_2 Content description.

```
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."
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           = BAD_DATA_FLAG
   COLUMN_NUMBER  = 8
```

```
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 21
   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           = SHIELD
   COLUMN_NUMBER  = 9
   BYTES          = 2048
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 23
   ITEMS          = 1024
   ITEM_BYTES     = 2
   DESCRIPTION    = "Contains a set of data values as defined by the Appendix SHIELD_2 content
description in the EDR SIS."
END_OBJECT    = COLUMN
```

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.

Start Byte	Length (bytes)	Data Type	Column Name	Summary (see format file text for full description)
1	4	MSB Unsigned Integer	MET	Mission elapsed time, in seconds, corresponding to the start of the accumulation period for the spectra.
5	4	MSB Unsigned Integer	ACCUM_TIME	Accumulation time, in seconds, of the anti-coincidence shield detector.
9	4	MSB Unsigned Integer	MIDPOINT_MET	The mission elapsed time at the midpoint of the observation. Defined as: MET at the start of the observation + (ACCUM_TIME / 2).
13	2	MSB Unsigned Integer	ORBIT_NUMBER	Unique consecutive integer identifying a given orbit of MESSENGER around Mercury.
15	2	MSB Unsigned Integer	START_BIN	The bin containing first shield counter (starting from zero). Nominally is zero.
17	2	MSB Unsigned Integer	NUMBER_OF_BINS	Number of bins in each science packet.
19	2	MSB Unsigned Integer	GRS_PRIORITY_LEVEL	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.
21	2	MSB Unsigned Integer	MISSING_DATA_PACKETS	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).
23	2	MSB Unsigned Integer	BAD_DATA_FLAG	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.
25	2 X 16384	MSB Unsigned Integer	SHIELD_COUNT_SPECTRA	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.

```
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 anti-coincidence
   shield 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 = "The bin containing first shield counter (starting from
   zero). Nominally is zero."
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 each science packet."
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 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    = 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           = 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      = COLUMN
```

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.

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

```
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
```

```
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.

Start Byte	Length (bytes)	Data Type	Column Name	Summary (see format file text for full description)
1	10	ASCII Integer	MET	Mission Elapsed Time in seconds.
13	5	ASCII Integer	ORBIT_NUMBER	Unique consecutive integer identifying a given orbit of MESSENGER around Mercury
20	10	ASCII Integer	HPGE_RAW_EVENTS	Counter for HPGe Raw events.
32	10	ASCII Integer	SHIELD_RAW_EVENTS	Count for SHIELD raw events.
44	10	ASCII Integer	ACCUMULATED_DEAD_TIME	Count for accumulated dead time.
56	10	ASCII Integer	HPGE_CHARGE_RESETS	Number of HPGe charge resets.
68	10	ASCII Integer	SHIELD_CHARGE_RESETS	Number of SHIELD charge resets.
80	10	ASCII Integer	ACCUMULATION_TIME	Accumulation time for software counters.
92	10	ASCII Integer	ALL_EVENTS	All events counter.
104	10	ASCII Integer	ALL_CH0_CH1_EVENTS	All channel 0 and 1 events.
116	10	ASCII Integer	ALL_CH0_EVENTS	All single channel 0 events.
128	10	ASCII Integer	ALL_CH1_EVENTS	All single channel 1 events.
140	10	ASCII Integer	INVALID_SINGLE_CH0	Channel 0 out-of-range events.
152	10	ASCII Integer	INVALID_SINGLE_CH1	Channel 1 out-of-range events.
164	10	ASCII Integer	INVALID_COINCIDENT_CH0	Channel 0 out-of-range coincidence events.
176	10	ASCII Integer	INVALID_COINCIDENT_CH1	Channel 1 out-of-range coincidence events.
188	10	ASCII Integer	VALID_SINGLE_CH0	Single channel 0 valid events.
200	10	ASCII Integer	VALID_COINCIDENT_CH0	Coincidence channel 0 valid events.
212	10	ASCII Integer	VALID_SINGLE_CH1	Single channel 1 valid events.
224	10	ASCII Integer	VALID_COINCIDENT_CH1	Coincidence channel 1 valid events.
236	10	ASCII Integer	ALL_VALID_COINCIDENT	All valid coincidence events.
248	10	ASCII Integer	INVERTED_CH0	Channel 0 inverted events.
260	10	ASCII Integer	CH0_PILEUP_REJECT	Channel 0 pileup rejected events.
272	10	ASCII Integer	FIFO_FULL_COUNT	Hardware FIFO full flag tested for all events.
284	10	ASCII Integer	PULSER_ENERGY_SUM	Pulser energy sum.
296	10	ASCII Integer	PULSER_ENERGY_SUM2	Pulser energy sum squared.
308	10	ASCII Integer	PULSER_EVENTS	Number of valid pulser events.
320	10	ASCII Integer	INVALID_PULSER_EVENTS	Out-of-range pulser events.
332	10	ASCII Integer	NEUTRON_EVENTS	Coincidence events meeting neutron criterion.
344	10	ASCII Integer	PULSER_OFFSET	Pulser energy offset.

```
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
```

```
   (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.

Start Byte	Length (bytes)	Data Type	Column Name	Summary (see format file text for full description)
1	12	ASCII Integer	MET	Mission Elapsed Time in seconds.
15	6	ASCII Integer	ORBIT_NUMBER	Unique consecutive integer identifying a given orbit of MESSENGER around Mercury
23	6	ASCII Integer	LVPS_PLUS5V	LVPS +5 volt monitor
31	6	ASCII Integer	LVPS_NEG5V	LVPS -5 volt monitor
39	6	ASCII Integer	LVPS_PLUS12V	LVPS +12 volt monitor
47	6	ASCII Integer	LVPS_NEG12V	LVPS -12 volt monitor
55	6	ASCII Integer	LVPS_EXT_C1	Unused
63	6	ASCII Integer	LVPS_EXT_C2	Unused
71	6	ASCII Integer	LVPS_EXT_C3	Unused
79	6	ASCII Integer	LVPS_EXT_C4	Unused
87	6	ASCII Integer	LVPS_EXT_C5	Unused
95	6	ASCII Integer	LVPS_PLUS5V_I	LVPS +5V current
103	6	ASCII Integer	LVPS_NEG5V_I	LVPS -5V current
111	6	ASCII Integer	LVPS_PLUS12V_I	LVPS +12V current
119	6	ASCII Integer	LVPS_NEG12V_I	LVPS -12V current
127	6	ASCII Integer	LVPS_TEMP	LVPS Temperature

135	6	ASCII Integer	LVPS_PRI_I	LVPS Primary Current
143	6	ASCII Integer	OP_HEATER_CURRENT	Op-heater Current
151	6	ASCII Integer	HVPS_TEMP	HVPS Temperature
159	6	ASCII Integer	HVPS_VOLT	HVPS Voltage
167	6	ASCII Integer	HVPS_REF_VOLT	HVPS Reference Voltage
175	6	ASCII Integer	HPGE_TEMP_1	HPGE Detector Temperature 1
183	6	ASCII Integer	HPGE_TEMP_2	HPGE Detector Temperature 2
191	6	ASCII Integer	HPGE_DET_LEAK	HPGE Detector Leakage current
199	6	ASCII Integer	HVPS_TEMP	HVPS Temperature
207	6	ASCII Integer	PREAMP_TEMP	PreAmp Temperature
215	6	ASCII Integer	SHAPER_TEMP	Shaper Temperature
223	6	ASCII Integer	AD_TEMP	AD Temperature
231	6	ASCII Integer	HV_MONITOR	HV Monitor
239	6	ASCII Integer	REF_2_5V	2.5V reference ADC counts
247	6	ASCII Integer	REF_2_5V_DIV2	2.5V reference / 2 ADC counts.
255	6	ASCII Integer	REF_2_5V_DIV3	2.5V reference / 3 ADC counts.
263	6	ASCII Integer	CONTROL_BOARD_TEMP	Controller board temperature.
271	6	ASCII Integer	ANNEAL_PRI_VOLT	Anneal primary voltage.
279	6	ASCII Integer	COOLER_PRI_VOLT	Cooler primary voltage.
287	6	ASCII Integer	ANNEAL_SEC_I	Anneal secondary current.
295	6	ASCII Integer	COOLER_SEC_I	Cooler secondary current.
303	6	ASCII Integer	COOLER_PRI_I	Cooler primary current.
311	6	ASCII Integer	ANNEAL_PRI_I	Anneal primary current.
319	6	ASCII Integer	COOLER_POWER_BOARD_TEMP	Cooler power board temperature.
327	6	ASCII Integer	STATOR_TEMP	Stator temperature.
335	6	ASCII Integer	HVAC_HEATER	Heater register.
343	6	ASCII Integer	HVAC_RELAY	Relay register.
351	6	ASCII Integer	HVAC_HEATER_POWER_LEVEL	Heater power level.
359	6	ASCII Integer	ANNEAL_MAX_VALID_TEMP	Anneal max valid temp reading limit.
367	6	ASCII Integer	ANNEAL_UPPER_TEMP	Anneal upper temp limit.
375	6	ASCII Integer	ANNEAL_LOWER_TEMP	Anneal lower temp limit.
383	6	ASCII Integer	ANNEAL_MIN_VALID_TEMP	Anneal min valid temp reading limit.
391	6	ASCII Integer	HVAC_COOLER_PWR	Cooler set point.
399	6	ASCII Integer	HPGE_HVPS_CMD	HPGe HVPS command.
407	1	ASCII Integer	CMD_HPGE_HV_ENABLE	Commanded HPGE HV enabled.
410	1	ASCII Integer	CMD_SHIELD_HV_ENABLE	Commanded Shield HV enabled.
413	1	ASCII Integer	COOLER_HEATER_STATE	Cooler Op-heater state.
416	1	ASCII Integer	COOLER_THERMOSTAT	Cooler thermostat enabled.
419	1	ASCII Integer	HPGE_HV_TEMP_OK	HPGe temp in range for HV.
422	1	ASCII Integer	HPGE_TEMP1_ENABLE	HPGe Temp1 sensor enabled.
425	1	ASCII Integer	HPGE_TEMP2_ENABLE	HPGe Temp2 sensor enabled.
428	1	ASCII Integer	HPGE_PILEUP_REJ_ENABLE	Pileup rejection enabled.
431	1	ASCII Integer	CMD_SCIENCE_MODE	Commanded to event classification.
434	1	ASCII Integer	COOLER_ENABLE	Cooler enabled.
437	1	ASCII Integer	COOLER_PI_ENABLE	Cooler PI control enabled.
440	1	ASCII Integer	COOLER_TEMP_OK	Cooler temperature in range.
443	1	ASCII Integer	HPGE_HTR_COOLER_OVERIDE	Allow anneal heater and cooler.
446	1	ASCII Integer	HPGE_HTR_WATCHDOG	Anneal heater watchdog enabled.
449	1	ASCII Integer	PULSER_SPECTRUM_ENABLE	Include pulser events in spectrum.
452	1	ASCII Integer	CMD_SCIENCE_PURGE	Purge science at end of accumulation.
455	1	ASCII Integer	CMD_UPDATE_MODE	Immediate update of periods.
458	1	ASCII Integer	IN_SCIENCE_MODE	In an accumulation/reporting cycle.
461	1	ASCII Integer	PREPARE_SCIENCE_DATA	Prepare to ship latest accumulation.
464	1	ASCII Integer	WATCHDOG_STARTED	Main watchdog enabled.
467	3	ASCII Integer	MINOR_SW_VERSION	Minor software version.
472	6	ASCII Integer	HPGE_TEMP_DELTA_MAX	Maximum diode sensor difference.
480	6	ASCII Integer	HPGE_TEMP_LOW_ON	Maximum temp to turn on HPGe HV.
488	6	ASCII Integer	HPGE_TEMP_HIGH_OFF	Temperature to turn off HPGe HV.
496	6	ASCII Integer	HPGE_HV_BIAS_THRESH	HPGe bias current safing threshold.
504	6	ASCII Integer	HPGE_HV_BIAS_CHECK	Min HPGe HV to check bias.
512	6	ASCII Integer	HPGE_CRITICAL_BIAS	HPGe critical bias condition.
520	6	ASCII Integer	HPGE_CRIT_BIAS_MAX_HV	HPGe critical bias max HV.
528	6	ASCII Integer	HPGE_LVL1_SAF_RETRIES	HPGe level 1 safing retries.

536	6	ASCII Integer	HPGE_LVL1_WAIT_TIME	HPGe level 1 wait time (minutes).
544	6	ASCII Integer	SHIELD_HV_RATE_THRESH	Shield event rate safing threshold.
552	6	ASCII Integer	SHIELD_LVL1_SAF_RETRIES	Shield level 1 safing retries.
560	6	ASCII Integer	SHIELD_LVL1_WAIT_TIME	Shield level 1 wait time (minutes).
568	6	ASCII Integer	COOLER_OP_HEATER_LOW_LIMIT	Cooler op heater lower limit.
576	6	ASCII Integer	COOLER_OP_HEATER_HIGH_LIMIT	Cooler op heater upper limit.
584	6	ASCII Integer	HPGE_PILEUP_OFFSET	Offset for pileup rejection window.
592	6	ASCII Integer	HPGE_PILEUP_HALF_WIDTH	Half-width for pileup rejection.
600	6	ASCII Integer	EVENT_COIN_OFFSET	Offset for event coincidence window.
608	6	ASCII Integer	EVENT_COIN_HALF_WIDTH	Half-width for coincidence.
616	6	ASCII Integer	NEUTRON_CH0_MIN_E	Neutron event Channel 0 min energy.
624	6	ASCII Integer	NEUTRON_CH0_MAX_E	Neutron event Channel 0 max energy.
632	6	ASCII Integer	NEUTRON_CH1_MIN_E	Neutron event Channel 1 min energy.
640	6	ASCII Integer	NEUTRON_CH1_MAX_E	Neutron event Channel 1 max energy.
648	6	ASCII Integer	PULSER_CH0_MIN_VALID	Valid pulser min energy.
656	6	ASCII Integer	PULSER_CH0_MAX_VALID	Valid pulser max energy.
664	6	ASCII Integer	PULSER_OFFSET	Offset for pulser statistics.
672	6	ASCII Integer	PULSER_SHIFT	Shift pulser energy for spectrum.
680	3	ASCII Integer	CONFIG_CHANGED	Config changed during accumulation.
685	3	ASCII Integer	DIAG_PACKETS_DROPPED	Diagnostic packets dropped.
690	1	ASCII Integer	LVPS_I2C_12V	LVPS 12V enabled.
693	1	ASCII Integer	LVPS_I2C_EXT_PR_1	LVPS External Primary 1 enabled.
696	1	ASCII Integer	LVPS_I2C_EXT_PR_2	LVPS External Primary 2 enabled.
699	1	ASCII Integer	HVPS_I2C_HV1_ENABLE	HVPS (SHIELD) HV enabled.
702	1	ASCII Integer	HVPS_I2C_HV2_ENABLE	Unused.
705	1	ASCII Integer	HVPS_I2C_MUX_ENABLE	Description not provided by GRNS team.
708	1	ASCII Integer	HVPS_I2C_REF_ENABLE	Description not provided by GRNS team.
711	6	ASCII Integer	HVPS_I2C_HV_CMD	HVPS I2C (SHIELD) HV command
719	6	ASCII Integer	HW_CH0_1SEC	Hardware Channel 0 1-sec event total.
727	6	ASCII Integer	HW_CH1_1SEC	Hardware Channel 1 1-sec event total.
735	6	ASCII Integer	HW_DEAD_TIME_1SEC	Hardware dead time 1-sec event total.
743	6	ASCII Integer	HPGE_CHRG_RSET_1SEC	Hardware HPGe charge reset 1-sec event total.
751	6	ASCII Integer	SHLD_CHRG_RSET_1SEC	Hardware SHIELD charge reset 1-sec total.
759	3	ASCII Integer	CH0_LATCHES_DETECTED	Channel 0 latches detected.
764	3	ASCII Integer	CH1_LATCHES_DETECTED	Channel 1 latches detected.
769	6	ASCII Integer	CMD_HPGE_MAX_HV	Commanded HPGe max HV level.
777	6	ASCII Integer	CMD_SHIELD_MAX_HV	Commanded SHIELD max HV level.
785	6	ASCII Integer	CMD_HPGE_HV	Commanded HPGe HV level.
793	6	ASCII Integer	CMD_SHIELD_HV	Commanded SHIELD HV level.
801	6	ASCII Integer	CALIB_AVG_DET_TEMP	Calibrated, averaged, detector temp.
809	6	ASCII Integer	HPGE_GOAL_HV_ENABLED	HPGe goal HV if HV enabled.
817	6	ASCII Integer	HPGE_GOAL_TEMP_SAFE	HPGe goal HV if temperature safe.
825	6	ASCII Integer	RAMP_2_HPGE_HV_B	Implements ramp to HPGE_HV_B
833	6	ASCII Integer	HPGE_HV_A_BIAS_SAFE	HPGE_HV_A HV if bias current safe.
841	6	ASCII Integer	HPGE_HV_TEMP_CYCLE	Transitions to or from safe temperature.
849	3	ASCII Integer	HPGE_HV_SAFING_LVL	Current safing level.
854	3	ASCII Integer	HPGE_HV_SAFING_CYC	Times increased safing levels.
859	6	ASCII Integer	HPGE_HV_UNCHANGED_TICKS	Seconds at current HPGe HV.
867	6	ASCII Integer	SHLD_GOAL_HV_ENABLED	SHIELD goal HV if HV enabled.
875	6	ASCII Integer	SHLD_GOAL_EVENT_SAFE	SHIELD goal HV if event rate safe.
883	6	ASCII Integer	RAMP_2_SHLD_HV_B	Implements ramp to SHIELD_HV_B.
891	6	ASCII Integer	OUTPUT_HVPS_EVENT_SAFE	Output to HVPS if event rate safe.
899	3	ASCII Integer	SHLD_HV_STATE	Not used.
904	3	ASCII Integer	SHLD_HV_SAFING_LVL	Current safing level.
909	3	ASCII Integer	SHLD_HV_SAFING_CYC	Times increased safing levels.
914	3	ASCII Integer	LAST_OPCODE	Last command opcode received.
919	6	ASCII Integer	SHLD_HV_UNCHANGED_TICKS	Seconds at current HPGe HV.
927	6	ASCII Integer	COOLER_TEMP_SETPOINT	Cooler temperature set point.
935	6	ASCII Integer	COOLER_POWER	Cooler power.

943	6	ASCII Integer	COOLER_PI_PROP	Cooler PI proportional gain.
951	6	ASCII Integer	COOLER_PI_INTEGRAL	Cooler PI integral gain.
959	6	ASCII Integer	COOLER_PI_OFFSET	Cooler PI offset for output.
967	6	ASCII Integer	COOLER_PI_MAX_ERR	PI max error to enable integration.
975	6	ASCII Integer	ACCUM_TIME_LEFT	Time left in current accumulation.
983	6	ASCII Integer	CMD_REPORT_PERIOD	Commanded reporting period.
991	6	ASCII Integer	CMD_ACCUM_TIME	Commanded accumulation time.
999	6	ASCII Integer	CMD_SHIP_MODE	Commanded science ship selection.
1007	6	ASCII Integer	A2D_SHIP_MODE	Microphonics ship mode.
1015	6	ASCII Integer	SCIENCE_PRIORITY	Base value for science ApIDs.
1023	6	ASCII Integer	STATUS_INTERVAL	Status interval (seconds).
1031	6	ASCII Integer	MACRO_FREE_BLOCKS	Free blocks for macros.
1039	6	ASCII Integer	TLM_VOLUME	Telemetry volume (kB).
1047	6	ASCII Integer	WATCH_ADDR	Debug watch address.
1055	6	ASCII Integer	WATCH_MEM	Debug watch page.
1063	3	ASCII Integer	WATCH_BYTE1	Debug watch byte 1.
1068	3	ASCII Integer	WATCH_BYTE2	Debug watch byte 2.
1073	3	ASCII Integer	SW_VERSION	Major software version.
1078	3	ASCII Integer	ALARM_ID	Last alarm ID.
1083	6	ASCII Integer	ALARM_COUNT	Total alarm count.
1091	1	ASCII Integer	ALARM_TYPE	Last alarm type.
1094	3	ASCII Integer	CMD_EXECUTED	Number of commands executed.
1099	3	ASCII Integer	CMD_REJECTED	Number of commands rejected.
1104	3	ASCII Integer	MACRO_CMD_EXEC	Macro commands executed.
1109	3	ASCII Integer	MACRO_CMD_REJECT	Macro commands rejected.
1114	3	ASCII Integer	MACRO_ID	Last macro ID.
1119	1	ASCII Integer	MACRO_LEARN	Macro learning mode.
1122	1	ASCII Integer	MEM_WRITE_ENABLE	Memory writing enabled.
1125	1	ASCII Integer	MON_RESPONSE	Monitor response.

```
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
```

```
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 167
   DESCRIPTION    = "HVPS Reference Voltage."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = HPGE_TEMP_1
   COLUMN_NUMBER  = 22
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 175
   DESCRIPTION    = "ADC0 Channel 0, HPGE Detector Temperature 1."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = HPGE_TEMP_2
   COLUMN_NUMBER  = 23
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 183
   DESCRIPTION    = "ADC0 Channel 1, HPGE Detector Temperature 2."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = HPGE_DET_LEAK
   COLUMN_NUMBER  = 24
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 191
   DESCRIPTION    = "ADC0 Channel 2, HPGE Detector Leakage current."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = HVPS_TEMP
   COLUMN_NUMBER  = 25
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 199
   DESCRIPTION    = "ADC0 Channel 3, HVPS Temperature."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = PREAMP_TEMP
   COLUMN_NUMBER  = 26
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 207
   DESCRIPTION    = "ADC0 Channel 4, Pre Amp Temperature."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SHAPER_TEMP
   COLUMN_NUMBER  = 27
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 215
   DESCRIPTION    = "ADC0 Channel 5, Shaper Temperature."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = AD_TEMP
   COLUMN_NUMBER  = 28
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 223
   DESCRIPTION    = "ADC0 Channel 6, AD Temperature."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = HV_MONITOR
   COLUMN_NUMBER  = 29
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 231
   DESCRIPTION    = "ADC0 Channel 7, HV Monitor."
```

```
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_OVERIDE
   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
```

```
OBJECT        = COLUMN
   NAME           = HVPS_I2C_HV2_ENABLE
   COLUMN_NUMBER  = 104
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 702
   DESCRIPTION    = "Unused."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = HVPS_I2C_MUX_ENABLE
   COLUMN_NUMBER  = 105
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 705
   DESCRIPTION    = "Enables/disables ADC MUX on HVPS board to provide HVPS
   housekeeping data."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = HVPS_I2C_REF_ENABLE
   COLUMN_NUMBER  = 106
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 708
   DESCRIPTION    = "Enables/disables use of reference HV on HVPS board to
   set/regulate HPGe HV."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = HVPS_I2C_HV_CMD
   COLUMN_NUMBER  = 107
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 711
   DESCRIPTION    = "HVPS I2C (Shield) HV Command."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = HW_CH0_1SEC
   COLUMN_NUMBER  = 108
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 719
   DESCRIPTION    = "Hardware channel 0 1-second event total."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = HW_CH1_1SEC
   COLUMN_NUMBER  = 109
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 727
   DESCRIPTION    = "Hardware channel 1 1-second event total."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = HW_DEAD_TIME_1SEC
   COLUMN_NUMBER  = 110
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 735
   DESCRIPTION    = "Hardware dead time 1-second event total."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = HPGE_CHRG_RSET_1SEC
   COLUMN_NUMBER  = 111
   BYTES          = 6
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 743
   DESCRIPTION    = "Hardware HPGe charge reset 1-second total."
END_OBJECT    = COLUMN
```

```
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
```

```
   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
```

```
   COLUMN_NUMBER  = 161
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 1099
   DESCRIPTION    = "Number of commands rejected (can be reset by command)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = MACRO_CMD_EXEC
   COLUMN_NUMBER  = 162
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 1104
   DESCRIPTION    = "Macro commands executed (can be reset by command)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = MACRO_CMD_REJECT
   COLUMN_NUMBER  = 163
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 1109
   DESCRIPTION    = "Macro commands rejected (can be reset by command)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = MACRO_ID
   COLUMN_NUMBER  = 164
   BYTES          = 3
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 1114
   DESCRIPTION    = "Last macro ID."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = MACRO_LEARN
   COLUMN_NUMBER  = 165
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 1119
   DESCRIPTION    = "Macro learning mode."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = MEM_WRITE_ENABLE
   COLUMN_NUMBER  = 166
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 1122
   DESCRIPTION    = "Memory writing enabled."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = MON_RESPONSE
   COLUMN_NUMBER  = 167
   BYTES          = 1
   DATA_TYPE      = ASCII_INTEGER
   START_BYTE     = 1125
   DESCRIPTION    = "Monitor response."
END_OBJECT    = COLUMN
```

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.

Start Byte	Length (bytes)	Data Type	Column Name	Summary (see format file text for full description)
1	4	MSB Unsigned Integer	MET	Mission Elapsed Time in seconds.
5	2	MSB Unsigned Integer	ORBIT_NUMBER	Unique consecutive integer identifying a given orbit of MESSENGER around Mercury

7	2	MSB Bit String	POWER_REGISTER	A two-byte integer containing information in individual bit fields. See format file text for full description.
9	2	MSB Bit String	TAP_REGISTER	A two-byte integer containing information in individual bit fields. See format file text for full description.
11	2	MSB Integer	CH0_TRIGGER_THRESHOLD	Channel 0 trigger threshold.
13	2	MSB Integer	CH1_TRIGGER_THRESHOLD	Channel 1 trigger threshold.
15	2	MSB Unsigned Integer	CH0_WINDOW	Channel 0 processing window.
17	2	MSB Unsigned Integer	CH1_WINDOW	Channel 1 processing window.
19	2	MSB Unsigned Integer	SETTLE_ADC	Settling time.
21	2	MSB Unsigned Integer	DITHER_SETTLE_ADC	Dither settling time.
23	2	MSB Unsigned Integer	DITHER_DAC_CMD	Dither DAC command.
25	2	MSB Unsigned Integer	GAIN_DAC_CMD	Gain DAC command.
27	2	MSB Bit String	STATUS_REGISTER	A two-byte integer containing information in individual bit fields. See format file text for full description.
29	2	MSB Unsigned Integer	TRIGGER_PER_SEC_CH0	Channel 0 triggers per second.
31	2	MSB Integer	EVENT_MAX_CH0	Channel 0 event max.
33	2	MSB Integer	EVENT_MIN_CH0	Channel 0 event min.
35	2	MSB Integer	EVENT_PEAK_CH0	Channel 0 event peak.
37	2	MSB Unsigned Integer	TRIGGER_PER_SEC_CH1	Channel 1 triggers per second.
39	2	MSB Integer	EVENT_MAX_CH1	Channel 1 event max.
41	2	MSB Integer	EVENT_MIN_CH1	Channel 1 event min.
43	2	MSB Integer	EVENT_PEAK_CH1	Channel 1 event peak.
45	2	MSB Integer	DELTA_PEAK_TIME	Time of channel 0 peak – time of channel 1 peak.
47	2	MSB Unsigned Integer	DEAD_TIME_ADC	Dead time per second.
49	2	MSB Unsigned Integer	Q_RESET_ADC	Channel 0 charge resets per second.
51	2	MSB Unsigned Integer	PMT_RESET_ADC	Channel 1 charge resets per second.
53	2	MSB Integer	CH0_ADC_TEST_PORT	Channel 0 ADC test port.
55	2	MSB Integer	CH1_ADC_TEST_PORT	Channel 1 ADC test port.
57	2	MSB Integer	CH2_ADC_TEST_PORT	Channel 2 ADC test port.
59	2	MSB Bit String	TEST_PULSE_REGISTER	A two-byte integer containing information in individual bit fields. See format file text for full description.
61	2	MSB Unsigned Integer	DELTA_CH0_MAX_MIN	Time between Channel 0 max and min.
63	2	MSB Unsigned Integer	DIAGNOSTIC_ADC	Diagnostic register.

```
OBJECT         = COLUMN
   NAME            = MET
   COLUMN_NUMBER   = 1
   BYTES           = 4
   DATA_TYPE       = MSB_UNSIGNED_INTEGER
   START_BYTE      = 1
   DESCRIPTION     = "Mission elapsed time in seconds."
END_OBJECT     = COLUMN

OBJECT         = COLUMN
   NAME            = ORBIT_NUMBER
   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            = POWER_REGISTER
   COLUMN_NUMBER   = 3
   BYTES           = 2
   DATA_TYPE       = MSB_BIT_STRING
```

```
   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_2_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
```

```
      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."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = SETTLE_ADC
   COLUMN_NUMBER  = 9
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 19
   DESCRIPTION    = "Settling time."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = DITHER_SETTLE_ADC
   COLUMN_NUMBER  = 10
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 21
   DESCRIPTION    = "Dither settling time."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = DITHER_DAC_CMD
   COLUMN_NUMBER  = 11
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 23
   DESCRIPTION    = "Dither DAC command."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   NAME           = GAIN_DAC_CMD
   COLUMN_NUMBER  = 12
   BYTES          = 2
   DATA_TYPE      = MSB_UNSIGNED_INTEGER
   START_BYTE     = 25
   DESCRIPTION    = "Gain DAC command."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
   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:"

   OBJECT     = BIT_COLUMN
      NAME           = EVENT_PENDING
      BIT_DATA_TYPE  = MSB_UNSIGNED_INTEGER
      START_BIT      = 1
      BITS           = 1
      DESCRIPTION    = "=0 No events pending. =1 Event pending in FIFO."
   END_OBJECT = BIT_COLUMN

   OBJECT     = BIT_COLUMN
      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."
   END_OBJECT = BIT_COLUMN

   OBJECT     = BIT_COLUMN
      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."
   END_OBJECT = BIT_COLUMN

   OBJECT     = BIT_COLUMN
      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_EVENT_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

END_OBJECT    = 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

END_OBJECT    = 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.

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

```
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 hexidecimal 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

CODMAC Level	Proc. Type	Data Processing Level Description
1	Raw Data	Telemetry data stream as received at the ground station, with science and engineering data embedded. Corresponds to NASA packet data.
2	Edited Data	Instrument science data (e.g. raw voltages, counts) at full resolution, time ordered, with duplicates and transmission errors removed. Referred to in the MESSENGER program as Experiment Data Records (EDRs). Corresponds to NASA Level 0 data.
3	Calibrated Data	Edited data that are still in units produced by instrument, but have transformed (e.g. calibrated, rearranged) in a reversible manner and packaged with needed ancillary and auxiliary data (e.g. radiances with calibration equations applied). Referred to in the MESSENGER Program as Calibrated Data Records (CDRs). In some cases these also qualify as derived data products (DDRs). Corresponds to NASA Level 1A.
4	Resampled data	Irreversibly transformed (e.g. resampled, remapped, calibrated) values of the instrument measurements (e.g. radiances, magnetic field strength). Referred to in the MESSENGER program as either derived data products (DDPs) or derived analysis products (DAPs). Corresponds to NASA Level 1B.
5	Derived Data	Derived results such as maps, reports, graphics, etc. Corresponds to NASA Levels 2 through 5
6	Ancillary Data	Non-Science data needed to generate calibrated or resampled data sets. Consists of instrument gains, offsets; pointing information for scan platforms, etc.
7	Corrective Data	Other science data needed to interpret space-borne data sets. May include ground based data observations such as soil type or ocean buoy measurements of wind drift.
8	User Description	Description of why the data were required, any peculiarities associated with the data sets., and enough documentation to allow secondary user to extract information from the data.

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

8.14 MESSENGER Acronym List

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

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