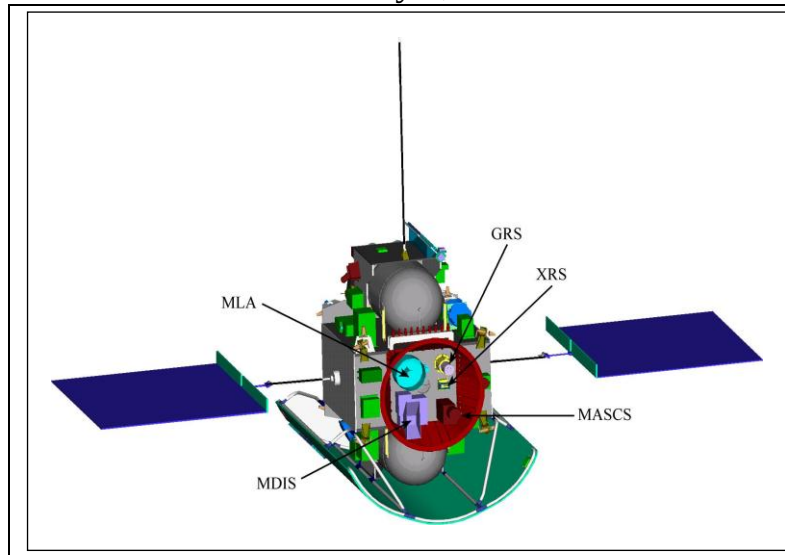


MESSENGER X-Ray Spectrometer Calibrated and Reduced Data Record Software Interface Specification

Version 1.35
February 8, 2017



Document Review

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

Richard Starr, MESSENGER XRS Instrument 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
8/15/05	All	Draft	1.0a
9/9/05	All	Draft	1.0b
10/6/05	All	Draft	1.0c
10/11/05	All	Draft	1.0d
04/20/06	Appendix 6.4	Changes to EDR data types	1.0e
08/17/06	Appendix, XRS Data Columns	Added new data type, DATA_QUALITY_FLAG	1.0f
12/21/07	All	Draft	1.1
01/09/08	All	Draft	1.2
02/04/08	All	Draft	1.3
10/13/08	All	Draft	1.4
11/03/08	All	Draft	1.5
01/20/09	All	Draft	1.6
02/03/09	All	Draft	1.7
03/19/09	All	Draft	1.8
04/07/09	All	Draft	1.9
04/14/09	All	Draft	1.10
04/15/09	All	Added search indexes	1.11
05/07/09	All	Added reference to the MESSENGER X-Ray (XRS) EDR-to-CDR Processing document	1.12
05/20/09	All	Added UNIT attribute to column definitions in XRS_CDR.FMT	1.13
06/12/09	5.6	Modified the archive's DATA sub-directory under the month sub-directory to be named after the day of the month not the day of the year.	1.14
11/5/09	5.2, 5.5.1, 5.6	Corrected the XRS label, added MISSION_PHASE_NAME, added software directory to archive	1.15
12/15/09	Header	Removed the draft in revision from the header	1.16
01/12/10	Appendix 7.5, 7.6	Revised wording for sc_range and sc_angle to document that -1 indicates value could not be computed	1.17
01/18/10	5.6.1	Minor modifications to the archive directory contents.	1.18
6/16/11	Document Review	Added document review information	1.19

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6/16/11	Table 3, 7.6	Changed “periherm” to “apoherm” in orbit start time descriptions for orbit numbering	1.20
5/26/12	2, 4.1	Changed “Data Management and Science Analysis Plan” to “Data Management and Archiving Plan”. Referenced that plan for extended mission updates.	1.21
06/14/2013	1, 3, 4, 5, 6	Add information regarding elemental ratio maps.	1.22
10/24/2013	5.2, 5.3, Appx. 7.4,	Updated sample PDS labels, edited table per RDR peer review.	1.23
11/7/2013	4.2, 5.2, 5.4	Added description of resolution map products.	1.24
11/14/2013	5.2, 5.4	Updated sample map labels; added resolution map to naming conventions.	1.25
12/4/2013	4.2	Changed scaling of maps from specifics to references to labels, data.	1.26
12/21/15	4.2	Updated to reflect final RDR map product generation.	1.27
12/22/15	All	Editorial changes.	1.28
1/6/16	All	Additional editorial changes.	1.29
1/6/16	All	Additional editorial changes.	1.30
1/7/16	All	Final editorial changes.	1.31
8/18/16	All	Added information regarding RDR Footprint data products.	1.32
8/29/16	4.2	Additional editorial changes.	1.33
1/13/17	4.3.2, 5.5.1	Edits resulting from RDR Footprint peer review.	1.34
2/8/17	5.3	Revised sample index file label.	1.35

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1 Purpose and Scope of Document

1.1 Purpose

This document provides users of the MESSENGER XRS data products with a detailed description of the XRS instrument, data product generation, validation, and storage. The data products are the calibrated data products produced from each of the EDR data products and the reduced data products produced from the calibrated data products. The primary XRS data product consists of an X-ray spectrometer measurement over a given area of the Mercury surface.

1.2 Scope

The goal of this document is to provide thorough and complete information, so that PDS users can read and understand the data product long after the completion of the MESSENGER mission. As such, this document provides a common reference for scientists, data analysts, software engineers, and researchers to access and understand the MESSENGER X-Ray Spectrometer PDS archived data. The primary XRS data product consists of three 244 channel X-ray spectra collected over a given area of the Mercury surface. The XRS determines the surface elemental composition by analyzing the most prominent fluorescent lines in the 1-10 keV energy range: Mg, Al, Si, S, Ca, Ti, and Fe.

This document addresses the calibrated data records (Level-3) and reduced data records (Level-5). Note that the data product levels stated in this document correspond to the data levels outlined by the National Research Council Committee on Data Management and Computation (CODMAC). These data levels are described more fully in Section 7.2 APPENDIX: CODMAC/NASA Definition of Processing Levels on page 33.

2 Applicable Documents

The Messenger XRS CDR/RDR SIS is responsive to the following documents:

- Planetary Data System Standards Reference, March 20, 2006, Version 3.7. JPL D-7669, Part-2.
- MESSENGER EDR Software Interface Specification for the X-RAY Spectrometer.
- MESSENGER Data Management and Archiving Plan. The Johns Hopkins University, APL.
- MESSENGER Project Archive Generation, Validation, and Distribution Plan.
- MESSENGER Mercury: Surface, Space Environment, Geochemistry, Ranging; A mission to Orbit and Explore the Planet Mercury, Concept Study, March 1999.
- [PLR] Appendix 7 to the discovery program Plan; Program Level Requirement for the MESSENGER Discovery project, June 20, 2001.
- MESSENGER Gamma Ray Spectrometer (GRS) EDR-to-CDR-to-RDR Processing.

3 Relationships with Other Interfaces

The XRS CDR data products are dependent on the XRS EDR data products. Changes to the EDR products have required revisions to the associated CDR products. The XRS CDR data products are also dependent on valid SPICE Kernel generation for timing and spatial information. Changes or revisions to the SPICE Kernel have also required revisions to the XRS CDR products. Changes to data processing programs (see Section 4.3, Data Processing on page 11) that convert EDR data to CDR data have also resulted in revised CDR data products.

The XRS RDR data products are dependent on the XRS CDR data products and on valid SPICE kernels for timing and spatial information. Changes to the XRS CDR data products or the SPICE kernels have resulted in revisions to the RDR products.

4 Data Product Characteristics and Environment

4.1 Instrument Overview

The Mercury Surface, Space Environment, Geochemistry and Ranging (MESSENGER) mission was designed to orbit Mercury following one Earth flyby, two flybys of Venus and three of Mercury. It launched in August 2004 and used the flybys of Earth, Venus and Mercury to achieve an orbit insertion around Mercury in March 2011. Initial data collection began during the three flybys of Mercury and primarily consisted of global mapping and measurements of the surface, atmosphere, and magnetosphere composition. MESSENGER remained in orbit for the rest of the nominal mission which ended in March 2012 [see MESSENGER Data Management and Archiving Plan for extended mission updates]. Once in orbit around Mercury, it began a series of observations using multiple instruments. These observations provided 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 XRS instrument on board the MESSENGER spacecraft was designed to answer questions such as:

- What planetary formational processes led to the high metal/silicate ratio in Mercury?
- What is the geological history of Mercury?

Answers to these questions will provide insight into the formation of planets from primitive solar nebula and contribute to our understanding of how terrestrial planets form and evolve. XRS collected information via X-Ray spectroscopy by analyzing the most prominent fluorescent lines in the 1-10 keV energy range, i.e. Mg, Al, Si, S, Ca, Ti, and Fe. X-rays emitted from the solar corona provide the excitation source for the detected X-rays from the planetary surface (to a depth of <100 μm). Thus quantification of elemental abundances from the observed XRS spectra also requires knowledge of the solar X-ray spectrum at the same time. In order to understand the structure and nomenclature of the XRS data products it is useful to understand how the XRS instrument operates. The XRS

instrument consists of three gas proportional counter (GPC) planetary X-ray detectors. The GPCs detect individual photons. An incoming X-ray photon penetrates the thin beryllium window of a sealed gas-filled chamber and interacts with the gas, producing an energetic photoelectron (known as the photoelectric effect). The kinetic energy of the electron is then progressively absorbed in the gas, leaving an ionization trail. The free electrons from the ionization are attracted to a thin wire anode at high potential stretched down the center of the chamber. In the region of high electric field strength, very close to the wire, the electrons reach sufficient energy to liberate even more electrons in a stable multiplication effect that provides signal gain. This signal gain helps to overcome the preamplifier noise. Because the energy resolution of GPCs is not adequate to separate the lower energy x-ray lines from Mg, Al, and Si, the balanced filter technique is used: one GPC has a thin aluminum filter, one a thin magnesium filter, and the third GPC has no filter.

To record solar X-ray spectra simultaneously with planetary observations, the XRS sensor consists of a passively cooled silicon Solar Monitor Detector with a beryllium filter. The entire sensor is stored in two physical units, the Solar Assembly for X-rays (SAX) and the Mercury X-ray Unit (MXU). A third unit, the Main Electronics for X-rays (MEX) unit, contains analog and digital electronics.

The SAX is located at the “top center” edge of the solar shield (see Figure 1) and contains the Solar Monitor Detector, Preamplifier and Shaping electronics, as well as the radiator and heater for thermal control. The MXU and MEX are co-located within the payload adapter ring.

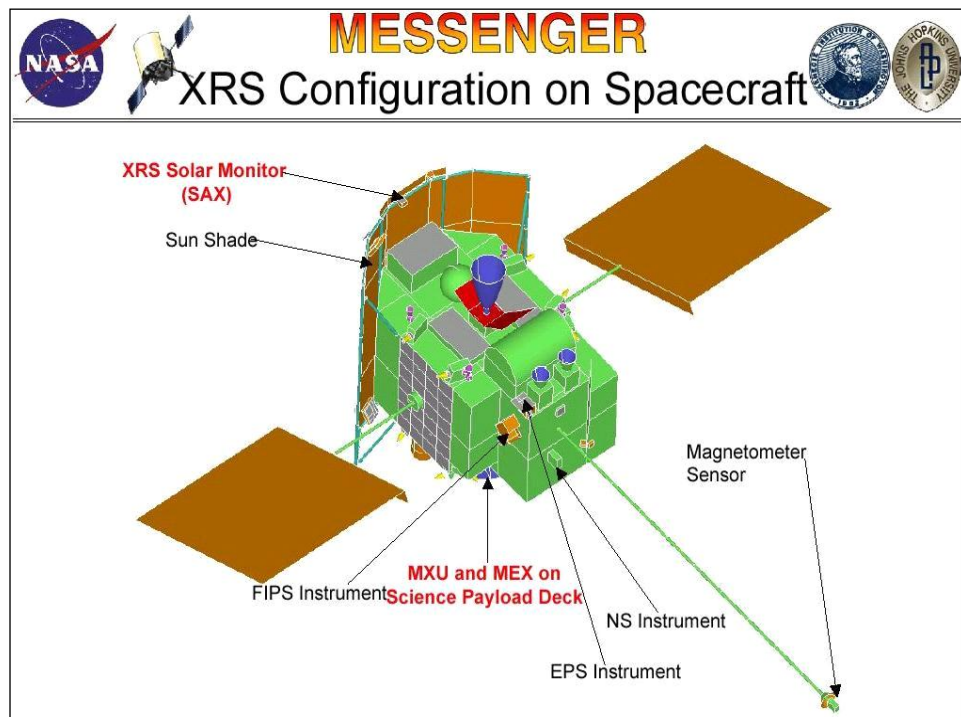


Figure 1 XRS Configuration on MESSENGER

The XRS sensor recorded 40 second integration periods at periherm and 450 second integration periods at apoherm. The data consists of three 244-element X-ray energy histograms, one for each GPC and one 231-element X-ray energy histogram for the SAX. The EPU software incremented one of the 244 software accumulators for each valid x-ray event. The accumulator was chosen based on the energy measurement provided by the sensor hardware.

The instrument paper can be found as follows:

“The X-Ray Spectrometer on the MESSENGER Spacecraft”

Charles E. Schlemm II, Richard D. Starr, George C. Ho, Kathryn E. Bechtold, Sarah A. Hamilton, John D. Boldt, William V. Boynton, Walter Bradley, Martin E. Fraeman, Robert E. Gold, John O. Goldsten, John R. Hayes, Stephen E. Jaskulek, Egidio Rossano, Robert A. Rumpf, Edward D. Schaefer, Kim Strohbehn, Richard G. Shelton, Raymond E. Thompson, Jacob I. Trombka, and Bruce D. Williams

Space Sci Rev DOI 10.1007/s11214-007-9248-5 (2007).

4.2 Data Product Overview

The XRS CDR is a single data product that contains the following spectra, each uniquely identified at the time of the collection interval:

Monitor Spectrum – A single energy calibrated solar monitor x-ray spectrum (channels 23 to 253) for each XRS collection interval.

GCP1-Mg Spectrum – A single energy calibrated GCP1-Mg x-ray spectrum (channels 10-253) for each XRS collection interval.

GPC2-Al Spectrum - A single energy calibrated GCP2-Al x-ray spectrum (channels 10-253) for each XRS collection interval.

GPC3-Un Spectrum - A single energy calibrated GCP3-UN x-ray spectrum (channels 10-253) for each XRS collection interval.

Event counts per channel are converted to flux as a function of energy.

The energy calibration is:

*GPC1: 0.0383*channel + 0.383*

*GPC2: 0.0383*channel + 0.383*

*GPC3: 0.0379*channel + 0.379*

*SolMon: 0.0375*channel + 0.863*

Engineering and housekeeping data are also part of each CDR.

The engineering data stored in the data files have been smoothed (See the MESSENGER XRS_EDR2CDR2RDR calibration document for details on the smoothing algorithm).

Each MESSENGER X-Ray Spectrometer CDR product consists of two files. One file contains the data itself and is arranged in binary table format. The other file is a label file that describes the content of the data file. The label file defines the start time and end time of the observation, product creation time, etc. It does NOT describe the structure of the binary file itself. Instead, the PDS label file contains a reference pointer to a separate format file. The format file describes the structure of the binary table and each of the different fields within the table. This format file resides in the label directory of the archive volume, because it applies to the structure of all the binary table files.

The RDR Footprint product consists of a data file and label for each CDR observation whose FOV_STATUS is 1 or 3; that is, each CDR observation whose footprint is on the planet (1) or partially on the planet (3) and the on-planet portion of the footprint is at least partially lit by the sun. Each RDR footprint consists of a set of points in latitude and longitude that correspond to the perimeter of the field of view of the instrument during the integration time of the CDR observation. The data file for the footprints is a comma-separated value file with each point in the perimeter on its own line, latitude followed by east longitude, both in decimal degrees.

The RDR Map product consists of a set of maps that show the variation in the ratios of detected elements over the surface of the planet for which CDR data is available: Mg/Si, Al/Si, S/Si, Ca/Si, and Fe/Si. A second set of maps shows the uncertainty in the measurements presented in the ratio maps. A third set of maps shows the effective resolution of the map; that is, the weighted average footprint of samples used to create the ratio maps in kilometers. Each of the five elemental maps, the five uncertainty maps, and the five effective resolution maps consists of two files: a JPEG2000 image using the lossless compression mode, and a label file. The relationship between the image and label is the same as the relationship between the CDR data file and the label. Both the ratio map and uncertainty map are dimensionless; the unit of the effective resolution map is kilometers.

The maps are 1440 x 720 pixels corresponding to 1/4-degree pixels in a equirectangular cylindrical projection with parallel equator, centered on {lat,lon}={0,0} (See SNYDER1987, *Map Projections – A Working Manual*, Snyder, 1987, page 90). Thus, the first column represents longitude = -180 to -179.75 degrees, the bottom row is -90 to -89.75 degrees south latitude, etc. All images are 8-bit grayscale.

The ratio, error, and effective resolution maps are linearly scaled such that the maximum pixel value, 255, represents the maximum data value for the map, specified in the concomitant label. A value of zero in any of the map types indicates no data. To derive the actual value of the map at a given position, one multiplies the pixel value by the

maximum data value divided by the maximum pixel value. For example, if the maximum pixel value corresponds to a Mg/Si ratio of 1.0 in the appropriate ratio map, one would find the value of the ratio at a particular location by multiplying the pixel value at that location by the factor $1.0/255 = 0.00392$.

The Mg/Si and Al/Si maps include data acquired both during solar flares and more quiescent 'quiet Sun' conditions. The dynamic range of Al/Si on Mercury is considerably smaller than that of Mg/Si and the errors on individual quiet sun Al/Si analyses are relatively large. The other three ratio maps all require flare data and as a result the spatial coverage is more spotty. To improve statistical precision, quiet-Sun data (Mg/Si and Al/Si maps) were spatially binned such that XRS count rates acquired within a given spatial bin were co-added prior to derivation of elemental ratios. Bin sizes were selected based on spatial resolution of individual measurements. Measurements with footprint sizes (equivalent diameters of a circular footprint with equivalent area to the actual measurement area) larger than 100 km were divided into bins of roughly 66×66 km; those with footprints from 50-100 km were divided into roughly 26×26 km bins and measurements with footprints smaller than 50 km were not binned.

The RDR maps are composed of a subset of CDR records spanning the Mercury Orbit, Mercury Orbit Year 2, Mercury Orbit Year 3, Mercury Orbit Year 4, and Mercury Orbit Year 5 mission phases. The criteria for inclusion in the map are the following: the FOV status of the record is 1 or 3; the signal-to-noise ratio of the GPC spectra was sufficient for elemental analysis; the SAX detector was on and provided a solar spectrum; contamination from charged particle interactions was below a threshold; and, the footprint of the sample given the position and pointing of the instrument was sufficiently small.

Map pixels represent a weighted average of the samples whose footprints overlap the pixel location; the weighted average favors measurements with smaller errors and smaller footprints. Because the mapping procedure introduces artifacts due to the sharp edges of individual measurement footprints, the maps are subjected to a final smoothing with a location-dependent smoothing algorithm, based on the spatial resolution (average footprint size of overlapping measurements) in a given pixel.

Please see the following paper for further details on RDR map generation:

Weider, S.Z., Nittler, L.R., Starr, R.D., Crapster-Pregont, E.J., Peplowski, P.N., Denevi, B.W., Head, J.W., Byrne, P.K., Hauck, S.A. II, Ebel, D.S. and Solomon, S.C. (2015) Evidence for geochemical terranes on Mercury: Global mapping of major elements with MESSENGER's X-Ray Spectrometer. *Earth Planet. Sci. Lett.* 416, 109-120.

4.3 Data Processing

4.3.1 Data Processing Level

The Committee on Data Management and Computation (CODMAC) data level numbering system is used to describe the processing level of the XRS data products. XRS CDR products are considered a CODMAC “Level 3” (Calibrated) or NASA “Level 1A.” The RDRs are CODMAC “Level 5” data products. See the “CODMAC/NASA Definition of Processing Levels for Science Data Sets” in section 7.2.

4.3.2 Data Product Generation

The X-Ray Spectrometer CDR files were produced by the University of Arizona and provided to MESSENGER Science Operations Center (SOC) operated jointly by APL and ACT. The University of Arizona was responsible for converting the data to the proper PDS labeled format. The CDR data products were made available to the MESSENGER Science Team for initial evaluation and validation. At the end of the evaluation and validation period, the data were organized and made available to the PDS for distribution to the science community. These products are used for engineering support, direct science analysis, and construction of other science products.

The XRS RDR Footprint files were produced at the University of Arizona using the integration start and stop times and midpoint altitudes from the corresponding CDR records, and the final SPICE kernels for the instrument and spacecraft. For each observation, a HEALPix map was created at a resolution dependent on the midpoint altitude. HEALPix creates a map on a sphere with equal area, curvilinear quadrilateral pixels centered on equally spaced latitude bands. The base map has twelve pixels that are subdivided based on the NSIDE parameter, which determines the number of subpixels placed along the side of each base map pixel; each pixel is, thus, divided into NSIDE by NSIDE subpixels. At altitudes at or below 10 km, NSIDE is set to 4096. At altitudes greater than 10 but less than and including 60 km, NSIDE is 1024. At altitudes above 60 km, NSIDE is 256. These values were determined experimentally and were modified until the consensus of the team was that the footprints produced reasonably represented the true footprint of the observations. Because the footprint perimeters are vertices of the HEALPix map at the selected resolution, the resolution of the map necessarily adds some uncertainty to the map boundaries.

For each CDR observation, the midpoint altitude and the instrument field of view are used to mark pixels on the HEALPix map that fall within the observation’s footprint. After all constituent pixels are marked, a perimeter is derived whose vertices are the exterior vertices of the boundary pixels. This perimeter is stored as latitude and east longitude pairs in decimal degrees. Pole-spanning footprints may contain a small number of anomalous vertices in the interior of the footprint shape; these are an artifact of the HEALPix processing and may be ignored.

There are two suggested methods for correlating footprints to their CDR record counterparts. When processing the dataset in bulk, the spacecraft clock can be used a primary key for associating footprints and CDR records. When processing much smaller sets, the UTC date can be used as a first key to constrain the search. CDR records are organized into folders based on UTC year, month, and day. Within a single UTC day, all

CDR records are collected into a single file with each observation a row in that file. Footprints are organized into folders based on UTC year, month, day, and hour. Within a single UTC hour, footprints are stored as individual files. To verify the correspondence of a footprint and CDR record, the spacecraft clock should be used.

For further details on the HEALPix library and algorithm, please see K. M. Gorski, E. Hivon, A. J. Banday, B. D. Wandelt, F. K. Hansen, M. Reinecke, M. Bartelman, HEALPix: A Framework for High-Resolution Discretization and Fast Analysis of Data Distributed on the Sphere, *Astrophysics*, 622, 759-771, 10.1086/427976, 2004.

The XRS RDR Map files were produced by the Carnegie Institute of Washington and provided to the MESSENGER Science Operations Center (SOC) operated jointly by APL and ACT. The University of Arizona was responsible for converting the data to the proper PDS labeled format. The RDR Map data products were made available to the MESSENGER Science Team for initial evaluation and validation. At the end of the evaluation and validation period, the data were organized and made available to the PDS for distribution to the science community. These products are used for engineering support, direct science analysis, and construction of other science products.

4.3.3 Data Flow

The MESSENGER Team plans data acquisition and generates and validates data archives under the auspices of the MESSENGER Project Scientist. The SOC supports and works with the MOC, The Science Team, instrument scientists, and the PDS.

A primary data server residing at the Johns Hopkins University/Applied Physics Lab (JHU/APL) served as the data storage facility for all MESSENGER instruments. Inputs to the SOC consisted of telemetry in the form of CCSDS packets.

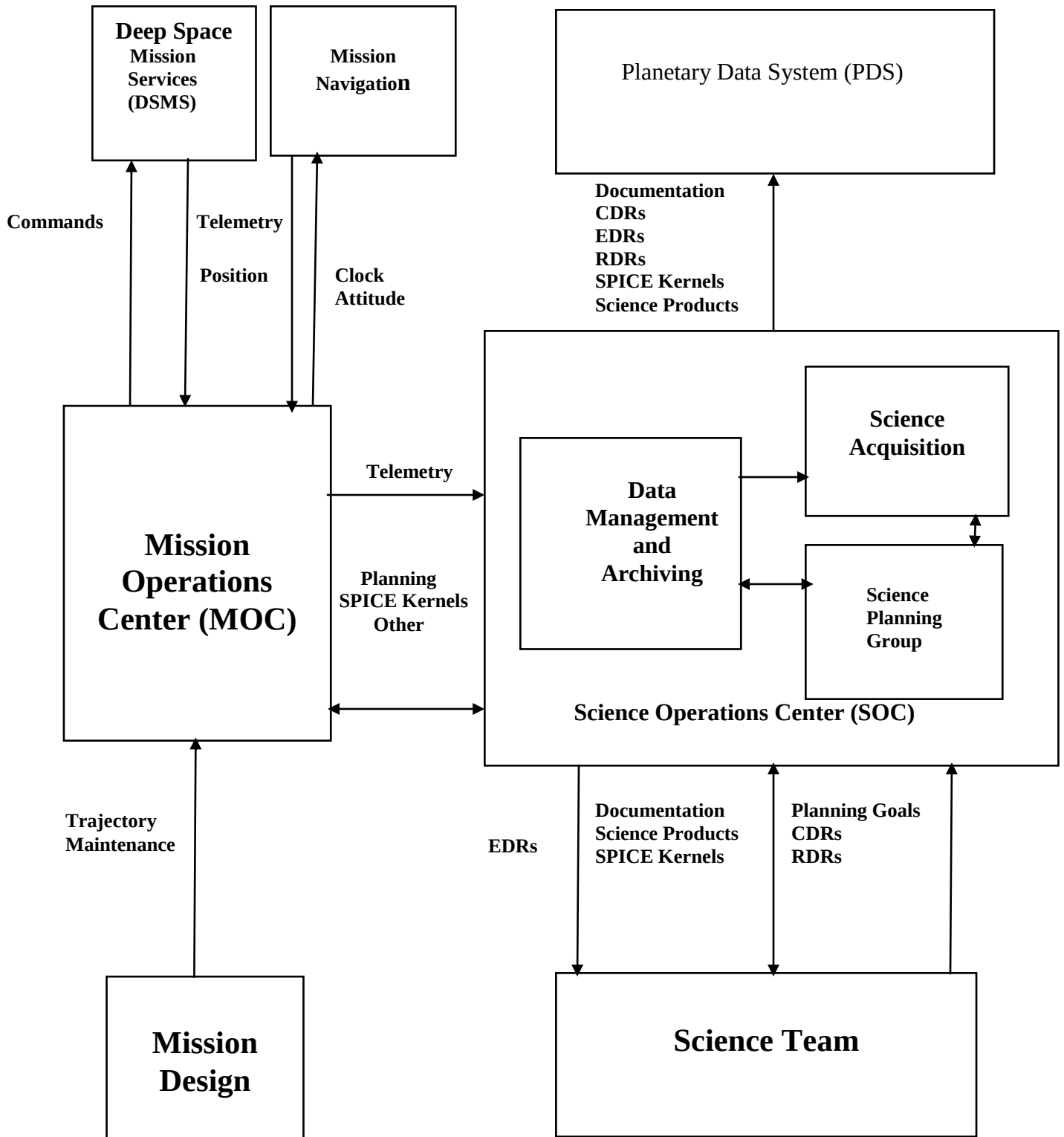


Figure 2 MESSENGER data flow

4.3.4 Labeling and Identification

There is a corresponding PDS label file for each X-Ray data file. See Section 5, Detailed Data Product Specifications, for sample PDS label files and a complete description of the label format.

4.4 Standards Used in Generating Data Products

4.4.1 PDS Standards

The XRS CDR and RDR data products comply with the PDS standards for file formats and labels as specified in the PDS Standards Reference.

The CDR data product includes:

- A binary table file (the primary data).
- A label file (includes a high-level description of the parameters corresponding to the binary table).
- A pointer to a FORMAT file describing the structure of the binary table file.

The RDR Footprint data product includes:

- A comma-separated value spreadsheet; each line represents a vertex in the footprint perimeter, and the values are recorded latitude and longitude in decimal degrees.
- A label file that describes the observation from which the footprint is derived.

The RDR Map data product includes:

- A JPEG 2000 file (the primary data).
- A label file (includes a high-level description of the parameters corresponding to the JP2 image file).

4.4.2 Coordinate Systems

There are two coordinate systems in use:

- The celestial reference system used for target and spacecraft position and velocity vectors and camera pointing.
- The planetary coordinate system for geometry vectors and target location. The celestial coordinate system is J2000 (Mean of Earth equator and equinox of J2000). The planetary coordinate system is **planetocentric**.

The list below describes the computational assumptions for the geometric and viewing data provided in the PDS label:

- The mid-point time of observation is used for the geometric element computations. (The mid-point is calculated using the Start and End times from the EDR set.)
- Label parameters reflect observed, not true, geometry. Therefore, light-time and stellar aberration corrections are used as appropriate.
- The inertial reference frame is J2000 (also called EME2000).
- Latitudes and longitudes are **planetocentric**.
- The "sub-point" of a body on a target is defined by the surface intercept of the body-to-target-center vector. This is not the closest point on the body to the observer.
- Distances are in km, speeds in km/sec, angles, in degrees, angular rates in degrees/sec, unless otherwise noted.
- Angle ranges are 0 to 360 degrees for azimuths and local hour angle. Longitudes range from 0 to 360 degrees (positive to the East). Latitudes range from -90 to 90 degrees.
- Solid angles units are in steradians.
- SPICE kernel files are used in the geometric parameters (See APPENDIX: SPICE Kernel Files Used in MESSENGER Data Products on page 33.)

4.4.3 Data Storage Conventions

The data are organized following PDS standards. The MESSENGER SOC transfers data to PDS via electronic transfer and delivery. After verification of the data transfer PDS provides public access to MESSENGER science data products through its online data distribution system.

4.5 Data Validation

The XRS CDR and RDR data products were validated by the XRS Instrument Scientist for science content and for compliance with PDS archive standards [MESSENGER Data Management and Archiving Plan].

5 Detailed Data Product Specifications

5.1 Data Product Structure and Organization

Timed series spectral analysis can be used to create calibrated data sets and temporally and spatially binned corrected X-ray spectra. The resulting data product is structured as a 231-column data table with data records collected over one earth day.

The XRS CDR data products are organized as binary data files containing the data values with a detached ASCII text PDS label file for each binary file.

The XRS RDR Footprint data products are organized in a tree similarly to the CDR data. They are grouped in subdirectories by UTC year, month, day, and hour, e.g. a footprint corresponding to a CDR observation whose start time was 2013-01-02-03:04:05 would be stored in subdirectory 2013/01/02/03. Each footprint corresponding to a CDR is stored in its own data file named XRS_FP_<P>_<MET>.CSV, where <P> is the spacecraft clock partition (either 1 or 2), and <MET> is the mission elapsed time in seconds within that clock partition. Each footprint has an accompanying label file that describes the footprint and the CDR record from which it was derived.

The XRS RDR Map data products are organized as five elemental maps, five uncertainty maps, and five effective resolution maps consisting of two files each: a JPEG2000 image using the lossless compression mode, and a label file.

See Section 5.2 Data Format Description on page 19 for sample PDS label files and an explanation of the label format.

5.1.1 Handling Errors

Even with data validation procedures applied to the volumes, it is inevitable errors will be introduced into the archive. A plan is required to handle errors discovered in data volumes that have already been produced.

As errors were discovered, they were reported to the XRS data processing facility. Corrected CDRs and RDRs were provided as part of the normal deliveries which occurred during the scheduled delivery dates.

5.1.2 Geometric Elements

The geometric elements are an essential part of the archive. They contain the data and information to characterize the geometric properties of the sensor and to fully describe the viewing geometry of an observation. These data are essential to geodetic, cartographic, and photometric applications.

The geometric elements are organized according to the SPICE kernel concepts adopted by the Navigational & Ancillary Information Facility (NAIF) at the Jet Propulsion Laboratory. SPICE is an acronym for **S**pacecraft, **P**lanet, **I**nstrument, **C**-matrix, and **E**vent kernels.

The SPICE kernel data set used in the creation of the CDR and RDR data sets is available from the NAIF ftp site. SPICE kernels evolve and improve as further analysis is done. The analysis may include correcting not-yet-discovered errors and filling in missing items. The PDS data labels attached to the CDRs and RDRs are based on the most up-to-

date SPICE information available at the time of product creation.

5.2 Data Format Description

CDR data are stored in binary table format. A detached PDS label file provides a detailed description of the structure of the binary table. For the CDR product, an example label follows:

```
PDS_VERSION_ID          = "PDS3"

/*** FILE FORMAT ***/
FILE_RECORDS             = 1
RECORD_TYPE              = FIXED_LENGTH
RECORD_BYTES             = 2755

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID               = "XRSCDR2011030"
PRODUCT_VERSION_ID       = "1.0"
PRODUCT_CREATION_TIME    = 2011-08-30T21:20:02
PRODUCT_TYPE             = "CDR"
STANDARD_DATA_PRODUCT_ID = "XRSCDR"
SOFTWARE_NAME            = "UA_LPL_EDR2CDR"
SOFTWARE_VERSION_ID      = "1.0"
INSTRUMENT_HOST_NAME     = "MESSENGER"
INSTRUMENT_NAME          = "XRAY SPECTROMETER"
INSTRUMENT_ID            = "XRS"
DATA_SET_ID              = "MESS-H-XRS-3-CDR-SPECTRA-V1.0"
MISSION_PHASE_NAME       = "MERCURY 3 CRUISE"
TARGET_NAME              = "MERCURY"
START_TIME               = 2011-08-03T05:59:16
STOP_TIME                = 2011-08-03T05:59:16
SPACECRAFT_CLOCK_START_COUNT = "220838615"
SPACECRAFT_CLOCK_STOP_COUNT = "220838615"
^TABLE                   = "XRSCDR2011030.DAT"

OBJECT                   = TABLE
  COLUMNS                = 231
  INTERCHANGE_FORMAT      = BINARY
  ROW_BYTES               = 2755
  ROWS                    = 1
  DESCRIPTION              = "
    This table contains X-ray spectra and associated instrument
    parameters, as observed by the MESSENGER X-Ray Spectrometer (XRS).
    Detailed descriptions for the parameters defined below are contained
    in the CDR SIS document. The complete column definitions are contained
    in an external file found in the LABEL directory of the archive volume.
  "
  ^STRUCTURE              = "XRS_CDR.FMT"
END_OBJECT               = TABLE
```

A sample label for the RDR Footprint product is as follows:

```
PDS_VERSION_ID          = PDS3

/*** FILE FORMAT ***/
FILE_RECORDS             = 840
RECORD_TYPE              = STREAM
RECORD_BYTES             = 29

/*** GENERAL DATA DESCRIPTION PARAMETERS ***/
PRODUCT_ID               = "XRS_FP_1_223411510_CSV"
PRODUCT_VERSION_ID       = "1.0"
PRODUCT_CREATION_TIME    = 2016-08-03T17:46:06
PRODUCT_TYPE             = "RDR"
STANDARD_DATA_PRODUCT_ID = "XRSRDR"
SOFTWARE_NAME            = "XMAP"
SOFTWARE_VERSION_ID      = "1.0"
INSTRUMENT_HOST_NAME     = "MESSENGER"
```

XRS CDR/RDR SIS

```

INSTRUMENT_NAME           = "XRAY SPECTROMETER"
INSTRUMENT_ID             = "XRS"
DATA_SET_ID              = "MESS-H-XRS-5-RDR-FOOTPRINTS-V1.0"
TARGET_NAME              = "MERCURY"
START_TIME               = 2011-09-02T00:40:42
STOP_TIME                = 2011-09-02T00:45:42
SPACECRAFT_CLOCK_START_COUNT = "1/223411510"
SPACECRAFT_CLOCK_STOP_COUNT  = "1/223411810"
^SPREADSHEET             = "XRS_FP_1_223411510.CSV"

OBJECT                   = SPREADSHEET
  ROWS                   = 840
  ROW_BYTES              = 29
  FIELDS                 = 2
  FIELD_DELIMITER        = "COMMA"

OBJECT                   = FIELD
  FIELD_NUMBER           = 1
  NAME                   = "LATITUDE"
  BYTES                  = 13
  DATA_TYPE             = ASCII_REAL
  UNIT                   = "DEGREE"
  DESCRIPTION            = "Latitude in Mercury-fixed coordinates of
    this vertex in the footprint perimeter."
  END_OBJECT             = FIELD

OBJECT                   = FIELD
  FIELD_NUMBER           = 2
  NAME                   = "LONGITUDE"
  BYTES                  = 13
  DATA_TYPE             = ASCII_REAL
  UNIT                   = "DEGREE"
  DESCRIPTION            = "East longitude in Mercury-fixed
    coordinates of this vertex in the footprint perimeter."
  END_OBJECT             = FIELD

END_OBJECT              = SPREADSHEET

END

```

A sample label for the RDR Map product is as follows:

```

PDS_VERSION_ID           = "PDS3"

PRODUCT_ID               = "XRS_MAP_MG_SI_20150424_JP2"
PRODUCT_VERSION_ID       = "1.0"
PRODUCT_CREATION_TIME    = 2015-11-25T16:23:01
PRODUCT_TYPE             = "RDR"
STANDARD_DATA_PRODUCT_ID = "XRSRDR"
SOFTWARE_NAME            = "UA_LPL_EDR2CDR"
SOFTWARE_VERSION_ID      = "1.0"
INSTRUMENT_HOST_NAME     = "MESSENGER"
INSTRUMENT_NAME          = "XRAY SPECTROMETER"
INSTRUMENT_ID            = "XRS"
DATA_SET_ID              = "MESS-H-XRS-3-RDR-MAPS-V1.0"
MISSION_PHASE_NAME       = {"MERCURY ORBIT", "MERCURY ORBIT YEAR 2",
    "MERCURY ORBIT YEAR 3",
    "MERCURY ORBIT YEAR 4",
    "MERCURY ORBIT YEAR 5"}

TARGET_NAME              = "MERCURY"
START_TIME               = 2011-04-07T03:19:53.691
STOP_TIME                = 2015-04-24T21:05:34.295
SPACECRAFT_CLOCK_START_COUNT = "1/210633861"
SPACECRAFT_CLOCK_STOP_COUNT  = "2/072233522"
DESCRIPTION              = "Map of the ratio of Mg to Si, linearly
    scaled such that the maximum pixel
    value corresponds to a Mg/Si value
    of 0.782055."

```

XRS CDR/RDR SIS

```

OBJECT                                = COMPRESSED_FILE
  FILE_NAME                           = "XRS_MAP_MG_SI_20150424.JP2"
  FILE_RECORDS                        = UNK
  RECORD_TYPE                         = UNDEFINED
  ENCODING_TYPE                       = JP2
  ENCODING_TYPE_VERSION_NAME          = "ISO/IEC15444-1:2004"
  INTERCHANGE_FORMAT                  = BINARY
  REQUIRED_STORAGE_BYTES               = "14745600"
  UNCOMPRESSED_FILE_NAME              = "XRS_MAP_MG_SI_20150424.IMG"
  ^DESCRIPTION                        = "JP2INFO.TXT"
END_OBJECT                           = COMPRESSED_FILE

OBJECT                                = UNCOMPRESSED_FILE
  RECORD_TYPE                         = FIXED_LENGTH
  FILE_RECORDS                        = 1440
  RECORD_BYTES                        = 11520
  ^IMAGE                              = "XRS_MAP_MG_SI_20150424.IMG"
  OBJECT                              = IMAGE
    NAME                              = "RATIO OF MG TO SI"
    LINES                             = 1440
    LINE_SAMPLES                      = 720
    SAMPLE_TYPE                       = LSB_INTEGER
    SAMPLE_BITS                       = 8
    UNIT                              = NONE
    SCALING_FACTOR                    = 0.0030668824
    OFFSET                            = 0
    DERIVED_MINIMUM                   = 0
    DERIVED_MAXIMUM                   = 0.782055
    MISSING_CONSTANT                  = 0
  END_OBJECT                          = IMAGE
END_OBJECT                           = UNCOMPRESSED_FILE

OBJECT                                = IMAGE_MAP_PROJECTION
  ^DATA_SET_MAP_PROJECTION            = "DSMAP.CAT"
  MAP_PROJECTION_TYPE                 = "SIMPLE CYLINDRICAL"
  KEYWORD_LATITUDE_TYPE               = "PLANETOCENTRIC"
  MAP_RESOLUTION                      = 4 <pix/degree>
  A_AXIS_RADIUS                       = 2439.4 <km>
  B_AXIS_RADIUS                       = 2439.4 <km>
  C_AXIS_RADIUS                       = 2439.4 <km>
  POSITIVE_LONGITUDE_DIRECTION        = "EAST"
  CENTER_LATITUDE                     = 0.0 <deg>
  CENTER_LONGITUDE                    = 0.0 <deg>
  LINE_FIRST_PIXEL                    = 1
  LINE_LAST_PIXEL                     = 1440
  SAMPLE_FIRST_PIXEL                  = 1
  SAMPLE_LAST_PIXEL                   = 720
  MAP_PROJECTION_ROTATION              = 0.0
  MAP_SCALE                           = 10.6 <km/pix>
  MAXIMUM_LATITUDE                    = 90.0 <deg>
  MINIMUM_LATITUDE                    = -90.0 <deg>
  WESTERNMOST_LONGITUDE               = -180.0 <deg>
  EASTERNMOST_LONGITUDE               = 180.0 <deg>
  LINE_PROJECTION_OFFSET              = 0.0 <pixel>
  SAMPLE_PROJECTION_OFFSET            = 0.0 <pixel>
  COORDINATE_SYSTEM_TYPE              = "BODY-FIXED ROTATING"
  COORDINATE_SYSTEM_NAME              = "PLANETOCENTRIC"
END_OBJECT                           = IMAGE_MAP_PROJECTION
END

```

Note: The external file “XRS_CDR.FMT” defines the structure of the binary table for the CDR product. No format files are provided for the RDR products.

5.3 Index Format Description

XRS CDR/RDR SIS

The index files are stored in ASCII table format. A detached PDS label file provides a detailed description of the structure of the ASCII table. Below is a sample index file label.

```

PDS_VERSION_ID          = PDS3
RECORD_TYPE              = FIXED_LENGTH
RECORD_BYTES            = 235
FILE_RECORDS            = 350582
^INDEX_TABLE             = "INDEX.TAB"
VOLUME_ID               = MESSXRS_3001
DATA_SET_ID              = {"MESS-H-XRS-5-RDR-FOOTPRINTS-V1.0",
                           "MESS-H-XRS-3-RDR-MAPS-V1.0"}

MISSION_NAME             = "MESSENGER"
INSTRUMENT_NAME          = "XRAY SPECTROMETER"
PRODUCT_CREATION_TIME    = 2017-02-08T14:33:23
DESCRIPTION               = "This index file lists information
                           about each of the Messenger XRS RDR data products contained on
                           this archive volume."

OBJECT                   = INDEX_TABLE
  INTERCHANGE_FORMAT     = ASCII
  ROW_BYTES              = 235
  ROWS                   = 350582
  COLUMNS               = 13
  INDEX_TYPE             = SINGLE

OBJECT                   = COLUMN
  COLUMN_NUMBER          = 1
  NAME                   = VOLUME_ID
  DATA_TYPE             = CHARACTER
  START_BYTE             = 2
  BYTES                  = 12
  DESCRIPTION            = "The volume on which a data product is
                           stored."
END_OBJECT

OBJECT                   = COLUMN
  COLUMN_NUMBER          = 2
  NAME                   = PATH_NAME
  DATA_TYPE             = CHARACTER
  START_BYTE             = 17
  BYTES                  = 30
  DESCRIPTION            = "The full directory path to the file
                           relative to the volume root directory."
END_OBJECT

OBJECT                   = COLUMN
  COLUMN_NUMBER          = 3
  NAME                   = FILE_NAME
  DATA_TYPE             = CHARACTER
  START_BYTE             = 50
  BYTES                  = 26
  DESCRIPTION            = "The name of the file containing a data
                           product's PDS label."
END_OBJECT

OBJECT                   = COLUMN
  COLUMN_NUMBER          = 4
  NAME                   = PRODUCT_ID
  DATA_TYPE             = CHARACTER
  START_BYTE             = 79
  BYTES                  = 26
  DESCRIPTION            = "Unique identifier for a XRS RDR
                           product."
END_OBJECT

OBJECT                   = COLUMN
  COLUMN_NUMBER          = 5
  NAME                   = PRODUCT_TYPE

```

XRS CDR/RDR SIS

```

DATA_TYPE           = CHARACTER
START_BYTE          = 108
BYTES               = 3
DESCRIPTION          = "Type of XRS product."
END_OBJECT           = COLUMN

OBJECT              = COLUMN
COLUMN_NUMBER        = 6
NAME                 = PRODUCT_CREATION_TIME
DATA_TYPE            = TIME
START_BYTE           = 113
BYTES                = 19
DESCRIPTION           = "UTC date and time that a product
                        was created, in the format
                        yyyy-mm-ddThh:mm:ss."
END_OBJECT           = COLUMN

OBJECT              = COLUMN
COLUMN_NUMBER        = 7
NAME                 = PRODUCT_VERSION_ID
DATA_TYPE            = CHARACTER
START_BYTE           = 134
BYTES                = 4
DESCRIPTION           = "The version identifier of the product.
                        The first version of a product is
                        version 1.0. If the product is revised
                        and re-released, the version ID is
                        incremented."
END_OBJECT           = COLUMN

OBJECT              = COLUMN
COLUMN_NUMBER        = 8
NAME                 = RELEASE_ID
DATA_TYPE            = CHARACTER
START_BYTE           = 141
BYTES                = 4
DESCRIPTION           = "The ID of the MESSENGER mission data
                        release. The first release is 0001,
                        followed by 0002, etc."
END_OBJECT           = COLUMN

OBJECT              = COLUMN
COLUMN_NUMBER        = 9
NAME                 = TARGET_NAME
DATA_TYPE            = CHARACTER
START_BYTE           = 148
BYTES                = 7
DESCRIPTION           = "Planetary body that is the target of
                        observation; e.g., MERCURY."
END_OBJECT           = COLUMN

OBJECT              = COLUMN
COLUMN_NUMBER        = 10
NAME                 = START_TIME
DATA_TYPE            = TIME
START_BYTE           = 157
BYTES                = 23
DESCRIPTION           = "UTC date and time at the beginning
                        of data acquisition for this product,
                        in the format yyyy-mm-ddThh:mm:ss."
END_OBJECT           = COLUMN

OBJECT              = COLUMN
COLUMN_NUMBER        = 11
NAME                 = STOP_TIME
DATA_TYPE            = TIME
START_BYTE           = 181
BYTES                = 23
DESCRIPTION           = "UTC date and time at the end of
                        data acquisition for this product,
                        in the format yyyy-mm-ddThh:mm:ss."

```

XRS CDR/RDR SIS

```

END_OBJECT          = COLUMN

OBJECT              = COLUMN
  COLUMN_NUMBER     = 12
  NAME              = SPACECRAFT_CLOCK_START_COUNT
  DATA_TYPE        = CHARACTER
  START_BYTE        = 206
  BYTES             = 12
  FORMAT            = "A12"
  DESCRIPTION       = "Value of the spacecraft clock at
                      the beginning of data acquisition
                      for this product."

END_OBJECT          = COLUMN

OBJECT              = COLUMN
  COLUMN_NUMBER     = 13
  NAME              = SPACECRAFT_CLOCK_STOP_COUNT
  DATA_TYPE        = CHARACTER
  START_BYTE        = 221
  BYTES             = 12
  FORMAT            = "A12"
  DESCRIPTION       = "Value of the spacecraft clock at
                      the end of data acquisition for this
                      product."

END_OBJECT          = COLUMN

END_OBJECT          = INDEX_TABLE
END

```

5.4 File Naming Conventions

The file names developed for PDS data volumes are restricted to a 36 character file name and a 3 character extension name with a period separating the file and extension names.

The general form of the XRS CDR file name is "XRSCDRYYYYDOY.DAT", where:

XRS	Instrument identifier: represents the XRS instrument
CDR	CDR data type
YYYY	The four-digit year corresponding to the MET for each record in the CDR
DOY	The three-digit UTC day of year corresponding to the MET for each record in the CDR
.DAT	The file extension is always the three character mnemonic 'DAT', indicating data stored in binary format.

The general form of the XRS RDR Footprint file name is XRS_FP_P_MET.CSV, where:

XRS	Instrument identifier
FP	RDR product identifier
P	Spacecraft clock time partition for the CDR from which the footprint is derived, either 1 or 2
MET	Spacecraft clock time in seconds within the partition
.CSV	The file extension is always the three character mnemonic 'CSV', indicating data stored in comma-separated value format

For the JPEG 2000 format RDR Map products, the general form of the name is “XRS_MXX_EL_SI_YYYYMMDD.JP2” where:

XRS	Instrument identifier
MXX	The type of RDR: MAP for map, UNC for uncertainty and RES for resolution
EL	Two-character element identifier: AL for aluminum, CA for calcium, FE for iron, MG for magnesium, and S_ for sulfur
SI	SI for silicon, the element that is the consequent in the ratio
YYYY	The four digit year corresponding to the last CDR sample included in the map
MM	The two-digit month (01-12) corresponding to the last CDR sample included in the map
DD	The two-digit day-of-month (01-31) corresponding to the last CDR sample included in the map

5.5 Label and Header Description

5.5.1 PDS Label File Format

The XRS CDR and RDR data products have detached PDS labels stored as ASCII text. A PDS label is object-oriented and describes the objects in the data file. The PDS label contains keywords for product identification and for data object definitions. The label also contains descriptive information needed to interpret or process the data objects in the file.

Below are the keyword definitions for the detached PDS label files:

BYTES

The number of bytes allowed in each field. Applies to RDR footprints only.

COLUMNS

Identifies the number of columns in the table. Applies to CDR tables only.

DATA_SET_ID

Uniquely identifies the CDR or RDR file as part of a volume collection, organized by sensor, mission phase, and version number.

DATA_TYPE

Supplies the internal representation and/or mathematical properties of a value being stored. In this case, “ASCII_REAL”. Applies to RDR footprints only.

FIELD_DELIMETER

Indicates the single character used to separate the fields within the spreadsheet. Applies to RDR footprints only.

FIELD_NUMBER

The sequential number of the enclosing field object within the spreadsheet definition. Applies to RDR footprints only.

FIELDS

Specifies the number of field objects defined within the spreadsheet object. Applies to RDR footprints only.

FILE_RECORDS

The file_records element indicates the number of physical file records in the detached data file.

INSTRUMENT_HOST_NAME

Provides the full name of the host on which an instrument is based. In this case, "MESSENGER".

INSTRUMENT_ID

Unique id associated with the instrument. In this case, "XRS".

INSTRUMENT_NAME

Full, unabbreviated name of the instrument. In this case, "XRAY SPECTROMETER".

INTERCHANGE_FORMAT

Identifies the manner in which the data items are stored.

MISSION_PHASE_NAME

The MISSION_PHASE_NAME provides the commonly-used identifier of a mission phase. Applies to CDRs and RDR Maps only.

NAME

The term used to define the field or image.

OBJECT

Specifies the type of CDR or RDR 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.

PDS_VERSION_ID

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

PRODUCT_CREATION_TIME

Stores the time the data product was created, in GMT time.

PRODUCT_ID

The product_id data element represents a permanent, unique identifier assigned to a data product by its producer.

Note: In the PDS, the value assigned to product_id must be unique within its data set.

PRODUCT_TYPE

Identifies the type or category of a product within a data set. In this case, CDR (Calibrated Data Record) or RDR (Reduced Data Record).

PRODUCT_VERSION_ID

The product_version_id element identifies the version of an individual product within a data set.

Example: 1.0, 2A, 1.2.3C.

Note: This is not the same as the data set version that is an element of the data_set_id value.

Product_version_id is intended to identify separate iterations of a given product, which also have a unique file_name.

RECORD_BYTES

This element indicates the number of bytes in a physical file record, including record terminators and separators.

RECORD_TYPE

The record_type element indicates the record format of a file.

ROW_BYTES

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

ROWS

Specifies the number of rows (records) in the table or spreadsheet.

SOFTWARE_NAME

Identifies the name and version number of the software system that created the data products.

SOFTWARE_VERSION_ID

Version number of the program or program library used by the instrument to collect observations.

SPACECRAFT_CLOCK_START_COUNT

Clock count of the spacecraft computer at the start of the observation.

SPACECRAFT_CLOCK_STOP_COUNT

Clock count of the spacecraft computer at the end of the observation.

SPREADSHEET

Identifies the name of the RDR footprint file that contains the data in CSV format.

STANDARD_DATA_PRODUCT_ID

Used to link a data product (file) to a standard data product (collection of similar files) described within software interface specification document for a particular data set.

START_TIME

Start time of the observation.

STOP_TIME

Time when the instrument stopped collecting measurements.

STRUCTURE

Pointer to the external file which provides the structure definition for the table object. This applies to CDR labels only.

TABLE

Identifies the name of the CDR file that contains the data in BINARY table format. The structure of the data file is defined in a referenced description text file. This applies to CDR labels only.

TARGET_NAME

Target of the observation.

UNIT

The unit of measurement in which the value is expressed.

5.5.2 Binary Table File Formats

Each XRS CDR PDS label contains a pointer to the XRS_CDR.FMT external file. This file describes the structure of the XRS binary table that includes column name, byte size, data type, applicable units, and a description of the value assigned to the column.

5.5.3 Format File Keyword Definitions

The following describes the keywords used in the XRS_CDR.FMT file:

OBJECT

Identifies the object as a column field within a binary table.

COLUMN_NUMBER

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

NAME

Indicates a literal value representing the common term used to identify an element or object.

Note: In the PDS data dictionary, name is restricted to 30 characters and must conform to PDS nomenclature standards.

BYTES

Specifies the total 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 data item.

ITEM_BYTES

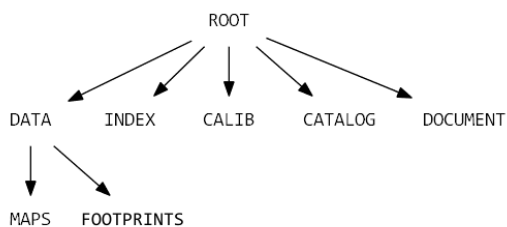
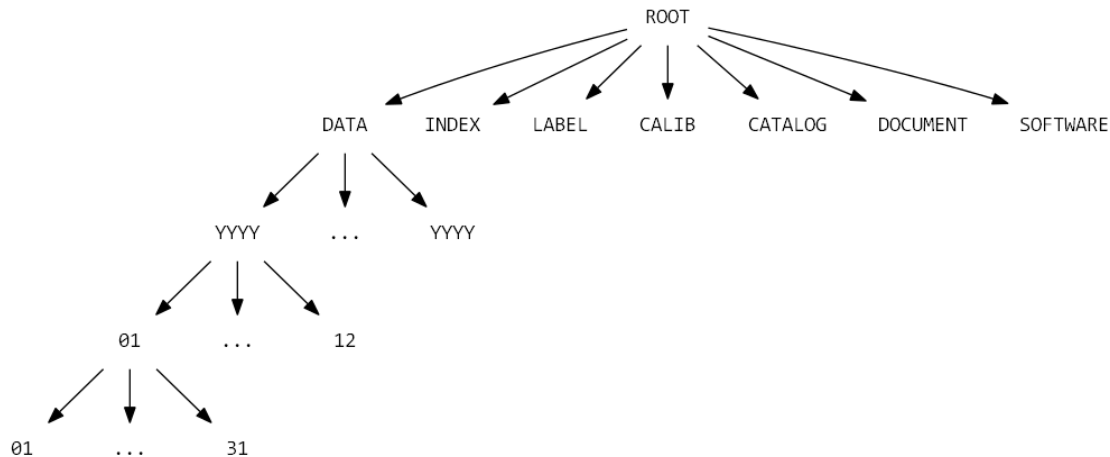
Represents the size in each individual item within the column field.

DESCRIPTION

Describes the value(s) stored in the column object.

5.6 Directory Structure and Contents for Static Volumes

The following illustration shows the directory structure for the CDR archive volume. Below the root directory are the DOCUMENT, INDEX, CATALOG, DATA, LABEL, CALIB and SOFTWARE directories. A detailed description of the directory tree is provided in the figure below. Empty directories are not included on the volume. (Empty directories occur when no data was received for a given day in which data was expected.)



The directory structure for the RDR products is the same with the exception that the LABEL and SOFTWARE directories are omitted. Rather than grouped in subdirectories by date, the RDR Map products are in a single subdirectory of DATA called MAPS. The RDR Footprint products are in a single subdirectory of

DATA called FOOTPRINTS. Within the FOOTPRINTS subdirectory, the footprint products are organized based on the UTC time corresponding to the start time of the CDR observation from which the footprint is derived. The subdirectories are organized by year, month, day, and hour. An observation from 2013-01-02-03:04:05 would be stored in DATA/FOOTPRINTS/2013/01/02/03.

Figure 3. Directory Structure Overview

5.6.1 Directory Contents

<ROOT> Directory

AAREADME.TXT - General information file. Provides users with information about the MESSENGER XRS data products. Directs user to more detailed documents on the volume.

VOLDESC.CAT - PDS file containing labels that describe the volume data products. Information includes: production date, producer name and institution, volume ID, etc.

ERRATA.TXT - Text file for tracking and recording discovered errors in the MESSENGER XRS data products.

<CALIB> Directory

CALINFO.TXT - Description of calib directory files. Calibration files are either used to create or process the data products.

<CATALOG> Directory

CATINFO.TXT - Description of catalog directory files.

*.**CAT** - Description of PDS catalog mission, spacecraft, instrument and data sets as ASCII text files in PDS-specified formats, to be entered into the PDS online catalog for searching.

<DATA> - Data Directory

This is the top level of the directories containing CDRs or RDRs.

<DATA/YYYY> - Data Directories

Sub-directories of the <DATA> directory for each year. (CDR volume only)

<DATA/YYYY/MM> - Data Directories

Sub-directories of the <DATA> directory for each month of a year, where MM is from 01 through 12. (CDR volume only)

<DATA/YYYY/MM/DD> - Data Directories

Sub-directories of a <DATA/YYYY/MM> directory, these are the top level directories for the CDR data products. The names of the data directories identify the day of the month for the start time of the data products contained in the directories. (CDR volume only)

<DATA/MAPS> - Data Directory

Sub-directory of the <DATA> directory for the map products. (RDR volume only)

<DATA/FOOTPRINTS/YYYY/MM/DD/HH> - Data Directory

Sub-directories of the <DATA> directory for the footprint products. (RDR volume only)

<DOCUMENT> Directory

DOCINFO.TXT - DOCUMENT directory description.

The documentation files exist in several forms in order to facilitate access to the documents:

- Extension '**TXT**' or '**ASC**' - ASCII text files (that virtually all text editors can read).
- Extension '**PDF**' - Adobe Portable Document File.
- Extension '**HTM**' - Hypertext Markup files, which are read in a web browser.

<**SIS**> - Subdirectory that contains the Software Interface Specification for the CDR and RDR XRS data products in PDF and HTML formats. Also contains an <**IMAGES**> subdirectory that is referenced by the HTML version of the document.

<**ED2CD2RD**> - Subdirectory that contains the EDR to CDR to RDR document in PDF and HTML formats. This document describes the conversion of Experiment Data Records (EDRs) to Calibrated Data Records (CDRs) to Reduced Data Records (RDRs).

<INDEX> Directory

INDXINFO.TXT - Text file describing contents of <INDEX> directory.

INDEX.TAB - The CDR or RDR index file is organized as a table. In the table, there is a row for each observation on the volume. The table 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. See section 5.3.

MD5.TAB - Contains the cumulative MD5 checksums for the archive volume.

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

<LABEL> Directory (CDR only)

LABINFO.TXT - Description of label directory files that include additional PDS labels and files not packaged with the data products.

XRS_CDR.FMT - Format file describing the XRS calibrated data records.

<SOFTWARE> Directory (CDR only)

SOFTINFO.TXT - Description of software that can be used to view the data products and where to obtain it.

5.6.2 Data Product Sizes

The following table shows sizes in bytes of each data product and total estimated size of the GRS CDR and RDR data sets.

Table 1. Data Product Sizes

Product Type	Time span covered	Typical product size (bytes)	Estimated mission total (byte)
XRS_CDR	1 Earth day	936700	346579000
XRS_RDR_MAPS	Mercury orbit year 1 and a portion of year 2	250000	5120000
XRS_RDR_FOOTPRINTS	1 CDR observation	12288	4324053323

6 Product Delivery

6.1 Product Delivery Mechanism

The XRS CDR and RDR volumes were delivered to Applied Coherent Technologies (ACT) in a file that has been created with gzip and tar. This file was delivered on a periodic basis to ACT. ACT extracted the volumes from the delivered file and created the index files. The initial delivery had in the .LBL files a PRODUCT_VERSION_ID of 1.0 and a SOFTWARE_VERSION_ID of 1.0.

6.2 Product Redelivery

The products were redelivered to ACT when a previously delivered product changed. Reasons for redelivery included:

- The software that converts the EDRs into CDRs or CDRs into RDRs changed. This resulted in a change to the data delivered. The PRODUCT_VERSION_ID and the SOFTWARE_VERSION_ID were incremented by 1 in the .LBL files of the redelivered product.
- The data in the DATA_QUALITY column in a XRSCDRYYYYDDD.DAT changed. The PRODUCT_VERSION_ID was incremented by 1 in the .LBL files of the redelivered product.
- XRS_CDR_RDR_SIS document changed.
- XRS_EDR2CDR2RDR document changed.

7 Appendices

7.1 APPENDIX: SPICE Kernel Files Used in MESSENGER Data Products

SPICE kernel files are inputs to the spatial and temporal data archived in this volume set. Improvements to some of these fundamental ancillary data were made as further analysis of MESSENGER data continued, so there were reprocessing releases of CDR or RDR volumes. The MESSENGER SPICE kernels are archived in a separate volume (MESSSP_1000) located at the PDS NAIF node.

7.2 APPENDIX: CODMAC/NASA Definition of Processing Levels

Table 2. CODMAC/NASA Definition of Processing Levels for Science Data Sets

CODMAC Level	Proc. Type	Data Processing Level Description
1	Raw Data	Telemetry data stream as received at the ground station, with science and engineering data embedded. Corresponds to NASA packet data.
2	Edited Data	Instrument science data (e.g. raw voltages, counts) at full resolution, time ordered, with duplicates and transmission errors removed. Referred to in the MESSENGER program as Experiment Data Records (EDRs). Corresponds to NASA Level 0 data.
3	Calibrated Data	Edited data that are still in units produced by instrument, but have been 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 wind drift measurements.
8	User Description	Description of why the data is required, any peculiarities associated with the data sets and enough documentation to allow the secondary user to extract information from the data.

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

7.3 **APPENDIX: MESSENGER XRS Glossary and Acronym List**

ACT	Applied Coherent Technology Corporation
APL	The Johns Hopkins University Applied Physics Laboratory
ASCII	American Standard Code for Information Interchange
ATDF	Archival Tracking Data File
B-frame	Body Frame
C&DH	Command and Data Handler
CA	Closest Approach
CCSDS	Consultative Committee for Space Data Systems
CDF	Common Data Format
CDR	Calibrated Data Record
CFDP	CCSDS File Delivery Protocol
CK	Camera Kernel (SPICE)
CODMAC	Committee on Data Management and Computation
Co-I	Co-Investigator
COP	Command Operation Procedure
CUCC	CSDS Unsegmented Time Code
DPU	Data Processing Unit
EDR	Experiment Data Record
EK	Event Kernel
ET	Ephemeris Time
FIPS	Fast Imaging Plasma Spectrometer
FITS	Flexible Image Transport System
FOP	Frame Operation Procedure
FOV	Field-of-View
FTP	File Transfer Protocol
GPC	Gas Proportional Counter
GSFC	Goddard Space Flight Center
I&T	Integration and Test
I2C	Inter-Integrated Circuit
IEM	Integrated Electronic Module
IK	Instrument Measurement Kernel (SPICE)
IMU	Inertial Measurement unit
ISI	Integral Systems Incorporated (EPOCH)
LSK	Leap seconds Kernel (SPICE)
LVPS	Low Voltage Power Supply
MCP	Monitor and Control Processor (DSN station)
MESSENGER	MERcury, Surface, Space ENvironment, GEOchemistry, and Ranging
MET	Mission Elapsed Time
MIA	Monitor Interface Assembly (DSN station)
MXU	Mercury X-ray Unit
NAIF	Navigation and Ancillary Information Facility
NASA	Navigation Aeronautics and Space Administration
NSSDC	National Space Science Data Center
ODF	Orbit Data File
ODL	Object Description Language
OWLT	One-Way Light Time
PCK	Planetary Constant Kernel (SPICE)
PDR	Packetized Data Records
PDS	Planetary Data System
PIN	Positive-Intrinsic-Negative silicon diode
RDR	Reduced Data Record
SAX	Solar Assembly for X-rays
SCET	Space Craft Event Time
SCLK	Space Clock Kernel (SPICE)
SCPS	Space Communication Protocol Standards
SFDU	Standard Formatted Data Unit
SPICE	Spacecraft, Planet, Instrument, C-matrix, Events
SPK	Spacecraft and Planets Kernel (SPICE)
TDB	Barycentric Dynamical Time, the same as ET in the SPICE system
TEC	Thermal Electric Cooler
UTC	Coordinated Universal Time

XRS

X-Ray Spectrometer

7.4 APPENDIX: XRS Engineering Conversions

C0-C7 are polynomial coefficients (lowest order term first)

<u>Name</u>	<u>C0</u>	<u>C1</u>	<u>C2</u>	<u>C3</u>	<u>C4</u>	<u>C5</u>	<u>C6</u>	<u>C7</u>	<u>Units</u>
SC_RANGE	0	30	0	0	0	0	0	0	Kilometers
SC_ANGLE	0	0.25	0	0	0	0	0	0	Degrees
LVPS_PLUS_5V	0	0.07935	0	0	0	0	0	0	Volts
LVPS_MINUS_5V	0	-0.07935	0	0	0	0	0	0	Volts
LVPS_PLUS_12V	0	0.07935	0	0	0	0	0	0	Volts
LVPS_MINUS_12V	0	-0.07935	0	0	0	0	0	0	Volts
LVPS_PLUS_5_I	0	7.808	0	0	0	0	0	0	mA
LVPS_MINUS_5_I	0	7.808	0	0	0	0	0	0	mA
LVPS_PLUS_12_I	0	7.808	0	0	0	0	0	0	mA
LVPS_MINUS_12_I	0	7.808	0	0	0	0	0	0	mA
LVPS_TEMP	-39.37	0.4227	-4.49E-05	5.08E-06	0	0	0	0	Deg C
LVPS_PRIMARY_I	0	7.808	0	0	0	0	0	0	mA
LVPS_SWITCHED_PRIMARY_I	0	7.808	0	0	0	0	0	0	mA
GPC1_MG_PLUS_5V	0	0.0421	0	0	0	0	0	0	Volts
GPC2_AL_PLUS_5V	0	0.0421	0	0	0	0	0	0	Volts
GPC3_UN_PLUS_5V	0	0.0421	0	0	0	0	0	0	Volts
SAX_PLUS_5V	0	0.0421	0	0	0	0	0	0	Volts
ANALOG_PLUS_5V	0	0.0421	0	0	0	0	0	0	Volts
DIGITAL_PLUS_5V	0	0.0421	0	0	0	0	0	0	Volts
GPC1_MG_MINUS_5V	See below								
GPC2_AL_MINUS_5V	See below								
GPC3_UN_MINUS_5V	See below								
SAX_MINUS_5V	See below								
ANALOG_MINUS_5V	-12.1	0.05732	0	0	0	0	0	0	Volts

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TEC_I	0	2.34	0	0	0	0	0	0	0	mA
MXU_TEMP	See below									
SOLAR_DETECTOR_TEMP	See below									
SAX_TEMP	-273	1.47	0	0	0	0	0	0	0	Deg C
SOLAR_DETECTOR_I	-667	4.017	0	0	0	0	0	0	0	pA
GPC1_MG_VOLTAGE	0	0.507	0	0	0	0	0	0	0	Volts
GPC2_AL_VOLTAGE	0	0.507	0	0	0	0	0	0	0	Volts
GPC3_UN_VOLTAGE	0	0.507	0	0	0	0	0	0	0	Volts
BIAS_VOLTAGE	0	0.507	0	0	0	0	0	0	0	Volts
GPC1_MG_SUPPLY_TEMP	-99.4	1.028	0	0	0	0	0	0	0	Deg C
GPC2_AL_SUPPLY_TEMP	-101.4	1.028	0	0	0	0	0	0	0	Deg C
GPC3_UN_SUPPLY_TEMP	-100.4	1.028	0	0	0	0	0	0	0	Deg C
BIAS_SUPPLY_TEMP	-98.3	1.028	0	0	0	0	0	0	0	Deg C
	Conversion Equation*			Units						
GPC1_MG_MINUS_5V	0.02559*GPC1_MG_MINUS_5V - 0.068202*GPC1_MG_PLUS_5V			Volts						
GPC2_AL_MINUS_5V	0.02559*GPC2_AL_MINUS_5V - 0.068202*GPC2_AL_PLUS_5V			Volts						
GPC3_UN_MINUS_5V	0.02559*GPC3_UN_MINUS_5V - 0.068202*GPC3_UN_PLUS_5V			Volts						
SAX_MINUS_5V	0.02559*SAX_MINUS_5V - 0.068202*SAX_PLUS_5V			Volts						
	Conversion Equation ^s					Units				
MXU_TEMP	MXU_TEMP*(-26.226*ln(M XU_TEMP+1)+129.14)					Deg C				
SOLAR_DETECTOR_TEMP (Hi)	4.57782E-09*SOLAR_DETECTOR_TEMP ⁵ - 3.16578E-06*SOLAR_DETECTOR_TEMP ⁴ + 8.58411E-04*SOLAR_DETECTOR_TEMP ³ - 1.11961E-01*SOLAR_DETECTOR_TEMP ² + 7.16858E+00*SOLAR_DETECTOR_TEMP - 1.23365E+2					Deg C				
SOLAR_DETECTOR_TEMP (Lo)	2.06686*[ln(SOLAR_DETECTOR_TEMP+1)] ² - 38.94592*ln(SOLAR_DETECTOR_TEMP+1) +107.39573					Deg C				

7.5 **APPENDIX: XRS CDR Data Columns**

This table lists the columns in all XRS CDR data files in alphabetical order. The format of each type of data file, including column locations, sizes, data types, units and full descriptions, can be found in the format files (*.FMT) in the LABEL directory.

Table 3. XRS CDR Data Types

Column Name	Data Type	Length	Units	Description	Appears In
ACTUAL_INTEGRATION_TIME	MSB_UNSIGNED_INTEGER	4	Second	"Actual integration period in seconds."	XRS_CDR
ACTUAL_REPORTING_TIME	MSB_UNSIGNED_INTEGER	4	Second	"Actual reporting time in seconds."	XRS_CDR
ALARM_COUNT	MSB_UNSIGNED_INTEGER	1		"Count of number of alarms."	XRS_CDR
ALARM_ID	MSB_UNSIGNED_INTEGER	1		"the identifier for the last XRS alarm, 0 for no alarm and non-zero for a long list of various parameters out of range."	XRS_CDR
ALARM_TYPE	MSB_UNSIGNED_INTEGER	1		"Latest alarm type. =0 persistent, =1 transient."	XRS_CDR
ANALOG_MINUS_5V	IEEE_REAL	8	Volt	"Analog -5 volt monitor, smoothed."	XRS_CDR
ANALOG_PLUS_5V	IEEE_REAL	8	Volt	"Analog +5 volt monitor, smoothed."	XRS_CDR
ANGLE_SUN_SOLAR_MONITOR	IEEE_REAL	4	Degree	"Angle between the Sun and the solar monitor."	XRS_CDR
AVG_EMISSION_ANGLE	IEEE_REAL	4	Degree	"Average emission angle (between normal to the surface and direction from the surface to the spacecraft)."	XRS_CDR
AVG_INC_EMI_COS_RATIO	IEEE_REAL	4		"Average ratio of the cosine of incidence angle to the cosine of emission angle."	XRS_CDR
AVG_INCIDENCE_ANGLE	IEEE_REAL	4	Degree	"Average incidence angle."	XRS_CDR

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AVG_SC_DISTANCE	IEEE_REAL	4	Kilometer	"Average distance of the planet from the Spacecraft."	XRS_CDR
BIAS_SUPPLY_TEMP	IEEE_REAL	8	Degree(C)	"Bias supply temperature measurement, smoothed."	XRS_CDR
BIAS_SUPPLY_VOLT_STEPPING	MSB_UNSIGNED_INTEGER	1		"Indicates whether the Bias detector's high voltage state is seeking. See the MESSENGER XRS Software Specification document for an explanation of the seeking state. =0 no, =1 yes."	XRS_CDR
BIAS_VOLTAGE	IEEE_REAL	8	Volt	"Bias voltage measurement, smoothed."	XRS_CDR
BIAS_VOLTAGE_SETTING	MSB_UNSIGNED_INTEGER	2		"Bias voltage setting."	XRS_CDR
BS_VECTOR_X	IEEE_REAL	4		"Boresight vector, x component in the J2000 frame."	XRS_CDR
BS_VECTOR_Y	IEEE_REAL	4		"Boresight vector, y component in the J2000 frame."	XRS_CDR
BS_VECTOR_Z	IEEE_REAL	4		"Boresight vector, z component in the J2000 frame."	XRS_CDR
CMD_EXECUTED	MSB_UNSIGNED_INTEGER	1		"Number of commands executed."	XRS_CDR
CMD_REJECTED	MSB_UNSIGNED_INTEGER	1		"Number of commands rejected."	XRS_CDR

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DATA_QUALITY	MSB_UNSIGNED_INTEGER	4		"Integer representation of a 32-bit array. Each bit represents a data quality flag. Currently only the least significant bit is being used. Other bit positions will be designated during the course of the mission as more data quality parameters are identified by the instrument team. =1, the actual data length in bytes does not match the reported length. =0, actual data length in bytes matches reported length."	XRS_CDR
DAY_INDEX	MSB_UNSIGNED_INTEGER	2		"Day of Mercury year."	XRS_CDR
DEBUG_COUNTERS	MSB_UNSIGNED_INTEGER	1		"Diagnostic for planetary sensor. =0 disabled, =1 enabled."	XRS_CDR
DELTA_ANGLE	IEEE_REAL	8	Degree	"Difference between instrument +y direction and true north at the middle of the pixel."	XRS_CDR
DIGITAL_PLUS_5V	IEEE_REAL	8	Volt	"Digital +5 volt monitor, smoothed."	XRS_CDR
DISCARDED_PACKET_COUNTER	MSB_UNSIGNED_INTEGER	1		"Number of calls to send-pkt that resulted in a return value of false."	XRS_CDR
EARTH_POSITION_X	IEEE_REAL	4		"Position of the Earth (ET*) in Mercury fixed coord. system (ET*)."	XRS_CDR

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EARTH_POSITION_Y	IEEE_REAL	4	"Position of the Earth (ET*) in Mercury fixed coord. system (ET*)." XRS_CDR
EARTH_POSITION_Z	IEEE_REAL	4	"Position of the Earth (ET*) in Mercury fixed coord. system (ET*)." XRS_CDR
FLARE_HANDLING_ENABLED	MSB_UNSIGNED_INTEGER	1	"Solar flare handling enabled flag, software checks this value upon detection of a solar flare. =0 do not handle solar flare detection. =1 continue algorithm for handling solar flare detection (see SOLAR_FLARE_ENACT)." XRS_CDR
FLARE_HANDLING_ENACTED	MSB_UNSIGNED_INTEGER	1	"Solar flare handling enacted flag. Allows software to determine if solar flare handling has already been enacted or whether this is a new detection of a solar flare. Only checked if solar flare handling has been enabled (see previous field). =0 the software sets it to true, starts the sf-time-enactable-left counter out at sf-max-time-enactable, sets a flag telling the 1Hz process to end the current integration and reporting period XRS_CDR

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				immediately, and returns control to the 1Hz process. =1 , the software decrements the sf-time-enactable-left counter and checks its value. If sf-time-enactable-left is still greater than 0, the algorithm does nothing further. If sf-time-enactable-left has reached 0, the algorithm starts the sf-timeout-left counter out at sf-timeout-period and sets the sf-handling-enacted-now flag to false."	
FOOTPRINT_SOLID_ANGLE	IEEE_REAL	4	Steradian	"Overall solid angle of the footprint contributing to the spectrum (visible from the spacecraft), relative to the instrument full field of view."	XRS_CDR

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FOV_STATUS	MSB_UNSIGNED_INTEGER	1		"Field of view 0 equals Field of view (FOV) is completely off the planet. 1 equals The field of view is totally on the planet and at least part of the footprint is lit by the sun. 2 equals The field of view is totally on the planet and is dark. (planet darkside). 3 equals Part of the field of view is off the planet and at least one plate is lit by the sun. 4 equals Part of the field of view is off the planet and is are dark."	XRS_CDR
GPC1_MG_ANALYZED_EVENT_RATE	MSB_UNSIGNED_INTEGER	4		"GPC1-MG analyzed event rate per integration period."	XRS_CDR
GPC1_MG_CENTER_ANODE_RATE	MSB_UNSIGNED_INTEGER	4		"GPC1-MG center anode rate per integration period."	XRS_CDR
GPC1_MG_ENABLE	MSB_UNSIGNED_INTEGER	1		"ENABLE criterion to determine valid event for GPC1_MG detector. =0 disabled, =1 enabled."	XRS_CDR
GPC1_MG_HIGH_ENERGY_RATE	MSB_UNSIGNED_INTEGER	4		"GPC1-MG high energy rate per integration period."	XRS_CDR
GPC1_MG_LIVE_TIME	IEEE_REAL	4	Second	"Mg filtered Xray actual integration time (sec.) - the."	XRS_CDR
GPC1_MG_LOSS_PERCENTAGE	MSB_UNSIGNED_INTEGER	1		"GPC1-MG loss percentage."	XRS_CDR
GPC1_MG_LOW_LEVEL_DISC	MSB_UNSIGNED_INTEGER	1		"GPC1-MG low level	XRS_CDR

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				discriminator."	
GPC1_MG_MINUS_5V	IEEE_REAL	8	Volt	"GPC1-MG -5 volt monitor, smoothed."	XRS_CDR
GPC1_MG_PILEUP_ENABLE	MSB_UNSIGNED_INTEGER	1		"PILEUP ENABLE criterion to determine valid event for GPC1_MG detector. =0 disabled, =1 enabled."	XRS_CDR
GPC1_MG_PILEUP_RATE	MSB_UNSIGNED_INTEGER	4		"GPC1-MG pileup rate per integration period."	XRS_CDR
GPC1_MG_PLUS_5V	IEEE_REAL	8	Volt	"GPC1-MG +5 volt monitor, smoothed."	XRS_CDR
GPC1_MG_POWER_ANALOG	MSB_UNSIGNED_INTEGER	1		"GPC1-MG analog power setting. =0 disabled, =1 enabled."	XRS_CDR
GPC1_MG_POWER_HVPS	MSB_UNSIGNED_INTEGER	1		"GPC1-MG HVPS power setting, =0 disabled, =1 enabled."	XRS_CDR
GPC1_MG_REAL_GAIN	IEEE_REAL	4	Kiloelectron-Volt/Ch.	"Measured gain of GPC1-Mg detector in keV/ch."	XRS_CDR
GPC1_MG_REAL_ZERO	IEEE_REAL	4	Kiloelectron-Volt	"Measured zero offset of GPC1-Mg detector in keV."	XRS_CDR
GPC1_MG_RISE_PILEUP	MSB_UNSIGNED_INTEGER	1		"RISE PILEUP criterion to determine valid event for GPC1_MG detector. =0 disabled, =1 enabled."	XRS_CDR
GPC1_MG_RISE_PILEUP_RATE	MSB_UNSIGNED_INTEGER	4		"GPC1-MG rise pileup rate per integration period."	XRS_CDR
GPC1_MG_RISE_TIME	MSB_UNSIGNED_INTEGER	1		"RISE TIME criterion to determine valid event for GPC1_MG detector. =0 disabled, =1 enabled."	XRS_CDR

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GPC1_MG_RISE_TIME_CHANNEL	IEEE_REAL	4	"Mg filtered Xray rise time valid discriminator threshold; events with energy exceeding the threshold will be rejected based on the rise time discrimination flag - the most recently cmded value for this."	XRS_CDR
GPC1_MG_RISE_TIME_DISC_1	MSB_UNSIGNED_INTEGER	1	"GPC1-MG rise time discriminator 1."	XRS_CDR
GPC1_MG_RISE_TIME_DISC_2	MSB_UNSIGNED_INTEGER	1	"GPC1-MG rise time discriminator 2."	XRS_CDR
GPC1_MG_RISE_TIME_REJECT	MSB_UNSIGNED_INTEGER	4	"GPC1-MG rise time reject rate per integration period."	XRS_CDR
GPC1_MG_SAFING_LEVEL	MSB_UNSIGNED_INTEGER	1	"The safing level set for the GPC1-MG detector. =0 level zero or nominal level safing; the software will monitor the planetary detector for the conditions which necessitate a higher level of safing. =1 level 1 safing; the HVPS voltage level for the affected sensor is ramped down to 0 at a rate of 100 V/sec. =2 level 2 safing; the software turns off analog power to the affected sensor and turns off the associated HVPS. No further attempts are made to restore the level-two-safed sensor to	XRS_CDR

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				nominal safing. The software waits for ground command to reset the affected HVPS voltage levels."	
GPC1_MG_SAFING_RETRY	MSB_UNSIGNED_INTEGER	1		"The max number of retry attempts to reset the GPC1-MG detector to level 0 safing."	XRS_CDR
GPC1_MG_SPARE_RATE_1	MSB_UNSIGNED_INTEGER	4		"Spare column for GPC1-MG rates per integration period."	XRS_CDR
GPC1_MG_SPARE_RATE_2	MSB_UNSIGNED_INTEGER	4		"Spare column for GPC1-MG rates."	XRS_CDR
GPC1_MG_SPECTRUM_10_253	MSB_UNSIGNED_INTEGER	488		"GPC1-MG spectra channels (10-253)."	XRS_CDR
GPC1_MG_SUPPLY_TEMP	IEEE_REAL	8	Degree(C)	"GPC1-MG supply temperature measurement, smoothed."	XRS_CDR
GPC1_MG_VALID_CHANNEL_HI	IEEE_REAL	4		"Mg filtered Xray rise time valid discriminator threshold; events with energy exceeding the threshold will be rejected based on the rise time discrimination flag - the most recently cmded value for this."	XRS_CDR
GPC1_MG_VALID_CHANNEL_LOW	IEEE_REAL	4		"Mg filtered Xray lower level discriminator threshold; events with energy less than the threshold will be rejected - the most recently cmded value for	XRS_CDR

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				this threshold."	
GPC1_MG_VALID_RATE	MSB_UNSIGNED_INTEGER	4		"GPC1-MG valid rate per integration period."	XRS_CDR
GPC1_MG_VETO_ANODE_RATE	MSB_UNSIGNED_INTEGER	4		"GPC1-MG veto anode rate per integration period."	XRS_CDR
GPC1_MG_VETO_DISC	MSB_UNSIGNED_INTEGER	1		"GPC1-MG veto discriminator."	XRS_CDR
GPC1_MG_VETO_ENABLE	MSB_UNSIGNED_INTEGER	1		"VETO ENABLE criterion to determine valid event for GPC1_MG detector. =0 disabled, =1 enabled."	XRS_CDR
GPC1_MG_VETO_RATE	MSB_UNSIGNED_INTEGER	4		"GPC1-MG veto rate per integration period."	XRS_CDR
GPC1_MG_VOLTAGE	IEEE_REAL	8	Volt	"GPC1-MG voltage measurement, smoothed."	XRS_CDR
GPC1_MG_VOLTAGE_SETTING	MSB_UNSIGNED_INTEGER	2		"GPC1-MG voltage setting."	XRS_CDR
GPC1_MG_VOLTAGE_STEPPING	MSB_UNSIGNED_INTEGER	1		"Indicates whether the GPC1-MG detector's high voltage state is seeking. See the MESSENGER XRS Software Specification document for an explanation of the seeking state. =0 no, =1 yes."	XRS_CDR
GPC2_AL_ANALYZED_EVENT_RATE	MSB_UNSIGNED_INTEGER	4		"GPC2-AL analyzed event rate per integration	XRS_CDR

XRS CDR/RDR SIS

				period."	
GPC2_AL_CENTER_ANODE_RATE	MSB_UNSIGNED_INTEGER	4		"GPC2-AL center anode rate per integration period."	XRS_CDR
GPC2_AL_ENABLE	MSB_UNSIGNED_INTEGER	1		"ENABLE criterion to determine valid event for GPC2_AL detector. =0 disabled, =1 enabled."	XRS_CDR
GPC2_AL_HIGH_ENERGY_RATE	MSB_UNSIGNED_INTEGER	4		"GPC2-AL high energy rate per integration period."	XRS_CDR
GPC2_AL_LIVE_TIME	IEEE_REAL	4	Second	"AI filtered Xray actual integration time- the portion of the period covered by this record in which the AI Xray sensor was unmasked and Integrating."	XRS_CDR
GPC2_AL_LOSS_PERCENTAGE	MSB_UNSIGNED_INTEGER	1		"GPC2-AL loss percentage."	XRS_CDR
GPC2_AL_LOW_LEVEL_DISC	MSB_UNSIGNED_INTEGER	1		"GPC2-AL low level discriminator."	XRS_CDR
GPC2_AL_MINUS_5V	IEEE_REAL	8	Volt	"GPC2-AL -5 volt monitor, smoothed."	XRS_CDR
GPC2_AL_PILEUP_ENABLE	MSB_UNSIGNED_INTEGER	1		"PILEUP_ENABLE criterion to determine valid event for GPC2_AL detector. =0 disabled, =1 enabled."	XRS_CDR
GPC2_AL_PILEUP_RATE	MSB_UNSIGNED_INTEGER	4		"GPC2-AL pileup rate per integration period."	XRS_CDR
GPC2_AL_PLUS_5V	IEEE_REAL	8	Volt	"GPC2-AL +5 volt monitor, smoothed."	XRS_CDR

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GPC2_AL_POWER_ANALOG	MSB_UNSIGNED_INTEGER	1		"GPC2-AL analog power setting, =0 disabled, =1 enabled."	XRS_CDR
GPC2_AL_POWER_HVPS	MSB_UNSIGNED_INTEGER	1		"GPC2-AL HVPS power setting, =0 disabled, =1 enabled."	XRS_CDR
GPC2_AL_REAL_GAIN	IEEE_REAL	4	Kiloeltron-Volt/Ch.	"Measured gain of GPC2-AL detector in keV/ch."	XRS_CDR
GPC2_AL_REAL_ZERO	IEEE_REAL	4	Kiloelectron-Volt	"Measured zero offset of GPC2-AL detector in keV."	XRS_CDR
GPC2_AL_RISE_PILEUP	MSB_UNSIGNED_INTEGER	1		"RISE PILEUP criterion to determine valid event for GPC2_AL detector. =0 disabled, =1 enabled."	XRS_CDR
GPC2_AL_RISE_PILEUP_RATE	MSB_UNSIGNED_INTEGER	4		"GPC2-AL rise pileup rate per integration period."	XRS_CDR
GPC2_AL_RISE_TIME	MSB_UNSIGNED_INTEGER	1		"RISE TIME criterion to determine valid event for GPC2_AL detector. =0 disabled, =1 enabled."	XRS_CDR
GPC2_AL_RISE_TIME_CHANNEL	IEEE_REAL	4		"Al filtered X-Ray rise time channel."	XRS_CDR
GPC2_AL_RISE_TIME_DISC_1	MSB_UNSIGNED_INTEGER	1		"GPC2-AL rise time discriminator 1."	XRS_CDR
GPC2_AL_RISE_TIME_DISC_2	MSB_UNSIGNED_INTEGER	1		"GPC2-AL rise time discriminator 2."	XRS_CDR
GPC2_AL_RISE_TIME_REJECT	MSB_UNSIGNED_INTEGER	4		"GPC2-AL rise time reject rate per integration period."	XRS_CDR

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GPC2_AL_SAFING_LEVEL	MSB_UNSIGNED_INTEGER	1	"The safing level set for the GPC2-AL detector. =0 level zero or nominal level safing; the software will monitor the planetary detector for the conditions which necessitate a higher level of safing. =1 level 1 safing; the HVPS voltage level for the affected sensor is ramped down to 0 at a rate of 100 V/sec. =2 level 2 safing; the software turns off analog power to the affected sensor and turns off the associated HVPS. No further attempts are made to restore the level-two-safed sensor to nominal safing. The software waits for ground command to reset the affected HVPS voltage levels."	XRS_CDR
GPC2_AL_SAFING_RETRY	MSB_UNSIGNED_INTEGER	1	The max number of retry attempts to reset the GPC2-AL detector to level 0 safing.	XRS_CDR
GPC2_AL_SPARE_RATE_1	MSB_UNSIGNED_INTEGER	4	"GPC2-AL spare rates column."	XRS_CDR
GPC2_AL_SPARE_RATE_2	MSB_UNSIGNED_INTEGER	4	"GPC2-AL spare rates column."	XRS_CDR
GPC2_AL_SPECTRUM_10_253	MSB_UNSIGNED_INTEGER	488	"GPC2-AL spectra channels (10-253)."	XRS_CDR

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GPC2_AL_SUPPLY_TEMP	IEEE_REAL	8	Degree(C)	"GPC2-AL supply temperature measurement, smoothed."	XRS_CDR
GPC2_AL_VALID_CHANNEL_HI	IEEE_REAL	4		"Al filtered X-Ray rise time high channel."	XRS_CDR
GPC2_AL_VALID_CHANNEL_LOW	IEEE_REAL	4		"Al filtered X-Ray rise time low channel."	XRS_CDR
GPC2_AL_VALID_RATE	MSB_UNSIGNED_INTEGER	4		"GPC2-AL valid rate per integration period."	XRS_CDR
GPC2_AL_VETO_ANODE_RATE	MSB_UNSIGNED_INTEGER	4		"GPC2-AL veto anode rate per integration period."	XRS_CDR
GPC2_AL_VETO_DISC	MSB_UNSIGNED_INTEGER	1		"GPC2-AL veto discriminator."	XRS_CDR
GPC2_AL_VETO_ENABLE	MSB_UNSIGNED_INTEGER	1		"VETO_ENABLE criterion to determine valid event for GPC2_AL detector. =0 disabled, =1 enabled."	XRS_CDR
GPC2_AL_VETO_RATE	MSB_UNSIGNED_INTEGER	4		"GPC2-AL veto rate per integration period."	XRS_CDR
GPC2_AL_VOLTAGE	IEEE_REAL	8	Volt	"GPC2-AL voltage measurement, smoothed."	XRS_CDR
GPC2_AL_VOLTAGE_SETTING	MSB_UNSIGNED_INTEGER	2		"GPC2-AL voltage setting."	XRS_CDR
GPC2_AL_VOLTAGE_STEPPING	MSB_UNSIGNED_INTEGER	1		"Indicates whether the GPC2-AL detector's high voltage state is seeking. See the MESSENGER XRS Software Specification document for an explanation of the seeking state. =0 no, =1 yes."	XRS_CDR

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GPC3_UN_ANALYZED_EVENT_RATE	MSB_UNSIGNED_INTEGER	4		"GPC3-UN analyzed event rate per integration period."	XRS_CDR
GPC3_UN_CENTER_ANODE_RATE	MSB_UNSIGNED_INTEGER	4		"GPC3-UN center anode rate per integration period."	XRS_CDR
GPC3_UN_ENABLE	MSB_UNSIGNED_INTEGER	1		"ENABLE criterion to determine valid event for GPC3_UN detector. =0 disabled, =1 enabled."	XRS_CDR
GPC3_UN_HIGH_ENERGY_RATE	MSB_UNSIGNED_INTEGER	4		"GPC3-UN high energy rate per integration period."	XRS_CDR
GPC3_UN_LIVE_TIME	IEEE_REAL	4	Second	"Unfiltered Xray actual integration time (sec.) - the portion of the period covered by this record in which the unfiltered Xray sensor was unmasked and integrating."	XRS_CDR
GPC3_UN_LOSS_PERCENTAGE	MSB_UNSIGNED_INTEGER	1		GPC3-UN loss percentage."	XRS_CDR
GPC3_UN_LOW_LEVEL_DISC	MSB_UNSIGNED_INTEGER	1		"GPC3-UN low level discriminator."	XRS_CDR
GPC3_UN_MINUS_5V	IEEE_REAL	8	Volt	"GPC3-UN -5 volt monitor, smoothed."	XRS_CDR
GPC3_UN_PILEUP_ENABLE	MSB_UNSIGNED_INTEGER	1		"PILEUP ENABLE criterion to determine valid event for GPC3_UN detector. =0 disabled, =1 enabled."	XRS_CDR
GPC3_UN_PILEUP_RATE	MSB_UNSIGNED_INTEGER	4		"GPC3-UN pileup rate per integration period."	XRS_CDR
GPC3_UN_PLUS_5V	IEEE_REAL	8	Volt	"GPC3-UN +5 volt monitor, smoothed."	XRS_CDR
GPC3_UN_POWER_ANALOG	MSB_UNSIGNED_INTEGER	1		"GPC3-UN analog power	XRS_CDR

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				setting."	
GPC3_UN_POWER_HVPS	MSB_UNSIGNED_INTEGER	1		"GPC3-UN HVPS power setting, =0 disabled, =1 enabled."	XRS_CDR
GPC3_UN_REAL_GAIN	IEEE_REAL	4	Kiloelectron-Volt/Ch.	"Measured gain of GPC3-UN detector in keV/ch."	XRS_CDR
GPC3_UN_REAL_ZERO	IEEE_REAL	4	Kiloelectron-Volt	"Measured zero offset of GPC3-UN detector in keV."	XRS_CDR
GPC3_UN_RISE_PILEUP	MSB_UNSIGNED_INTEGER	1		"RISE PILEUP criterion to determine valid event for GPC3_UN detector. =0 disabled, =1 enabled."	XRS_CDR
GPC3_UN_RISE_PILEUP_RATE	MSB_UNSIGNED_INTEGER	4		"GPC3-UN rise pileup rate per integration period."	XRS_CDR
GPC3_UN_RISE_TIME	MSB_UNSIGNED_INTEGER	1		"RISE TIME criterion to determine valid event for GPC3_UN detector. =0 disabled, =1 enabled."	XRS_CDR
GPC3_UN_RISE_TIME_CHANNEL	IEEE_REAL	4		"Rise time threshold channel in the new (after calibration) energy scale."	XRS_CDR
GPC3_UN_RISE_TIME_DISC_1	MSB_UNSIGNED_INTEGER	1		"GPC3-UN rise time discriminator 1."	XRS_CDR
GPC3_UN_RISE_TIME_DISC_2	MSB_UNSIGNED_INTEGER	1		"GPC3-UN rise time discriminator 2."	XRS_CDR
GPC3_UN_RISE_TIME_REJECT	MSB_UNSIGNED_INTEGER	4		"GPC3-UN rise time reject rate per integration period."	XRS_CDR
GPC3_UN_SAFING_LEVEL	MSB_UNSIGNED_INTEGER	1		The safing level set for the GPC3-UNfiltered (UN) detector. =0 level zero or nominal level	XRS_CDR

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			safing; the software will monitor the planetary detector for the conditions which necessitate a higher level of safing. =1 level 1 safing; the HVPS voltage level for the affected sensor is ramped down to 0 at a rate of 100 V/sec. =2 level 2 safing; the software turns off analog power to the affected sensor and turns off the associated HVPS. No further attempts are made to restore the level-two-safed sensor to nominal safing. The software waits for ground command to reset the affected HVPS voltage levels.	
GPC3_UN_SAFING_RETRY	MSB_UNSIGNED_INTEGER	1	"The max number of retry attempts to reset the GPC3-UN detector to level 0 safing."	XRS_CDR
GPC3_UN_SPARE_RATE_1	MSB_UNSIGNED_INTEGER	4	"Spare column for GPC3-UN rates."	XRS_CDR
GPC3_UN_SPARE_RATE_2	MSB_UNSIGNED_INTEGER	4	"Spare column for GPC3-UN rates."	XRS_CDR
GPC3_UN_SPECTRUM_10_253	MSB_UNSIGNED_INTEGER	488	"GPC3-UN spectra channels (10-253)."	XRS_CDR
GPC3_UN_SUPPLY_TEMP	IEEE_REAL	8	Degree(C) "GPC3-UN supply temperature measurement,	XRS_CDR

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				smoothed."	
GPC3_UN_VALID_CHANNEL_HI	IEEE_REAL	4		"Highest channel of the spectrum in original (no calibration) or new (after calibration) energy scale."	XRS_CDR
GPC3_UN_VALID_CHANNEL_LOW	IEEE_REAL	4		"Lowest channel of the spectrum in original (no calibration) or new (after calibration) energy scale."	XRS_CDR
GPC3_UN_VALID_RATE	MSB_UNSIGNED_INTEGER	4		"GPC3-UN valid rate per integration period."	XRS_CDR
GPC3_UN_VETO_ANODE_RATE	MSB_UNSIGNED_INTEGER	4		"GPC3-UN veto anode rate per integration period."	XRS_CDR
GPC3_UN_VETO_DISC	MSB_UNSIGNED_INTEGER	1		"GPC3-UN veto discriminator."	XRS_CDR
GPC3_UN_VETO_ENABLE	MSB_UNSIGNED_INTEGER	1		"VETO ENABLE criterion to determine valid event for GPC3_UN detector. =0 disabled, =1 enabled."	XRS_CDR
GPC3_UN_VETO_RATE	MSB_UNSIGNED_INTEGER	4		"GPC3-UN veto rate per integration period."	XRS_CDR
GPC3_UN_VOLTAGE	IEEE_REAL	8	Volt	"GPC3-UN voltage measurement, smoothed."	XRS_CDR
GPC3_UN_VOLTAGE_SETTING	MSB_UNSIGNED_INTEGER	2		"GPC3-UN voltage setting."	XRS_CDR
GPC3_UN_VOLTAGE_STEPPING	MSB_UNSIGNED_INTEGER	1		"Indicates whether the GPC3-UN detector's high voltage state is seeking. See the MESSENGER XRS Software Specification	XRS_CDR

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				document for an explanation of the seeking state. =0 no, =1 yes."	
HERMEOCENTRIC_LATITUDE	IEEE_REAL	8	Degree	"Sub spacecraft latitude in Mercury fixed coordinates at the middle of the pixel."	XRS_CDR
HERMEOCENTRIC_LONGITUDE	IEEE_REAL	8	Degree	"Sub spacecraft longitude in Mercury fixed coordinated at the middle of the pixel. Longitude increases towards the East."	XRS_CDR
I2C_BUS_ERROR_COUNT	MSB_UNSIGNED_INTEGER	1		"I2C bus error count."	XRS_CDR
INSTR_BORESIGHT_MERCURY_X	IEEE_REAL	4	Kilometer	"Sub instrument boresight x component in Mercury fixed coordinates."	XRS_CDR
INSTR_BORESIGHT_MERCURY_Y	IEEE_REAL	4	Kilometer	"Sub instrument boresight y component in Mercury fixed coordinates."	XRS_CDR
INSTR_BORESIGHT_MERCURY_Z	IEEE_REAL	4	Kilometer	"Sub instrument boresight z component in Mercury fixed coordinates."	XRS_CDR
INTERSECTION	BOOLEAN	1		"True if the pointing vector intersects Mercury."	XRS_CDR
LOCAL_HOUR	MSB_UNSIGNED_INTEGER	1	Hour	"Local Sun hour at the sub-spacecraft point."	XRS_CDR

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LOCAL_MINUTE	MSB_UNSIGNED_INTEGER	1	Minute	"Local Sun minute at the sub-spacecraft point."	XRS_CDR
LVPS_MINUS_12_I	IEEE_REAL	8	Microamp	"LVPS -12V current, smoothed."	XRS_CDR
LVPS_MINUS_12V	IEEE_REAL	8	Volt	"LVPS -12 volt monitor, smoothed."	XRS_CDR
LVPS_MINUS_5_I	IEEE_REAL	8	Microamp	"LVPS -5V current, smoothed."	XRS_CDR
LVPS_MINUS_5V	IEEE_REAL	8	Volt	"LVPS -5 volt monitor, smoothed."	XRS_CDR
LVPS_PLUS_12_I	IEEE_REAL	8	Microamp	"LVPS +12V current, smoothed."	XRS_CDR
LVPS_PLUS_12V	IEEE_REAL	8	Volt	"LVPS +12 volt monitor, smoothed."	XRS_CDR
LVPS_PLUS_5_I	IEEE_REAL	8	Microamp	"LVPS +5V current, smoothed."	XRS_CDR
LVPS_PLUS_5V	IEEE_REAL	8	Volt	"LVPS +5 volt monitor, smoothed."	XRS_CDR
LVPS_PRIMARY_I	IEEE_REAL	8	Microamp	"LVPS primary current, smoothed."	XRS_CDR
LVPS_SPARE0	MSB_UNSIGNED_INTEGER	1		"Spare unused column for LVPS monitoring."	XRS_CDR
LVPS_SPARE1	MSB_UNSIGNED_INTEGER	1		"Spare unused column for LVPS monitoring."	XRS_CDR
LVPS_SWITCHED_PRIMARY_I	IEEE_REAL	8	Microamp	"LVPS switched primary current, smoothed."	XRS_CDR
LVPS_TEMP	IEEE_REAL	8	Degree(C)	"LVPS temperature, smoothed."	XRS_CDR
MACRO_BLOCKS	MSB_UNSIGNED_INTEGER	2		"Number of macro blocks free."	XRS_CDR
MACRO_ID	MSB_UNSIGNED_INTEGER	1		"ID of most recent macro executed."	XRS_CDR
MACRO_LEARN_MODE	MSB_UNSIGNED_INTEGER	1		"Macro learn mode. =0 not learning, =1 learning."	XRS_CDR

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MACROS_EXECUTED	MSB_UNSIGNED_INTEGER	1		"Number of macro commands executed."	XRS_CDR
MACROS_REJECTED	MSB_UNSIGNED_INTEGER	1		"Number of macro commands rejected."	XRS_CDR
MEM_WRITE_ENABLE	MSB_UNSIGNED_INTEGER	1		"Memory write enable. =0 disabled, =1 enabled."	XRS_CDR
MERCURY_SOL	IEEE_REAL	8		"Longitude of the Sun at 0 hours UT on the date of the record. Taken from the Association of Lunar and Planetary Observers Ephemeris for Physical Observation of Mercury."	XRS_CDR
MET	MSB_UNSIGNED_INTEGER	4	Second	"Time tag in seconds, 0 = MESSENGER launch."	XRS_CDR
MONITOR_RESPONSE	MSB_UNSIGNED_INTEGER	1		"Monitor response. =0 disabled, =1 enabled. This means whether the internal alarm autonomy is enabled for action. If there is an alarm, MONITOR_RESPONSE enabled means that the action macro, if there is one, will be executed. Disabled means that there can be an alarm detected and reported, but no action will take place within XRS to remove the error that causes the fault. The enable is off at startup, and is	XRS_CDR

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				enabled shortly after boot by command, and should remain enabled."	
MXU_TEMP	IEEE_REAL	8	Degree(C)	"MXU temperature, smoothed."	XRS_CDR
ORBIT_NUMBER	MSB_UNSIGNED_INTEGER	4		"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."	XRS_CDR
PHASE_ANGLE	IEEE_REAL	4	Degree	"Phase angle (between direction from the sun to the surface and direction from the surface to the spacecraft)."	XRS_CDR
PIN_ENABLE	MSB_UNSIGNED_INTEGER	1		"ENABLE criterion to determine valid event for PIN detector. =0 disabled, =1 enabled."	XRS_CDR
PIN_LOW_LEVEL_DISC	MSB_UNSIGNED_INTEGER	1		"PIN low level discriminator (energy threshold)."	XRS_CDR

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PIN_PILEUP_ENABLE	MSB_UNSIGNED_INTEGER	1		"PIN PILEUP criterion to determine valid event for PIN detector. =0 disabled, =1 enabled."	XRS_CDR
PIN_POWER_ANALOG	MSB_UNSIGNED_INTEGER	1		"PIN analog power setting. =0 disabled, =1 enabled."	XRS_CDR
PIN_POWER_BIAS	MSB_UNSIGNED_INTEGER	1		"PIN power bias =0 disabled, =1 enabled."	XRS_CDR
PIN_TEC_ENABLE	MSB_UNSIGNED_INTEGER	1		"PIN TEC enable, =0 disabled, =1 enabled."	XRS_CDR
PIN_TEC_MODE	MSB_UNSIGNED_INTEGER	1		"PIN TEC mode, =0 cool, =1 heat."	XRS_CDR
POINTING	BOOLEAN	1		"True if pointing data was available."	XRS_CDR
SAX_LIVE_TIME	IEEE_REAL	4		"Live time of the solar monitor."	XRS_CDR
SAX_MINUS_5V	IEEE_REAL	8	Volt	"SAX -5 volt monitor, smoothed."	XRS_CDR
SAX_PLUS_5V	IEEE_REAL	8	Volt	"SAX +5 volt monitor, smoothed."	XRS_CDR
SAX_TEMP	IEEE_REAL	8	Degree(C)	"SAX temperature, smoothed."	XRS_CDR
SAX_TEMP_MODE	MSB_UNSIGNED_INTEGER	1		"SAX Temperature Mode. 0 = Off, 1 = On, 2 = Software control."	XRS_CDR
SC_ANGLE	IEEE_REAL	8	Degree	" +Z angle to Mercury surface, smoothed. -1 means it cannot be calculated."	XRS_CDR
SC_POSITION_X	IEEE_REAL	4		"Position of spacecraft in J2000 frame."	XRS_CDR
SC_POSITION_Y	IEEE_REAL	4		"Position of spacecraft in J2000 frame."	XRS_CDR

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SC_POSITION_Z	IEEE_REAL	4		"Position of spacecraft in J2000 frame."	XRS_CDR
SC_RANGE	IEEE_REAL	8	Kilometer	" +Z range to Mercury surface, smoothed. -1 means it cannot be calculated."	XRS_CDR
SCALT	IEEE_REAL	4	Kilometer	"Hermocentric altitude, in kilometers, of the sub-spacecraft point in Mercury-fixed rotating frame at the middle of the pixel."	XRS_CDR
SCIENCE_RECORD_VERSION	MSB_UNSIGNED_INTEGER	1		"Version of science packet format."	XRS_CDR
SENSOR_CONFIG_CHANGED	MSB_UNSIGNED_INTEGER	1		"Flag showing whether sensor configuration has changed. =0 no change, =1 change."	XRS_CDR
SOFTWARE_SUB_VERSION	MSB_UNSIGNED_INTEGER	1		"Sub-version of flight software."	XRS_CDR
SOLAR_DETECTOR_I	IEEE_REAL	8		"Solar detector current, smoothed."	XRS_CDR
SOLAR_DETECTOR_TEMP	IEEE_REAL	8	Degree(C)	"Solar detector temperature, smoothed."	XRS_CDR
SOLAR_FLARE_DETECTED	MSB_UNSIGNED_INTEGER	1		"Solar flare detection flag. =0 no solar flare detected, =1 flare detected."	XRS_CDR
SOLAR_MONITOR_ANALYZED_RATE	MSB_UNSIGNED_INTEGER	4		"Number of events that get fully processed. The number of counts in a solar monitor spectrum ."	XRS_CDR

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SOLAR_MONITOR_HIGH_E_RATE	MSB_UNSIGNED_INTEGER	4	"Solar monitor high energy rate per integration period. All counts above the top channel."	XRS_CDR
SOLAR_MONITOR_LOSS	MSB_UNSIGNED_INTEGER	1	"The loss rate from the electronics to the software. It's the fraction of events that overflow the FIFO and are lost. It does not include front-end losses."	XRS_CDR
SOLAR_MONITOR_PILEUP_RATE	MSB_UNSIGNED_INTEGER	4	"Number of events that suffer from pileup."	XRS_CDR
SOLAR_MONITOR_RATE	MSB_UNSIGNED_INTEGER	4	"Solar monitor detector rate per integration period."	XRS_CDR
SOLAR_MONITOR_SPECT_SHIFT	MSB_UNSIGNED_INTEGER	2	"The divisor (bit shift) for the Solar Monitor spectrum. When any channel in the solar monitor spectrum exceeds 65535, the spectrum is shifted to the right, throwing out the least significant bits, keeping the 16 most significant bits."	XRS_CDR
SOLAR_MON_SPECTRUM_23_253	MSB_UNSIGNED_INTEGER	462	"Solar monitor spectra channels (23-253)."	XRS_CDR
SOLAR_MONITOR_VALID_RATE	MSB_UNSIGNED_INTEGER	4	"Solar monitor valid rate per integration period."	XRS_CDR

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SOLAR_STABILITY	MSB_UNSIGNED_INTEGER	20	"A 10 element array of solar monitor detector rate measurements. The integration period is divided into 10 equal segments with an accumulated rate (per second) for each. Valid data for this column is only obtained by the instrument if solar flare handling is enabled at the start of the integration and reporting period. Values are set to a default of 999 if solar flare handling was not enabled."	XRS_CDR
SPARE	MSB_UNSIGNED_INTEGER	1	"Spare column for possible future use."	XRS_CDR
SPARE_DAC_1	MSB_UNSIGNED_INTEGER	1	"Spare column (DAC 1)."	XRS_CDR
SPARE_DAC_2	MSB_UNSIGNED_INTEGER	1	"Spare column (DAC 2)."	XRS_CDR
STATUS_INTERVAL	MSB_UNSIGNED_INTEGER	2	"Time period (in seconds) between status packets."	XRS_CDR
SUB_SCPOS_MERCURY_X	IEEE_REAL	4	"Sub spacecraft vector x component in Mercury fixed coordinates at the middle of the pixel."	XRS_CDR
SUB_SCPOS_MERCURY_Y	IEEE_REAL	4	"Sub spacecraft vector y component in Mercury fixed coordinates at the middle of the pixel."	XRS_CDR

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SUB_SCPOS_MERCURY_Z	IEEE_REAL	4		"Sub spacecraft vector z component in Mercury fixed coordinates at the middle of the pixel."	XRS_CDR
SUN_DISTANCE	IEEE_REAL	4	Kilometer	"Sun Position vector magnitude."	XRS_CDR
SUN_POSITION_X	IEEE_REAL	4		"Position of the Sun in Mercury fixed coord. System."	XRS_CDR
SUN_POSITION_Y	IEEE_REAL	4		"Position of the Sun in Mercury fixed coord. System."	XRS_CDR
SUN_POSITION_Z	IEEE_REAL	4		"Position of the Sun in Mercury fixed coord. system."	XRS_CDR
SW_VERSION	MSB_UNSIGNED_INTEGER	1		"Software version number."	XRS_CDR
TEC_CURRENT_SETTING	MSB_UNSIGNED_INTEGER	1		"TEC current setting."	XRS_CDR
TEC_I	IEEE_REAL	8	Microamp	"TEC current, smoothed."	XRS_CDR
TEC_LOSS_OF_CONTROL	MSB_UNSIGNED_INTEGER	1		"TEC loss of control flag. =0 no loss of control, =1 loss of control."	XRS_CDR
TOTAL_EFF_SOLID_ANGLE	IEEE_REAL	4	Steradian	"Overall solid angle in the footprint contributing to the spectrum (lit by the sun and visible from the spacecraft) and weighted by the response function of the collimator, relatively the instrument full field of view."	XRS_CDR

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TOTAL_ILLUMINATED_AREA	IEEE_REAL	4	Kilometer**2	"Total area in the footprint contributing to the spectrum (lit by the sun and visible from the spacecraft)."	XRS_CDR
TOTAL_VISIBLE_AREA	IEEE_REAL	4	Kilometer**2	"Total area in the footprint visible from the spacecraft."	XRS_CDR
UTC	CHARACTER	23		"MET converted to UTC, stored as: yyyy-mm-ddThh:mm:ss.sss."	XRS_CDR

7.6 APPENDIX: XRS PDS FMT File: XRS_CDR.FMT

```

OBJECT      = COLUMN
NAME        = MET
COLUMN_NUMBER = 1
BYTES      = 4
DATA_TYPE  = MSB_UNSIGNED_INTEGER
START_BYTE = 1
UNIT       = Seconds
DESCRIPTION = "Time tag in seconds, 0 = MESSENGER launch."
END_OBJECT = COLUMN

OBJECT      = COLUMN
NAME        = ORBIT_NUMBER
COLUMN_NUMBER = 2
BYTES      = 4
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        = STATUS_INTERVAL
COLUMN_NUMBER = 3
BYTES      = 2
DATA_TYPE  = MSB_UNSIGNED_INTEGER
START_BYTE = 9
UNIT       = Seconds
DESCRIPTION = "Time period (in seconds) between status packets."
END_OBJECT = COLUMN

OBJECT      = COLUMN
NAME        = SC_RANGE
COLUMN_NUMBER = 4
BYTES      = 8
DATA_TYPE  = IEEE_REAL
START_BYTE = 11
UNIT       = Kilometers
DESCRIPTION = "+Z range to Mercury surface, smoothed.
-1 means it cannot be calculated."
END_OBJECT = COLUMN

OBJECT      = COLUMN
NAME        = SC_ANGLE
COLUMN_NUMBER = 5
BYTES      = 8
DATA_TYPE  = IEEE_REAL
START_BYTE = 19
UNIT       = Degrees
DESCRIPTION = "+Z angle to Mercury surface, smoothed.
-1 means it cannot be calculated."
END_OBJECT = COLUMN

OBJECT      = COLUMN
NAME        = DATA_QUALITY
COLUMN_NUMBER = 6
BYTES      = 4
DATA_TYPE  = MSB_UNSIGNED_INTEGER
START_BYTE = 27
DESCRIPTION = "Integer representation of a 32-bit array. Each bit

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represents a data quality flag. Currently only the least significant bit is being used. Other bit positions will be designated during the course of the mission as more data quality parameters are identified by the instrument team. =1, the actual data length in bytes does not match the reported length. =0, actual data length in bytes matches reported length."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = SW_VERSION

COLUMN_NUMBER = 7

BYTES = 1

DATA_TYPE = MSB_UNSIGNED_INTEGER

START_BYTE = 31

DESCRIPTION = "Software version number."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = ALARM_ID

COLUMN_NUMBER = 8

BYTES = 1

DATA_TYPE = MSB_UNSIGNED_INTEGER

START_BYTE = 32

DESCRIPTION = "The identifier for the last XRS alarm, 0 for no alarm and non-zero for a long list of various parameters out of range."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = ALARM_TYPE

COLUMN_NUMBER = 9

BYTES = 1

DATA_TYPE = MSB_UNSIGNED_INTEGER

START_BYTE = 33

DESCRIPTION = "Latest alarm type. =0 persistent, =1 transient."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = ALARM_COUNT

COLUMN_NUMBER = 10

BYTES = 1

DATA_TYPE = MSB_UNSIGNED_INTEGER

START_BYTE = 34

DESCRIPTION = "Count of number of alarms."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = CMD_EXECUTED

COLUMN_NUMBER = 11

BYTES = 1

DATA_TYPE = MSB_UNSIGNED_INTEGER

START_BYTE = 35

DESCRIPTION = "Number of commands executed."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = CMD_REJECTED

COLUMN_NUMBER = 12

BYTES = 1

DATA_TYPE = MSB_UNSIGNED_INTEGER

START_BYTE = 36

DESCRIPTION = "Number of commands rejected."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = MONITOR_RESPONSE

COLUMN_NUMBER = 13

BYTES = 1

DATA_TYPE = MSB_UNSIGNED_INTEGER

START_BYTE = 37

DESCRIPTION = "Monitor response. =0 disabled, =1 enabled."

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```

END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = MEM_WRITE_ENABLE
  COLUMN_NUMBER = 14
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 38
  DESCRIPTION = "Memory write enable. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = MACRO_LEARN_MODE
  COLUMN_NUMBER = 15
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 39
  DESCRIPTION = "Macro learn mode. =0 not learning, =1 learning."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = SPARE
  COLUMN_NUMBER = 16
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 40
  DESCRIPTION = "Spare column for possible future use."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = SCIENCE_RECORD_VERSION
  COLUMN_NUMBER = 17
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 41
  DESCRIPTION = "Version of science packet format."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = MACRO_ID
  COLUMN_NUMBER = 18
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 42
  DESCRIPTION = "ID of most recent macro executed."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = MACROS_REJECTED
  COLUMN_NUMBER = 19
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 43
  DESCRIPTION = "Number of macro commands rejected."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = MACROS_EXECUTED
  COLUMN_NUMBER = 20
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 44
  DESCRIPTION = "Number of macro commands executed."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = MACRO_BLOCKS
  COLUMN_NUMBER = 21
  BYTES     = 2
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 45

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```

DESCRIPTION  = "Number of macro blocks free."
END_OBJECT = COLUMN

OBJECT      = COLUMN
NAME        = GPC1_MG_SAFING_LEVEL
COLUMN_NUMBER = 22
BYTES       = 1
DATA_TYPE   = MSB_UNSIGNED_INTEGER
START_BYTE  = 47
DESCRIPTION = "The safing level set for the GPC1-MG detector.
=0 level zero or nominal level safing; the software will
monitor the planetary detector for the conditions which
necessitate a higher level of safing. =1 level 1 safing; the
HVPS voltage level for the affected sensor is ramped
down to 0 at a rate of 100 V/sec. =2 level 2 safing; the
software turns off analog power to the affected sensor and
turns off the associated HVPS. No further attempts are made
to restore the level-two-safed sensor to nominal safing. The
software waits for ground command to reset the affected HVPS
voltage levels."
END_OBJECT = COLUMN

OBJECT      = COLUMN
NAME        = GPC1_MG_SAFING_RETRY
COLUMN_NUMBER = 23
BYTES       = 1
DATA_TYPE   = MSB_UNSIGNED_INTEGER
START_BYTE  = 48
DESCRIPTION = "The max number of retry attempts to reset the
GPC1-MG detector to level 0 safing."
END_OBJECT = COLUMN

OBJECT      = COLUMN
NAME        = GPC2_AL_SAFING_LEVEL
COLUMN_NUMBER = 24
BYTES       = 1
DATA_TYPE   = MSB_UNSIGNED_INTEGER
START_BYTE  = 49
DESCRIPTION = "The safing level set for the GPC2-AL detector.
=0 level zero or nominal level safing; the software will
monitor the planetary detector for the conditions which
necessitate a higher level of safing. =1 level 1 safing; the
HVPS voltage level for the affected sensor is ramped
down to 0 at a rate of 100 V/sec. =2 level 2 safing; the
software turns off analog power to the affected sensor and
turns off the associated HVPS. No further attempts are made
to restore the level-two-safed sensor to nominal safing.
The software waits for ground command to reset the affected
HVPS voltage levels."
END_OBJECT = COLUMN

OBJECT      = COLUMN
NAME        = GPC2_AL_SAFING_RETRY
COLUMN_NUMBER = 25
BYTES       = 1
DATA_TYPE   = MSB_UNSIGNED_INTEGER
START_BYTE  = 50
DESCRIPTION = "The max number of retry attempts to reset the
GPC2-AL detector to level 0 safing."
END_OBJECT = COLUMN

OBJECT      = COLUMN
NAME        = GPC3_UN_SAFING_LEVEL
COLUMN_NUMBER = 26
BYTES       = 1
DATA_TYPE   = MSB_UNSIGNED_INTEGER
START_BYTE  = 51
DESCRIPTION = "The safing level set for the GPC3-UNfiltered (UN)
detector. =0 level zero or nominal level safing; the software
will monitor the planetary detector for the conditions which
necessitate a higher level of safing. =1 level 1 safing; the

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HVPS voltage level for the affected sensor is ramped down to 0 at a rate of 100 V/sec. =2 level 2 safing; the software turns off analog power to the affected sensor and turns off the associated HVPS. No further attempts are made to restore the level-two-safed sensor to nominal safing. The software waits for ground command to reset the affected HVPS voltage levels."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = GPC3_UN_SAFING_RETRY

COLUMN_NUMBER = 27

BYTES = 1

DATA_TYPE = MSB_UNSIGNED_INTEGER

START_BYTE = 52

DESCRIPTION = "The max number of retry attempts to reset the GPC3-UN detector to level 0 safing."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = DISCARDED_PACKET_COUNTER

COLUMN_NUMBER = 28

BYTES = 1

DATA_TYPE = MSB_UNSIGNED_INTEGER

START_BYTE = 53

DESCRIPTION = "Number of calls to send-pkt that resulted in a return value of false."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = TEC_LOSS_OF_CONTROL

COLUMN_NUMBER = 29

BYTES = 1

DATA_TYPE = MSB_UNSIGNED_INTEGER

START_BYTE = 54

DESCRIPTION = "TEC loss of control flag. =0 no loss of control, =1 loss of control."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = SOLAR_FLARE_DETECTED

COLUMN_NUMBER = 30

BYTES = 1

DATA_TYPE = MSB_UNSIGNED_INTEGER

START_BYTE = 55

DESCRIPTION = "Solar flare detection flag. =0 no solar flare detected, =1 flare detected."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = FLARE_HANDLING_ENABLED

COLUMN_NUMBER = 31

BYTES = 1

DATA_TYPE = MSB_UNSIGNED_INTEGER

START_BYTE = 56

DESCRIPTION = "Solar flare handling enabled flag, software checks this value upon detection of a solar flare. =0 do not handle solar flare detection. =1 continue algorithm for handling solar flare detection (see SOLAR_FLARE_ENACT)."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = FLARE_HANDLING_ENACTED

COLUMN_NUMBER = 32

BYTES = 1

DATA_TYPE = MSB_UNSIGNED_INTEGER

START_BYTE = 57

DESCRIPTION = "Solar flare handling enacted flag. Allows software to determine if solar flare handling has already been enacted or whether this is a new detection of a solar flare. Only checked if solar flare handling has been enabled (see previous field). =0 the software sets it to true, starts the sf-time-enactable-left

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```

counter out at sf-max-time-enactable, sets a flag telling the 1Hz
process to end the current integration and reporting period
immediately, and returns control to the 1Hz process. =1 , the
software decrements the sf-time-enactable-left counter and checks
its value. If sf-time-enactable-left is still greater than 0, the
algorithm does nothing further. If sf-time-enactable-left has reached
0, the algorithm starts the sf-timeout-left counter out at
sf-timeout-period and sets the sf-handling-enacted-now flag to false."
END_OBJECT = COLUMN

OBJECT      = COLUMN
NAME        = SENSOR_CONFIG_CHANGED
COLUMN_NUMBER = 33
BYTES       = 1
DATA_TYPE   = MSB_UNSIGNED_INTEGER
START_BYTE  = 58
DESCRIPTION = "Flag showing whether sensor configuration has
changed. =0 no change, =1 change."
END_OBJECT = COLUMN

OBJECT      = COLUMN
NAME        = LVPS_PLUS_5V
COLUMN_NUMBER = 34
BYTES       = 8
DATA_TYPE   = IEEE_REAL
START_BYTE  = 59
UNIT        = Volts
DESCRIPTION = "LVPS +5 volt monitor, smoothed."
END_OBJECT = COLUMN

OBJECT      = COLUMN
NAME        = LVPS_MINUS_5V
COLUMN_NUMBER = 35
BYTES       = 8
DATA_TYPE   = IEEE_REAL
START_BYTE  = 67
UNIT        = Volts
DESCRIPTION = "LVPS -5 volt monitor, smoothed."
END_OBJECT = COLUMN

OBJECT      = COLUMN
NAME        = LVPS_PLUS_12V
COLUMN_NUMBER = 36
BYTES       = 8
DATA_TYPE   = IEEE_REAL
START_BYTE  = 75
DESCRIPTION = "LVPS +12 volt monitor, smoothed."
UNIT        = Volts
END_OBJECT = COLUMN

OBJECT      = COLUMN
NAME        = LVPS_MINUS_12V
COLUMN_NUMBER = 37
BYTES       = 8
DATA_TYPE   = IEEE_REAL
START_BYTE  = 83
UNIT        = Volts
DESCRIPTION = "LVPS -12 volt monitor, smoothed."
END_OBJECT = COLUMN

OBJECT      = COLUMN
NAME        = LVPS_SPARE0
COLUMN_NUMBER = 38
BYTES       = 1
DATA_TYPE   = MSB_UNSIGNED_INTEGER
START_BYTE  = 91
DESCRIPTION = "Spare unused column for LVPS monitoring."
END_OBJECT = COLUMN

OBJECT      = COLUMN
NAME        = LVPS_SPARE1

```


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```

COLUMN_NUMBER = 39
BYTES         = 1
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 92
DESCRIPTION   = "Spare unused column for LVPS monitoring."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
NAME        = LVPS_SPARE2
COLUMN_NUMBER = 40
BYTES       = 1
DATA_TYPE   = MSB_UNSIGNED_INTEGER
START_BYTE  = 93
DESCRIPTION = "Spare unused column for LVPS monitoring."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
NAME        = SOFTWARE_SUB_VERSION
COLUMN_NUMBER = 41
BYTES       = 1
DATA_TYPE   = MSB_UNSIGNED_INTEGER
START_BYTE  = 94
DESCRIPTION = "Sub-version of flight software."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
NAME        = I2C_BUS_ERROR_COUNT
COLUMN_NUMBER = 42
BYTES       = 1
DATA_TYPE   = MSB_UNSIGNED_INTEGER
START_BYTE  = 95
DESCRIPTION = "I2C bus error count."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
NAME        = LVPS_PLUS_5_I
COLUMN_NUMBER = 43
BYTES       = 8
DATA_TYPE   = IEEE_REAL
START_BYTE  = 96
UNIT        = MicroAmps
DESCRIPTION = "LVPS +5V current, smoothed."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
NAME        = LVPS_MINUS_5_I
COLUMN_NUMBER = 44
BYTES       = 8
DATA_TYPE   = IEEE_REAL
START_BYTE  = 104
UNIT        = MicroAmps
DESCRIPTION = "LVPS -5V current, smoothed."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
NAME        = LVPS_PLUS_12_I
COLUMN_NUMBER = 45
BYTES       = 8
DATA_TYPE   = IEEE_REAL
START_BYTE  = 112
UNIT        = MicroAmps
DESCRIPTION = "LVPS +12V current, smoothed."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
NAME        = LVPS_MINUS_12_I
COLUMN_NUMBER = 46
BYTES       = 8
DATA_TYPE   = IEEE_REAL
START_BYTE  = 120
UNIT        = MicroAmps

```

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```

    DESCRIPTION = "LVPS -12V current, smoothed."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = LVPS_TEMP
    COLUMN_NUMBER = 47
    BYTES      = 8
    DATA_TYPE = IEEE_REAL
    START_BYTE = 128
    UNIT       = Degrees(C)
    DESCRIPTION = "LVPS temperature, smoothed."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = LVPS_PRIMARY_I
    COLUMN_NUMBER = 48
    BYTES      = 8
    DATA_TYPE = IEEE_REAL
    START_BYTE = 136
    UNIT       = MicroAmps
    DESCRIPTION = "LVPS primary current, smoothed."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = LVPS_SWITCHED_PRIMARY_I
    COLUMN_NUMBER = 49
    BYTES      = 8
    DATA_TYPE = IEEE_REAL
    START_BYTE = 144
    UNIT       = MicroAmps
    DESCRIPTION = "LVPS switched primary current, smoothed."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = GPC1_MG_PLUS_5V
    COLUMN_NUMBER = 50
    BYTES      = 8
    DATA_TYPE = IEEE_REAL
    START_BYTE = 152
    UNIT       = Volts
    DESCRIPTION = "GPC1-MG +5 volt monitor, smoothed."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = GPC2_AL_PLUS_5V
    COLUMN_NUMBER = 51
    BYTES      = 8
    DATA_TYPE = IEEE_REAL
    START_BYTE = 160
    UNIT       = Volts
    DESCRIPTION = "GPC2-AL +5 volt monitor, smoothed."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = GPC3_UN_PLUS_5V
    COLUMN_NUMBER = 52
    BYTES      = 8
    DATA_TYPE = IEEE_REAL
    START_BYTE = 168
    UNIT       = Volts
    DESCRIPTION = "GPC3-UN +5 volt monitor, smoothed."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = SAX_PLUS_5V
    COLUMN_NUMBER = 53
    BYTES      = 8
    DATA_TYPE = IEEE_REAL
    START_BYTE = 176
    UNIT       = Volts
    DESCRIPTION = "SAX +5 volt monitor, smoothed."

```

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END_OBJECT = COLUMN

```
OBJECT      = COLUMN
NAME        = ANALOG_PLUS_5V
COLUMN_NUMBER = 54
BYTES       = 8
DATA_TYPE   = IEEE_REAL
START_BYTE  = 184
UNIT        = Volts
DESCRIPTION = "Analog +5 volt monitor, smoothed."
END_OBJECT = COLUMN
```

```
OBJECT      = COLUMN
NAME        = DIGITAL_PLUS_5V
COLUMN_NUMBER = 55
BYTES       = 8
DATA_TYPE   = IEEE_REAL
START_BYTE  = 192
UNIT        = Volts
DESCRIPTION = "Digital +5 volt monitor, smoothed."
END_OBJECT = COLUMN
```

```
OBJECT      = COLUMN
NAME        = GPC1_MG_MINUS_5V
COLUMN_NUMBER = 56
BYTES       = 8
DATA_TYPE   = IEEE_REAL
START_BYTE  = 200
UNIT        = Volts
DESCRIPTION = "GPC1-MG -5 volt monitor, smoothed."
END_OBJECT = COLUMN
```

```
OBJECT      = COLUMN
NAME        = GPC2_AL_MINUS_5V
COLUMN_NUMBER = 57
BYTES       = 8
DATA_TYPE   = IEEE_REAL
START_BYTE  = 208
UNIT        = Volts
DESCRIPTION = "GPC2-AL -5 volt monitor, smoothed."
END_OBJECT = COLUMN
```

```
OBJECT      = COLUMN
NAME        = GPC3_UN_MINUS_5V
COLUMN_NUMBER = 58
BYTES       = 8
DATA_TYPE   = IEEE_REAL
START_BYTE  = 216
UNIT        = Volts
DESCRIPTION = "GPC3-UN -5 volt monitor, smoothed."
END_OBJECT = COLUMN
```

```
OBJECT      = COLUMN
NAME        = SAX_MINUS_5V
COLUMN_NUMBER = 59
BYTES       = 8
DATA_TYPE   = IEEE_REAL
START_BYTE  = 224
UNIT        = Volts
DESCRIPTION = "SAX -5 volt monitor, smoothed."
END_OBJECT = COLUMN
```

```
OBJECT      = COLUMN
NAME        = ANALOG_MINUS_5V
COLUMN_NUMBER = 60
BYTES       = 8
DATA_TYPE   = IEEE_REAL
START_BYTE  = 232
UNIT        = Volts
DESCRIPTION = "Analog -5 volt monitor, smoothed."
END_OBJECT = COLUMN
```

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```

OBJECT      = COLUMN
  NAME      = TEC_I
  COLUMN_NUMBER = 61
  BYTES     = 8
  DATA_TYPE = IEEE_REAL
  START_BYTE = 240
  UNIT      = MicroAmps
  DESCRIPTION = "TEC current, smoothed."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = MXU_TEMP
  COLUMN_NUMBER = 62
  BYTES     = 8
  DATA_TYPE = IEEE_REAL
  START_BYTE = 248
  UNIT      = Degrees(C)
  DESCRIPTION = "MXU temperature, smoothed."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = SOLAR_DETECTOR_TEMP
  COLUMN_NUMBER = 63
  BYTES     = 8
  DATA_TYPE = IEEE_REAL
  START_BYTE = 256
  UNIT      = Degrees(C)
  DESCRIPTION = "Solar detector temperature, smoothed."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = SAX_TEMP
  COLUMN_NUMBER = 64
  BYTES     = 8
  DATA_TYPE = IEEE_REAL
  START_BYTE = 264
  UNIT      = Degrees(C)
  DESCRIPTION = "SAX temperature, smoothed."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = SOLAR_DETECTOR_I
  COLUMN_NUMBER = 65
  BYTES     = 8
  DATA_TYPE = IEEE_REAL
  START_BYTE = 272
  UNIT      = Pico-Amps
  DESCRIPTION = "Solar detector current, smoothed."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC1_MG_VOLTAGE_STEPPING
  COLUMN_NUMBER = 66
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 280
  DESCRIPTION = "Indicates whether the GPC1-MG detector's high
  voltage state is seeking. See the MESSENGER XRS Software
  Specification document for an explanation of the seeking
  state. =0 no, =1 yes."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC1_MG_VOLTAGE
  COLUMN_NUMBER = 67
  BYTES     = 8
  DATA_TYPE = IEEE_REAL
  START_BYTE = 281
  UNIT      = Volts
  DESCRIPTION = "GPC1-MG voltage measurement, smoothed."

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END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = GPC2_AL_VOLTAGE_STEPPING
 COLUMN_NUMBER = 68
 BYTES = 1
 DATA_TYPE = MSB_UNSIGNED_INTEGER
 START_BYTE = 289
 DESCRIPTION = "Indicates whether the GPC2-AL detector's high voltage state is seeking. See the MESSENGER XRS Software Specification document for an explanation of the seeking state. =0 no, =1 yes."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = GPC2_AL_VOLTAGE
 COLUMN_NUMBER = 69
 BYTES = 8
 DATA_TYPE = IEEE_REAL
 START_BYTE = 290
 UNIT = Volts
 DESCRIPTION = "GPC2-AL voltage measurement, smoothed."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = GPC3_UN_VOLTAGE_STEPPING
 COLUMN_NUMBER = 70
 BYTES = 1
 DATA_TYPE = MSB_UNSIGNED_INTEGER
 START_BYTE = 298
 DESCRIPTION = "Indicates whether the GPC3-UN detector's high voltage state is seeking. See the MESSENGER XRS Software Specification document for an explanation of the seeking state. =0 no, =1 yes."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = GPC3_UN_VOLTAGE
 COLUMN_NUMBER = 71
 BYTES = 8
 DATA_TYPE = IEEE_REAL
 START_BYTE = 299
 UNIT = Volts
 DESCRIPTION = "GPC3-UN voltage measurement, smoothed."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = BIAS_SUPPLY_VOLT_STEPPING
 COLUMN_NUMBER = 72
 BYTES = 1
 DATA_TYPE = MSB_UNSIGNED_INTEGER
 START_BYTE = 307
 DESCRIPTION = "Indicates whether the Bias detector's high voltage state is seeking. See the MESSENGER XRS Software Specification document for an explanation of the seeking state. =0 no, =1 yes."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = BIAS_VOLTAGE
 COLUMN_NUMBER = 73
 BYTES = 8
 DATA_TYPE = IEEE_REAL
 START_BYTE = 308
 UNIT = Volts
 DESCRIPTION = "Bias voltage measurement, smoothed."

END_OBJECT = COLUMN

OBJECT = COLUMN

NAME = GPC1_MG_SUPPLY_TEMP
 COLUMN_NUMBER = 74

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    BYTES          = 8
    DATA_TYPE     = IEEE_REAL
    START_BYTE     = 316
    UNIT           = Degrees(C)
    DESCRIPTION    = "GPC1-MG supply temperature measurement, smoothed."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
  NAME      = GPC2_AL_SUPPLY_TEMP
  COLUMN_NUMBER = 75
  BYTES     = 8
  DATA_TYPE = IEEE_REAL
  START_BYTE = 324
  UNIT      = Degrees(C)
  DESCRIPTION = "GPC2-AL supply temperature measurement, smoothed."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
  NAME      = GPC3_UN_SUPPLY_TEMP
  COLUMN_NUMBER = 76
  BYTES     = 8
  DATA_TYPE = IEEE_REAL
  START_BYTE = 332
  UNIT      = Degrees(C)
  DESCRIPTION = "GPC3-UN supply temperature measurement, smoothed."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
  NAME      = BIAS_SUPPLY_TEMP
  COLUMN_NUMBER = 77
  BYTES     = 8
  DATA_TYPE = IEEE_REAL
  START_BYTE = 340
  UNIT      = Degrees(C)
  DESCRIPTION = "Bias supply temperature measurement, smoothed."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
  NAME      = ACTUAL_INTEGRATION_TIME
  COLUMN_NUMBER = 78
  BYTES     = 4
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 348
  UNIT      = Seconds
  DESCRIPTION = "Actual integration period in seconds."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
  NAME      = ACTUAL_REPORTING_TIME
  COLUMN_NUMBER = 79
  BYTES     = 4
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 352
  UNIT      = Seconds
  DESCRIPTION = "Actual reporting time in seconds."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
  NAME      = GPC1_MG_POWER_ANALOG
  COLUMN_NUMBER = 80
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 356
  DESCRIPTION = "GPC1-MG analog power setting. =0 disabled,
    =1 enabled."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
  NAME      = GPC1_MG_POWER_HVPS
  COLUMN_NUMBER = 81
  BYTES     = 1

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```

DATA_TYPE      = MSB_UNSIGNED_INTEGER
START_BYTE     = 357
DESCRIPTION    = "GPC1-MG HVPS power setting, =0 disabled,
=1 enabled."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = GPC1_MG_VOLTAGE_SETTING
COLUMN_NUMBER = 82
BYTES         = 2
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 358
DESCRIPTION   = "GPC1-MG voltage setting."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = GPC2_AL_POWER_ANALOG
COLUMN_NUMBER = 83
BYTES         = 1
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 360
DESCRIPTION   = "GPC2-AL analog power setting, =0 disabled,
=1 enabled."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = GPC2_AL_POWER_HVPS
COLUMN_NUMBER = 84
BYTES         = 1
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 361
DESCRIPTION   = "GPC2-AL HVPS power setting, =0 disabled,
=1 enabled."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = GPC2_AL_VOLTAGE_SETTING
COLUMN_NUMBER = 85
BYTES         = 2
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 362
DESCRIPTION   = "GPC2-AL voltage setting."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = GPC3_UN_POWER_ANALOG
COLUMN_NUMBER = 86
BYTES         = 1
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 364
DESCRIPTION   = "GPC3-UN analog power setting."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = GPC3_UN_POWER_HVPS
COLUMN_NUMBER = 87
BYTES         = 1
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 365
DESCRIPTION   = "GPC3-UN HVPS power setting, =0 disabled,
=1 enabled."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = GPC3_UN_VOLTAGE_SETTING
COLUMN_NUMBER = 88
BYTES         = 2
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 366
DESCRIPTION   = "GPC3-UN voltage setting."
END_OBJECT = COLUMN

```

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```

OBJECT      = COLUMN
  NAME      = PIN_POWER_ANALOG
  COLUMN_NUMBER = 89
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 368
  DESCRIPTION = "PIN analog power setting. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
  NAME      = PIN_TEC_ENABLE
  COLUMN_NUMBER = 90
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 369
  DESCRIPTION = "PIN TEC enable, =0 disabled, =1 enabled."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
  NAME      = PIN_TEC_MODE
  COLUMN_NUMBER = 91
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 370
  DESCRIPTION = "PIN TEC mode, =0 cool, =1 heat."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
  NAME      = PIN_POWER_BIAS
  COLUMN_NUMBER = 92
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 371
  DESCRIPTION = "PIN power bias =0 disabled, =1 enabled."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
  NAME      = BIAS_VOLTAGE_SETTING
  COLUMN_NUMBER = 93
  BYTES     = 2
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 372
  DESCRIPTION = "Bias voltage setting."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
  NAME      = GPC1_MG_LOW_LEVEL_DISC
  COLUMN_NUMBER = 94
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 374
  DESCRIPTION = "GPC1-MG low level discriminator."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
  NAME      = GPC1_MG_RISE_TIME_DISC_1
  COLUMN_NUMBER = 95
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 375
  DESCRIPTION = "GPC1-MG rise time discriminator 1."
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
  NAME      = GPC1_MG_RISE_TIME_DISC_2
  COLUMN_NUMBER = 96
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 376
  DESCRIPTION = "GPC1-MG rise time discriminator 2."

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END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC1_MG_VETO_DISC
  COLUMN_NUMBER = 97
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 377
  DESCRIPTION = "GPC1-MG veto discriminator."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC2_AL_LOW_LEVEL_DISC
  COLUMN_NUMBER = 98
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 378
  DESCRIPTION = "GPC2-AL low level discriminator."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC2_AL_RISE_TIME_DISC_1
  COLUMN_NUMBER = 99
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 379
  DESCRIPTION = "GPC2-AL rise time discriminator 1."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC2_AL_RISE_TIME_DISC_2
  COLUMN_NUMBER = 100
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 380
  DESCRIPTION = "GPC2-AL rise time discriminator 2."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC2_AL_VETO_DISC
  COLUMN_NUMBER = 101
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 381
  DESCRIPTION = "GPC2-AL veto discriminator."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC3_UN_LOW_LEVEL_DISC
  COLUMN_NUMBER = 102
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 382
  DESCRIPTION = "GPC3-UN low level discriminator."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC3_UN_RISE_TIME_DISC_1
  COLUMN_NUMBER = 103
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 383
  DESCRIPTION = "GPC3-UN rise time discriminator 1."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC3_UN_RISE_TIME_DISC_2
  COLUMN_NUMBER = 104
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 384

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    DESCRIPTION = "GPC3-UN rise time discriminator 2."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = GPC3_UN_VETO_DISC
    COLUMN_NUMBER = 105
    BYTES      = 1
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 385
    DESCRIPTION = "GPC3-UN veto discriminator."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = PIN_LOW_LEVEL_DISC
    COLUMN_NUMBER = 106
    BYTES      = 1
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 386
    DESCRIPTION = "PIN low level discriminator (energy threshold)."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = TEC_CURRENT_SETTING
    COLUMN_NUMBER = 107
    BYTES      = 1
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 387
    DESCRIPTION = "TEC current setting."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = SPARE_DAC_1
    COLUMN_NUMBER = 108
    BYTES      = 1
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 388
    DESCRIPTION = "Spare column (DAC 1)."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = SPARE_DAC_2
    COLUMN_NUMBER = 109
    BYTES      = 1
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 389
    DESCRIPTION = "Spare column (DAC 2)."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = GPC2_AL_RISE_PILEUP
    COLUMN_NUMBER = 110
    BYTES      = 1
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 390
    DESCRIPTION = "RISE PILEUP criterion to determine valid event for
    GPC2_AL detector. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = GPC2_AL_RISE_TIME
    COLUMN_NUMBER = 111
    BYTES      = 1
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 391
    DESCRIPTION = "RISE TIME criterion to determine valid event for
    GPC2_AL detector. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = GPC2_AL_PILEUP_ENABLE
    COLUMN_NUMBER = 112

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BYTES           = 1
DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BYTE      = 392
DESCRIPTION     = "PILEUP_ENABLE criterion to determine valid event for
  GPC2_AL detector. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = GPC2_AL_VETO_ENABLE
COLUMN_NUMBER   = 113
BYTES           = 1
DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BYTE      = 393
DESCRIPTION     = "VETO_ENABLE criterion to determine valid event for
  GPC2_AL detector. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = GPC2_AL_ENABLE
COLUMN_NUMBER   = 114
BYTES           = 1
DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BYTE      = 394
DESCRIPTION     = "ENABLE criterion to determine valid event for
  GPC2_AL detector. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = GPC1_MG_RISE_PILEUP
COLUMN_NUMBER   = 115
BYTES           = 1
DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BYTE      = 395
DESCRIPTION     = "RISE PILEUP criterion to determine valid event for
  GPC1_MG detector. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = GPC1_MG_RISE_TIME
COLUMN_NUMBER   = 116
BYTES           = 1
DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BYTE      = 396
DESCRIPTION     = "RISE TIME criterion to determine valid event for
  GPC1_MG detector. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = GPC1_MG_PILEUP_ENABLE
COLUMN_NUMBER   = 117
BYTES           = 1
DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BYTE      = 397
DESCRIPTION     = "PILEUP_ENABLE criterion to determine valid event
  for GPC1_MG detector. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = GPC1_MG_VETO_ENABLE
COLUMN_NUMBER   = 118
BYTES           = 1
DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BYTE      = 398
DESCRIPTION     = "VETO_ENABLE criterion to determine valid event
  for GPC1_MG detector. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = GPC1_MG_ENABLE
COLUMN_NUMBER   = 119
BYTES           = 1

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DATA_TYPE      = MSB_UNSIGNED_INTEGER
START_BYTE     = 399
DESCRIPTION    = "ENABLE criterion to determine valid event for
                  GPC1 MG detector. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

OBJECT         = COLUMN
NAME           = DEBUG_COUNTERS
COLUMN_NUMBER = 120
BYTES         = 1
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 400
DESCRIPTION   = "Diagnostic for planetary sensor. =0 disabled,
                  =1 enabled."
END_OBJECT = COLUMN

OBJECT         = COLUMN
NAME           = PIN_PILEUP_ENABLE
COLUMN_NUMBER = 121
BYTES         = 1
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 401
DESCRIPTION   = "PIN PILEUP criterion to determine valid event
                  for PIN detector. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

OBJECT         = COLUMN
NAME           = PIN_ENABLE
COLUMN_NUMBER = 122
BYTES         = 1
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 402
DESCRIPTION   = "ENABLE criterion to determine valid event for
                  PIN detector. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

OBJECT         = COLUMN
NAME           = GPC3_UN_RISE_PILEUP
COLUMN_NUMBER = 123
BYTES         = 1
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 403
DESCRIPTION   = "RISE PILEUP criterion to determine valid event
                  for GPC3_UN detector. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

OBJECT         = COLUMN
NAME           = GPC3_UN_RISE_TIME
COLUMN_NUMBER = 124
BYTES         = 1
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 404
DESCRIPTION   = "RISE TIME criterion to determine valid event for
                  GPC3_UN detector. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

OBJECT         = COLUMN
NAME           = GPC3_UN_PILEUP_ENABLE
COLUMN_NUMBER = 125
BYTES         = 1
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 405
DESCRIPTION   = "PILEUP ENABLE criterion to determine valid event
                  for GPC3_UN detector. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

OBJECT         = COLUMN
NAME           = GPC3_UN_VETO_ENABLE
COLUMN_NUMBER = 126
BYTES         = 1
DATA_TYPE     = MSB_UNSIGNED_INTEGER

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START_BYTE      = 406
DESCRIPTION      = "VETO ENABLE criterion to determine valid event
                    for GPC3_UN detector. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = GPC3_UN_ENABLE
COLUMN_NUMBER   = 127
BYTES           = 1
DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BYTE      = 407
DESCRIPTION      = "ENABLE criterion to determine valid event for
                    GPC3_UN detector. =0 disabled, =1 enabled."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = SOLAR_MONITOR_RATE
COLUMN_NUMBER   = 128
BYTES           = 4
DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BYTE      = 408
DESCRIPTION      = "Solar monitor detector rate per integration period."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = SOLAR_MONITOR_PILEUP_RATE
COLUMN_NUMBER   = 129
BYTES           = 4
DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BYTE      = 412
DESCRIPTION      = "Number of events that suffer from pileup."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = SOLAR_MONITOR_VALID_RATE
COLUMN_NUMBER   = 130
BYTES           = 4
DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BYTE      = 416
DESCRIPTION      = "Solar monitor valid rate per integration period."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = SOLAR_MONITOR_ANALYZED_RATE
COLUMN_NUMBER   = 131
BYTES           = 4
DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BYTE      = 420
DESCRIPTION      = "Number of events that get fully processed.
                    The number of counts in a solar monitor spectrum ."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = SOLAR_MONITOR_HIGH_E_RATE
COLUMN_NUMBER   = 132
BYTES           = 4
DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BYTE      = 424
DESCRIPTION      = "Solar monitor high energy rate per integration
                    period. All counts above the top channel."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = SOLAR_MONITOR_LOSS
COLUMN_NUMBER   = 133
BYTES           = 1
DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BYTE      = 428
DESCRIPTION      = "The loss rate from the electronics to the software.
                    It's the fraction of events that overflow the FIFO and are lost.
                    It does not include front-end losses."

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END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC1_MG_CENTER_ANODE_RATE
  COLUMN_NUMBER = 134
  BYTES     = 4
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 429
  DESCRIPTION = "GPC1-MG center anode rate per integration period."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC1_MG_VETO_ANODE_RATE
  COLUMN_NUMBER = 135
  BYTES     = 4
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 433
  DESCRIPTION = "GPC1-MG veto anode rate per integration period."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC1_MG_VETO_RATE
  COLUMN_NUMBER = 136
  BYTES     = 4
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 437
  DESCRIPTION = "GPC1-MG veto rate per integration period."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC1_MG_PILEUP_RATE
  COLUMN_NUMBER = 137
  BYTES     = 4
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 441
  DESCRIPTION = "GPC1-MG pileup rate per integration period."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC1_MG_RISE_PILEUP_RATE
  COLUMN_NUMBER = 138
  BYTES     = 4
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 445
  DESCRIPTION = "GPC1-MG rise pileup rate per integration period."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC1_MG_VALID_RATE
  COLUMN_NUMBER = 139
  BYTES     = 4
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 449
  DESCRIPTION = "GPC1-MG valid rate per integration period."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC1_MG_ANALYZED_EVENT_RATE
  COLUMN_NUMBER = 140
  BYTES     = 4
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 453
  DESCRIPTION = "GPC1-MG analyzed event rate per integration period."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC1_MG_RISE_TIME_REJECT
  COLUMN_NUMBER = 141
  BYTES     = 4
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 457

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    DESCRIPTION = "GPC1-MG rise time reject rate per integration
    period."
END_OBJECT = COLUMN

OBJECT = COLUMN
    NAME = GPC1_MG_HIGH_ENERGY_RATE
    COLUMN_NUMBER = 142
    BYTES = 4
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 461
    DESCRIPTION = "GPC1-MG high energy rate per integration period."
END_OBJECT = COLUMN

OBJECT = COLUMN
    NAME = GPC1_MG_SPARE_RATE_1
    COLUMN_NUMBER = 143
    BYTES = 4
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 465
    DESCRIPTION = "Spare column for GPC1-MG rates per integration
    period."
END_OBJECT = COLUMN

OBJECT = COLUMN
    NAME = GPC1_MG_SPARE_RATE_2
    COLUMN_NUMBER = 144
    BYTES = 4
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 469
    DESCRIPTION = "Spare column for GPC1-MG rates."
END_OBJECT = COLUMN

OBJECT = COLUMN
    NAME = GPC1_MG_LOSS_PERCENTAGE
    COLUMN_NUMBER = 145
    BYTES = 1
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 473
    DESCRIPTION = "GPC1-MG loss percentage."
END_OBJECT = COLUMN

OBJECT = COLUMN
    NAME = GPC2_AL_CENTER_ANODE_RATE
    COLUMN_NUMBER = 146
    BYTES = 4
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 474
    DESCRIPTION = "GPC2-AL center anode rate per integration period."
END_OBJECT = COLUMN

OBJECT = COLUMN
    NAME = GPC2_AL_VETO_ANODE_RATE
    COLUMN_NUMBER = 147
    BYTES = 4
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 478
    DESCRIPTION = "GPC2-AL veto anode rate per integration period."
END_OBJECT = COLUMN

OBJECT = COLUMN
    NAME = GPC2_AL_VETO_RATE
    COLUMN_NUMBER = 148
    BYTES = 4
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 482
    DESCRIPTION = "GPC2-AL veto rate per integration period."
END_OBJECT = COLUMN

OBJECT = COLUMN
    NAME = GPC2_AL_PILEUP_RATE
    COLUMN_NUMBER = 149

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    BYTES           = 4
    DATA_TYPE      = MSB_UNSIGNED_INTEGER
    START_BYTE      = 486
    DESCRIPTION     = "GPC2-AL pileup rate per integration period."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME     = GPC2_AL_RISE_PILEUP_RATE
    COLUMN_NUMBER = 150
    BYTES     = 4
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 490
    DESCRIPTION = "GPC2-AL rise pileup rate per integration period."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME     = GPC2_AL_VALID_RATE
    COLUMN_NUMBER = 151
    BYTES     = 4
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 494
    DESCRIPTION = "GPC2-AL valid rate per integration period."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME     = GPC2_AL_ANALYZED_EVENT_RATE
    COLUMN_NUMBER = 152
    BYTES     = 4
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 498
    DESCRIPTION = "GPC2-AL analyzed event rate per integration period."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME     = GPC2_AL_RISE_TIME_REJECT
    COLUMN_NUMBER = 153
    BYTES     = 4
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 502
    DESCRIPTION = "GPC2-AL rise time reject rate per integration
    period."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME     = GPC2_AL_HIGH_ENERGY_RATE
    COLUMN_NUMBER = 154
    BYTES     = 4
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 506
    DESCRIPTION = "GPC2-AL high energy rate per integration period."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME     = GPC2_AL_SPARE_RATE_1
    COLUMN_NUMBER = 155
    BYTES     = 4
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 510
    DESCRIPTION = "GPC2-AL spare rates column."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME     = GPC2_AL_SPARE_RATE_2
    COLUMN_NUMBER = 156
    BYTES     = 4
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 514
    DESCRIPTION = "GPC2-AL spare rates column."
END_OBJECT = COLUMN

OBJECT      = COLUMN

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NAME          = GPC2_AL_LOSS_PERCENTAGE
COLUMN_NUMBER = 157
BYTES         = 1
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 518
DESCRIPTION   = "GPC2-AL loss percentage."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = GPC3_UN_CENTER_ANODE_RATE
COLUMN_NUMBER = 158
BYTES         = 4
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 519
DESCRIPTION   = "GPC3-UN center anode rate per integration period."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = GPC3_UN_VETO_ANODE_RATE
COLUMN_NUMBER = 159
BYTES         = 4
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 523
DESCRIPTION   = "GPC3-UN veto anode rate per integration period."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = GPC3_UN_VETO_RATE
COLUMN_NUMBER = 160
BYTES         = 4
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 527
DESCRIPTION   = "GPC3-UN veto rate per integration period."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = GPC3_UN_PILEUP_RATE
COLUMN_NUMBER = 161
BYTES         = 4
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 531
DESCRIPTION   = "GPC3-UN pileup rate per integration period."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = GPC3_UN_RISE_PILEUP_RATE
COLUMN_NUMBER = 162
BYTES         = 4
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 535
DESCRIPTION   = "GPC3-UN rise pileup rate per integration period."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = GPC3_UN_VALID_RATE
COLUMN_NUMBER = 163
BYTES         = 4
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 539
DESCRIPTION   = "GPC3-UN valid rate per integration period."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = GPC3_UN_ANALYZED_EVENT_RATE
COLUMN_NUMBER = 164
BYTES         = 4
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 543
DESCRIPTION   = "GPC3-UN analyzed event rate per integration period."
END_OBJECT = COLUMN

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OBJECT      = COLUMN
  NAME      = GPC3_UN_RISE_TIME_REJECT
  COLUMN_NUMBER = 165
  BYTES     = 4
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 547
  DESCRIPTION = "GPC3-UN rise time reject rate per integration
    period."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC3_UN_HIGH_ENERGY_RATE
  COLUMN_NUMBER = 166
  BYTES     = 4
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 551
  DESCRIPTION = "GPC3-UN high energy rate per integration period."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC3_UN_SPARE_RATE_1
  COLUMN_NUMBER = 167
  BYTES     = 4
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 555
  DESCRIPTION = "Spare column for GPC3-UN rates."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC3_UN_SPARE_RATE_2
  COLUMN_NUMBER = 168
  BYTES     = 4
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 559
  DESCRIPTION = "Spare column for GPC3-UN rates."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = GPC3_UN_LOSS_PERCENTAGE
  COLUMN_NUMBER = 169
  BYTES     = 1
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 563
  DESCRIPTION = "GPC3-UN loss percentage."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = SOLAR_STABILITY
  COLUMN_NUMBER = 170
  BYTES     = 20
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 564
  ITEMS     = 10
  ITEM_BYTES = 2
  DESCRIPTION = "A 10 element array of solar monitor detector rate
    measurements. The integration period is divided into 10 equal
    segments with an accumulated rate (per second) for each. Valid
    data for this column is only obtained by the instrument if solar
    flare handling is enabled at the start of the integration and
    reporting period. Values are set to a default of 999 if solar
    flare handling was not enabled."
END_OBJECT = COLUMN

OBJECT      = COLUMN
  NAME      = SOLAR_MONITOR_SPECT_SHIFT
  COLUMN_NUMBER = 171
  BYTES     = 2
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 584
  DESCRIPTION = "The divisor (bit shift) for the Solar Monitor
    spectrum. When any channel in the solar monitor spectrum exceeds

```

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65535, the spectrum is shifted to the right, throwing out the least significant bits, keeping the 16 most significant bits."
END_OBJECT = COLUMN

```
OBJECT      = COLUMN
NAME        = SOLAR_MON_SPECTRUM_23_253
COLUMN_NUMBER = 172
BYTES       = 462
DATA_TYPE   = MSB_UNSIGNED_INTEGER
START_BYTE  = 586
ITEMS       = 231
ITEM_BYTES  = 2
DESCRIPTION = "Solar monitor spectra channels (23-253)."
```

END_OBJECT = COLUMN

```
OBJECT      = COLUMN
NAME        = GPC1_MG_SPECTRUM_10_253
COLUMN_NUMBER = 173
BYTES       = 488
DATA_TYPE   = MSB_UNSIGNED_INTEGER
START_BYTE  = 1048
ITEMS       = 244
ITEM_BYTES  = 2
DESCRIPTION = "GPC1-MG spectra channels (10-253)."
```

END_OBJECT = COLUMN

```
OBJECT      = COLUMN
NAME        = GPC2_AL_SPECTRUM_10_253
COLUMN_NUMBER = 174
BYTES       = 488
DATA_TYPE   = MSB_UNSIGNED_INTEGER
START_BYTE  = 1536
ITEMS       = 244
ITEM_BYTES  = 2
DESCRIPTION = "GPC2-AL spectra channels (10-253)."
```

END_OBJECT = COLUMN

```
OBJECT      = COLUMN
NAME        = GPC3_UN_SPECTRUM_10_253
COLUMN_NUMBER = 175
BYTES       = 488
DATA_TYPE   = MSB_UNSIGNED_INTEGER
START_BYTE  = 2024
ITEMS       = 244
ITEM_BYTES  = 2
DESCRIPTION = "GPC3-UN spectra channels (10-253)."
```

END_OBJECT = COLUMN

```
OBJECT      = COLUMN
NAME        = UTC
COLUMN_NUMBER = 176
BYTES       = 23
DATA_TYPE   = CHARACTER
START_BYTE  = 2512
DESCRIPTION = "MET converted to UTC, stored as:
              yyyy-mm-ddThh:mm:ss.sss."
```

END_OBJECT = COLUMN

```
OBJECT      = COLUMN
NAME        = LOCAL_HOUR
COLUMN_NUMBER = 177
BYTES       = 1
DATA_TYPE   = MSB_UNSIGNED_INTEGER
START_BYTE  = 2535
UNIT        = Hours
DESCRIPTION = "Local Sun hour at the sub-spacecraft point."
```

END_OBJECT = COLUMN

```
OBJECT      = COLUMN
NAME        = LOCAL_MINUTE
COLUMN_NUMBER = 178
```

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```

    BYTES          = 1
    DATA_TYPE     = MSB_UNSIGNED_INTEGER
    START_BYTE     = 2536
    UNIT           = Minutes
    DESCRIPTION    = "Local Sun minute at the sub-spacecraft point."
END_OBJECT = COLUMN

OBJECT           = COLUMN
    NAME          = MERCURY_SOL
    COLUMN_NUMBER = 179
    BYTES         = 8
    DATA_TYPE    = IEEE_REAL
    START_BYTE    = 2537
    UNIT         = Degrees
    DESCRIPTION   = "Longitude of the Sun at 0 hours UT on the date
of the record. Taken from the Association of Lunar and Planetary
Observers Ephemeris for Physical Observation of Mercury."
END_OBJECT = COLUMN

OBJECT           = COLUMN
    NAME          = PHASE_ANGLE
    COLUMN_NUMBER = 180
    BYTES         = 4
    DATA_TYPE    = IEEE_REAL
    START_BYTE    = 2545
    UNIT         = Degrees
    DESCRIPTION   = "Phase angle (between direction from the sun to the
surface and direction from the surface to the spacecraft)."
END_OBJECT = COLUMN

OBJECT           = COLUMN
    NAME          = AVG_SC_DISTANCE
    COLUMN_NUMBER = 181
    BYTES         = 4
    DATA_TYPE    = IEEE_REAL
    START_BYTE    = 2549
    UNIT         = Kilometers
    DESCRIPTION   = "Average distance of the planet from the Spacecraft."
END_OBJECT = COLUMN

OBJECT           = COLUMN
    NAME          = ANGLE_SUN_SOLAR_MONITOR
    COLUMN_NUMBER = 182
    BYTES         = 4
    DATA_TYPE    = IEEE_REAL
    START_BYTE    = 2553
    UNIT         = Degrees
    DESCRIPTION   = "Angle between the Sun and the solar monitor."
END_OBJECT = COLUMN

OBJECT           = COLUMN
    NAME          = SUN_DISTANCE
    COLUMN_NUMBER = 183
    BYTES         = 4
    DATA_TYPE    = IEEE_REAL
    START_BYTE    = 2557
    UNIT         = Kilometers
    DESCRIPTION   = "Sun Position vector magnitude."
END_OBJECT = COLUMN

OBJECT           = COLUMN
    NAME          = INTERSECTION
    COLUMN_NUMBER = 184
    BYTES         = 1
    DATA_TYPE    = BOOLEAN
    START_BYTE    = 2561
    DESCRIPTION   = "True if the pointing vector intersects Mercury."
END_OBJECT = COLUMN

OBJECT           = COLUMN
    NAME          = POINTING

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```

COLUMN_NUMBER = 185
BYTES         = 1
DATA_TYPE     = BOOLEAN
START_BYTE    = 2562
DESCRIPTION   = "True if pointing data was available."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = HERMEOCENTRIC_LATITUDE
COLUMN_NUMBER = 186
BYTES         = 8
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2563
UNIT          = Degrees
DESCRIPTION   = "Sub spacecraft longitude in Mercury fixed
coordinates at the middle of the pixel."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = HERMEOCENTRIC_LONGITUDE
COLUMN_NUMBER = 187
BYTES         = 8
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2571
UNIT          = Degrees
DESCRIPTION   = "Sub spacecraft longitude in Mercury fixed
coordinates at the middle of the pixel. Longitude increases
towards the East."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = SCALT
COLUMN_NUMBER = 188
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2579
UNIT          = Kilometers
DESCRIPTION   = "Hermocentric altitude, in kilometers, of the
sub-spacecraft point in Mercury-fixed rotating frame in the
middle of the pixel."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = BS_VECTOR_X
COLUMN_NUMBER = 189
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2583
DESCRIPTION   = "Boresight vector, x component in the J2000 frame."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = BS_VECTOR_Y
COLUMN_NUMBER = 190
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2587
DESCRIPTION   = "Boresight vector, y component in the J2000 frame."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = BS_VECTOR_Z
COLUMN_NUMBER = 191
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2591
DESCRIPTION   = "Boresight vector, z component in the J2000 frame."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = INSTR_BORESIGHT_MERCURY_X

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```

COLUMN_NUMBER = 192
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2595
UNIT          = Kilometers
DESCRIPTION    = "Sub instrument boresight x component in Mercury fixed
                coordinates."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = INSTR_BORESIGHT_MERCURY_Y
COLUMN_NUMBER = 193
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2599
UNIT          = Kilometers
DESCRIPTION    = "Sub instrument boresight y component in Mercury fixed
                coordinates."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = INSTR_BORESIGHT_MERCURY_Z
COLUMN_NUMBER = 194
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2603
UNIT          = Kilometers
DESCRIPTION    = "Sub instrument boresight z component in Mercury fixed
                coordinates."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = EARTH_POSITION_X
COLUMN_NUMBER = 195
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2607
DESCRIPTION    = "Position of the Earth (ET*) in Mercury fixed coord.
                system (ET*)."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = EARTH_POSITION_Y
COLUMN_NUMBER = 196
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2611
DESCRIPTION    = "Position of the Earth (ET*) in Mercury fixed coord.
                system (ET*)."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = EARTH_POSITION_Z
COLUMN_NUMBER = 197
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2615
DESCRIPTION    = "Position of the Earth (ET*) in Mercury fixed coord.
                system (ET*)."
END_OBJECT = COLUMN

OBJECT        = COLUMN
NAME          = SC_POSITION_X
COLUMN_NUMBER = 198
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2619
DESCRIPTION    = "Position of spacecraft in J2000 frame."
END_OBJECT = COLUMN

OBJECT        = COLUMN

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```

NAME          = SC_POSITION_Y
COLUMN_NUMBER = 199
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2623
DESCRIPTION    = "Position of spacecraft in J2000 frame."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME          = SC_POSITION_Z
COLUMN_NUMBER = 200
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2627
DESCRIPTION    = "Position of spacecraft in J2000 frame."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME          = SUB_SCPOS_MERCURY_X
COLUMN_NUMBER = 201
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2631
DESCRIPTION    = "Sub spacecraft vector x component in Mercury fixed
coordinates at the middle of the pixel."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME          = SUB_SCPOS_MERCURY_Y
COLUMN_NUMBER = 202
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2635
DESCRIPTION    = "Sub spacecraft vector y component in Mercury fixed
coordinates at the middle of the pixel."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME          = SUB_SCPOS_MERCURY_Z
COLUMN_NUMBER = 203
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2639
DESCRIPTION    = "Sub spacecraft vector z component in Mercury fixed
coordinates at the middle of the pixel."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME          = SUN_POSITION_X
COLUMN_NUMBER = 204
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2643
DESCRIPTION    = "Position of the Sun in Mercury fixed coord. System."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME          = SUN_POSITION_Y
COLUMN_NUMBER = 205
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2647
DESCRIPTION    = "Position of the Sun in Mercury fixed coord. system."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
NAME          = SUN_POSITION_Z
COLUMN_NUMBER = 206
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2651

```

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```

    DESCRIPTION = "Position of the Sun in Mercury fixed coord. system."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = DELTA_ANGLE
    COLUMN_NUMBER = 207
    BYTES      = 8
    DATA_TYPE = IEEE_REAL
    START_BYTE = 2655
    UNIT       = Degrees
    DESCRIPTION = "Difference between instrument +y direction and true
    north at the middle of the pixel."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = AVG_EMISSION_ANGLE
    COLUMN_NUMBER = 208
    BYTES      = 4
    DATA_TYPE = IEEE_REAL
    START_BYTE = 2663
    UNIT       = Degrees
    DESCRIPTION = "Average emission angle (between normal to the surface
    and direction from the surface to the spacecraft)."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = AVG_INC_EMI_COS_RATIO
    COLUMN_NUMBER = 209
    BYTES      = 4
    DATA_TYPE = IEEE_REAL
    START_BYTE = 2667
    DESCRIPTION = "Average ratio of the cosine of incidence angle to the
    cosine of emission angle."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = AVG_INCIDENCE_ANGLE
    COLUMN_NUMBER = 210
    BYTES      = 4
    DATA_TYPE = IEEE_REAL
    START_BYTE = 2671
    UNIT       = Degrees
    DESCRIPTION = "Average incidence angle."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = FOOTPRINT_SOLID_ANGLE
    COLUMN_NUMBER = 211
    BYTES      = 4
    DATA_TYPE = IEEE_REAL
    START_BYTE = 2675
    UNIT       = Steradians
    DESCRIPTION = "Overall solid angle in the footprint contributing
    to the spectrum (visible from the spacecraft), relatively the
    instrument full field of view."
END_OBJECT = COLUMN

OBJECT      = COLUMN
    NAME      = TOTAL_EFF_SOLID_ANGLE
    COLUMN_NUMBER = 212
    BYTES      = 4
    DATA_TYPE = IEEE_REAL
    START_BYTE = 2679
    UNIT       = Steradians
    DESCRIPTION = "Overall solid angle of the footprint contributing
    to the spectrum (lit by the sun and visible from the spacecraft)
    and weighted by the response function of the collimator,
    relatively the instrument full field of view."
END_OBJECT = COLUMN

OBJECT      = COLUMN

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NAME          = TOTAL_ILLUMINATED_AREA
COLUMN_NUMBER = 213
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2683
UNIT          = Kilometer**2
DESCRIPTION   = "Total area of the footprint contributing to the spectrum
(lit by the sun and visible from the spacecraft)."
```

END_OBJECT = COLUMN

```

OBJECT        = COLUMN
NAME          = TOTAL_VISIBLE_AREA
COLUMN_NUMBER = 214
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2687
UNIT          = Kilometer**2
DESCRIPTION   = "Total area of the footprint visible from the spacecraft."
```

END_OBJECT = COLUMN

```

OBJECT        = COLUMN
NAME          = FOV_STATUS
COLUMN_NUMBER = 215
BYTES         = 1
DATA_TYPE     = MSB_UNSIGNED_INTEGER
START_BYTE    = 2691
DESCRIPTION   = "Field of view 0 equals Field of view (FOV)
is completely off the planet. 1 equals The field of view
is totally on the planet and at least part of the footprint
is lit by the sun. 2 equals The field of view is totally on
the planet and is dark. (planet darkside). 3 equals Part of
the field of view is off the planet and at least one plate is
lit by the sun. 4 equals Part of the field of view is off the
planet and is dark."
```

END_OBJECT = COLUMN

```

OBJECT        = COLUMN
NAME          = GPC2_AL_LIVE_TIME
COLUMN_NUMBER = 216
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2692
UNIT          = Seconds
DESCRIPTION   = "Al filtered Xray actual integration time- the portion
of the period covered by this record in which the Al Xray sensor
was unmasked and Integrating."
```

END_OBJECT = COLUMN

```

OBJECT        = COLUMN
NAME          = GPC2_AL_VALID_CHANNEL_HI
COLUMN_NUMBER = 217
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2696
DESCRIPTION   = "Al filtered X-Ray rise time high channel."
```

END_OBJECT = COLUMN

```

OBJECT        = COLUMN
NAME          = GPC2_AL_VALID_CHANNEL_LOW
COLUMN_NUMBER = 218
BYTES         = 4
DATA_TYPE     = IEEE_REAL
START_BYTE    = 2700
DESCRIPTION   = "Al filtered X-Ray rise time low channel."
```

END_OBJECT = COLUMN

```

OBJECT        = COLUMN
NAME          = GPC2_AL_REAL_GAIN
COLUMN_NUMBER = 219
BYTES         = 4
DATA_TYPE     = IEEE_REAL
```

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```

START_BYTE      = 2704
UNIT             = keV/Ch.
DESCRIPTION      = "Measured gain of GPC2-Al detector in keV/ch."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = GPC2_AL_REAL_ZERO
COLUMN_NUMBER   = 220
BYTES           = 4
DATA_TYPE       = IEEE_REAL
START_BYTE      = 2708
UNIT            = keV
DESCRIPTION      = "Measured zero offset of GPC2-Al detector in keV."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = GPC1_MG_LIVE_TIME
COLUMN_NUMBER   = 221
BYTES           = 4
DATA_TYPE       = IEEE_REAL
START_BYTE      = 2712
UNIT            = Seconds
DESCRIPTION      = "Mg filtered Xray actual integration time (sec.)."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = GPC1_MG_VALID_CHANNEL_HI
COLUMN_NUMBER   = 222
BYTES           = 4
DATA_TYPE       = IEEE_REAL
START_BYTE      = 2716
DESCRIPTION      = "Mg filtered Xray rise time valid discriminator
threshold; events with energy exceeding the threshold will be
rejected based on the rise time discrimination flag - the most
recently cmded value for this."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = GPC1_MG_VALID_CHANNEL_LOW
COLUMN_NUMBER   = 223
BYTES           = 4
DATA_TYPE       = IEEE_REAL
START_BYTE      = 2720
DESCRIPTION      = "Mg filtered Xray lower level discriminator
threshold; events with energy less than the threshold will be rejected
- the most recently cmded value for this threshold."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = GPC1_MG_REAL_GAIN
COLUMN_NUMBER   = 224
BYTES           = 4
DATA_TYPE       = IEEE_REAL
START_BYTE      = 2724
UNIT            = keV/Ch.
DESCRIPTION      = "Measured gain of GPC1-Mg detector in keV/ch."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = GPC1_MG_REAL_ZERO
COLUMN_NUMBER   = 225
BYTES           = 4
DATA_TYPE       = IEEE_REAL
START_BYTE      = 2728
UNIT            = keV
DESCRIPTION      = "Measured zero offset of GPC1-Mg detector in keV."
END_OBJECT = COLUMN

OBJECT          = COLUMN
NAME            = GPC3_UN_LIVE_TIME
COLUMN_NUMBER   = 226

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```

BYTES           = 4
DATA_TYPE       = IEEE_REAL
START_BYTE      = 2732
UNIT            = Seconds
DESCRIPTION     = "Unfiltered Xray actual integration time (sec.) - the
                  portion of the period covered by this record in which the
                  unfiltered Xray sensor was unmasked and integrating."
END_OBJECT = COLUMN

```

```

OBJECT          = COLUMN
NAME            = GPC3_UN_VALID_CHANNEL_HI
COLUMN_NUMBER   = 227
BYTES           = 4
DATA_TYPE       = IEEE_REAL
START_BYTE      = 2736
DESCRIPTION     = "Highest channel of the spectrum in original
                  (no calibration) or new (after calibration) energy scale."
END_OBJECT = COLUMN

```

```

OBJECT          = COLUMN
NAME            = GPC3_UN_VALID_CHANNEL_LOW
COLUMN_NUMBER   = 228
BYTES           = 4
DATA_TYPE       = IEEE_REAL
START_BYTE      = 2740
DESCRIPTION     = "Lowest channel of the spectrum in original
                  (no calibration) or new (after calibration) energy scale."
END_OBJECT = COLUMN

```

```

OBJECT          = COLUMN
NAME            = GPC3_UN_REAL_GAIN
COLUMN_NUMBER   = 229
BYTES           = 4
DATA_TYPE       = IEEE_REAL
START_BYTE      = 2744
UNIT            = keV/Ch.
DESCRIPTION     = "Measured gain of GPC3-UN detector in keV/ch."
END_OBJECT = COLUMN

```

```

OBJECT          = COLUMN
NAME            = GPC3_UN_REAL_ZERO
COLUMN_NUMBER   = 230
BYTES           = 4
DATA_TYPE       = IEEE_REAL
START_BYTE      = 2748
UNIT            = keV
DESCRIPTION     = "Measured zero offset of GPC3-UN detector in keV."
END_OBJECT = COLUMN

```

```

OBJECT          = COLUMN
NAME            = SAX_LIVE_TIME
COLUMN_NUMBER   = 231
BYTES           = 4
DATA_TYPE       = IEEE_REAL
START_BYTE      = 2752
UNIT            = Seconds
DESCRIPTION     = "Live time of the solar monitor."
END_OBJECT = COLUMN

```