Mars Exploration Rover (MER)

Software Interface Specification

Interface Title: **Mössbauer Reduced Data Record (RDR)**

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Mars Exploration Rover (MER) Project

MB Reduced Data Record (RDR) Software Interface Specification (SIS)

Version 1.0

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Jet Propulsion Laboratory
California Institute of Technology

CHANGE LOG

DATE	SECTIONS CHANGED	REASON FOR CHANGE	REVISION
7/31/03	All	First draft	Draft
7/26/04	All	Second draft	Draft
8/4/04	Appendix B	Fixed the valid values in the EARTH_RECEIVED_START_TIME and EARTH_RECEIVED_STOP_TIME (removed the letter “Z” from the end). In the START_TIME and the STOP_TIME definitions, removed the quotes around: YYYY-MM-DDThh:mm:ss[.fff]	Draft
8/4/04	Page Headers and 2nd cover page	Inserted the Document number JPL D-29708	Draft
8/4/04	Cover Page	Removed D. Bass and F. Singleton from the cover page. Their signatures are no longer necessary.	Draft
8/5/04	Front 2 Cover Pages	Removed the word “Draft” and changed the date to August 5, 2004.	**Initial**
9/26/05	All	Removed descriptions of the MGV and MXV products	**1.0**

TBD ITEMS

SECTION	DESCRIPTION
Appendix A	E. Guinness to design label for MIN product based on data file descriptions from team.

CONTENTS

LIST OF TABLES

ACRONYMS

ASCII	American Standard Code for Information Interchange
MB	Mössbauer
CODMAC	Committee on Data Management and Computation
EDR	Experiment Data Record
ISO	International Standards Organization
JPL	Jet Propulsion Laboratory
MER	Mars Exploration Rover
NASA	National Aeronautics and Space Administration
ODL	Object Description Language
OSS	Operations Storage Server
PDS	Planetary Data System
RDR	Reduced Data Record
SIS	Software Interface Specification
SOWG	Science Operations Working Group
STG	Science Theme Group
TBD	To Be Determined

1. INTRODUCTION

1.1 Purpose and Scope

The purpose of this data product SIS is to provide users of the MER Mössbauer (MB) Reduced Data Record (RDR) products with detailed descriptions of the products and descriptions of how they were generated, including data sources and destinations. The products are ASCII tables of data derived from MER MB Experiment Data Record (EDR) products. The RDR products include summed spectra in counts as a function of channel number, energy spectra in counts as a function of energy, and tables of Fe-mineral and Fe-state components within a sample. There are seven different types of MB RDR products that are divided into two separate data sets: Summed Spectra, and Mineral Abundances.

This SIS is intended to provide enough information to enable users to read and understand these data products. The users for whom this SIS is intended are the scientists who will analyze the data, including those associated with the MER Project and those in the general planetary science community.

1.2 Contents

This data product SIS describes how the MB RDR products are generated, formatted, labeled, and uniquely identified. The document discusses standards used in generating the products and software that may be used to access the products. The products are described in sufficient detail to enable a user to read the products. Finally, examples of the PDS labels are provided, along with definitions for label keywords.

1.3 Applicable Documents and Constraints

This Data Product SIS is responsive to the following MER documents:

1. Mars Exploration Program Data Management Plan, R. E. Arvidson, S. Slavney, and S. Nelson, Rev. 3, March 20, 2002.
2. Mars Exploration Rover Project Archive Generation, Validation and Transfer Plan, R. E. Arvidson and S. Slavney, JPL D-19658, March 22, 2002.
3. MER Project MB EDR SIS, E. Guinness, JPL D-22849, Version 2.0, June 13, 2003.

This SIS is also consistent with the following Planetary Data System documents:

4. Planetary Data System Data Preparation Workbook, Version 3.1, JPL D-7669, Part 1, February 1, 1995.
5. Planetary Data System Data Standards Reference, Version 3.5, JPL D-7669, Part 2, October, 15, 2002
6. Planetary Science Data Dictionary Document, JPL D-7116, August 28, 2002.

The reader is referred to the following documents for additional information:

7. Athena MIMOS II Mössbauer spectrometer investigation, G. Klingelhöfer, R. V. Morris, B. Bernhardt, D. Rodionov, P. A. de Souza Jr., S. W. Squyres, J. Foh, E. Kankeleit, U.

Bonnes, R. Gellert, C. Schröder, S. Linkin, E. Evlanov, B. Zubkov, and O. Prilutski, JGR, Vol. 108, NO: E12, 8067, doi:10.1029/2003JE002138, 2003.

Finally, this SIS is meant to be consistent with the contract negotiated between the MER Project and the Athena Principal Investigator in which reduced data records and documentation are explicitly defined as deliverable products.

1.4 Relationships with Other Interfaces

Changes to the MB EDR data product and the SIS that describes the EDR product [3] could affect the MB RDR data products and/or this SIS. In addition, changes to the processing tools used to generate the MB RDR data products could affect both the data products and this SIS.

2. DATA PRODUCT CHARACTERISTICS AND ENVIRONMENT

2.1 Data Product Overview

The MB RDR data products are ASCII formatted tables. Each ASCII table has an associated detached PDS label, also formatted as ASCII. There are seven MB RDR data products from intermediate data reduction to more highly derived ones. The product types include summed spectra in counts as a function of channel number, energy spectra in counts as a function of energy, and tables of Fe-mineral and Fe-state components within a sample.

2.2 Data Processing

2.2.1 Data Processing Level

This SIS uses the Committee On Data Management And Computation (CODMAC) data level numbering system to describe the processing level of the MB RDR data products. These data products are considered CODMAC "Level 4" ["Resampled Data" equivalent to NASA Level 1-B] or "Level 5" ["Derived Data" equivalent to NASA Level 2]. Refer to Table 1 for a summary of the CODMAC and NASA data processing levels.

Table 1. Processing Levels for Science Data Sets

NASA	CODMAC	Description
Packet data	Raw - Level 1	Telemetry data stream as received at the ground station, with science and engineering data embedded.
Level-0	Edited - Level 2	Instrument science data (e.g., raw voltages, counts) at full resolution, time ordered, with duplicates and transmission errors removed.
Level 1-A	Calibrated - Level 3	Level 0 data that have been located in space and may have been transformed (e.g., calibrated, rearranged) in a reversible manner and packaged with needed ancillary and auxiliary data (e.g., radiances with the calibration equations applied).

NASA	CODMAC	Description
Level 1-B	Resampled - Level 4	Irreversibly transformed (e.g., resampled, remapped, calibrated) values of the instrument measurements (e.g., radiances, magnetic field strength).
Level 1-C	Derived - Level 5	Level 1A or 1B data that have been resampled and mapped onto uniform space-time grids. The data are calibrated (i.e., radiometrically corrected) and may have additional corrections applied (e.g., terrain correction).
Level 2	Derived - Level 5	Geophysical parameters, generally derived from Level 1 data, and located in space and time commensurate with instrument location, pointing, and sampling.
Level 3	Derived - Level 5	Geophysical parameters mapped onto uniform space-time grids.

2.2.2 Data Product Generation

The MB RDR data products are produced by MB instrument team members from the Johannes Gutenberg University (Mainz, Germany) using software tools developed by the MB team. The first set of RDR data products – summed spectra in counts as a function of channel number - is generated after each sol in which MB data were acquired. This step comprises an extraction of the MB spectra from the EDR products and subsequent conversion into ASCII formatted tables. Further sets of RDR data products are added in a non-specified timeframe according to the progress in analysis of the data by the MB team.

The MB instrument has four counters to store eight measurements from the MB detectors (4 detectors with 2 energies each) [7]. As a result the measurements from pairs of detectors are added together and stored in one counter. These four co-added spectra are included in the MB EDR data products. In generating the RDR products, the two 6.4 keV spectra from each EDR are summed, as are the two 14.4 keV spectra. These summed spectra exist, and are labeled as separate products in the RDR data set (i.e., MGC and MXC products).

The interpretation of MB spectra requires precise knowledge at any given time of the drive velocity, which has a temperature dependence. There is documentation in the CALIB directory of the MB RDR data set that explains how the velocity calibration can be done. The CALIB directory also contains data files with velocity scales that take the temperature dependence into account. Each column in these velocity files corresponds to a preset temperature window that matches the columns in the MGC and the MXC data files.

Integration times for each MB measurement are listed in the observation table provided in the DOCUMENT directory of the RDR data set.

2.2.3 Data Flow

MB RDR data products are generated from binary EDR files that are extracted from the OSS to the MB team workstations. Once RDR data products are generated, they are transferred back to the OSS for access by other MER science and operations team members. After a science validation period, the MB RDR data products are transferred to the PDS for final validation and archiving in accordance with the MER archive plan [2].

2.2.4 Labeling and Identification

2.2.4.1 Data Sets Identification

The MB RDR data products are divided into two separate data sets. The groupings are based on the level of data processing and calibration that was applied to the EDR data. The two data sets with the PDS data set id's listed are:

MERn-M-MB-4-SUMSPEC-SCI-V1.0 – Spectra in counts as a function of channel number with data from all detectors summed together.

MERn-M-MB-5-MINERAL-SCI-V1.0 – Iron state and minerals present within a sample as derived from analysis by the MB team on the calibrated spectra.

Note the 'n' in the data set id is used to indicate the rover with 1 for Opportunity (MERB) and 2 for Spirit (MERA).

2.2.4.2 File Naming

A file naming scheme has been adapted for the MER image and non-image data products. The file naming scheme adheres to the ISO Level II 27.3 filename convention to be compliant with PDS standards.

Each MER EDR or RDR data product can be uniquely identified by incorporating into the product filename the Rover Mission identifier, the Instrument identifier, the Starting Spacecraft Clock count (SCLK) of the observation, the data Product Type, the Site location, the rover Position within the site, the Sequence number, the camera “Eye”, the spectral Filter, the product Creator identifier and a Version number. For non-camera data, several fields do not apply.

Each MB RDR has a detached PDS label associated with the MB data file. The file naming scheme for the MB RDR data products is formed by:

<rover><inst><sclk><prod><site><pos><seq><eye><filt><who><ver>.<ext>

Where,

rover = (1 integer) MER rover mission identifier. Valid values are “**1**” (MER-1), “**2**” (MER-2), **”3”** (SIM-1) or **“4”** (SIM-2)

inst = (1 alpha character) MER science instrument identifier.
Valid value for MB is **B**:

sclk = (9 integers) Starting Spacecraft Clock time.

prod = (3 alpha characters) Product type. Indicates the product to be an EDR or one of several types of Non-projected RDRs. All product types that begin with “**E**” denote a type of EDR, while all other product types denote a type of Non-projected RDR.

Valid values for MER non-camera instrument products:

Data Product	Value
14.4 keV spectra as a function of channel number	“**MGC**”
6.4 keV spectra as a function of channel number	“**MXC**”

14.4 keV reference spectra as a function of channel number	“**RSC**”
Energy spectra as a function of channel number	“**ESC**”
Differential signal as a function of channel number	"**DSC**"
Energy spectra as a function of energy	“**ESE**”
Fe-mineral and Fe-state	“**MIN**”

site = (2 alphanumeric) Site location count. Use of both integers and alphas allows for a total range of 0 thru 1295.A value greater than 1295 is denoted by “##“ (2 pound signs),requiring the user to extract actual value from label.

The valid values,in their progression,are as follows:
Range 0 thru 99 - **“00 ”,“01 ”,“02 ”… “99 ”**
Range 100 thru 1035 - **“A0 ”,“A1 ” … “A9 ”,“AA ”,“AB ”…“AZ ”,“B0 ”,“B1 ”… “ZZ ”**
Range 1036 thru 1295 - **“0A ”,“0B ”…”0Z ”,“1A ”,“1B ”…“9Z ”**
Range 1296 or greater - **“##”** (2 pound signs)

Example value is “AK ” for value of 120..

pos = (2 alphanumeric) Position-within-Site count. Use of both integers and alphas allows for a total range of 0 thru 1295.A value greater than 1295 is denoted by “##“ (2 pound signs), requiring the user to extract actual value from label.

The valid values,in their progression,are as follows:
Range 0 thru 99 - **“00 ”,“01 ”,“02 ”… “99 ”**
Range 100 thru 1035 - **“A0 ”,“A1 ” … “A9 ”,“AA ”,“AB ”…“AZ ”,“B0 ”,“B1 ”… “ZZ ”**
Range 1036 thru 1295 - **“0A ”,“0B ”…”0Z ”,“1A ”,“1B ”…“9Z ”**
Range 1296 or greater - **“##”** (2 pound signs)

Example value is “AK ” for value of 120..

seq = (1 alpha character plus 4 integers) Sequence Number. Denotes a group of related commands used as keys for the Ops processing.

Valid values for character (position 1) in field:

“**C**” - Cruise

“**P**” – PMA instr. (Pancam, Navcam, MTES)

“**D**” – IDD & RAT

“**R**” – Rover Driving

“**E**” – Engineering

“**S**” – Submaster

“**F**” – Flight Software (Seq rejected)

“**T**” – Test

“**G**” – (spare)

“**W**” – Seq. triggered by a commun. Window

“**K**” – (spare)

“**X**” – Contingency

“**M**” – Master (Surface only)

"**Y**" – (spare)

"**N**" – In-Situ instr. (APXS, MB, MI)

"**Z**" – SCM Seq's

Valid values for integers (positions 2 thru 5) in field:

0001 thru **4095** - Valid Sequence number, commanded by Ground

Needs "F" in character position (Camera only):

1000 - Commanded by NAV
2000 - Commanded by SAPP
3000 - Commanded by Fault protection
4000 - Commanded by EDL

Example value is "N0268".

eye = (1 alpha character) Camera eye. Valid values are:

"**L**" - Left camera eye
"**R**" - Right camera eye
"**B**" - Both left and right camera eyes
"**M**" - Monoscopic (one camera eye)
"**N**" - Not Applicable (non-image data)

filt = (1 integer) Filter number, with a valid range of **0-8** (0 = "no filter" or "N/A").

who = (1 alpha character) Product creator indicator. Valid values are as follows, though others may be added in the future:

"**A**" - Arizona State University
"**C**" - Cornell University
"**F**" - USGS at Flagstaff
"**J**" - Johannes Gutenberg Univ. (Germany)
"**M**" - OPGS (MIPL) at JPL
"**N**" - NASA Ames Research Center
"**P**" - Max Planck Institute (Germany)
"**S**" - SOAS at JPL
"**U**" - University of Arizona
"**V**" - SSV Team (E. De Jong) at JPL
"**X**" - Other

ver = (1 alphanumeric) Version identifier providing uniqueness for book keeping.

The valid values, in their progression, are as follows:

Range 1 thru 9 - **"1", "2",…"9"**
Range 10 thru 35 - "**A", "B",…Z**"

Example value is "E" for value of 14.

ext = (3 alpha characters) PDS product type extension.

Valid values for:

"**CSV**" – Comma delimited data file
"**LBL**" - Detached PDS labels for APXS and Mössbauer data

Example:

a) 1B123456789MGC0103N0062N0J1.CSV Rover MER-1, MB instrument, 14.4 keV Spectra, Site 01, Position 03, Seq N0062, produced by Johannes Gutenberg U, product version 1.

2.3 Standards Used in Generating Data Products

2.3.1 PDS Standards

The MB RDR data products comply with Planetary Data System standards for file formats and labels, as specified in the PDS Standards Reference [5] and the Planetary Science Data Dictionary Document [6].

2.3.2 Time Standards

PDS labels for MB RDR data products use keywords containing time values, such as start time and stop time. Each time value standard is defined according to the keyword definition. See Appendix B.

2.3.3 Data Storage Conventions

MB RDR data products and detached PDS label files are stored as ASCII text. Each line or record in the files is terminated with a two-character sequence of carriage return (<CR>, ASCII 13) and line feed (<LF>, ASCII 10) to comply with PDS standards [5]. This line terminator sequence will allow the data files and labels to be easily read on most computers, which recognize either the carriage return, the line feed, or the <CR>/<LF> sequence as an ASCII record terminator.

2.4 Data Validation

Validation of MB RDR data product labels includes checking for correct PDS syntax, for accepted standard values of keywords, and for internal consistency of label items.

3. DETAILED DATA PRODUCT SPECIFICATIONS

3.1 Data Format Description

Each MB RDR data file is a comma delimited ASCII text table with variable length columns. The number of columns and rows in each table is dependent on the type of RDR. Each row is terminated with a carriage return and line feed character. Table 2 is a summary of the MB RDR product types and tables 3-9 contains the column definitions for each of the data products.

Table 2. MB RDR data product types

Data Product Type	Product Type Code	Data Set ID	Table with Description
14.4 keV spectra as a function of channel number	MGC	MERn-M-MB-4-SUMSPEC-SCI-V1.0	3
6.4 keV spectra as a function of channel number	MXC	MERn-M-MB-4-SUMSPEC-SCI-V1.0	4
14.4 keV reference spectra as a function of channel number	RSC	MERn-M-MB-4-SUMSPEC-SCI-V1.0	5

Differential signal as a function of channel number	DSC	MERn-M-MB-4-SUMSPEC-SCI-V1.0	6
Energy spectra as a function of channel number	ESC	MERn-M-MB-4-SUMSPEC-SCI-V1.0	7
Energy spectra as a function of energy	ESE	MERn-M-MB-4-SUMSPEC-SCI-V1.0	8
Fe-mineral and Fe-state	MIN	MERn-M-MB-5-MINERAL-SCI-V1.0	9

Table 3. 14.4 keV MB spectra as a function of channel number (MGC).

COLUMN NUMBER	NAME	DATA TYPE	DESCRIPTION
1	Temperature bin m1	Integer	The number is the sum of 14.4 keV photons counted by all four detectors within a temperature range from 0 to 180 K.
2	Temperature bin m2	Integer	The number is the sum of 14.4 keV photons counted by all four detectors within a temperature range from 180 to 190 K.
3	Temperature bin m3	Integer	The number is the sum of 14.4 keV photons counted by all four detectors within a temperature range from 190 to 200 K.
4	Temperature bin m4	Integer	The number is the sum of 14.4 keV photons counted by all four detectors within a temperature range from 200 to 210 K.
5	Temperature bin m5	Integer	The number is the sum of 14.4 keV photons counted by all four detectors within a temperature range from 210 to 220 K.
6	Temperature bin m6	Integer	The number is the sum of 14.4 keV photons counted by all four detectors within a temperature range from 220 to 230 K.
7	Temperature bin m7	Integer	The number is the sum of 14.4 keV photons counted by all four detectors within a temperature range from 230 to 240 K.
8	Temperature bin m8	Integer	The number is the sum of 14.4 keV photons counted by all four detectors within a temperature range from 240 to 250 K.
9	Temperature bin m9	Integer	The number is the sum of 14.4 keV photons counted by all four detectors within a temperature range from 250 to 260 K.
10	Temperature bin m10	Integer	The number is the sum of 14.4 keV photons counted by all four detectors within a temperature range from 260 to 270 K.
11	Temperature bin m11	Integer	The number is the sum of 14.4 keV photons counted by all four detectors within a temperature range from 270 to 280 K.
12	Temperature bin m12	Integer	The number is the sum of 14.4 keV photons counted by all four detectors within a temperature range from 280 to 290 K.
13	Temperature bin m13	Integer	The number is the sum of 14.4 keV photons counted by all four detectors at temperatures higher than 290 K.
Rows counted from the top correspond to channel number.			

Table 4. 6.4 keV MB spectra as a function of channel number (MXC).

COLUMN NUMBER	NAME	DATA TYPE	DESCRIPTION
1	Temperature bin m1	Integer	The number is the sum of 6.4 keV photons counted by all four detectors within a temperature range from 0 to 180 K.
2	Temperature bin m2	Integer	The number is the sum of 6.4 keV photons counted by all four detectors within a temperature range from 180 to 190 K.
3	Temperature bin m3	Integer	The number is the sum of 6.4 keV photons counted by all four detectors within a temperature range from 190 to 200 K.
4	Temperature bin m4	Integer	The number is the sum of 6.4 keV photons counted by all four detectors within a temperature range from 200 to 210 K.
5	Temperature bin m5	Integer	The number is the sum of 6.4 keV photons counted by all four detectors within a temperature range from 210 to 220 K.
6	Temperature bin m6	Integer	The number is the sum of 6.4 keV photons counted by all four detectors within a temperature range from 220 to 230 K.
7	Temperature bin m7	Integer	The number is the sum of 6.4 keV photons counted by all four detectors within a temperature range from 230 to 240 K.
8	Temperature bin m8	Integer	The number is the sum of 6.4 keV photons counted by all four detectors within a temperature range from 240 to 250 K.
9	Temperature bin m9	Integer	The number is the sum of 6.4 keV photons counted by all four detectors within a temperature range from 250 to 260 K.
10	Temperature bin m10	Integer	The number is the sum of 6.4 keV photons counted by all four detectors within a temperature range from 260 to 270 K.
11	Temperature bin m11	Integer	The number is the sum of 6.4 keV photons counted by all four detectors within a temperature range from 270 to 280 K.
12	Temperature bin m12	Integer	The number is the sum of 6.4 keV photons counted by all four detectors within a temperature range from 280 to 290 K.
13	Temperature bin m13	Integer	The number is the sum of 6.4 keV photons counted by all four detectors at temperatures higher than 290 K.
Rows counted from the top correspond to channel number.			

Table 5. 14.4 keV MB reference spectra as a function of channel number (RSC).

COLUMN NUMBER	NAME	DATA TYPE	DESCRIPTION
1	Temperature bin m1	Integer	14.4 keV photons counted by the reference detector within a temperature range from 0 to 180 K.
2	Temperature bin m2	Integer	14.4 keV photons counted by the reference detector within a temperature range from 180 to 190 K.

3	Temperature bin m3	Integer	14.4 keV photons counted by the reference detector within a temperature range from 190 to 200 K.
4	Temperature bin m4	Integer	14.4 keV photons counted by the reference detector within a temperature range from 200 to 210 K.
5	Temperature bin m5	Integer	14.4 keV photons counted by the reference detector within a temperature range from 210 to 220 K.
6	Temperature bin m6	Integer	14.4 keV photons counted by the reference detector within a temperature range from 220 to 230 K.
7	Temperature bin m7	Integer	14.4 keV photons counted by the reference detector within a temperature range from 230 to 240 K.
8	Temperature bin m8	Integer	14.4 keV photons counted by the reference detector within a temperature range from 240 to 250 K.
9	Temperature bin m9	Integer	14.4 keV photons counted by the reference detector within a temperature range from 250 to 260 K.
10	Temperature bin m10	Integer	14.4 keV photons counted by the reference detector within a temperature range from 260 to 270 K.
11	Temperature bin m11	Integer	14.4 keV photons counted by the reference detector within a temperature range from 270 to 280 K.
12	Temperature bin m12	Integer	14.4 keV photons counted by the reference detector within a temperature range from 280 to 290 K.
13	Temperature bin m13	Integer	14.4 keV photons counted by the reference detector at temperatures higher than 290 K.
Rows counted from the top correspond to channel number.			

Table 6. Differential signal as a function of channel number (DSC).

COLUMN NUMBER	NAME	DATA TYPE	DESCRIPTION
1	Differential signal	Integer	The number is proportional to the velocity difference between actual drive velocity and the triangular nominal velocity signal.
Rows counted from the top correspond to channel number.			

Table 7. Energy spectra as a function of channel number (ESC).

COLUMN NUMBER	NAME	DATA TYPE	DESCRIPTION
1	Detector 1	Integer	Energy spectrum.
2	Detector 2	Integer	Energy spectrum.
3	Detector 3	Integer	Energy spectrum.
4	Detector 4	Integer	Energy spectrum.

5	Reference detector	Integer	Energy spectrum.
Rows counted from the top correspond to channel number.			

Table 8. Energy spectra as a function of energy (ESE).

COLUMN NUMBER	NAME	DATA TYPE	DESCRIPTION
1	Energy for detector 1	Real	Energy in keV.
2	Detector 1	Integer	Energy spectrum in counts.
3	Energy for detector 2	Real	Energy in keV.
4	Detector 2	Integer	Energy spectrum in counts.
5	Energy for detector 3	Real	Energy in keV.
6	Detector 3	Integer	Energy spectrum in counts.
7	Energy for detector 4	Real	Energy in keV.
8	Detector 4	Integer	Energy spectrum in counts.
9	Energy for reference detector	Real	Energy in keV.
10	Reference detector	Integer	Energy spectrum in counts.

Table 9. Results of mineralogical MB analysis (MIN).

COLUMN NUMBER	NAME	DATA TYPE	DESCRIPTION
1	Mineral name	Text	Mineral components identified in MB spectrum
2	Isomer shift	Real	Value of Isomer shift in mm/s.
3	Quadrupole splitting	Real	Value of quadrupole splitting n mm/s.
4	Internal magnetic field	Real	Value of the internal magnetic field in mm/s.
5	Temperature	Real	Value of the temperature /temperature range during measurement
6	Area %	Real	Relative peak area of component in MB spectrum (1.0 = 100 %).

7	Fe2+/Fe_Total	Real	Fe2+/Fe_Total number for overall sample.

3.2 PDS Label Description

Each MB RDR data product has a detached PDS label, which is stored as ASCII text. The PDS label is object-oriented with keywords for product identification, along with the data object definition. The data object definition within the label contains descriptive information needed to interpret or process the data.

PDS labels are written in Object Description Language (ODL) [5]. PDS label statements have the form of "keyword = value". Each label statement is terminated with a carriage return character (ASCII 13) and a line feed character (ASCII 10) sequence to allow the label to be read by many operating systems. Pointer statements with the following format are used to indicate the location of data objects in the data product:

^object = location

where the carat character (^, also called a pointer) is followed by the name of the specific data object. For detached PDS labels, location is the name of the file that contains data object and optionally the starting record number of the data object within the file or byte offset from the start of the file.

MB RDR data products are described using the PDS spreadsheet object. Appendix A lists example PDS labels for the each MB RDR type.

APPENDIX A - SAMPLE MB RDR LABEL

MGC

```
PDS_VERSION_ID                   = PDS3

/* FILE DATA ELEMENTS */

RECORD_TYPE                      = STREAM
FILE_RECORDS                     = 512
^SPREADSHEET                     = "2B127615581MGC0309N1940N0J1.CSV"

/* IDENTIFICATION DATA ELEMENTS */

DATA_SET_ID                      = "MER2-M-MB-4-SUMSPEC-SCI-V1.0"
PRODUCT_ID                       = "2B127615581MGC0309N1940N0J1"
PRODUCT_TYPE                     = MB_MGC
SOURCE_PRODUCT_ID                = "2B127615581EDR0309N1940N0M1"
RELEASE_ID                       = "0001"
ROVER_MOTION_COUNTER             = (3, 9, 28, 983, 166)
ROVER_MOTION_COUNTER_NAME        = (SITE, DRIVE, IDD, PMA, HGA)
COMMAND_SEQUENCE_NUMBER          = 6
INSTRUMENT_HOST_ID               = MER2
INSTRUMENT_HOST_NAME             = "MARS EXPLORATION ROVER 2"
INSTRUMENT_ID                    = MB
INSTRUMENT_TYPE                  = SPECTROMETER
INSTRUMENT_VERSION_ID            = FM3
LOCAL_TRUE_SOLAR_TIME            = "14:00:44"
MAGNET_ID                        = "NULL"
MISSION_NAME                     = "MARS EXPLORATION ROVER"
MISSION_PHASE_NAME               = "PRIMARY MISSION"
OBSERVATION_ID                   = "0"
PLANET_DAY_NUMBER                = 14
PRODUCER_INSTITUTION_NAME        = "JOHANNES GUTENBERG UNIVERSITY"
PRODUCT_CREATION_TIME            = 2004-07-15T17:30:00
SEQUENCE_ID                      = n1940
SEQUENCE_VERSION_ID              = "0"
SPACECRAFT_CLOCK_CNT_PARTITION   = 1
SPACECRAFT_CLOCK_START_COUNT     = "127615519.910"
SPACECRAFT_CLOCK_STOP_COUNT      = "127615581.921"
START_TIME                       = 2004-01-17T12:43:54.397
STOP_TIME                        = 2004-01-17T12:44:56.409
TARGET_NAME                      = MARS
TARGET_TYPE                      = PLANET

/* TELEMETRY DATA ELEMENTS */

APPLICATION_PROCESS_ID           = 33
APPLICATION_PROCESS_NAME         = MB
APPLICATION_PROCESS_SUBTYPE_ID   = 0
EARTH_RECEIVED_START_TIME        = 2004-01-17T12:58:47.445
EARTH_RECEIVED_STOP_TIME         = 2004-01-17T13:01:30.412
EXPECTED_PACKETS                 = "N/A"
PACKET_MAP_MASK                  = "N/A"
RECEIVED_PACKETS                 = "N/A"
```

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SAMPLING_COUNT                   = 1
SPICE_FILE_NAME                  = "chronos.mer"
TELEMETRY_FORMAT_ID              = ALL
TELEMETRY_PROVIDER_ID            = "SSW MER_DP"
TELEMETRY_SOURCE_NAME            = "033_000_n1940-000-0006_001_0127615581-
236.dat"
TELEMETRY_SOURCE_TYPE            = "DATA PRODUCT"
TLM_INST_DATA_HEADER_ID          = 3

/* INSTRUMENT DATA ELEMENTS */
/* COORDINATE SYSTEM STATE: ROVER */

GROUP                            = ROVER_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME         = ROVER_FRAME
  COORDINATE_SYSTEM_INDEX        = (3, 9, 28, 983, 166)
  COORDINATE_SYSTEM_INDEX_NAME   = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR           = (0.00000, 0.00000, 0.00000)
  ORIGIN_ROTATION_QUATERNION     = (0.806580, 0.0261539, 0.00125047,
                                    -0.590545)
  POSITIVE_AZIMUTH_DIRECTION     = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION   = UP
  QUATERNION_MEASUREMENT_METHOD  = FINE
  REFERENCE_COORD_SYSTEM_NAME    = SITE_FRAME
  REFERENCE_COORD_SYSTEM_INDEX   = 3
END_GROUP                        = ROVER_COORDINATE_SYSTEM

/* ARTICULATION DEVICE STATE: INSTRUMENT DEPLOYMENT DEVICE AT THE START */

GROUP                            = START_IDD_ARTICULATION_STATE
  ARTICULATION_DEVICE_ID         = IDD
  ARTICULATION_DEVICE_NAME       = "INSTRUMENT DEPLOYMENT DEVICE"
  ARTICULATION_DEVICE_ANGLE      = (0.465600 <rad>, -0.0927715 <rad>,
                                    1.69880 <rad>, 0.0614155 <rad>,
                                    -1.73933 <rad>, 0.457609 <rad>,
                                    -0.0979819 <rad>, 1.70045 <rad>,
                                    0.0651506 <rad>, -1.75427 <rad>)
  ARTICULATION_DEVICE_ANGLE_NAME = ("JOINT 1 AZIMUTH-ENCODER",
                                    "JOINT 2 ELEVATION-ENCODER",
                                    "JOINT 3 ELBOW-ENCODER",
                                    "JOINT 4 WRIST-ENCODER",
                                    "JOINT 5 TURRET-ENCODER",
                                    "JOINT 1 AZIMUTH-POTENTIOMETER",
                                    "JOINT 2 ELEVATION-POTENTIOMETER",
                                    "JOINT 3 ELBOW-POTENTIOMETER",
                                    "JOINT 4 WRIST-POTENTIOMETER",
                                    "JOINT 5 TURRET-POTENTIOMETER")
  ARTICULATION_DEVICE_MODE       = GUARDED
  ARTICULATION_DEVICE_TEMP       = (-5.73978 <degC>, 6.06055 <degC>)
  ARTICULATION_DEVICE_TEMP_NAME  = ("AZIMUTH JOINT 1", "TURRET JOINT 5")
  ARTICULATION_DEV_VECTOR        = (-0.0329073, 0.0407135, 0.998629)
  ARTICULATION_DEV_VECTOR_NAME   = GRAVITY
  CONTACT_SENSOR_STATE           = ("NO CONTACT", "NO CONTACT", CONTACT,
                                    CONTACT, "NO CONTACT", CONTACT,
                                    OPEN, "NO CONTACT")
  CONTACT_SENSOR_STATE_NAME      = ("MI SWITCH 1", "MI SWITCH 2",
                                    "RAT SWITCH 1", "RAT SWITCH 2",
                                    "MB SWITCH 1", "MB SWITCH 2",
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                                   "APXS DOOR SWITCH", "APXS CONTACT
SWITCH")
  ARTICULATION_DEV_INSTRUMENT_ID = MB
END_GROUP                        = START_IDD_ARTICULATION_STATE

/* COORDINATE SYSTEM STATE: INSTRUMENT DEPLOYMENT DEVICE AT THE START */

GROUP                            = START_IDD_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME         = MB_FRAME
  COORDINATE_SYSTEM_INDEX        = (3, 9, 28, 983, 166)
  COORDINATE_SYSTEM_INDEX_NAME   = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR           = (0.933273, 0.138497, 0.297693)
  ORIGIN_ROTATION_QUATERNION     = (0.524170, -0.0291228, -0.0432519,
                                   0.850016)
  POSITIVE_AZIMUTH_DIRECTION     = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION   = DOWN
  REFERENCE_COORD_SYSTEM_NAME    = ROVER_FRAME
  REFERENCE_COORD_SYSTEM_INDEX   = (3, 9, 28, 983, 166)
END_GROUP                        = START_IDD_COORDINATE_SYSTEM

/* ARTICULATION DEVICE STATE: INSTRUMENT DEPLOYMENT DEVICE AT END */

GROUP                            = STOP_IDD_ARTICULATION_STATE
  ARTICULATION_DEVICE_ID         = IDD
  ARTICULATION_DEVICE_NAME       = "INSTRUMENT DEPLOYMENT DEVICE"
  ARTICULATION_DEVICE_ANGLE      = (0.465600 <rad>, -0.0927715 <rad>,
                                   1.69880 <rad>, 0.0614155 <rad>,
                                   -1.73933 <rad>, 0.457807 <rad>,
                                   -0.0981386 <rad>, 1.70082 <rad>,
                                   0.0647358 <rad>, -1.75427 <rad>)
  ARTICULATION_DEVICE_ANGLE_NAME = ("JOINT 1 AZIMUTH-ENCODER",
                                   "JOINT 2 ELEVATION-ENCODER",
                                   "JOINT 3 ELBOW-ENCODER",
                                   "JOINT 4 WRIST-ENCODER",
                                   "JOINT 5 TURRET-ENCODER",
                                   "JOINT 1 AZIMUTH-POTENTIOMETER",
                                   "JOINT 2 ELEVATION-POTENTIOMETER",
                                   "JOINT 3 ELBOW-POTENTIOMETER",
                                   "JOINT 4 WRIST-POTENTIOMETER",
                                   "JOINT 5 TURRET-POTENTIOMETER")
  ARTICULATION_DEVICE_MODE       = GUARDED
  ARTICULATION_DEVICE_TEMP       = (-5.67178 <degC>, 6.17491 <degC>)
  ARTICULATION_DEVICE_TEMP_NAME  = ("AZIMUTH JOINT 1", "TURRET JOINT 5")
  ARTICULATION_DEV_VECTOR        = (-0.0329073, 0.0407135, 0.998629)
  ARTICULATION_DEV_VECTOR_NAME   = GRAVITY
  CONTACT_SENSOR_STATE           = ("NO CONTACT", "NO CONTACT", CONTACT,
                                   CONTACT, "NO CONTACT", CONTACT,
                                   OPEN, "NO CONTACT")
  CONTACT_SENSOR_STATE_NAME      = ("MI SWITCH 1", "MI SWITCH 2",
                                   "RAT SWITCH 1", "RAT SWITCH 2",
                                   "MB SWITCH 1", "MB SWITCH 2",
                                   "APXS DOOR SWITCH", "APXS CONTACT
SWITCH")
  ARTICULATION_DEV_INSTRUMENT_ID = MB
END_GROUP                        = STOP_IDD_ARTICULATION_STATE

/* COORDINATE SYSTEM STATE: INSTRUMENT DEPLOYMENT DEVICE AT END */
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```
GROUP                              = STOP_IDD_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME           = MB_FRAME
  COORDINATE_SYSTEM_INDEX          = (3, 9, 28, 983, 167)
  COORDINATE_SYSTEM_INDEX_NAME     = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR             = (0.933273, 0.138497, 0.297693)
  ORIGIN_ROTATION_QUATERNION       = (0.524170, -0.0291228, -0.0432519,
                                      0.850016)
  POSITIVE_AZIMUTH_DIRECTION       = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION     = DOWN
  REFERENCE_COORD_SYSTEM_NAME      = ROVER_FRAME
  REFERENCE_COORD_SYSTEM_INDEX     = (3, 9, 28, 983, 167)
END_GROUP                          = STOP_IDD_COORDINATE_SYSTEM

OBJECT                             = SPREADSHEET
  INTERCHANGE_FORMAT               = ASCII
  ROWS                             = 512
  FIELDS                           = 13
  ROW_BYTES                        = 132
  FIELD_DELIMITER                  = "COMMA"
  DESCRIPTION                      = "14.4 keV MB spectra as a function
    of channel number.  Rows counted from the top correspond to channel
    number."

  OBJECT                           = FIELD
    NAME                           = "TEMPERATURE01"
    FIELD_NUMBER                   = 1
    DATA_TYPE                      = ASCII_INTEGER
    BYTES                          = 10
    DESCRIPTION                    = "The sum of 14.4 keV photons counted by
      all four detectors within a temperature range from 0 to 180 K."
  END_OBJECT                       = FIELD

  OBJECT                           = FIELD
    NAME                           = "TEMPERATURE02"
    FIELD_NUMBER                   = 2
    DATA_TYPE                      = ASCII_INTEGER
    BYTES                          = 10
    DESCRIPTION                    = "The sum of 14.4 keV photons counted by
      all four detectors within a temperature range from 180 to 190 K."
  END_OBJECT                       = FIELD

  OBJECT                           = FIELD
    NAME                           = "TEMPERATURE03"
    FIELD_NUMBER                   = 3
    DATA_TYPE                      = ASCII_INTEGER
    BYTES                          = 10
    DESCRIPTION                    = "The sum of 14.4 keV photons counted by
      all four detectors within a temperature range from 190 to 200 K."
  END_OBJECT                       = FIELD

  OBJECT                           = FIELD
    NAME                           = "TEMPERATURE04"
    FIELD_NUMBER                   = 4
    DATA_TYPE                      = ASCII_INTEGER
    BYTES                          = 10
    DESCRIPTION                    = "The sum of 14.4 keV photons counted by
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    all four detectors within a temperature range from 200 to 210 K."
END_OBJECT                     = FIELD

OBJECT                         = FIELD
  NAME                         = "TEMPERATURE05"
  FIELD_NUMBER                 = 5
  DATA_TYPE                    = ASCII_INTEGER
  BYTES                        = 10
  DESCRIPTION                  = "The sum of 14.4 keV photons counted by
    all four detectors within a temperature range from 210 to 220 K."
END_OBJECT                     = FIELD

OBJECT                         = FIELD
  NAME                         = "TEMPERATURE06"
  FIELD_NUMBER                 = 6
  DATA_TYPE                    = ASCII_INTEGER
  BYTES                        = 10
  DESCRIPTION                  = "The sum of 14.4 keV photons counted by
    all four detectors within a temperature range from 220 to 230 K."
END_OBJECT                     = FIELD

OBJECT                         = FIELD
  NAME                         = "TEMPERATURE07"
  FIELD_NUMBER                 = 7
  DATA_TYPE                    = ASCII_INTEGER
  BYTES                        = 10
  DESCRIPTION                  = "The sum of 14.4 keV photons counted by
    all four detectors within a temperature range from 230 to 240 K."
END_OBJECT                     = FIELD

OBJECT                         = FIELD
  NAME                         = "TEMPERATURE08"
  FIELD_NUMBER                 = 8
  DATA_TYPE                    = ASCII_INTEGER
  BYTES                        = 10
  DESCRIPTION                  = "The sum of 14.4 keV photons counted by
    all four detectors within a temperature range from 240 to 250 K."
END_OBJECT                     = FIELD

OBJECT                         = FIELD
  NAME                         = "TEMPERATURE09"
  FIELD_NUMBER                 = 9
  DATA_TYPE                    = ASCII_INTEGER
  BYTES                        = 10
  DESCRIPTION                  = "The sum of 14.4 keV photons counted by
    all four detectors within a temperature range from 250 to 260 K."
END_OBJECT                     = FIELD

OBJECT                         = FIELD
  NAME                         = "TEMPERATURE10"
  FIELD_NUMBER                 = 10
  DATA_TYPE                    = ASCII_INTEGER
  BYTES                        = 10
  DESCRIPTION                  = "The sum of 14.4 keV photons counted by
    all four detectors within a temperature range from 260 to 270 K."
END_OBJECT                     = FIELD
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```
  OBJECT                          = FIELD
    NAME                          = "TEMPERATURE11"
    FIELD_NUMBER                  = 11
    DATA_TYPE                     = ASCII_INTEGER
    BYTES                         = 10
    DESCRIPTION                   = "The sum of 14.4 keV photons counted by
      all four detectors within a temperature range from 270 to 280 K."
  END_OBJECT                      = FIELD

  OBJECT                          = FIELD
    NAME                          = "TEMPERATURE12"
    FIELD_NUMBER                  = 12
    DATA_TYPE                     = ASCII_INTEGER
    BYTES                         = 10
    DESCRIPTION                   = "The sum of 14.4 keV photons counted by
      all four detectors within a temperature range from 280 to 290 K."
  END_OBJECT                      = FIELD

  OBJECT                          = FIELD
    NAME                          = "TEMPERATURE13"
    FIELD_NUMBER                  = 13
    DATA_TYPE                     = ASCII_INTEGER
    BYTES                         = 10
    DESCRIPTION                   = "The sum of 14.4 keV photons counted by
      all four detectors at temperatures higher than 290 K."
  END_OBJECT                      = FIELD
END_OBJECT                        = SPREADSHEET
END
```

MXC

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PDS_VERSION_ID                    = PDS3

/* FILE DATA ELEMENTS */

RECORD_TYPE                       = STREAM
FILE_RECORDS                      = 512
^SPREADSHEET                      = "2B127615581MXC0309N1940N0J1.CSV"

/* IDENTIFICATION DATA ELEMENTS */

DATA_SET_ID                       = "MER2-M-MB-4-SUMSPEC-SCI-V1.0"
PRODUCT_ID                        = "2B127615581MXC0309N1940N0J1"
PRODUCT_TYPE                      = MB_MXC
SOURCE_PRODUCT_ID                 = "2B127615581EDR0309N1940N0M1"
RELEASE_ID                        = "0001"
ROVER_MOTION_COUNTER              = (3, 9, 28, 983, 166)
ROVER_MOTION_COUNTER_NAME         = (SITE, DRIVE, IDD, PMA, HGA)
COMMAND_SEQUENCE_NUMBER           = 6
INSTRUMENT_HOST_ID                = MER2
INSTRUMENT_HOST_NAME              = "MARS EXPLORATION ROVER 2"
INSTRUMENT_ID                     = MB
INSTRUMENT_TYPE                   = SPECTROMETER
INSTRUMENT_VERSION_ID             = FM3
LOCAL_TRUE_SOLAR_TIME             = "14:00:44"
MAGNET_ID                         = "NULL"
```

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MISSION_NAME                       = "MARS EXPLORATION ROVER"
MISSION_PHASE_NAME                 = "PRIMARY MISSION"
OBSERVATION_ID                     = "0"
PLANET_DAY_NUMBER                  = 14
PRODUCER_INSTITUTION_NAME          = "JOHANNES GUTENBERG UNIVERSITY"
PRODUCT_CREATION_TIME              = 2004-07-15T17:30:00
SEQUENCE_ID                        = n1940
SEQUENCE_VERSION_ID                = "0"
SPACECRAFT_CLOCK_CNT_PARTITION     = 1
SPACECRAFT_CLOCK_START_COUNT       = "127615519.910"
SPACECRAFT_CLOCK_STOP_COUNT        = "127615581.921"
START_TIME                         = 2004-01-17T12:43:54.397
STOP_TIME                          = 2004-01-17T12:44:56.409
TARGET_NAME                        = MARS
TARGET_TYPE                        = PLANET

/* TELEMETRY DATA ELEMENTS */

APPLICATION_PROCESS_ID             = 33
APPLICATION_PROCESS_NAME           = MB
APPLICATION_PROCESS_SUBTYPE_ID     = 0
EARTH_RECEIVED_START_TIME          = 2004-01-17T12:58:47.445
EARTH_RECEIVED_STOP_TIME           = 2004-01-17T13:01:30.412
EXPECTED_PACKETS                   = "N/A"
PACKET_MAP_MASK                    = "N/A"
RECEIVED_PACKETS                   = "N/A"
SAMPLING_COUNT                     = 1
SPICE_FILE_NAME                    = "chronos.mer"
TELEMETRY_FORMAT_ID                = ALL
TELEMETRY_PROVIDER_ID              = "SSW MER_DP"
TELEMETRY_SOURCE_NAME              = "033_000_n1940-000-0006_001_0127615581-
236.dat"
TELEMETRY_SOURCE_TYPE              = "DATA PRODUCT"
TLM_INST_DATA_HEADER_ID            = 3

/* INSTRUMENT DATA ELEMENTS */
/* COORDINATE SYSTEM STATE: ROVER */

GROUP                              = ROVER_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME           = ROVER_FRAME
  COORDINATE_SYSTEM_INDEX          = (3, 9, 28, 983, 166)
  COORDINATE_SYSTEM_INDEX_NAME     = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR             = (0.00000, 0.00000, 0.00000)
  ORIGIN_ROTATION_QUATERNION       = (0.806580, 0.0261539, 0.00125047,
                                      -0.590545)
  POSITIVE_AZIMUTH_DIRECTION       = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION     = UP
  QUATERNION_MEASUREMENT_METHOD    = FINE
  REFERENCE_COORD_SYSTEM_NAME      = SITE_FRAME
  REFERENCE_COORD_SYSTEM_INDEX     = 3
END_GROUP                          = ROVER_COORDINATE_SYSTEM

/* ARTICULATION DEVICE STATE: INSTRUMENT DEPLOYMENT DEVICE AT THE START */

GROUP                              = START_IDD_ARTICULATION_STATE
  ARTICULATION_DEVICE_ID           = IDD
  ARTICULATION_DEVICE_NAME         = "INSTRUMENT DEPLOYMENT DEVICE"
```

```
  ARTICULATION_DEVICE_ANGLE      = (0.465600 <rad>, -0.0927715 <rad>,
                                    1.69880 <rad>, 0.0614155 <rad>,
                                    -1.73933 <rad>, 0.457609 <rad>,
                                    -0.0979819 <rad>, 1.70045 <rad>,
                                    0.0651506 <rad>, -1.75427 <rad>)
  ARTICULATION_DEVICE_ANGLE_NAME = ("JOINT 1 AZIMUTH-ENCODER",
                                    "JOINT 2 ELEVATION-ENCODER",
                                    "JOINT 3 ELBOW-ENCODER",
                                    "JOINT 4 WRIST-ENCODER",
                                    "JOINT 5 TURRET-ENCODER",
                                    "JOINT 1 AZIMUTH-POTENTIOMETER",
                                    "JOINT 2 ELEVATION-POTENTIOMETER",
                                    "JOINT 3 ELBOW-POTENTIOMETER",
                                    "JOINT 4 WRIST-POTENTIOMETER",
                                    "JOINT 5 TURRET-POTENTIOMETER")
  ARTICULATION_DEVICE_MODE       = GUARDED
  ARTICULATION_DEVICE_TEMP       = (-5.73978 <degC>, 6.06055 <degC>)
  ARTICULATION_DEVICE_TEMP_NAME  = ("AZIMUTH JOINT 1", "TURRET JOINT 5")
  ARTICULATION_DEV_VECTOR        = (-0.0329073, 0.0407135, 0.998629)
  ARTICULATION_DEV_VECTOR_NAME   = GRAVITY
  CONTACT_SENSOR_STATE           = ("NO CONTACT", "NO CONTACT", CONTACT,
                                    CONTACT, "NO CONTACT", CONTACT,
                                    OPEN, "NO CONTACT")
  CONTACT_SENSOR_STATE_NAME      = ("MI SWITCH 1", "MI SWITCH 2",
                                    "RAT SWITCH 1", "RAT SWITCH 2",
                                    "MB SWITCH 1", "MB SWITCH 2",
                                    "APXS DOOR SWITCH", "APXS CONTACT
SWITCH")
  ARTICULATION_DEV_INSTRUMENT_ID = MB
END_GROUP                        = START_IDD_ARTICULATION_STATE

/* COORDINATE SYSTEM STATE: INSTRUMENT DEPLOYMENT DEVICE AT THE START */

GROUP                            = START_IDD_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME         = MB_FRAME
  COORDINATE_SYSTEM_INDEX        = (3, 9, 28, 983, 166)
  COORDINATE_SYSTEM_INDEX_NAME   = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR           = (0.933273, 0.138497, 0.297693)
  ORIGIN_ROTATION_QUATERNION     = (0.524170, -0.0291228, -0.0432519,
                                    0.850016)
  POSITIVE_AZIMUTH_DIRECTION     = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION   = DOWN
  REFERENCE_COORD_SYSTEM_NAME    = ROVER_FRAME
  REFERENCE_COORD_SYSTEM_INDEX   = (3, 9, 28, 983, 166)
END_GROUP                        = START_IDD_COORDINATE_SYSTEM

/* ARTICULATION DEVICE STATE: INSTRUMENT DEPLOYMENT DEVICE AT END */

GROUP                            = STOP_IDD_ARTICULATION_STATE
  ARTICULATION_DEVICE_ID         = IDD
  ARTICULATION_DEVICE_NAME       = "INSTRUMENT DEPLOYMENT DEVICE"
  ARTICULATION_DEVICE_ANGLE      = (0.465600 <rad>, -0.0927715 <rad>,
                                    1.69880 <rad>, 0.0614155 <rad>,
                                    -1.73933 <rad>, 0.457807 <rad>,
                                    -0.0981386 <rad>, 1.70082 <rad>,
                                    0.0647358 <rad>, -1.75427 <rad>)
  ARTICULATION_DEVICE_ANGLE_NAME = ("JOINT 1 AZIMUTH-ENCODER",
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                                   "JOINT 2 ELEVATION-ENCODER",
                                   "JOINT 3 ELBOW-ENCODER",
                                   "JOINT 4 WRIST-ENCODER",
                                   "JOINT 5 TURRET-ENCODER",
                                   "JOINT 1 AZIMUTH-POTENTIOMETER",
                                   "JOINT 2 ELEVATION-POTENTIOMETER",
                                   "JOINT 3 ELBOW-POTENTIOMETER",
                                   "JOINT 4 WRIST-POTENTIOMETER",
                                   "JOINT 5 TURRET-POTENTIOMETER")
  ARTICULATION_DEVICE_MODE        = GUARDED
  ARTICULATION_DEVICE_TEMP        = (-5.67178 <degC>, 6.17491 <degC>)
  ARTICULATION_DEVICE_TEMP_NAME   = ("AZIMUTH JOINT 1", "TURRET JOINT 5")
  ARTICULATION_DEV_VECTOR         = (-0.0329073, 0.0407135, 0.998629)
  ARTICULATION_DEV_VECTOR_NAME    = GRAVITY
  CONTACT_SENSOR_STATE            = ("NO CONTACT", "NO CONTACT", CONTACT,
                                   CONTACT, "NO CONTACT", CONTACT,
                                   OPEN, "NO CONTACT")
  CONTACT_SENSOR_STATE_NAME       = ("MI SWITCH 1", "MI SWITCH 2",
                                   "RAT SWITCH 1", "RAT SWITCH 2",
                                   "MB SWITCH 1", "MB SWITCH 2",
                                   "APXS DOOR SWITCH", "APXS CONTACT
SWITCH")
  ARTICULATION_DEV_INSTRUMENT_ID = MB
END_GROUP                        = STOP_IDD_ARTICULATION_STATE

/* COORDINATE SYSTEM STATE: INSTRUMENT DEPLOYMENT DEVICE AT END */

GROUP                            = STOP_IDD_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME         = MB_FRAME
  COORDINATE_SYSTEM_INDEX        = (3, 9, 28, 983, 167)
  COORDINATE_SYSTEM_INDEX_NAME   = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR           = (0.933273, 0.138497, 0.297693)
  ORIGIN_ROTATION_QUATERNION     = (0.524170, -0.0291228, -0.0432519,
                                   0.850016)
  POSITIVE_AZIMUTH_DIRECTION     = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION   = DOWN
  REFERENCE_COORD_SYSTEM_NAME    = ROVER_FRAME
  REFERENCE_COORD_SYSTEM_INDEX   = (3, 9, 28, 983, 167)
END_GROUP                        = STOP_IDD_COORDINATE_SYSTEM

OBJECT                           = SPREADSHEET
  INTERCHANGE_FORMAT             = ASCII
  ROWS                           = 512
  FIELDS                         = 13
  ROW_BYTES                      = 132
  FIELD_DELIMITER                = "COMMA"
  DESCRIPTION                    = "6.4 keV MB spectra as a function
    of channel number.  Rows counted from the top correspond to channel
    number."

  OBJECT                         = FIELD
    NAME                         = "TEMPERATURE01"
    FIELD_NUMBER                 = 1
    DATA_TYPE                    = ASCII_INTEGER
    BYTES                        = 10
    DESCRIPTION                  = "The sum of 6.4 keV photons counted by
      all four detectors within a temperature range from 0 to 180 K."
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END_OBJECT                    = FIELD

OBJECT                        = FIELD
  NAME                        = "TEMPERATURE02"
  FIELD_NUMBER                = 2
  DATA_TYPE                   = ASCII_INTEGER
  BYTES                       = 10
  DESCRIPTION                 = "The sum of 6.4 keV photons counted by
    all four detectors within a temperature range from 180 to 190 K."
END_OBJECT                    = FIELD

OBJECT                        = FIELD
  NAME                        = "TEMPERATURE03"
  FIELD_NUMBER                = 3
  DATA_TYPE                   = ASCII_INTEGER
  BYTES                       = 10
  DESCRIPTION                 = "The sum of 6.4 keV photons counted by
    all four detectors within a temperature range from 190 to 200 K."
END_OBJECT                    = FIELD

OBJECT                        = FIELD
  NAME                        = "TEMPERATURE04"
  FIELD_NUMBER                = 4
  DATA_TYPE                   = ASCII_INTEGER
  BYTES                       = 10
  DESCRIPTION                 = "The sum of 6.4 keV photons counted by
    all four detectors within a temperature range from 200 to 210 K."
END_OBJECT                    = FIELD

OBJECT                        = FIELD
  NAME                        = "TEMPERATURE05"
  FIELD_NUMBER                = 5
  DATA_TYPE                   = ASCII_INTEGER
  BYTES                       = 10
  DESCRIPTION                 = "The sum of 6.4 keV photons counted by
    all four detectors within a temperature range from 210 to 220 K."
END_OBJECT                    = FIELD

OBJECT                        = FIELD
  NAME                        = "TEMPERATURE06"
  FIELD_NUMBER                = 6
  DATA_TYPE                   = ASCII_INTEGER
  BYTES                       = 10
  DESCRIPTION                 = "The sum of 6.4 keV photons counted by
    all four detectors within a temperature range from 220 to 230 K."
END_OBJECT                    = FIELD

OBJECT                        = FIELD
  NAME                        = "TEMPERATURE07"
  FIELD_NUMBER                = 7
  DATA_TYPE                   = ASCII_INTEGER
  BYTES                       = 10
  DESCRIPTION                 = "The sum of 6.4 keV photons counted by
    all four detectors within a temperature range from 230 to 240 K."
END_OBJECT                    = FIELD

OBJECT                        = FIELD
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    NAME                          = "TEMPERATURE08"
    FIELD_NUMBER                  = 8
    DATA_TYPE                     = ASCII_INTEGER
    BYTES                         = 10
    DESCRIPTION                   = "The sum of 6.4 keV photons counted by
      all four detectors within a temperature range from 240 to 250 K."
  END_OBJECT                      = FIELD

  OBJECT                          = FIELD
    NAME                          = "TEMPERATURE09"
    FIELD_NUMBER                  = 9
    DATA_TYPE                     = ASCII_INTEGER
    BYTES                         = 10
    DESCRIPTION                   = "The sum of 6.4 keV photons counted by
      all four detectors within a temperature range from 250 to 260 K."
  END_OBJECT                      = FIELD

  OBJECT                          = FIELD
    NAME                          = "TEMPERATURE10"
    FIELD_NUMBER                  = 10
    DATA_TYPE                     = ASCII_INTEGER
    BYTES                         = 10
    DESCRIPTION                   = "The sum of 6.4 keV photons counted by
      all four detectors within a temperature range from 260 to 270 K."
  END_OBJECT                      = FIELD

  OBJECT                          = FIELD
    NAME                          = "TEMPERATURE11"
    FIELD_NUMBER                  = 11
    DATA_TYPE                     = ASCII_INTEGER
    BYTES                         = 10
    DESCRIPTION                   = "The sum of 6.4 keV photons counted by
      all four detectors within a temperature range from 270 to 280 K."
  END_OBJECT                      = FIELD

  OBJECT                          = FIELD
    NAME                          = "TEMPERATURE12"
    FIELD_NUMBER                  = 12
    DATA_TYPE                     = ASCII_INTEGER
    BYTES                         = 10
    DESCRIPTION                   = "The sum of 6.4 keV photons counted by
      all four detectors within a temperature range from 280 to 290 K."
  END_OBJECT                      = FIELD

  OBJECT                          = FIELD
    NAME                          = "TEMPERATURE13"
    FIELD_NUMBER                  = 13
    DATA_TYPE                     = ASCII_INTEGER
    BYTES                         = 10
    DESCRIPTION                   = "The sum of 6.4 keV photons counted by
      all four detectors at temperatures higher than 290 K."
  END_OBJECT                      = FIELD

END_OBJECT                        = SPREADSHEET
END
```

RSC

```
PDS_VERSION_ID                    = PDS3

/* FILE DATA ELEMENTS */

RECORD_TYPE                       = STREAM
FILE_RECORDS                      = 512
^SPREADSHEET                      = "2B127615581RSC0309N1940N0J1.CSV"

/* IDENTIFICATION DATA ELEMENTS */

DATA_SET_ID                       = "MER2-M-MB-4-SUMSPEC-SCI-V1.0"
PRODUCT_ID                        = "2B127615581RSC0309N1940N0J1"
PRODUCT_TYPE                      = MB_RSC
SOURCE_PRODUCT_ID                 = "2B127615581EDR0309N1940N0M1"
RELEASE_ID                        = "0001"
ROVER_MOTION_COUNTER              = (3, 9, 28, 983, 166)
ROVER_MOTION_COUNTER_NAME         = (SITE, DRIVE, IDD, PMA, HGA)
COMMAND_SEQUENCE_NUMBER           = 6
INSTRUMENT_HOST_ID                = MER2
INSTRUMENT_HOST_NAME              = "MARS EXPLORATION ROVER 2"
INSTRUMENT_ID                     = MB
INSTRUMENT_TYPE                   = SPECTROMETER
INSTRUMENT_VERSION_ID             = FM3
LOCAL_TRUE_SOLAR_TIME             = "14:00:44"
MAGNET_ID                         = "NULL"
MISSION_NAME                      = "MARS EXPLORATION ROVER"
MISSION_PHASE_NAME                = "PRIMARY MISSION"
OBSERVATION_ID                    = "0"
PLANET_DAY_NUMBER                 = 14
PRODUCER_INSTITUTION_NAME         = "JOHANNES GUTENBERG UNIVERSITY"
PRODUCT_CREATION_TIME             = 2004-07-15T17:30:00
SEQUENCE_ID                       = n1940
SEQUENCE_VERSION_ID               = "0"
SPACECRAFT_CLOCK_CNT_PARTITION    = 1
SPACECRAFT_CLOCK_START_COUNT      = "127615519.910"
SPACECRAFT_CLOCK_STOP_COUNT       = "127615581.921"
START_TIME                        = 2004-01-17T12:43:54.397
STOP_TIME                         = 2004-01-17T12:44:56.409
TARGET_NAME                       = MARS
TARGET_TYPE                       = PLANET

/* TELEMETRY DATA ELEMENTS */

APPLICATION_PROCESS_ID            = 33
APPLICATION_PROCESS_NAME          = MB
APPLICATION_PROCESS_SUBTYPE_ID    = 0
EARTH_RECEIVED_START_TIME         = 2004-01-17T12:58:47.445
EARTH_RECEIVED_STOP_TIME          = 2004-01-17T13:01:30.412
EXPECTED_PACKETS                  = "N/A"
PACKET_MAP_MASK                   = "N/A"
RECEIVED_PACKETS                  = "N/A"
SAMPLING_COUNT                    = 1
SPICE_FILE_NAME                   = "chronos.mer"
TELEMETRY_FORMAT_ID               = ALL
TELEMETRY_PROVIDER_ID             = "SSW MER_DP"
```

```
TELEMETRY_SOURCE_NAME            = "033_000_n1940-000-0006_001_0127615581-
236.dat"
TELEMETRY_SOURCE_TYPE            = "DATA PRODUCT"
TLM_INST_DATA_HEADER_ID          = 3

/* INSTRUMENT DATA ELEMENTS */
/* COORDINATE SYSTEM STATE: ROVER */

GROUP                            = ROVER_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME         = ROVER_FRAME
  COORDINATE_SYSTEM_INDEX        = (3, 9, 28, 983, 166)
  COORDINATE_SYSTEM_INDEX_NAME   = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR           = (0.00000, 0.00000, 0.00000)
  ORIGIN_ROTATION_QUATERNION     = (0.806580, 0.0261539, 0.00125047,
                                    -0.590545)
  POSITIVE_AZIMUTH_DIRECTION     = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION   = UP
  QUATERNION_MEASUREMENT_METHOD  = FINE
  REFERENCE_COORD_SYSTEM_NAME    = SITE_FRAME
  REFERENCE_COORD_SYSTEM_INDEX   = 3
END_GROUP                        = ROVER_COORDINATE_SYSTEM

/* ARTICULATION DEVICE STATE: INSTRUMENT DEPLOYMENT DEVICE AT THE START */

GROUP                            = START_IDD_ARTICULATION_STATE
  ARTICULATION_DEVICE_ID         = IDD
  ARTICULATION_DEVICE_NAME       = "INSTRUMENT DEPLOYMENT DEVICE"
  ARTICULATION_DEVICE_ANGLE      = (0.465600 <rad>, -0.0927715 <rad>,
                                    1.69880 <rad>, 0.0614155 <rad>,
                                    -1.73933 <rad>, 0.457609 <rad>,
                                    -0.0979819 <rad>, 1.70045 <rad>,
                                    0.0651506 <rad>, -1.75427 <rad>)
  ARTICULATION_DEVICE_ANGLE_NAME = ("JOINT 1 AZIMUTH-ENCODER",
                                    "JOINT 2 ELEVATION-ENCODER",
                                    "JOINT 3 ELBOW-ENCODER",
                                    "JOINT 4 WRIST-ENCODER",
                                    "JOINT 5 TURRET-ENCODER",
                                    "JOINT 1 AZIMUTH-POTENTIOMETER",
                                    "JOINT 2 ELEVATION-POTENTIOMETER",
                                    "JOINT 3 ELBOW-POTENTIOMETER",
                                    "JOINT 4 WRIST-POTENTIOMETER",
                                    "JOINT 5 TURRET-POTENTIOMETER")
  ARTICULATION_DEVICE_MODE       = GUARDED
  ARTICULATION_DEVICE_TEMP       = (-5.73978 <degC>, 6.06055 <degC>)
  ARTICULATION_DEVICE_TEMP_NAME  = ("AZIMUTH JOINT 1", "TURRET JOINT 5")
  ARTICULATION_DEV_VECTOR        = (-0.0329073, 0.0407135, 0.998629)
  ARTICULATION_DEV_VECTOR_NAME   = GRAVITY
  CONTACT_SENSOR_STATE           = ("NO CONTACT", "NO CONTACT", CONTACT,
                                    CONTACT, "NO CONTACT", CONTACT,
                                    OPEN, "NO CONTACT")
  CONTACT_SENSOR_STATE_NAME      = ("MI SWITCH 1", "MI SWITCH 2",
                                    "RAT SWITCH 1", "RAT SWITCH 2",
                                    "MB SWITCH 1", "MB SWITCH 2",
                                    "APXS DOOR SWITCH", "APXS CONTACT
SWITCH")
  ARTICULATION_DEV_INSTRUMENT_ID = MB
END_GROUP                        = START_IDD_ARTICULATION_STATE
```

```
/* COORDINATE SYSTEM STATE: INSTRUMENT DEPLOYMENT DEVICE AT THE START */

GROUP                              = START_IDD_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME           = MB_FRAME
  COORDINATE_SYSTEM_INDEX          = (3, 9, 28, 983, 166)
  COORDINATE_SYSTEM_INDEX_NAME     = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR             = (0.933273, 0.138497, 0.297693)
  ORIGIN_ROTATION_QUATERNION       = (0.524170, -0.0291228, -0.0432519,
                                      0.850016)
  POSITIVE_AZIMUTH_DIRECTION       = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION     = DOWN
  REFERENCE_COORD_SYSTEM_NAME      = ROVER_FRAME
  REFERENCE_COORD_SYSTEM_INDEX     = (3, 9, 28, 983, 166)
END_GROUP                          = START_IDD_COORDINATE_SYSTEM

/* ARTICULATION DEVICE STATE: INSTRUMENT DEPLOYMENT DEVICE AT END */

GROUP                              = STOP_IDD_ARTICULATION_STATE
  ARTICULATION_DEVICE_ID           = IDD
  ARTICULATION_DEVICE_NAME         = "INSTRUMENT DEPLOYMENT DEVICE"
  ARTICULATION_DEVICE_ANGLE        = (0.465600 <rad>, -0.0927715 <rad>,
                                      1.69880 <rad>, 0.0614155 <rad>,
                                      -1.73933 <rad>, 0.457807 <rad>,
                                      -0.0981386 <rad>, 1.70082 <rad>,
                                      0.0647358 <rad>, -1.75427 <rad>)
  ARTICULATION_DEVICE_ANGLE_NAME = ("JOINT 1 AZIMUTH-ENCODER",
                                      "JOINT 2 ELEVATION-ENCODER",
                                      "JOINT 3 ELBOW-ENCODER",
                                      "JOINT 4 WRIST-ENCODER",
                                      "JOINT 5 TURRET-ENCODER",
                                      "JOINT 1 AZIMUTH-POTENTIOMETER",
                                      "JOINT 2 ELEVATION-POTENTIOMETER",
                                      "JOINT 3 ELBOW-POTENTIOMETER",
                                      "JOINT 4 WRIST-POTENTIOMETER",
                                      "JOINT 5 TURRET-POTENTIOMETER")
  ARTICULATION_DEVICE_MODE         = GUARDED
  ARTICULATION_DEVICE_TEMP         = (-5.67178 <degC>, 6.17491 <degC>)
  ARTICULATION_DEVICE_TEMP_NAME    = ("AZIMUTH JOINT 1", "TURRET JOINT 5")
  ARTICULATION_DEV_VECTOR          = (-0.0329073, 0.0407135, 0.998629)
  ARTICULATION_DEV_VECTOR_NAME     = GRAVITY
  CONTACT_SENSOR_STATE             = ("NO CONTACT", "NO CONTACT", CONTACT,
                                      CONTACT, "NO CONTACT", CONTACT,
                                      OPEN, "NO CONTACT")
  CONTACT_SENSOR_STATE_NAME        = ("MI SWITCH 1", "MI SWITCH 2",
                                      "RAT SWITCH 1", "RAT SWITCH 2",
                                      "MB SWITCH 1", "MB SWITCH 2",
                                      "APXS DOOR SWITCH", "APXS CONTACT
SWITCH")
  ARTICULATION_DEV_INSTRUMENT_ID = MB
END_GROUP                          = STOP_IDD_ARTICULATION_STATE

/* COORDINATE SYSTEM STATE: INSTRUMENT DEPLOYMENT DEVICE AT END */

GROUP                              = STOP_IDD_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME           = MB_FRAME
  COORDINATE_SYSTEM_INDEX          = (3, 9, 28, 983, 167)
```

```
  COORDINATE_SYSTEM_INDEX_NAME   = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR           = (0.933273, 0.138497, 0.297693)
  ORIGIN_ROTATION_QUATERNION     = (0.524170, -0.0291228, -0.0432519,
                                    0.850016)
  POSITIVE_AZIMUTH_DIRECTION     = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION   = DOWN
  REFERENCE_COORD_SYSTEM_NAME    = ROVER_FRAME
  REFERENCE_COORD_SYSTEM_INDEX   = (3, 9, 28, 983, 167)
END_GROUP                        = STOP_IDD_COORDINATE_SYSTEM

OBJECT                           = SPREADSHEET
  INTERCHANGE_FORMAT             = ASCII
  ROWS                           = 512
  FIELDS                         = 13
  ROW_BYTES                      = 132
  FIELD_DELIMITER                = "COMMA"
  DESCRIPTION                    = "14.4 keV MB reference spectra as a
    function of channel number.  Rows counted from the top correspond
    to channel number."

  OBJECT                         = FIELD
    NAME                         = "TEMPERATURE01"
    FIELD_NUMBER                 = 1
    DATA_TYPE                    = ASCII_INTEGER
    BYTES                        = 10
    DESCRIPTION                  = "The sum of 14.4 keV photons counted by
      the reference detector within a temperature range from 0 to 180 K."
  END_OBJECT                     = FIELD

  OBJECT                         = FIELD
    NAME                         = "TEMPERATURE02"
    FIELD_NUMBER                 = 2
    DATA_TYPE                    = ASCII_INTEGER
    BYTES                        = 10
    DESCRIPTION                  = "The sum of 14.4 keV photons counted by
      the reference detector within a temperature range from 180 to 190 K."
  END_OBJECT                     = FIELD

  OBJECT                         = FIELD
    NAME                         = "TEMPERATURE03"
    FIELD_NUMBER                 = 3
    DATA_TYPE                    = ASCII_INTEGER
    BYTES                        = 10
    DESCRIPTION                  = "The sum of 14.4 keV photons counted by
      the reference detector within a temperature range from 190 to 200 K."
  END_OBJECT                     = FIELD

  OBJECT                         = FIELD
    NAME                         = "TEMPERATURE04"
    FIELD_NUMBER                 = 4
    DATA_TYPE                    = ASCII_INTEGER
    BYTES                        = 10
    DESCRIPTION                  = "The sum of 14.4 keV photons counted by
      the reference detector within a temperature range from 200 to 210 K."
  END_OBJECT                     = FIELD

  OBJECT                         = FIELD
```

```
    NAME                          = "TEMPERATURE05"
    FIELD_NUMBER                  = 5
    DATA_TYPE                     = ASCII_INTEGER
    BYTES                         = 10
    DESCRIPTION                   = "The sum of 14.4 keV photons counted by
      the reference detector within a temperature range from 210 to 220 K."
  END_OBJECT                      = FIELD

  OBJECT                          = FIELD
    NAME                          = "TEMPERATURE06"
    FIELD_NUMBER                  = 6
    DATA_TYPE                     = ASCII_INTEGER
    BYTES                         = 10
    DESCRIPTION                   = "The sum of 14.4 keV photons counted by
      the reference detector within a temperature range from 220 to 230 K."
  END_OBJECT                      = FIELD

  OBJECT                          = FIELD
    NAME                          = "TEMPERATURE07"
    FIELD_NUMBER                  = 7
    DATA_TYPE                     = ASCII_INTEGER
    BYTES                         = 10
    DESCRIPTION                   = "The sum of 14.4 keV photons counted by
      the reference detector within a temperature range from 230 to 240 K."
  END_OBJECT                      = FIELD

  OBJECT                          = FIELD
    NAME                          = "TEMPERATURE08"
    FIELD_NUMBER                  = 8
    DATA_TYPE                     = ASCII_INTEGER
    BYTES                         = 10
    DESCRIPTION                   = "The sum of 14.4 keV photons counted by
      the reference detector within a temperature range from 240 to 250 K."
  END_OBJECT                      = FIELD

  OBJECT                          = FIELD
    NAME                          = "TEMPERATURE09"
    FIELD_NUMBER                  = 9
    DATA_TYPE                     = ASCII_INTEGER
    BYTES                         = 10
    DESCRIPTION                   = "The sum of 14.4 keV photons counted by
      the reference detector within a temperature range from 250 to 260 K."
  END_OBJECT                      = FIELD

  OBJECT                          = FIELD
    NAME                          = "TEMPERATURE10"
    FIELD_NUMBER                  = 10
    DATA_TYPE                     = ASCII_INTEGER
    BYTES                         = 10
    DESCRIPTION                   = "The sum of 14.4 keV photons counted by
      the reference detector within a temperature range from 260 to 270 K."
  END_OBJECT                      = FIELD

  OBJECT                          = FIELD
    NAME                          = "TEMPERATURE11"
    FIELD_NUMBER                  = 11
    DATA_TYPE                     = ASCII_INTEGER
```

```
    BYTES                           = 10
    DESCRIPTION                     = "The sum of 14.4 keV photons counted by
      the reference detector within a temperature range from 270 to 280 K."
  END_OBJECT                        = FIELD

  OBJECT                            = FIELD
    NAME                            = "TEMPERATURE12"
    FIELD_NUMBER                    = 12
    DATA_TYPE                       = ASCII_INTEGER
    BYTES                           = 10
    DESCRIPTION                     = "The sum of 14.4 keV photons counted by
      the reference detector within a temperature range from 280 to 290 K."
  END_OBJECT                        = FIELD

  OBJECT                            = FIELD
    NAME                            = "TEMPERATURE13"
    FIELD_NUMBER                    = 13
    DATA_TYPE                       = ASCII_INTEGER
    BYTES                           = 10
    DESCRIPTION                     = "The sum of 14.4 keV photons counted by
      the reference detector at temperatures higher than 290 K."
  END_OBJECT                        = FIELD
END_OBJECT                          = SPREADSHEET
END
```

ESC

```
PDS_VERSION_ID                      = PDS3

/* FILE DATA ELEMENTS */

RECORD_TYPE                         = STREAM
FILE_RECORDS                        = 256
^SPREADSHEET                        = "2B127615581ESC0309N1940N0J1.CSV"

/* IDENTIFICATION DATA ELEMENTS */

DATA_SET_ID                         = "MER2-M-MB-4-SUMSPEC-SCI-V1.0"
PRODUCT_ID                          = "2B127615581ESC0309N1940N0J1"
PRODUCT_TYPE                        = MB_ESC
SOURCE_PRODUCT_ID                   = "2B127615581EDR0309N1940N0M1"
RELEASE_ID                          = "0001"
ROVER_MOTION_COUNTER                = (3, 9, 28, 983, 166)
ROVER_MOTION_COUNTER_NAME           = (SITE, DRIVE, IDD, PMA, HGA)
COMMAND_SEQUENCE_NUMBER             = 6
INSTRUMENT_HOST_ID                  = MER2
INSTRUMENT_HOST_NAME                = "MARS EXPLORATION ROVER 2"
INSTRUMENT_ID                       = MB
INSTRUMENT_TYPE                     = SPECTROMETER
INSTRUMENT_VERSION_ID               = FM3
LOCAL_TRUE_SOLAR_TIME               = "14:00:44"
MAGNET_ID                           = "NULL"
MISSION_NAME                        = "MARS EXPLORATION ROVER"
MISSION_PHASE_NAME                  = "PRIMARY MISSION"
OBSERVATION_ID                      = "0"
PLANET_DAY_NUMBER                   = 14
```

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PRODUCER_INSTITUTION_NAME         = "JOHANNES GUTENBERG UNIVERSITY"
PRODUCT_CREATION_TIME             = 2004-07-15T17:30:00
SEQUENCE_ID                       = n1940
SEQUENCE_VERSION_ID               = "0"
SPACECRAFT_CLOCK_CNT_PARTITION    = 1
SPACECRAFT_CLOCK_START_COUNT      = "127615519.910"
SPACECRAFT_CLOCK_STOP_COUNT       = "127615581.921"
START_TIME                        = 2004-01-17T12:43:54.397
STOP_TIME                         = 2004-01-17T12:44:56.409
TARGET_NAME                       = MARS
TARGET_TYPE                       = PLANET

/* TELEMETRY DATA ELEMENTS */

APPLICATION_PROCESS_ID            = 33
APPLICATION_PROCESS_NAME          = MB
APPLICATION_PROCESS_SUBTYPE_ID    = 0
EARTH_RECEIVED_START_TIME         = 2004-01-17T12:58:47.445
EARTH_RECEIVED_STOP_TIME          = 2004-01-17T13:01:30.412
EXPECTED_PACKETS                  = "N/A"
PACKET_MAP_MASK                   = "N/A"
RECEIVED_PACKETS                  = "N/A"
SAMPLING_COUNT                    = 1
SPICE_FILE_NAME                   = "chronos.mer"
TELEMETRY_FORMAT_ID               = ALL
TELEMETRY_PROVIDER_ID             = "SSW MER_DP"
TELEMETRY_SOURCE_NAME             = "033_000_n1940-000-0006_001_0127615581-
236.dat"
TELEMETRY_SOURCE_TYPE             = "DATA PRODUCT"
TLM_INST_DATA_HEADER_ID           = 3

/* INSTRUMENT DATA ELEMENTS */
/* COORDINATE SYSTEM STATE: ROVER */

GROUP                             = ROVER_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME          = ROVER_FRAME
  COORDINATE_SYSTEM_INDEX         = (3, 9, 28, 983, 166)
  COORDINATE_SYSTEM_INDEX_NAME    = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR            = (0.00000, 0.00000, 0.00000)
  ORIGIN_ROTATION_QUATERNION      = (0.806580, 0.0261539, 0.00125047,
                                     -0.590545)
  POSITIVE_AZIMUTH_DIRECTION      = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION    = UP
  QUATERNION_MEASUREMENT_METHOD   = FINE
  REFERENCE_COORD_SYSTEM_NAME     = SITE_FRAME
  REFERENCE_COORD_SYSTEM_INDEX    = 3
END_GROUP                         = ROVER_COORDINATE_SYSTEM

/* ARTICULATION DEVICE STATE: INSTRUMENT DEPLOYMENT DEVICE AT THE START */

GROUP                             = START_IDD_ARTICULATION_STATE
  ARTICULATION_DEVICE_ID          = IDD
  ARTICULATION_DEVICE_NAME        = "INSTRUMENT DEPLOYMENT DEVICE"
  ARTICULATION_DEVICE_ANGLE       = (0.465600 <rad>, -0.0927715 <rad>,
                                     1.69880 <rad>, 0.0614155 <rad>,
                                     -1.73933 <rad>, 0.457609 <rad>,
                                     -0.0979819 <rad>, 1.70045 <rad>,
```

```
                                   0.0651506 <rad>, -1.75427 <rad>)
  ARTICULATION_DEVICE_ANGLE_NAME = ("JOINT 1 AZIMUTH-ENCODER",
                                   "JOINT 2 ELEVATION-ENCODER",
                                   "JOINT 3 ELBOW-ENCODER",
                                   "JOINT 4 WRIST-ENCODER",
                                   "JOINT 5 TURRET-ENCODER",
                                   "JOINT 1 AZIMUTH-POTENTIOMETER",
                                   "JOINT 2 ELEVATION-POTENTIOMETER",
                                   "JOINT 3 ELBOW-POTENTIOMETER",
                                   "JOINT 4 WRIST-POTENTIOMETER",
                                   "JOINT 5 TURRET-POTENTIOMETER")
  ARTICULATION_DEVICE_MODE       = GUARDED
  ARTICULATION_DEVICE_TEMP       = (-5.73978 <degC>, 6.06055 <degC>)
  ARTICULATION_DEVICE_TEMP_NAME  = ("AZIMUTH JOINT 1", "TURRET JOINT 5")
  ARTICULATION_DEV_VECTOR        = (-0.0329073, 0.0407135, 0.998629)
  ARTICULATION_DEV_VECTOR_NAME   = GRAVITY
  CONTACT_SENSOR_STATE           = ("NO CONTACT", "NO CONTACT", CONTACT,
                                   CONTACT, "NO CONTACT", CONTACT,
                                   OPEN, "NO CONTACT")
  CONTACT_SENSOR_STATE_NAME      = ("MI SWITCH 1", "MI SWITCH 2",
                                   "RAT SWITCH 1", "RAT SWITCH 2",
                                   "MB SWITCH 1", "MB SWITCH 2",
                                   "APXS DOOR SWITCH", "APXS CONTACT
SWITCH")
  ARTICULATION_DEV_INSTRUMENT_ID = MB
END_GROUP                        = START_IDD_ARTICULATION_STATE

/* COORDINATE SYSTEM STATE: INSTRUMENT DEPLOYMENT DEVICE AT THE START */

GROUP                            = START_IDD_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME         = MB_FRAME
  COORDINATE_SYSTEM_INDEX        = (3, 9, 28, 983, 166)
  COORDINATE_SYSTEM_INDEX_NAME   = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR           = (0.933273, 0.138497, 0.297693)
  ORIGIN_ROTATION_QUATERNION     = (0.524170, -0.0291228, -0.0432519,
                                   0.850016)
  POSITIVE_AZIMUTH_DIRECTION     = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION   = DOWN
  REFERENCE_COORD_SYSTEM_NAME    = ROVER_FRAME
  REFERENCE_COORD_SYSTEM_INDEX   = (3, 9, 28, 983, 166)
END_GROUP                        = START_IDD_COORDINATE_SYSTEM

/* ARTICULATION DEVICE STATE: INSTRUMENT DEPLOYMENT DEVICE AT END */

GROUP                            = STOP_IDD_ARTICULATION_STATE
  ARTICULATION_DEVICE_ID         = IDD
  ARTICULATION_DEVICE_NAME       = "INSTRUMENT DEPLOYMENT DEVICE"
  ARTICULATION_DEVICE_ANGLE      = (0.465600 <rad>, -0.0927715 <rad>,
                                   1.69880 <rad>, 0.0614155 <rad>,
                                   -1.73933 <rad>, 0.457807 <rad>,
                                   -0.0981386 <rad>, 1.70082 <rad>,
                                   0.0647358 <rad>, -1.75427 <rad>)
  ARTICULATION_DEVICE_ANGLE_NAME = ("JOINT 1 AZIMUTH-ENCODER",
                                   "JOINT 2 ELEVATION-ENCODER",
                                   "JOINT 3 ELBOW-ENCODER",
                                   "JOINT 4 WRIST-ENCODER",
                                   "JOINT 5 TURRET-ENCODER",
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```
                                 "JOINT 1 AZIMUTH-POTENTIOMETER",
                                 "JOINT 2 ELEVATION-POTENTIOMETER",
                                 "JOINT 3 ELBOW-POTENTIOMETER",
                                 "JOINT 4 WRIST-POTENTIOMETER",
                                 "JOINT 5 TURRET-POTENTIOMETER")
  ARTICULATION_DEVICE_MODE       = GUARDED
  ARTICULATION_DEVICE_TEMP       = (-5.67178 <degC>, 6.17491 <degC>)
  ARTICULATION_DEVICE_TEMP_NAME  = ("AZIMUTH JOINT 1", "TURRET JOINT 5")
  ARTICULATION_DEV_VECTOR        = (-0.0329073, 0.0407135, 0.998629)
  ARTICULATION_DEV_VECTOR_NAME   = GRAVITY
  CONTACT_SENSOR_STATE           = ("NO CONTACT", "NO CONTACT", CONTACT,
                                 CONTACT, "NO CONTACT", CONTACT,
                                 OPEN, "NO CONTACT")
  CONTACT_SENSOR_STATE_NAME      = ("MI SWITCH 1", "MI SWITCH 2",
                                 "RAT SWITCH 1", "RAT SWITCH 2",
                                 "MB SWITCH 1", "MB SWITCH 2",
                                 "APXS DOOR SWITCH", "APXS CONTACT
SWITCH")
  ARTICULATION_DEV_INSTRUMENT_ID = MB
END_GROUP                        = STOP_IDD_ARTICULATION_STATE

/* COORDINATE SYSTEM STATE: INSTRUMENT DEPLOYMENT DEVICE AT END */

GROUP                            = STOP_IDD_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME         = MB_FRAME
  COORDINATE_SYSTEM_INDEX        = (3, 9, 28, 983, 167)
  COORDINATE_SYSTEM_INDEX_NAME   = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR           = (0.933273, 0.138497, 0.297693)
  ORIGIN_ROTATION_QUATERNION     = (0.524170, -0.0291228, -0.0432519,
                                 0.850016)
  POSITIVE_AZIMUTH_DIRECTION     = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION   = DOWN
  REFERENCE_COORD_SYSTEM_NAME    = ROVER_FRAME
  REFERENCE_COORD_SYSTEM_INDEX   = (3, 9, 28, 983, 167)
END_GROUP                        = STOP_IDD_COORDINATE_SYSTEM

OBJECT                           = SPREADSHEET
  INTERCHANGE_FORMAT             = ASCII
  ROWS                           = 256
  FIELDS                         = 5
  ROW_BYTES                      = 132
  FIELD_DELIMITER                = "COMMA"
  DESCRIPTION                    = "Energy spectra in counts as a
    function of channel number.  Rows counted from the top correspond
    to channel number."

  OBJECT                         = FIELD
    NAME                         = "DETECTOR_1"
    FIELD_NUMBER                 = 1
    DATA_TYPE                    = ASCII_INTEGER
    BYTES                        = 10
    DESCRIPTION                  = "Energy spectrum for detector 1."
  END_OBJECT                     = FIELD

  OBJECT                         = FIELD
    NAME                         = "DETECTOR_2"
    FIELD_NUMBER                 = 2
```

```
    DATA_TYPE                      = ASCII_INTEGER
    BYTES                          = 10
    DESCRIPTION                    = "Energy spectrum for detector 2."
  END_OBJECT                       = FIELD

  OBJECT                           = FIELD
    NAME                           = "DETECTOR_3"
    FIELD_NUMBER                   = 3
    DATA_TYPE                      = ASCII_INTEGER
    BYTES                          = 10
    DESCRIPTION                    = "Energy spectrum for detector 3."
  END_OBJECT                       = FIELD

  OBJECT                           = FIELD
    NAME                           = "DETECTOR_4"
    FIELD_NUMBER                   = 4
    DATA_TYPE                      = ASCII_INTEGER
    BYTES                          = 10
    DESCRIPTION                    = "Energy spectrum for detector 4."
  END_OBJECT                       = FIELD

  OBJECT                           = FIELD
    NAME                           = "REFERENCE_DETECTOR"
    FIELD_NUMBER                   = 5
    DATA_TYPE                      = ASCII_INTEGER
    BYTES                          = 10
    DESCRIPTION                    = "Energy spectrum for reference detector."
  END_OBJECT                       = FIELD
END_OBJECT                         = SPREADSHEET
END
```

DSC

```
PDS_VERSION_ID                     = PDS3

/* FILE DATA ELEMENTS */

RECORD_TYPE                        = STREAM
FILE_RECORDS                       = 512
^SPREADSHEET                       = "2B127615581DSC0309N1940N0J1.CSV"

/* IDENTIFICATION DATA ELEMENTS */

DATA_SET_ID                        = "MER2-M-MB-4-SUMSPEC-SCI-V1.0"
PRODUCT_ID                         = "2B127615581DSC0309N1940N0J1"
PRODUCT_TYPE                       = MB_DSC
SOURCE_PRODUCT_ID                  = "2B127615581EDR0309N1940N0M1"
RELEASE_ID                         = "0001"
ROVER_MOTION_COUNTER               = (3, 9, 28, 983, 166)
ROVER_MOTION_COUNTER_NAME          = (SITE, DRIVE, IDD, PMA, HGA)
COMMAND_SEQUENCE_NUMBER            = 6
INSTRUMENT_HOST_ID                 = MER2
INSTRUMENT_HOST_NAME               = "MARS EXPLORATION ROVER 2"
INSTRUMENT_ID                      = MB
INSTRUMENT_TYPE                    = SPECTROMETER
INSTRUMENT_VERSION_ID              = FM3
```

```
LOCAL_TRUE_SOLAR_TIME            = "14:00:44"
MAGNET_ID                        = "NULL"
MISSION_NAME                     = "MARS EXPLORATION ROVER"
MISSION_PHASE_NAME               = "PRIMARY MISSION"
OBSERVATION_ID                   = "0"
PLANET_DAY_NUMBER                = 14
PRODUCER_INSTITUTION_NAME        = "JOHANNES GUTENBERG UNIVERSITY"
PRODUCT_CREATION_TIME            = 2004-07-15T17:30:00
SEQUENCE_ID                      = n1940
SEQUENCE_VERSION_ID              = "0"
SPACECRAFT_CLOCK_CNT_PARTITION   = 1
SPACECRAFT_CLOCK_START_COUNT     = "127615519.910"
SPACECRAFT_CLOCK_STOP_COUNT      = "127615581.921"
START_TIME                       = 2004-01-17T12:43:54.397
STOP_TIME                        = 2004-01-17T12:44:56.409
TARGET_NAME                      = MARS
TARGET_TYPE                      = PLANET

/* TELEMETRY DATA ELEMENTS */

APPLICATION_PROCESS_ID           = 33
APPLICATION_PROCESS_NAME         = MB
APPLICATION_PROCESS_SUBTYPE_ID   = 0
EARTH_RECEIVED_START_TIME        = 2004-01-17T12:58:47.445
EARTH_RECEIVED_STOP_TIME         = 2004-01-17T13:01:30.412
EXPECTED_PACKETS                 = "N/A"
PACKET_MAP_MASK                  = "N/A"
RECEIVED_PACKETS                 = "N/A"
SAMPLING_COUNT                   = 1
SPICE_FILE_NAME                  = "chronos.mer"
TELEMETRY_FORMAT_ID              = ALL
TELEMETRY_PROVIDER_ID            = "SSW MER_DP"
TELEMETRY_SOURCE_NAME            = "033_000_n1940-000-0006_001_0127615581-
236.dat"
TELEMETRY_SOURCE_TYPE            = "DATA PRODUCT"
TLM_INST_DATA_HEADER_ID          = 3

/* INSTRUMENT DATA ELEMENTS */
/* COORDINATE SYSTEM STATE: ROVER */

GROUP                            = ROVER_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME         = ROVER_FRAME
  COORDINATE_SYSTEM_INDEX        = (3, 9, 28, 983, 166)
  COORDINATE_SYSTEM_INDEX_NAME   = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR           = (0.00000, 0.00000, 0.00000)
  ORIGIN_ROTATION_QUATERNION     = (0.806580, 0.0261539, 0.00125047,
                                    -0.590545)
  POSITIVE_AZIMUTH_DIRECTION     = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION   = UP
  QUATERNION_MEASUREMENT_METHOD  = FINE
  REFERENCE_COORD_SYSTEM_NAME    = SITE_FRAME
  REFERENCE_COORD_SYSTEM_INDEX   = 3
END_GROUP                        = ROVER_COORDINATE_SYSTEM

/* ARTICULATION DEVICE STATE: INSTRUMENT DEPLOYMENT DEVICE AT THE START */

GROUP                            = START_IDD_ARTICULATION_STATE
```

```
  ARTICULATION_DEVICE_ID          = IDD
  ARTICULATION_DEVICE_NAME        = "INSTRUMENT DEPLOYMENT DEVICE"
  ARTICULATION_DEVICE_ANGLE       = (0.465600 <rad>, -0.0927715 <rad>,
                                     1.69880 <rad>, 0.0614155 <rad>,
                                     -1.73933 <rad>, 0.457609 <rad>,
                                     -0.0979819 <rad>, 1.70045 <rad>,
                                     0.0651506 <rad>, -1.75427 <rad>)
  ARTICULATION_DEVICE_ANGLE_NAME = ("JOINT 1 AZIMUTH-ENCODER",
                                     "JOINT 2 ELEVATION-ENCODER",
                                     "JOINT 3 ELBOW-ENCODER",
                                     "JOINT 4 WRIST-ENCODER",
                                     "JOINT 5 TURRET-ENCODER",
                                     "JOINT 1 AZIMUTH-POTENTIOMETER",
                                     "JOINT 2 ELEVATION-POTENTIOMETER",
                                     "JOINT 3 ELBOW-POTENTIOMETER",
                                     "JOINT 4 WRIST-POTENTIOMETER",
                                     "JOINT 5 TURRET-POTENTIOMETER")
  ARTICULATION_DEVICE_MODE        = GUARDED
  ARTICULATION_DEVICE_TEMP        = (-5.73978 <degC>, 6.06055 <degC>)
  ARTICULATION_DEVICE_TEMP_NAME   = ("AZIMUTH JOINT 1", "TURRET JOINT 5")
  ARTICULATION_DEV_VECTOR         = (-0.0329073, 0.0407135, 0.998629)
  ARTICULATION_DEV_VECTOR_NAME    = GRAVITY
  CONTACT_SENSOR_STATE            = ("NO CONTACT", "NO CONTACT", CONTACT,
                                     CONTACT, "NO CONTACT", CONTACT,
                                     OPEN, "NO CONTACT")
  CONTACT_SENSOR_STATE_NAME       = ("MI SWITCH 1", "MI SWITCH 2",
                                     "RAT SWITCH 1", "RAT SWITCH 2",
                                     "MB SWITCH 1", "MB SWITCH 2",
                                     "APXS DOOR SWITCH", "APXS CONTACT
SWITCH")
  ARTICULATION_DEV_INSTRUMENT_ID = MB
END_GROUP                         = START_IDD_ARTICULATION_STATE

/* COORDINATE SYSTEM STATE: INSTRUMENT DEPLOYMENT DEVICE AT THE START */

GROUP                             = START_IDD_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME          = MB_FRAME
  COORDINATE_SYSTEM_INDEX         = (3, 9, 28, 983, 166)
  COORDINATE_SYSTEM_INDEX_NAME    = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR            = (0.933273, 0.138497, 0.297693)
  ORIGIN_ROTATION_QUATERNION      = (0.524170, -0.0291228, -0.0432519,
                                     0.850016)
  POSITIVE_AZIMUTH_DIRECTION      = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION    = DOWN
  REFERENCE_COORD_SYSTEM_NAME     = ROVER_FRAME
  REFERENCE_COORD_SYSTEM_INDEX    = (3, 9, 28, 983, 166)
END_GROUP                         = START_IDD_COORDINATE_SYSTEM

/* ARTICULATION DEVICE STATE: INSTRUMENT DEPLOYMENT DEVICE AT END */

GROUP                             = STOP_IDD_ARTICULATION_STATE
  ARTICULATION_DEVICE_ID          = IDD
  ARTICULATION_DEVICE_NAME        = "INSTRUMENT DEPLOYMENT DEVICE"
  ARTICULATION_DEVICE_ANGLE       = (0.465600 <rad>, -0.0927715 <rad>,
                                     1.69880 <rad>, 0.0614155 <rad>,
                                     -1.73933 <rad>, 0.457807 <rad>,
                                     -0.0981386 <rad>, 1.70082 <rad>,
```

```
                                   0.0647358 <rad>, -1.75427 <rad>)
  ARTICULATION_DEVICE_ANGLE_NAME = ("JOINT 1 AZIMUTH-ENCODER",
                                   "JOINT 2 ELEVATION-ENCODER",
                                   "JOINT 3 ELBOW-ENCODER",
                                   "JOINT 4 WRIST-ENCODER",
                                   "JOINT 5 TURRET-ENCODER",
                                   "JOINT 1 AZIMUTH-POTENTIOMETER",
                                   "JOINT 2 ELEVATION-POTENTIOMETER",
                                   "JOINT 3 ELBOW-POTENTIOMETER",
                                   "JOINT 4 WRIST-POTENTIOMETER",
                                   "JOINT 5 TURRET-POTENTIOMETER")
  ARTICULATION_DEVICE_MODE        = GUARDED
  ARTICULATION_DEVICE_TEMP        = (-5.67178 <degC>, 6.17491 <degC>)
  ARTICULATION_DEVICE_TEMP_NAME   = ("AZIMUTH JOINT 1", "TURRET JOINT 5")
  ARTICULATION_DEV_VECTOR         = (-0.0329073, 0.0407135, 0.998629)
  ARTICULATION_DEV_VECTOR_NAME    = GRAVITY
  CONTACT_SENSOR_STATE            = ("NO CONTACT", "NO CONTACT", CONTACT,
                                   CONTACT, "NO CONTACT", CONTACT,
                                   OPEN, "NO CONTACT")
  CONTACT_SENSOR_STATE_NAME       = ("MI SWITCH 1", "MI SWITCH 2",
                                   "RAT SWITCH 1", "RAT SWITCH 2",
                                   "MB SWITCH 1", "MB SWITCH 2",
                                   "APXS DOOR SWITCH", "APXS CONTACT
SWITCH")
  ARTICULATION_DEV_INSTRUMENT_ID = MB
END_GROUP                         = STOP_IDD_ARTICULATION_STATE

/* COORDINATE SYSTEM STATE: INSTRUMENT DEPLOYMENT DEVICE AT END */

GROUP                             = STOP_IDD_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME          = MB_FRAME
  COORDINATE_SYSTEM_INDEX         = (3, 9, 28, 983, 167)
  COORDINATE_SYSTEM_INDEX_NAME    = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR            = (0.933273, 0.138497, 0.297693)
  ORIGIN_ROTATION_QUATERNION      = (0.524170, -0.0291228, -0.0432519,
                                   0.850016)
  POSITIVE_AZIMUTH_DIRECTION      = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION    = DOWN
  REFERENCE_COORD_SYSTEM_NAME     = ROVER_FRAME
  REFERENCE_COORD_SYSTEM_INDEX    = (3, 9, 28, 983, 167)
END_GROUP                         = STOP_IDD_COORDINATE_SYSTEM

OBJECT                            = SPREADSHEET
  INTERCHANGE_FORMAT              = ASCII
  ROWS                            = 512
  FIELDS                          = 1
  ROW_BYTES                       = 12
  FIELD_DELIMITER                 = "COMMA"
  DESCRIPTION                     = "Differential signal as a function
    channel number.  Rows counted from the top correspond
    to channel number."

  OBJECT                          = FIELD
    NAME                          = "DIFFERENTIAL_SIGNAL"
    FIELD_NUMBER                  = 1
    DATA_TYPE                     = ASCII_INTEGER
    BYTES                         = 10
```

```
    DESCRIPTION                   = "Value is proportional to the velocity
      difference between actual drive velocity and the triangular nominal
      velocity signal."
  END_OBJECT                      = FIELD
END_OBJECT                        = SPREADSHEET
END
```

ESE

```
PDS_VERSION_ID                    = PDS3

/* FILE DATA ELEMENTS */

RECORD_TYPE                       = STREAM
FILE_RECORDS                      = 256
^SPREADSHEET                      = "2B127615581ESE0309N1940N0J1.CSV"

/* IDENTIFICATION DATA ELEMENTS */

DATA_SET_ID                       = "MER2-M-MB-5-CALSPEC-SCI-V1.0"
PRODUCT_ID                        = "2B127615581ESE0309N1940N0J1"
PRODUCT_TYPE                      = MB_ESE
SOURCE_PRODUCT_ID                 = "2B127615581EDR0309N1940N0M1"
RELEASE_ID                        = "0001"
ROVER_MOTION_COUNTER              = (3, 9, 28, 983, 166)
ROVER_MOTION_COUNTER_NAME         = (SITE, DRIVE, IDD, PMA, HGA)
COMMAND_SEQUENCE_NUMBER           = 6
INSTRUMENT_HOST_ID                = MER2
INSTRUMENT_HOST_NAME              = "MARS EXPLORATION ROVER 2"
INSTRUMENT_ID                     = MB
INSTRUMENT_TYPE                   = SPECTROMETER
INSTRUMENT_VERSION_ID             = FM3
LOCAL_TRUE_SOLAR_TIME             = "14:00:44"
MAGNET_ID                         = "NULL"
MISSION_NAME                      = "MARS EXPLORATION ROVER"
MISSION_PHASE_NAME                = "PRIMARY MISSION"
OBSERVATION_ID                    = "0"
PLANET_DAY_NUMBER                 = 14
PRODUCER_INSTITUTION_NAME         = "JOHANNES GUTENBERG UNIVERSITY"
PRODUCT_CREATION_TIME             = 2004-07-15T17:30:00
SEQUENCE_ID                       = n1940
SEQUENCE_VERSION_ID               = "0"
SPACECRAFT_CLOCK_CNT_PARTITION    = 1
SPACECRAFT_CLOCK_START_COUNT      = "127615519.910"
SPACECRAFT_CLOCK_STOP_COUNT       = "127615581.921"
START_TIME                        = 2004-01-17T12:43:54.397
STOP_TIME                         = 2004-01-17T12:44:56.409
TARGET_NAME                       = MARS
TARGET_TYPE                       = PLANET

/* TELEMETRY DATA ELEMENTS */

APPLICATION_PROCESS_ID            = 33
APPLICATION_PROCESS_NAME          = MB
APPLICATION_PROCESS_SUBTYPE_ID    = 0
EARTH_RECEIVED_START_TIME         = 2004-01-17T12:58:47.445
```

```
EARTH_RECEIVED_STOP_TIME         = 2004-01-17T13:01:30.412
EXPECTED_PACKETS                 = "N/A"
PACKET_MAP_MASK                  = "N/A"
RECEIVED_PACKETS                 = "N/A"
SAMPLING_COUNT                   = 1
SPICE_FILE_NAME                  = "chronos.mer"
TELEMETRY_FORMAT_ID              = ALL
TELEMETRY_PROVIDER_ID            = "SSW MER_DP"
TELEMETRY_SOURCE_NAME            = "033_000_n1940-000-0006_001_0127615581-
236.dat"
TELEMETRY_SOURCE_TYPE            = "DATA PRODUCT"
TLM_INST_DATA_HEADER_ID          = 3

/* INSTRUMENT DATA ELEMENTS */
/* COORDINATE SYSTEM STATE: ROVER */

GROUP                            = ROVER_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME         = ROVER_FRAME
  COORDINATE_SYSTEM_INDEX        = (3, 9, 28, 983, 166)
  COORDINATE_SYSTEM_INDEX_NAME   = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR           = (0.00000, 0.00000, 0.00000)
  ORIGIN_ROTATION_QUATERNION     = (0.806580, 0.0261539, 0.00125047,
                                    -0.590545)
  POSITIVE_AZIMUTH_DIRECTION     = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION   = UP
  QUATERNION_MEASUREMENT_METHOD  = FINE
  REFERENCE_COORD_SYSTEM_NAME    = SITE_FRAME
  REFERENCE_COORD_SYSTEM_INDEX   = 3
END_GROUP                        = ROVER_COORDINATE_SYSTEM

/* ARTICULATION DEVICE STATE: INSTRUMENT DEPLOYMENT DEVICE AT THE START */

GROUP                            = START_IDD_ARTICULATION_STATE
  ARTICULATION_DEVICE_ID         = IDD
  ARTICULATION_DEVICE_NAME       = "INSTRUMENT DEPLOYMENT DEVICE"
  ARTICULATION_DEVICE_ANGLE      = (0.465600 <rad>, -0.0927715 <rad>,
                                    1.69880 <rad>, 0.0614155 <rad>,
                                    -1.73933 <rad>, 0.457609 <rad>,
                                    -0.0979819 <rad>, 1.70045 <rad>,
                                    0.0651506 <rad>, -1.75427 <rad>)
  ARTICULATION_DEVICE_ANGLE_NAME = ("JOINT 1 AZIMUTH-ENCODER",
                                    "JOINT 2 ELEVATION-ENCODER",
                                    "JOINT 3 ELBOW-ENCODER",
                                    "JOINT 4 WRIST-ENCODER",
                                    "JOINT 5 TURRET-ENCODER",
                                    "JOINT 1 AZIMUTH-POTENTIOMETER",
                                    "JOINT 2 ELEVATION-POTENTIOMETER",
                                    "JOINT 3 ELBOW-POTENTIOMETER",
                                    "JOINT 4 WRIST-POTENTIOMETER",
                                    "JOINT 5 TURRET-POTENTIOMETER")
  ARTICULATION_DEVICE_MODE       = GUARDED
  ARTICULATION_DEVICE_TEMP       = (-5.73978 <degC>, 6.06055 <degC>)
  ARTICULATION_DEVICE_TEMP_NAME  = ("AZIMUTH JOINT 1", "TURRET JOINT 5")
  ARTICULATION_DEV_VECTOR        = (-0.0329073, 0.0407135, 0.998629)
  ARTICULATION_DEV_VECTOR_NAME   = GRAVITY
  CONTACT_SENSOR_STATE           = ("NO CONTACT", "NO CONTACT", CONTACT,
                                    CONTACT, "NO CONTACT", CONTACT,
```

```
                                 OPEN, "NO CONTACT")
  CONTACT_SENSOR_STATE_NAME      = ("MI SWITCH 1", "MI SWITCH 2",
                                 "RAT SWITCH 1", "RAT SWITCH 2",
                                 "MB SWITCH 1", "MB SWITCH 2",
                                 "APXS DOOR SWITCH", "APXS CONTACT
                                  SWITCH")
  ARTICULATION_DEV_INSTRUMENT_ID = MB
END_GROUP                        = START_IDD_ARTICULATION_STATE

/* COORDINATE SYSTEM STATE: INSTRUMENT DEPLOYMENT DEVICE AT THE START */

GROUP                            = START_IDD_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME         = MB_FRAME
  COORDINATE_SYSTEM_INDEX        = (3, 9, 28, 983, 166)
  COORDINATE_SYSTEM_INDEX_NAME   = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR           = (0.933273, 0.138497, 0.297693)
  ORIGIN_ROTATION_QUATERNION     = (0.524170, -0.0291228, -0.0432519,
                                 0.850016)
  POSITIVE_AZIMUTH_DIRECTION     = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION   = DOWN
  REFERENCE_COORD_SYSTEM_NAME    = ROVER_FRAME
  REFERENCE_COORD_SYSTEM_INDEX   = (3, 9, 28, 983, 166)
END_GROUP                        = START_IDD_COORDINATE_SYSTEM

/* ARTICULATION DEVICE STATE: INSTRUMENT DEPLOYMENT DEVICE AT END */

GROUP                            = STOP_IDD_ARTICULATION_STATE
  ARTICULATION_DEVICE_ID         = IDD
  ARTICULATION_DEVICE_NAME       = "INSTRUMENT DEPLOYMENT DEVICE"
  ARTICULATION_DEVICE_ANGLE      = (0.465600 <rad>, -0.0927715 <rad>,
                                 1.69880 <rad>, 0.0614155 <rad>,
                                 -1.73933 <rad>, 0.457807 <rad>,
                                 -0.0981386 <rad>, 1.70082 <rad>,
                                 0.0647358 <rad>, -1.75427 <rad>)
  ARTICULATION_DEVICE_ANGLE_NAME = ("JOINT 1 AZIMUTH-ENCODER",
                                 "JOINT 2 ELEVATION-ENCODER",
                                 "JOINT 3 ELBOW-ENCODER",
                                 "JOINT 4 WRIST-ENCODER",
                                 "JOINT 5 TURRET-ENCODER",
                                 "JOINT 1 AZIMUTH-POTENTIOMETER",
                                 "JOINT 2 ELEVATION-POTENTIOMETER",
                                 "JOINT 3 ELBOW-POTENTIOMETER",
                                 "JOINT 4 WRIST-POTENTIOMETER",
                                 "JOINT 5 TURRET-POTENTIOMETER")
  ARTICULATION_DEVICE_MODE       = GUARDED
  ARTICULATION_DEVICE_TEMP       = (-5.67178 <degC>, 6.17491 <degC>)
  ARTICULATION_DEVICE_TEMP_NAME  = ("AZIMUTH JOINT 1", "TURRET JOINT 5")
  ARTICULATION_DEV_VECTOR        = (-0.0329073, 0.0407135, 0.998629)
  ARTICULATION_DEV_VECTOR_NAME   = GRAVITY
  CONTACT_SENSOR_STATE           = ("NO CONTACT", "NO CONTACT", CONTACT,
                                 CONTACT, "NO CONTACT", CONTACT,
                                 OPEN, "NO CONTACT")
  CONTACT_SENSOR_STATE_NAME      = ("MI SWITCH 1", "MI SWITCH 2",
                                 "RAT SWITCH 1", "RAT SWITCH 2",
                                 "MB SWITCH 1", "MB SWITCH 2",
                                 "APXS DOOR SWITCH", "APXS CONTACT
                                 SWITCH")
```

```
  ARTICULATION_DEV_INSTRUMENT_ID = MB
END_GROUP                        = STOP_IDD_ARTICULATION_STATE

/* COORDINATE SYSTEM STATE: INSTRUMENT DEPLOYMENT DEVICE AT END */

GROUP                            = STOP_IDD_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME         = MB_FRAME
  COORDINATE_SYSTEM_INDEX        = (3, 9, 28, 983, 167)
  COORDINATE_SYSTEM_INDEX_NAME   = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR           = (0.933273, 0.138497, 0.297693)
  ORIGIN_ROTATION_QUATERNION     = (0.524170, -0.0291228, -0.0432519,
                                    0.850016)
  POSITIVE_AZIMUTH_DIRECTION     = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION   = DOWN
  REFERENCE_COORD_SYSTEM_NAME    = ROVER_FRAME
  REFERENCE_COORD_SYSTEM_INDEX   = (3, 9, 28, 983, 167)
END_GROUP                        = STOP_IDD_COORDINATE_SYSTEM

OBJECT                           = SPREADSHEET
  INTERCHANGE_FORMAT             = ASCII
  ROWS                           = 256
  FIELDS                         = 10
  ROW_BYTES                      = 132
  FIELD_DELIMITER                = "COMMA"
  DESCRIPTION                    = "Energy spectra in counts as a
    function of energy."

  OBJECT                         = FIELD
    NAME                         = "ENERGY_1"
    FIELD_NUMBER                 = 1
    DATA_TYPE                    = ASCII_REAL
    BYTES                        = 10
    DESCRIPTION                  = "Energy in keV for detector 1."
  END_OBJECT                     = FIELD

  OBJECT                         = FIELD
    NAME                         = "DETECTOR_1"
    FIELD_NUMBER                 = 2
    DATA_TYPE                    = ASCII_INTEGER
    BYTES                        = 10
    DESCRIPTION                  = "Energy spectrum for detector 1."
  END_OBJECT                     = FIELD

  OBJECT                         = FIELD
    NAME                         = "ENERGY_2"
    FIELD_NUMBER                 = 3
    DATA_TYPE                    = ASCII_REAL
    BYTES                        = 10
    DESCRIPTION                  = "Energy in keV for detector 2."
  END_OBJECT                     = FIELD

  OBJECT                         = FIELD
    NAME                         = "DETECTOR_2"
    FIELD_NUMBER                 = 4
    DATA_TYPE                    = ASCII_INTEGER
    BYTES                        = 10
    DESCRIPTION                  = "Energy spectrum for detector 2."
```

```
  END_OBJECT                        = FIELD

  OBJECT                            = FIELD
    NAME                            = "ENERGY_3"
    FIELD_NUMBER                    = 5
    DATA_TYPE                       = ASCII_REAL
    BYTES                           = 10
    DESCRIPTION                     = "Energy in keV for detector 3."
  END_OBJECT                        = FIELD

  OBJECT                            = FIELD
    NAME                            = "DETECTOR_3"
    FIELD_NUMBER                    = 6
    DATA_TYPE                       = ASCII_INTEGER
    BYTES                           = 10
    DESCRIPTION                     = "Energy spectrum for detector 3."
  END_OBJECT                        = FIELD

  OBJECT                            = FIELD
    NAME                            = "ENERGY_4"
    FIELD_NUMBER                    = 7
    DATA_TYPE                       = ASCII_REAL
    BYTES                           = 10
    DESCRIPTION                     = "Energy in keV for detector 4."
  END_OBJECT                        = FIELD

  OBJECT                            = FIELD
    NAME                            = "DETECTOR_4"
    FIELD_NUMBER                    = 8
    DATA_TYPE                       = ASCII_INTEGER
    BYTES                           = 10
    DESCRIPTION                     = "Energy spectrum for detector 4."
  END_OBJECT                        = FIELD

  OBJECT                            = FIELD
    NAME                            = "ENERGY_REFERENCE"
    FIELD_NUMBER                    = 9
    DATA_TYPE                       = ASCII_REAL
    BYTES                           = 10
    DESCRIPTION                     = "Energy in keV for reference detector."
  END_OBJECT                        = FIELD

  OBJECT                            = FIELD
    NAME                            = "REFERENCE_DETECTOR"
    FIELD_NUMBER                    = 10
    DATA_TYPE                       = ASCII_INTEGER
    BYTES                           = 10
    DESCRIPTION                     = "Energy spectrum for reference detector."
  END_OBJECT                        = FIELD
END_OBJECT                          = SPREADSHEET
END
```

MIN

TBD

APPENDIX B – LABEL KEYWORD DEFINITIONS

Note see the Planetary Science Data Dictionary [6] for the definitions of keywords within the spreadsheet object.

Keyword Name	Definition	Type	Units	Valid Values
APPLICATION_PROCESS_ID	Identifies the source/process which created the data.	integer		(see APPLICATION_PROCESS_NAME)
APPLICATION_PROCESS_NAME	Provides the name associated with the source/process which created the data. Note: For Mars Pathfinder, the queues were distinguished on the basis of type and priority of data.	string (256)		APID NAME 21 "PANCAM LEFT" 22 "PANCAM RIGHT" 23 "NAVCAM LEFT" 24 "NAVCAM RIGHT" 25 "HAZCAM LEFT FRONT" 26 "HAZCAM RIGHT FRONT" 27 "HAZCAM LEFT REAR" 28 "HAZCAM RIGHT REAR" 29 "MI" 30 "DESCENT IMAGER" 31 "MINITES" 32 "APXS" 33 "MB" 34 "RAT"
APPLICATION_PROCESS_SUBTYPE_ID	Identifies the source/subprocess which created the data.	integer		0 MB SCIENCE DATA of one or five blocks of data
ARTICULATION_DEVICE_ANGLE	Provides the value of an angle between two parts or segments of an articulated device. Note: MER uses radians. The PDS default unit for this keyword is degrees, so the <rad> tag is required for MER data.	float array[10]	radians (<rad> unit tag required)	

Keyword Name	Definition	Type	Units	Valid Values
ARTICULATION_DEVICE_ANGLE_NAME	Provides the formal name which identifies each of the values used in ARTICULATION_DEVICE_ANGLE.	string array[10]		("JOINT 1 AZIMUTH-ENCODER", "JOINT 2 ELEVATION-ENCODER", "JOINT 3 ELBOW-ENCODER", "JOINT 4 WRIST-ENCODER", "JOINT 5 TURRET-ENCODER", "JOINT 1 AZIMUTH-POTENTIOMETER", "JOINT 2 ELEVATION-POTENTIOMETER", "JOINT 3 ELBOW-POTENTIOMETER", "JOINT 4 WRIST-POTENTIOMETER", "JOINT 5 TURRET-POTENTIOMETER")
ARTICULATION_DEVICE_ID	Specifies the abbreviated ID of the articulation device described by the containing group. An articulation device is anything that can move independently of the spacecraft to which it is attached, e.g. mast heads, wheel bogies, arms, etc.	string		“IDD”
ARTICULATION_DEVICE_MODE	Indicates the deployment state (i.e., physical configuration) of an articulation device at the time of data acquisition. For MER, this is the mode of the last move: FREE SPACE-IDD arm was moved where there was no contact with a target expected. GUARDED-IDD arm was moved where contact with the target was expected. RETRACTING-IDD arm was moved where an instrument is removed from a target. PRELOAD-IDD arm stays in contact with the target and applies force or overtravel on an instrument.	string		IDD 0="FREE SPACE", 1="GUARDED", 2="RETRACTING", 3="PRELOAD"
ARTICULATION_DEVICE_NAME	Specifies the common name of the articulation device described by the containing group. Note: The associated ARTICULATION_DEVICE_ID element provides an abbreviated name or acronym for the articulated device.	string		"INSTRUMENT DEPLOYMENT DEVICE"
ARTICULATION_DEVICE_TEMP	Provides the temperature, in degrees Celsius, of an articulated device or some part of an articulated device.	float array[2]	deg C (<degC> unit tag required)	-3.4e38 to 3.4e38
ARTICULATION_DEVICE_TEMP_NAME	An array of the formal names identifying each of the values used in ARTICULATION_DEVICE_TEMP.	string array[2]		("AZIMUTH JOINT 1", "TURRET JOINT 5")

Keyword Name	Definition	Type	Units	Valid Values
ARTICULATION_DEV_INSTRUMENT_ID	Provides an abbreviated name or acronym which identifies an instrument mounted on the articulation device.	string(12)		IDD 0 = "MI" 1 = "RAT" 2 = "MB" 3 = "APXS"
ARTICULATION_DEV_VECTOR	Provides the direction and magnitude of an external force acting on the articulation device, in the rover's coordinate system at the time the pose was computed.	float array[3]		
ARTICULATION_DEV_VECTOR_NAME	Provides the formal name of the vector type of the articulation device.	string		"GRAVITY"
COMMAND_SEQUENCE_NUMBER	Provides a numeric identifier for a sequence of commands sent to a spacecraft or instrument. Note: For MER, this is the command number which identifies the specific generating command within the specified sequence.	integer		
CONTACT_SENSOR_STATE	An array of identifiers for the state of an instrument's or instrument host's contact sensors at a specified time. For MER, "CONTACT" or "NO CONTACT" for most values. For the value corresponding to APXS DOOR SWITCH (entry 7), values are "OPEN" or "CLOSED".	string array[8]		0="NO CONTACT" or "CLOSED" 1="CONTACT" or "OPEN" "CONTACT" or "NO CONTACT" for all array positions except for position 7, which would be "OPEN" or "CLOSED"
CONTACT_SENSOR_STATE_NAME	An array of the formal names identifying each of the values used in CONTACT_SENSOR_STATE.	string array[8]		("MI SWITCH 1", "MI SWITCH 2", "RAT SWITCH 1", "RAT SWITCH 2", "MB SWITCH 1", "MB SWITCH 2", "APXS DOOR SWITCH", "APXS CONTACT SWITCH")

Keyword Name	Definition	Type	Units	Valid Values
COORDINATE_SYSTEM_INDEX	Instance of the coordinate frame in which the values herein are expressed. This is a group of integers that can be used to record and track the movement of a rover during surface operations. When in a COORDINATE_SYSTEM_STATE group, this keyword identifies which instance of the coordinate frame named by COORDINATE_SYSTEM_NAME is being defined by the group. This index is a set of integers which serve to identify coordinate system instances in a mission-specific manner. For MER, the indices are based on the ROVER_MOTION_COUNTER. This counter is incremented each time the rover moves (or may potentially have moved, e.g. due to arm motion). The full counter may have up to 5 values (SITE, DRIVE, IDD, PMA, HGA), but normally only the first value (for SITE frames) or the five values (for LOCAL_LEVEL or ROVER frames) are used for defining coordinate system instances. It is legal to use any number of indices to describe a coordinate system instance, however. Example: COORDINATE_SYSTEM_INDEX = (1,3,2,3,2)	integer array[5]		
COORDINATE_SYSTEM_INDEX_NAME	An array of the formal names identifying each integer specified in COORDINATE_SYSTEM_INDEX.	string array[6]		("SITE", "DRIVE", "IDD", "PMA", "HGA")
COORDINATE_SYSTEM_NAME	Provides the full name of the coordinate system to which the state vectors are referenced. When in a COORDINATE_SYSTEM_STATE group, this keyword provides the full name of the coordinate system being defined by the group. The rest of the keywords in the group describe how this coordinate system is related to some other (the "reference"). Non-unique coordinate systems (such as "SITE" for rover missions), which have multiple instances using the same name, also require COORDINATE_SYSTEM_INDEX to completely identify the coordinate system.	string(30)		"ROVER_FRAME", "SITE_FRAME", "MAST_FRAME", "LOCAL_LEVEL_FRAME", <u>IDD only</u> 0="MI_FRAME" 1="RAT_FRAME" 2="MB_FRAME" 3="APXS_FRAME",

Keyword Name	Definition	Type	Units	Valid Values
DATA_SET_ID	A unique alphanumeric identifier for a data set or a data product. The DATA_SET_ID value for a given data set or product is constructed according to flight project naming conventions. In most cases the DATA_SET_ID is an abbreviation of the DATA_SET_NAME. Note: In the PDS, the values for both DATA_SET_ID and DATA_SET_NAME are constructed according to standards outlined in the Standards Reference.	string(40)		
EARTH_RECEIVED_START_TIME	Provides the beginning time at which telemetry was received during a time period of interest. This should be represented in UTC system format.	datetime		YYYY-MM-DDThh:mm:ss[.fff]
EARTH_RECEIVED_STOP_TIME	Provides the ending time for receiving telemetry during a time period of interest. This should be represented in UTC system format.	datetime		YYYY-MM-DDThh:mm:ss[.fff]
EXPECTED_PACKETS	Provides the total number of telemetry packets which constitute a complete data product, i.e., a data product without missing data. For MER, “Packets” are also referred to as “Parts”.	integer		
FILE_RECORDS	Indicates the number of physical file records, including both label records and data records. Note: In the PDS the use of FILE_RECORDS along with other file-related data elements is fully described in the Standards Reference.	integer		256 or 512
INSTRUMENT_HOST_ID	Provides a unique identifier for the host where an instrument is located. This host can be either a spacecraft or an earth base (e.g., and observatory or laboratory on the earth). Thus, INSTRUMENT_HOST_ID can contain values which are either SPACECRAFT_ID values or EARTH_BASE_ID values.	string(6)		**SCID** **Keyword Values** 253 “MER1” 254 “MER2” 253 “SIM1” 255 “SIM2”
INSTRUMENT_HOST_NAME	Provides the full name of the host on which an instrument is based. This host can be either a spacecraft or an earth base. Thus, the INSTRUMENT_HOST_NAME element can contain values which are either SPACECRAFT_NAME values or EARTH_BASE_NAME values.	string		“MARS EXPLORATION ROVER 1” “MARS EXPLORATION ROVER 2” “SIMULATED MARS EXPLORATION ROVER 1” “SIMULATED MARS EXPLORATION ROVER 2”
INSTRUMENT_ID	Provides an abbreviated name or acronym which identifies an instrument. Note: INSTRUMENT_ID is not a unique identifier for a given instrument. Note also that the associated INSTRUMENT_NAME element provides the full name of the instrument.	string(12)		IDD 29 = "MI" 34 = "RAT" 33 = "MB" 32 = "APXS"

Keyword Name	Definition	Type	Units	Valid Values
INSTRUMENT_TYPE	Identifies the type of an instrument. Example values: POLARIMETER, RADIOMETER, REFLECTANCE SPECTROMETER, VIDICON CAMERA.	string		"SPECTROMETER"
INSTRUMENT_VERSION_ID	Identifies the specific model of an instrument used to obtain data. For example, this keyword could be used to distinguish between an engineering model of a camera used to acquire test data, and a flight model of a camera used to acquire science data during a mission.	string(8)		"FM1", "FM2", "QM"
LOCAL_TRUE_SOLAR_TIME	Local true solar time, or LTST, is one of two types of solar time used to express the time of day at a point on the surface of a planetary body. LTST is measured relative to the true position of the Sun as seen from a point on the planet' s surface. The coordinate system used to define LTST has its origin at the center of the planet. Its Z- axis is the north pole vector (or spin axis) of the planet. The X- axis is chosen to point in the direction of the vernal equinox of the planet' s orbit. (The vernal or autumnal equinox vectors are found by searching the planetary ephemeris for those times when the vector from the planet' s center to the Sun is perpendicular to the planet' s north pole vector. The vernal equinox is the time when the Sun appears to rise above the planet' s equator.) Positions of points in this frame can be expressed as a radius and areocentric ' right ascension' and ' declination' angles. The areocentric right ascension angle, or ARA, is measured positive eastward in the equatorial plane from the vernal equinox vector to the intersection of the meridian containing the point with the equator. Similarly, the areocentric declination is the angle between the equatorial plane and the vector to the point. LTST is a function of the difference between the ARAs of the vectors to the Sun and to the point on the planet' s surface. Specifically, LTST = (a(P) – a(TS)) * (24 / 360) + 12 where, LTST = the local true solar time in true solar hours a(P) = ARA of the point on the planet' s surface in deg a(TS) = ARA of the true sun in deg	string(12)		NOTE: Value will be uncalibrated if SPICE kernels are unavailable.

Keyword Name	Definition	Type	Units	Valid Values
MAGNET_ID	Identifies a magnet instrument that is visible in an image or observation.	string		"N/A", "CAPTURE", "FILTER", "UNK"
MISSION_NAME	Identifies a major planetary mission or project. A given planetary mission may be associated with one or more spacecraft. Note that mosaics may contain more than one value in an array.	string		"MARS EXPLORATION ROVER"
MISSION_PHASE_NAME	Provides the commonly-used identifier of a mission phase.	string(30)		" "PRIMARY MISSION", "TBD"
OBSERVATION_ID	Uniquely identifies a scientific observation within a data set. It is set via the data product context ID - which doesn't necessarily map to a specific object - it's just used to group various instrument data sets together via a common keyword.	string		
ORIGIN_OFFSET_VECTOR	Specifies the offset from the reference coordinate system's origin to the origin of the coordinate system being defined by the enclosing COORDINATE_SYSTEM_STATE group. In other words, it is the location of the current system's origin as measured in the reference system. Example for MER: In the case of the PMA_COORDINATE_SYSTEM group, ORIGIN_OFFSET_VECTOR describes the rotation fo the PMA (camera head) boresight (about the ORIGIN_OFFSET_VECTOR) relative to the Rover frame.	float array[3]	meters	

Keyword Name	Definition	Type	Units	Valid Values
ORIGIN_ROTATION_QUATERNION	Provides an array of four values that specifies the rotation of the coordinate system being defined by the enclosing COORDINATE_SYSTEM_STATE group, relative to the reference system. Mathematically this can be expressed as follows: Given a vector expressed in the current frame, multiplication by this quaternion will give the same vector as expressed in the reference frame. Quaternions are expressed as a set of four numbers in the order (s, v1, v2, v3), where s = cos(theta/2) v(n) = sin(theta/2)*a(n). theta = the angle of rotation a = the (x,y,z) vector around which the rotation occurs. For MER, the value for ORIGIN_ROTATION_QUATERNION that defines a coordinate frame like Rover frame is computed with respect to only the orientations of the frame's axes… regardless of whether POSITVE_ELEVATION_DIRECTION is declared to be "UP" or "DOWN" Example for MER In the case of the PMA_COORDINATE_SYSTEM group, ORIGIN_OFFSET_VECTOR describes the rotation of the PMA (camera head) boresight (about the ORIGIN_OFFSET_VECTOR) relative to the Rover frame.	float array[4]		
PACKET_MAP_MASK	A binary or hexadecimal number identifying which of a data file's expected packets were actually received. The digits correspond positionally with the relative packet numbers of the data file. The bits are to be read left to right; i.e., the first (left-most) digit of the number corresponds to the first packet of the data file. A bit value of 1 indicates that the packet was received; a value of 0 indicates that it was not received. The number is stored in the PDS radix notation of <radix>#<value>#.	non-decimal		

Keyword Name	Definition	Type	Units	Valid Values
PDS_VERSION_ID	Represents the version number of the PDS standards document that is valid when a data product label is created. Values for the PDS_version_id are formed by appending the integer for the latest version number to the letters 'PDS'. Examples: PDS3, PDS4.	string(6)		"PDS3"
PLANET_DAY_NUMBER	Indicates the number of sidereal days (rotation of 360 degrees) elapsed since a reference day (e.g., the day on which a landing vehicle set down). Days are measured in rotations of the planet in question from the reference day (which is day zero).	integer		NOTE: Value will be uncalibrated if SPICE kernels are not available.
POSITIVE_AZIMUTH_DIRECTION	Provides the direction in which azimuth is measured in positive degrees for an observer on the surface of a body. The azimuth is measured with respect to the elevational reference plane. A value of CLOCKWISE indicates that Azimuth is measured positively Clockwise, and COUNTERCLOCKWISE indicates that Azimuth increases positively Counter-clockwise.	string		"CLOCKWISE", "COUNTERCLOCKWISE"
POSITIVE_ELEVATION_DIRECTION	Provides the direction in which elevation is measured in positive degrees for an observer on the surface of a body. The elevation is measured with respect to the azimuthal reference plane. A value of UP indicates that elevation is measured positively upwards, i.e., the zenith point would be at +90 degrees and the nadir point at -90 degrees. DOWN indicates that the elevation is measured positively downwards; the zenith point would be at -90 degrees and the nadir point at +90 degrees. For MER, which follows the Mars Pathfinder convention, increasing elevation ("UP") moves towards the negative Z axis.	string		"UP", "DOWN"
PRODUCER_INSTITUTION_NAME	Identifies a university, research center, NASA center or other institution associated with the production of a data set. This would generally be an institution associated with the element PRODUCER_FULL_NAME.	string(60)		
PRODUCT_CREATION_TIME	Defines the UTC system format time when a product was created. Formation rule: YYYY-MM-DDThh:mm:ss[.fff]	string		
PRODUCT_ID	Represents a permanent, unique identifier assigned to a data product by its producer. See also: source_product_id. Note: In the PDS, the value assigned to product_id must be unique within its data set.	string(40)		Filename less the extension
PRODUCT_TYPE	Identifies the type or category of a data product within a data set.	string(8)		

Keyword Name	Definition	Type	Units	Valid Values
QUATERNION_MEASUREMENT_METHOD	Specifies the quality of the rover orientation estimate. “UNKNOWN” - The attitude should simply not be trusted. This is the initial grade given on Landing, for example. “TILT_ONLY” - The attitude estimate is only good for tilt determination (2-axis knowledge). Activities which require azimuth knowledge should be careful. “COARSE” - The attitude estimate is "complete" (it has all three axes) but is crude. This can occur because a sungaze has not yet been performed or because some event (such as traverses or IDD activity) have reduced the quality of the estimate (a.k.a. “ThreeAxisCoarse”). “FINE” - Sungaze completed successfully, and the attitude estimate is sufficient for pointing HGA (a.k.a. “ThreeAxisFine”).	string		0 = “UNKNOWN” 1 = “TILT_ONLY” 2 = “COARSE” 3 = “FINE”
RECEIVED_PACKETS	Provides the total number of telemetry packets which constitute a reconstructed data product.	integer		
RECORD_TYPE	Indicates the record format of a file. Note: In the PDS, when record_type is used in a detached label file it always describes its corresponding detached data file, not the label file itself. The use of record_type along with other file-related data elements is fully described in the PDS Standards Reference.	string(20)		“STREAM”

Keyword Name	Definition	Type	Units	Valid Values
REFERENCE_COORD_SYSTEM_INDEX	Identifies which instance of the coordinate system named by REFERENCE_COORD_SYSTEM_NAME is the reference coordinate system for the group in which the keyword occurs. This index is a set of integers which serve to identify coordinate system instances in a mission-specific manner. For MER, the indices are based on the ROVER_MOTION_COUNTER. This counter is incremented each time the rover moves (or may potentially have moved, e.g. due to arm motion). The full counter may have up to 5 values (SITE, DRIVE, IDD, PMA, HGA), but normally only the first value (for SITE frames) or the first two values (for LOCAL_LEVEL or ROVER frames) are used for defining reference coordinate system instances. It is legal to use any number of indices to describe a reference coordinate system instance, however. See also REFERENCE_COORD_SYSTEM_NAME and COORDINATE_SYSTEM_INDEX.	integer array[5]		
REFERENCE_COORD_SYSTEM_NAME	Provides the full name of the reference coordinate system for the group in which the keyword occurs. All vectors and positions relating to 3-D space within the enclosing group are expressed using this reference coordinate system. Non-unique coordinate systems (such as "SITE" for rover missions), which have multiple instances using the same name, also require REFERENCE_COORD_SYSTEM_INDEX to completely identify the reference coordinate system. For MER, the reference is usually a SITE frame.	string(20)		"ROVER_FRAME", "SITE_FRAME", "MAST_FRAME", “LOCAL_LEVEL_FRAME”,
RELEASE _ID	Unique identifier associated with the release to the public of all or part of a data set. The first release of a data set should have a RELEASE_ID of “0001” When a data set is released incrementally, such as every three months during a mission, the RELEASE_ID is updated each time part of the data set is released. For each Rover mission, the first release of a data set should have a value of “0001”	string		

Keyword Name	Definition	Type	Units	Valid Values
ROVER_MOTION_COUNTER	A set of integers which describe a (potentially) unique location (position/orientation) for a rover. Each time something happens that moves, or could potentially move, the rover, a new motion counter value is created. This includes intentional motion due to drive commands, as well as potential motion due to other articulating devices, such as arms or antennae. This motion counter (or part of it) is used as a reference to define instances of coordinate systems which can move such as SITE or ROVER frames. The motion counter is defined in a mission-specific manner. Although the original intent was to have incrementing indices (e.g. MER), the motion counter could also contain any integer values which conform to the above definition, such as time or spacecraft clock values. For MER, the motion counter consists of five values. In order, they are Site, Drive, IDD, PMA, and HGA. The Site value increments whenever a new major Site frame is declared. The Drive value increments any time intentional driving is done. Each of those resets all later indices to 0 when they increment. The IDD, PMA, and HGA increment whenever the corresponding articulation device moves. It is TBD whether IDD, PMA, and HGA are independent of each other, or reset the others to 0 in a hierarchical manner when they are incremented.	integer array[5]		
ROVER_MOTION_COUNTER_NAME	An array that provides the formal names identifiying each integer in ROVER_MOTION_COUNTER.	string array[5]		("SITE", "DRIVE", "IDD", “PMA”, “HGA”)
SAMPLING_COUNT	The sampling_count element provides the number of data samples taken by an instrument or detector.	integer		
SEQUENCE_ID	Provides an identification of the spacecraft sequence associated with the given product. This element replaces the older seq_id, which should no longer be used.	string(30)		
SEQUENCE_VERSION_ID	Provides the version identifier for a particular observation sequence used during planning or data processing.	string(30)		
SOURCE_PRODUCT_ID	The unique identifier for the source data product used to generate a derived product. See also: product_id.	string		
SPACECRAFT_CLOCK_CNT_PARTITION	Indicates the clock partition active for the SPACECRAFT_CLOCK_START_COUNT and SPACECRAFT_CLOCK_STOP_COUNT elements.	integer		1

Keyword Name	Definition	Type	Units	Valid Values
SPACECRAFT_CLOCK_START_COUNT	Provides the value of the spacecraft clock at the beginning of a time period of interest. Format is dddddddddd.ddd, measured in units of seconds and stored internally as a floating point number.	string(30)		
SPACECRAFT_CLOCK_STOP_COUNT	Provides the value of the spacecraft clock at the end of a time period of interest. Format is dddddddddd.ddd, measured in units of seconds and stored internally as a floating point number.	string(30)		
SPICE_FILE_NAME	Provides the names of the SPICE files used in processing the data. For Galileo, the SPICE files are used to determine navigation and lighting information.	string (180)		
START_TIME	Provides the date and time of the beginning of an event or observation (whether it be a spacecraft, ground-based, or system event) in UTC system format. Formation rule: YYYY-MM-DDThh:mm:ss[.fff]	string		
STOP_TIME	Provides the date and time of the beginning of an event or observation (whether it be a spacecraft, ground-based, or system event) in UTC system format. Formation rule: YYYY-MM-DDThh:mm:ss[.fff]	string		
TARGET_NAME	Identifies a target. The target may be a planet, satellite, ring, region, feature, asteroid or comet. See TARGET_TYPE.	string(30)		“MARS”, “CALIBRATION”
TARGET_TYPE	Identifies the type of a named target.	string		“CALIBRATION”, “DUST”, “N/A”, “SUN”, “PLANET”
TELEMETRY_FORMAT_ID	A telemetry format code	string(3)		MB 120=ALL (ALL BLOCKS) 121=BK1 (BLOCK1) 122=BK2 (BLOCK2) 123=BK3 (BLOCK3) 124=BK4 (BLOCK4) 125=BK5 (BLOCK5)
TELEMETRY_PROVIDER_ID	Identifies the provider and version of the telemetry data used in the generation of this data.	string		“SSW MER_DP” TTACS
TELEMETRY_SOURCE_NAME	Identifies the name the source of the telemetry source used in the creation of this data set.	string		
TELEMETRY_SOURCE_TYPE	Classifies the source of the telemetry used in creation of this data set.	string(12)		“DATA PRODUCT”, SFDU
TLM_INST_DATA_HEADER_ID	Indicates the version of the instrument specific information provided with telemetry data products. Incremented by FSW whenever there is a change to the header structure.	Integer		