

Mars Exploration Rover (MER)

Software Interface Specification

Interface Title: **RAT Experiment Data Record (EDR)**

Mission: MER Date: July 31, 2004

Module ID: SIS-SCI010-MER

Module Type (REFerence Only or MISsion-specific info included): MIS

Reference Module ID: N/A

Date: N/A

Signatures

GDS Generating Elements:

Ops Product Generation Subsystem (OPGS)
Justin Maki

Subsystem Engineer Date

GDS Receiving Elements:

MER GDS SOAS Subsystem Engineer
Deborah Bass

Subsystem Engineer Date

Concurrence:

RAT Payload Element Lead
Kiel Davis

PEL Date

MER RAT Investigation Scientist
Robert Anderson

Investigation Scientist Date

MER Science Manager
John Callas

Manager Date

PDS Central Node Data Engineer
Betty Sword

Data Engineer Date

MER MIPL Cognizant Engineer
Doug Alexander

Cognizant Engineer Date

GDS:

Ground Data System (GDS)
GDS SE

Frank Singleton Date

Mars Exploration Rover (MER) Project

Rock Abrasion Tool (RAT) EDR Software Interface Specification (SIS)

Version 1.01

Prepared by:
Susan Slavney
Helen Mortensen

Paper copies of this document may not be current and should not be relied on for official purposes. The current version is in the MER Project Library at <http://mars03-lib.jpl.nasa.gov>, in the Controlled Documents and Records folder.

JPL D-22850

July 31, 2004



Jet Propulsion Laboratory
California Institute of Technology

CHANGE LOG

DATE	SECTIONS CHANGED	REASON FOR CHANGE	REVISION
9/15/01	All	First draft	Draft
4/10/02	All	Many TBDs filled in; changed product storage format from ASCII to binary	Draft
5/16/02	Running header	Added JPL-D and SIS numbers	Draft
5/16/02	2.5 Data Validation	Added text provided by MIPL	Draft
6/13/02	Appendix A	Revised PDS Label provided by MIPL	Draft
7/31/02	Table 2, Columns in RAT EDR Table	Revised table provided by Bob Anderson	V 1.0
7/31/02	2.3.4 Labeling and Identification	File naming scheme revised to be compatible with Pancam scheme	V 1.0
7/31/02	Appendix A	Revised PDS Label provided by MIPL.	V 1.0
7/31/02	Appendix B	Keyword definitions provided by MIPL	V 1.0
8/26/02	Table 3, Columns in RAT EDR Table	Some revised definitions provided by Bob Steinke	V 1.0
8/26/02	Appendix A	Corrections to PDS Label by Betty Sword	V 1.0
1/22/03	All	Update reflect decision to not support multiple instances of groups, support unique group names, use a Data Product as the input to mertelemproc, update the filenaming convention, and update to the latest RAT format.	V 1.0
1/22/03	1.4	Remove APSS dependencies.	V 1.0
1/24/03	Appendix A & B	Fix typos and valid values.	V1.0
2/6/03	Cover, 3.1, 4.1, Appendix A & B	Change Title for PDS Data Engineer, Change caption of Figure 2 to one file, remove reference to RAT RDRs., add new RELEASE_ID keyword to PDS label and definitions.	V1.0
3/7/03	2.3.3, 2.3.4, 2.4.4, Appendix A and B	Updates from SIS review. Added "prod" values, updated "seq" definition, "who" values. Updated label example and add units where possible, removed PRODUCER_ID keyword, changed COMMAND_NAME to COMMAND_OPCODE. Added Time Management FDD to reference documents. Changed MAXIMUM_LENGTH to MAXIMUM_TRAVEL_DISTANCE per PDS request. Changed Z_AXIS_LENGTH to Z_AXIS_DISTANCE. Added MAXIMUM_CURRENT_PERSISTENCE. File naming convention site and pos updated	V1.0
3/28/03	Appendix A & B	STOP and START_TIME, PRODUCT_VERSION_ID updates.	1.0

6/16/03	2.3.4, 3.1, Appendix A & B	Updated filenaming convention. Updated label example and definitions. Removed SPICE_FILE_ID and INSTRUMENT_VERSION_ID.	1.0
10/7/03	Table 3, appendix A & B	Added status bytes for motor controllers. Added LOCAL_TRUE_SOLAR_TIME	1.0
10/14/03	2.3.4, Appendix A & B	Replace SPARE with status flags as requested.	1.0
10/31/03	Acronyms, Table 3, appendix A & B	Update butterfly switch description. Update label and definitions.	1.0
11/5/03	Figure 1, Table 3, Appendix A	Update the Rover Coordinate System diagram and the sclk definitions in the table and the label.	1.0
7/31/04	Appendix A	<p>For archive data, added double quotes to RELEASE_ID, LOCAL_TRUE_SOLAR_TIME, OBSERVATION_ID, SEQUENCE_VERSION_ID, SPACECRAFT_CLOCK_START_COUNT, SPACECRAFT_CLOCK_STOP_COUNT.</p> <p>Removed double quotes from PRODUCT_CREATION_TIME, START_TIME, STOP_TIME, EARTH_RECEIVED_START_TIME, EARTH_RECEIVED_STOP_TIME.</p> <p>Added OPS to DATA_SET_ID.</p>	1.01

TBD ITEMS

SECTION	DESCRIPTION	RESPONSIBILITY
1.3 Applicable Documents and Constraints	Add references to papers describing the RAT, if any.	RAT Team

CONTENTS

CHANGE LOG	iii
TBD ITEMS	v
CONTENTS	vi
TABLES	vii
FIGURES	vii
ACRONYMS	viii
1. INTRODUCTION	1
1.1 Purpose and Scope	1
1.2 Contents	1
1.3 Applicable Documents and Constraints	1
1.4 Relationships with Other Interfaces	2
2. Data Product Characteristics and Environment	2
2.1 Instrument Overview	2
2.2 Data Product Overview	2
2.3 Data Processing	3
2.3.1 Data Processing Level	3
2.3.2 Data Product Generation	3
2.3.3 Data Flow	4
2.3.4 Labeling and Identification	4
2.4 Standards Used in Generating Data Products	6
2.4.1 PDS Standards	6
2.4.2 Time Standards	7
2.4.3 Coordinate Systems	7
2.4.4 Data Storage Conventions	8
2.5 Data Validation	8
3. Detailed Data Product Specifications	9
3.1 Data Product Structure, Organization, and Format.....	9
3.2 Data Format Descriptions	9
3.3 Label and Header Descriptions.....	12
3.3.1 PDS Label	12
3.3.2 PDS Table Object	12
4. Applicable Software	12
4.1 Utility Programs	12
4.2 Applicable PDS Software Tools	13
4.3 Software Distribution and Update Procedures	13
Appendix A – Example RAT EDR Label.....	14
Appendix B – PDS LABEL KEYWORDS.....	27

TABLES

Table 1. Processing Levels for Science Data Sets..... 3
Table 2. Coordinate Frames Used for MER Surface Operations 7
Table 3. Columns in a RAT EDR Table..... 9

FIGURES

Figure 1. S, S_R, and R Frame Coordinate Systems..... 8
Figure 2: The RAT EDR consists of one file..... 9

ACRONYMS

ASCII	American Standard Code for Information Interchange
APSS	Activity Planning and Sequencing Subsystem
CODMAC	Committee on Data Management and Computation
DVT	Data Validity Time
EDR	Experiment Data Record
FDD	Functional Design Document
FEI	File Exchange Interface
ICD	Interface Control Document
IDD	Instrument Deployment Device
JPL	Jet Propulsion Laboratory
MER	Mars Exploration Rover
MIPL	Multimission Image Processing Laboratory
NASA	National Aeronautics and Space Administration
ODL	Object Description Language
OPGS	Operations Product Generation Subsystem
OSS	Operations Storage Server
PDS	Planetary Data System
PEL	Payload Element Lead
PPPCS	Pointing, Positioning, Phasing, & Coordinate systems
PSICLOPS	Petrologic Surface Interaction Correlation Library for Operations Planning and Science
RAM	Random Access Memory
RAT	Rock Abrasion Tool
RDR	Reduced Data Record
RSVP	Rover Sequence and Visualization Program
SAP	Science Activity Planner
SFDU	Standard Formatted Data Unit
SIS	Software Interface Specification
SOAS	Science Operations Analysis Subsystem
SPICE	Spacecraft, Planet, Instrument, C-matrix, and Events
SSW	System Software – GDS Team
TBD	To Be Determined
TDS	Telemetry Delivery Subsystem
VICAR	Video Image Communication and Retrieval system

1. INTRODUCTION

1.1 Purpose and Scope

The purpose of this Data Product SIS is to provide users of the Rock Abrasion Tool (RAT) Experiment Data Record (EDR) with a detailed description of the product and a description of how it was generated, including data sources and destinations. The RAT EDR is a time-ordered table of currents, temperatures, and encoder values associated with a deployment of the RAT on a target. This SIS is intended to provide enough information to enable users to read and understand the data product. 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 RAT EDR is acquired by the RAT instrument, and how it is processed, formatted, labeled, and uniquely identified. The document discusses standards used in generating the product and software that may be used to access the product. The data product structure and organization is described in sufficient detail to enable a user to read the product. Finally, an example of a product label is provided.

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 and S. Slavney, Rev. 2, Nov. 2, 2000.
2. Mars Exploration Rover Project Archive Generation, Validation and Transfer Plan, R. E. Arvidson and S. Slavney, JPL D-19658, January 2, 2001.
3. MER Flight-Mission Systems ICD (FMICD), Vol. 4 Command Dictionary, MER 420-3-15.04, JPL D-20616.
4. MER Flight-Mission Systems ICD (FMICD), Vol. 7 Telemetry Dictionary, MER 420-3-15.07, JPL D-20617.
5. Pointing, Positioning, Phasing & Coordinate Systems Master (PPPCS), S. R. Doudrick, JPL D-19720, June 28, 2001.
6. MER Flight Systems Functional Design Description (FDD), Volume 5:Time Management/Recovery, MER 420-8-534.05, JPL D-22431

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

7. Planetary Data System Data Preparation Workbook, Version 3.1, JPL D-7669, Part 1, February 1, 1995.
8. Planetary Data System Data Standards Reference, Version 3.6, JPL D-7669, Part 2, August 1, 2003.
9. Planetary Science Data Dictionary Document, JPL D-7116, August 28, 2002.

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

1.4 Relationships with Other Interfaces

Changes to this RAT EDR SIS document affect the following products, software, and/or documents.

Name	Type P=product S=software D=document	Owner
RAT EDRs	P	OPGS/MIPL
mertelemproc	S	MIPL
MIPL database schema	P	MIPL
RATDAT	S	RAT Science Team
PSICLOPS	P	RAT Science Team

2. DATA PRODUCT CHARACTERISTICS AND ENVIRONMENT

2.1 Instrument Overview

The Rock Abrasion Tool is one of four instruments deployed by the rover instrument arm. When positioned against a rock by the arm, the RAT uses a pair of diamond-tipped grinding wheels to remove dust and weathered rock, exposing fresh rock underneath. The RAT exposes an area 4.5 cm in diameter, and can grind down to a depth of at least 0.5 cm.

The RAT has three actuators. One causes each of two grinding wheels to rotate at high speeds. Each of these grinding wheels has two teeth, which cut out a circular area associated with each grinding head as the head rotates. A second actuator causes the two grinding wheels to revolve around one another at a much slower rate, sweeping the two circular cutting areas around the full 4.5-cm diameter cutting region. Finally, a third “z-axis” actuator translates the entire cutting head toward the rock, causing it to penetrate to the commanded depth. Encoders monitor penetration progress and allow closed-loop control of the grinding process. During the operation of the RAT, the rover will monitor currents, temperatures, and encoder readouts for all three RAT actuators. These data can be used to infer information about the strength properties of the rocks that have undergone grinding.

2.2 Data Product Overview

A RAT EDR is a time-ordered table of actuator current measurements, temperatures, and encoder values recorded during a single RAT deployment. The table is stored in a file as binary data with a PDS label attached to the beginning of the file.

2.3 Data Processing

2.3.1 Data Processing Level

This documentation uses the “Committee On Data Management And Computation” (CODMAC) data level numbering system. The data files referred to in this document are considered “level 2” or “Edited Data” (equivalent to NASA level 0). The data files are generated from level 1 or “Raw Data” which are the telemetry packets within the Project-specific Standard Formatted Data Unit (SFDU) record. Refer to Table 1.

2.3.2 Data Product Generation

RAT EDRs will be generated by the MIPL (Multimission Image Processing Laboratory) under the OPGS using the telemetry processing software “mertelemproc” at JPL. The EDRs produced will be raw uncalibrated data reconstructed from telemetry data products and formatted according to this EDR SIS. Meta-data acquired from the telemetry data headers and a meta-data database will be used to propagate the PDS label. There will not be multiple versions of a RAT EDR. If telemetry packets are missing during the initial downlink, the missing data will be identified and reported for retransmission of the data to the ground. The data will be reprocessed after all data is received and the original version will be overwritten.

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).
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.

2.3.3 Data Flow

The RAT EDRs are generated by MIPL from telemetry data products from the MER Project SSW team, and SPICE kernels. The EDRs are created and stored on the MER Operations Storage Server (OSS) and then deposited into MIPL's File Exchange Interface (FEI) server for electronic distribution to remote sites via a secure subscription protocol. After a data validation period, the EDRs are collected with other science data and written to physical media for archiving with the Planetary Data System by MIPL.

The size of a RAT EDR is 2.5 MB. The total estimated volume of the RAT EDRs over the course of the MER mission is 15-20 MB. The RAT EDR will be generated 60 seconds after the data product for the EDR has been received by MIPL from the MER OSS. The RAT data will be reprocessed only if packets in the original downlink are not received. The RAT EDR will be reprocessed after all data is retransmitted and received and the original version will be overwritten and placed into FEI for distribution.

2.3.4 Labeling and Identification

There is a file naming scheme adapted for the MER image and non-image data products. The scheme applies to the EDR and several RDR data products. The file naming scheme adheres to the 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 camera event, 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 RAT EDR has an attached PDS label associated with the RAT binary data file. The file naming scheme for the RAT EDR and 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 values for MER instruments:

"A" - APXS

"T" - Mini-TES

"B" - Mössbauer

"D" - RAT ("D" for Drill)

Valid values for MER camera instruments not described in this SIS:

"P" - Pancam

"R" - Rear Hazcam

"N" - Navcam

"M" - Microscopic Imager

"F" - Front Hazcam

"E" - EDLcam

sclk = (9 integers) Spacecraft Clock time of the DVT (Data Validity 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. All product types that end with "C" denote CAHV-linearization.

Valid values for MER non-camera instrument products:

Data Product	Value
APXS/Mini-TES/MB/RAT Detailed Report EDR	"EDR"
RAT Anomaly Report EDR	"EAR"
RAT Parameter EDR	"EDP"
Mini-TES Spectra Emissivity Image Cube	"EMS"
Mini-TES Mineral Abundance Image or Map	"MIN"
Mini-TES Data Cube (general)	"QUB"
APXS/MB Spectra	"SPE"
APXS/MB table on concentrations and components	"TBL"
Mini-TES Temperature and Thermal Inertia Map	"TTH"

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 Identifier. 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:

0000 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 "P0268".

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", 1 thru 8 are valid filter positions).

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" - MIPL (OPGS) at JPL
- "N" - NASA Ames Research (L. Edwards)
- "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 bookkeeping.

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 MER non-camera instrument products:

- "QUB" - Mini-TES Data Cube
- "DAT" - APXS spectra, Mössbauer spectra, RAT binary data
- "TAB" - APXS table data, Mössbauer table data
- "LBL" - Detached PDS labels for APXS and Mössbauer data.

Example:

- a) 1D123456789EDR0103P0062N0M1.DAT Rover MER-1, RAT instrument, EDR, Site 01, Position 03,
Seq P0062, produced by MIPL, product version 1.

2.4 Standards Used in Generating Data Products

2.4.1 PDS Standards

The RAT EDR complies with Planetary Data System standards for file formats and labels, as specified in the PDS Standards Reference [8].

2.4.2 Time Standards

The EDR PDS label uses keywords containing time values. Each time value standard is defined according to the keyword description. See Appendix B, PDS Label Items.

The time reference used in column 1 of the RAT data is the spacecraft clock count at the time of the beginning of a measurement. See MER FDD, Volume 5: Time Management/Recovery [7]

2.4.3 Coordinate Systems

The coordinate systems defined for MER surface operations are listed in Table 2 and illustrated in Figure 1 below. Refer to the Pointing, Positioning, Phasing and Coordinate Systems document [5] for more details.

Table 2. Coordinate Frames Used for MER Surface Operations

Imaging-Related Coordinate Systems		Coordinate System Origin	Coordinate System Orientation
Name	Label Keyword Value		
Lander Frame (L Frame)	"LANDER_FRAME"	Attached to Lander	Aligned with Lander
Mars Body Fixed (MBF)	does not appear in label	Attached to Mars center of Mass	x=equatorial plane, intersects the prime meridian, z= Mars spin axis, points toward the North pole, y completes the right-handed system
Mast Frame	"MAST_FRAME"	Attached to PMA mast head	Aligned with pointing of mast head
Pancam Frame	"PANCAM_FRAME"	Attached to Camera	Aligned with camera pointing
Rover Frame (R Frame)	"ROVER_FRAME"	Attached to Rover	Aligned with Rover
Surface (S_n Frame) (Site Frame)	"SITE_FRAME"	Attached to Surface	North/East/Nadir
Surface Rover (S_R Frame) (Local Level)	"LOCAL_LEVEL_FRAME"	Attached to Rover (coincident with Rover Frame)	North/East/Nadir

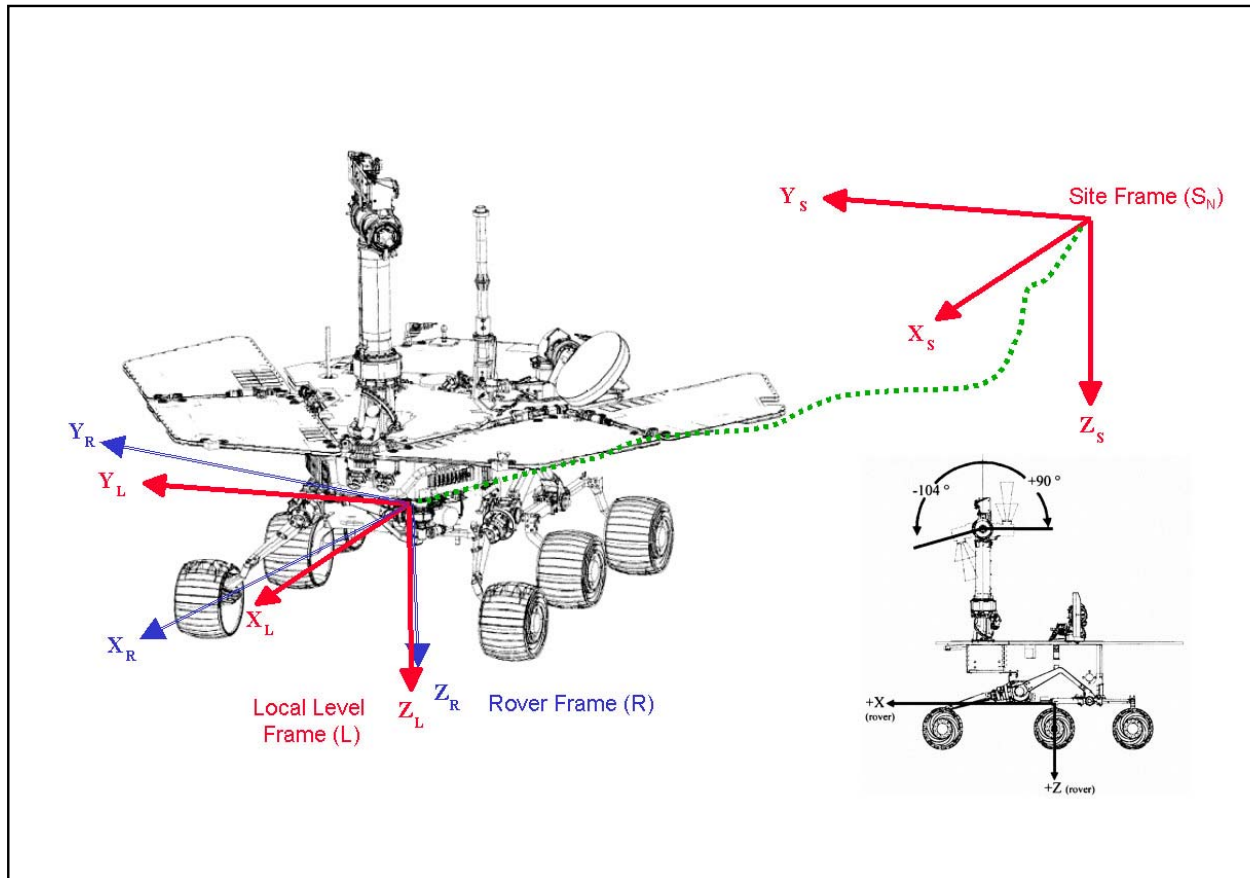


Figure 1. S , S_R , and R Frame Coordinate Systems

2.4.4 Data Storage Conventions

RAT EDR data are stored in binary files with fixed-length records. The attached PDS label is ASCII format. See Section 3.3.1 for more information on the PDS label.

2.5 Data Validation

Validation of the MER EDRs will fall into two primary categories: automated and manual. Automated validation will be performed on every EDR product produced for the mission. Manual validation will only be performed on a subset.

Automated validation will be performed as a part of the archiving process and will be done simultaneously with the archive volume validation. Validations performed will include such things as verification that the checksum in the label matches a calculated checksum for the data product (i.e., that the data product included in the archive is identical to that produced by the real-time process), a validation of the PDS syntax of the label, a check of the label values against the database and against the index tables included on the archive volume, and checks for internal consistency of the label items. The latter include such things as verifying that the product creation date is later than the earth received time, and comparing the geometry pointing

information with the specified target. As problems are discovered and/or new possibilities identified for automated verification, they will be added to the validation procedure.

Manual validation of the data will be performed both as spot-checking of data throughout the life of the mission and as comprehensive validation of a subset of the data (for example, a couple of days' worth of data). These products will be viewed by a human being. Validation in this case will include inspection of the data object for errors not specified in the label parameters, verification that the target shown / apparent geometry matches that specified in the label, verification that the product is viewable using the specified software tools, and a general check for any problems that might not have been anticipated in the automated validation procedure.

3. DETAILED DATA PRODUCT SPECIFICATIONS

3.1 Data Product Structure, Organization, and Format

The structure of the RAT EDR consists of an attached ASCII PDS label and a binary data file as shown in Figure 2. It should be noted that an EDR can be generated with only the PDS label. This will occur when only the telemetry header and no binary data is received.

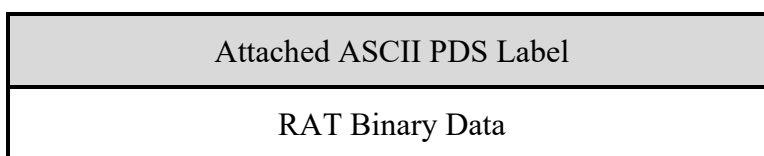


Figure 2: The RAT EDR consists of one file.

3.2 Data Format Descriptions

A RAT EDR data consists of a table of time-ordered current, encoder, and temperature measurements for the three RAT motors during a single RAT deployment. A RAT EDR covers a maximum time interval of 3 hours, and has a maximum sampling rate of 8 Hz. Both the sampling rate and time interval are commandable. Each RAT EDR is contained in a separate file. The file is binary with fixed-length records of 96 bytes, and with a PDS label in ASCII text attached to the beginning of the file. The maximum file size is 7.8 Mbytes.

Table 3 lists the columns in the EDR product. Appendix A gives an example of a PDS label for RAT data.

Table 3. Columns in a RAT EDR Table

	Column	Description	Units	Data Type	Bytes
1	SPACECRAFT CLOCK COUNT (seconds)	Spacecraft clock value.	Seconds	unsigned MSB integer	4
2	SPACECRAFT CLOCK COUNT (subseconds)	Spacecraft clock value.	subrti	unsigned MSB integer	2
3	SPARE	Spare bytes		MSB integer	2
4	ROTATION MOTOR	Angular position of the grinding wheel.	Radians	IEEE real	8

	Column	Description	Units	Data Type	Bytes
	POSITION				
5	ROTATION MOTOR CURRENT SENSOR	Rotation motor current.	Amps	IEEE real	8
6	REVOLUTION MOTOR POSITION	Angular position of the grinding stage.	Radians	IEEE real	8
7	REVOLUTION MOTOR CURRENT SENSOR	Revolution motor current.	Amps	IEEE real	8
8	Z MOTOR POSITION	Linear position of the grinding wheels.	Mm	IEEE real	8
9	Z MOTOR CURRENT SENSOR	Z-axis motor current.	Amps	IEEE real	8
10	TEMPERATURE SENSOR	Temperature reading from RAT PRT.	Degrees Celsius	IEEE real	8
11	BUTTERFLY SWITCH 1	Cumulative state word for butterfly switch #1 – add 1 if the switch is in the incorrect state and add 0 if the switch is in the correct state, updated at 8Hz.	Count	unsigned MSB integer	4
12	BUTTERFLY SWITCH 2	Cumulative state word for butterfly switch #2 – add 1 if the switch is in the incorrect state and add 0 if the switch is in the correct state, updated at 8Hz.	Count	unsigned MSB integer	4
13	RAT OVER CURRENT ALARM	Cumulative state word for rotate motor over current alarm – add 1 if over threshold, add 0 if not. Updated at 8Hz.	Count	unsigned MSB integer	4
14	Z-AXIS MOTOR CONTROLLER STATUS	BIT00=motor controller active BIT01=motor turning BIT02=motor not keeping up with commanded profile BIT03=motor stalled BIT04=motor H-bridge over temperature BIT05=motor controller enable BIT06=motor reached commanded position BIT07=awaiting Mini-TES sync pulse (should always be 0 for RAT)	N/A	N/A	1
15	REVOLVE MOTOR CONTROLLER STATUS	BIT00=motor controller active BIT01=motor turning BIT02=motor not keeping up with commanded profile BIT03=motor stalled BIT04=motor H-bridge over temperature BIT05=motor controller enable BIT06=motor reached commanded position BIT07=awaiting Mini-TES sync pulse (should always be 0 for RAT)	N/A	N/A	1
16	GRIND MOTOR CONTROLLER STATUS	BIT00=motor controller active BIT01=motor turning BIT02=motor not keeping up with commanded profile BIT03=motor stalled BIT04=motor H-bridge over temperature BIT05=motor controller enable BIT06=motor reached commanded position BIT07=awaiting Mini-TES sync pulse	N/A	N/A	1

	Column	Description	Units	Data Type	Bytes
		(should always be 0 for RAT)			
17	SPARE		N/A	N/A	1
18	ROVER BUS VOLTAGE	Rover bus voltage.	Volts	IEEE real	8
19	ALGORITHM STATE	Describes the current state of the RAT. Valid values are: 0=INACTIVE 1=AWAITING_INACTIVE 2=DEACTIVATING 3=IDLE 4=AWAITING_IDLE 5=STOPPING 6=DIAG_REQUESTING 7=DIAG_CALIBRATING 8=DIAG_HOMING 9=DIAG_COLLECTING_CURRENT 10=DIAG_COLLECTING_VOLTAGE 11=CAL_REQUESTING 12=CAL_CALIBRATING 13=CAL_HOMING 14=CAL_COLLECTING_CURRENT 15=CAL_COLLECTING_VOLTAGE 16=SEEK_SEEKING_REQUESTING 17=SEEK_SEEKING 18=SCAN_Z_STEPPING 19=SCAN_REVOLVING 20=GRIND_REQUESTING 21=GRIND_GRINDING 22=GRIND_Z_RETRACTING 23=GRIND_Z_EXTENDING 24=GRIND_DWELLING 25=BRUSH_REQUESTING 26=BRUSH_CALIBRATING 27=BRUSH_MOVING_Z 28=BRUSH_BRUSHING 29=MOVE_REQUESTING 30=MOVE_MOVING 31=HOMING 32=NO_FAULT 33=GRIND_DUMPING_DP 34=GRIND_RESUMING	N/A	unsigned MSB integer	4
20	ANOMALY FLAG	Describes the fault protection condition that may have ended the current command and produced an anomaly report. This is a bit mask where 1=TRUE, 0=FALSE. Bit fields are: BIT 0 = HBRIDGE_Z BIT 1 = HBRIDGE_REV BIT 2 = HBRIDGE_ROT BIT 3 = OVERHEAT_Z BIT 4 = OVERHEAT_REV BIT 5 = OVERHEAT_ROT BIT 6 = CSTALL_Z BIT 7 = CSTALL_REV BIT 8 = CSTALL_ROT BIT 9 = STALL_Z	N/A	MSB bit string	4

	Column	Description	Units	Data Type	Bytes
		BIT 10 = STALL_REV BIT 11 = STALL_ROT BIT 12 = POS_Z BIT 13 = CMAX_Z BIT 14 = CMAX_REV BIT 15 = CMAX_ROT BIT 16 = CONTACT BIT 17 = COMMAND_QUIT BIT 18 = MAXCUR – Motor Current exceeded maxcur argument. BIT 19 = ANOMALY_NOW – An anomaly has occurred in this sample. BIT 20 = ENCODER_STALL_ROT – encoder stall on the rotate motor.			

3.3 Label and Header Descriptions

3.3.1 PDS Label

A RAT EDR has a PDS label attached at the beginning of the data file. The label is ASCII text although the data in the file are stored as binary numbers. A PDS label is object-oriented and describes the objects in the data file. The PDS label contains keywords for product identification and for table definitions. The label also contains descriptive information needed to interpret or process the table data in the file.

PDS labels are written in Object Description Language (ODL) [8]. 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 file:

$$\text{^object} = \text{location}$$

where the carat character (^, also called a pointer) is followed by the name of the specific data object. The location is the starting record number for the data object within the file.

3.3.2 PDS Table Object

A RAT EDR consists of a data object described in the PDS label as a table. The table has **20** columns and a variable number of rows, one for each observation. Each row is 96 bytes long. The data in the table are stored as binary integers and real numbers. The PDS label defines the starting byte, number of bytes, and data type of each column.

4. APPLICABLE SOFTWARE

4.1 Utility Programs

RATDAT is a data analysis tool developed by the RAT Team at Honeybee Robotics. RATDAT will be used by the Team to generate “quick-look” data products so that RAT health and performance can be assessed in real time. RATDAT facilitates instrument health analysis by comparing downlinked RAT initialization data to calibration data. Real-time comparative

performance analysis is done using the searchable RAT grinding experiment data base, PSICLOPS (Petrologic Surface Interaction Correlation Library for Operations Planning and Science). PSICLOPS is a collection of derived data taken from pre-mission experiments, mission operations, and post-mission simulations. Both the calibration data and the PSICLOPS database are included in the PDS archive of RAT data products.

4.2 Applicable PDS Software Tools

PDS-labeled images and tables can be viewed with the program NASAView, developed by the PDS and available for a variety of computer platforms from the PDS web site <http://pdsproto.jpl.nasa.gov/Distribution/license.html>. There is no charge for NASAView.

4.3 Software Distribution and Update Procedures

RATDAT software will be included on RAT archive volumes and will be available for downloading from PDS web sites that distribute RAT data products.

APPENDIX A – EXAMPLE RAT EDR LABEL

```

PDS_VERSION_ID                = PDS3

/* FILE DATA ELEMENTS */

RECORD_TYPE                    = FIXED_LENGTH
RECORD_BYTES                   = 96
FILE_RECORDS                   = <TBD>
LABEL_RECORDS                  = 299

/* POINTERS TO DATA OBJECTS */

^TABLE                          = 300

/* IDENTIFICATION DATA ELEMENTS */

DATA_SET_ID                    = "MER2-M-RAT-2-EDR-V1.0"
PRODUCT_ID                     = "2D128573892EAR0023D2520N0M1"
PRODUCT_TYPE                   = RAT_EDR
PRODUCT_VERSION_ID             = "V1.0 D-22850"
RELEASE_ID                     = "0001"
ROVER_MOTION_COUNTER           = (0, 25, 54, 141, 70)
ROVER_MOTION_COUNTER_NAME      = (SITE, DRIVE, IDD, PMA, HGA)
COMMAND_SEQUENCE_NUMBER       = 4
INSTRUMENT_HOST_ID            = MER2
INSTRUMENT_HOST_NAME          = "MARS EXPLORATION ROVER 2"
INSTRUMENT_ID                 = RAT
INSTRUMENT_TYPE               = DRILL
LOCAL_TRUE_SOLAR_TIME          = "09:01:00"
MISSION_NAME                   = "MARS EXPLORATION ROVER"
MISSION_PHASE_NAME            = "PRIMARY MISSION"
OBSERVATION_ID                = "0"
PLANET_DAY_NUMBER             = 25
PRODUCER_INSTITUTION_NAME     = "MULTIMISSION IMAGE PROCESSING SUBSYSTEM,
                                JET PROPULSION LAB"
PRODUCT_CREATION_TIME          = 2003-03-04T18:02:49.000
SEQUENCE_ID                   = d2520
SEQUENCE_VERSION_ID           = "0"
SPACECRAFT_CLOCK_CNT_PARTITION = 1
SPACECRAFT_CLOCK_START_COUNT   = "128573865.213"
SPACECRAFT_CLOCK_STOP_COUNT    = "128573892.076"
START_TIME                    = 2004-01-28T14:56:41.648
STOP_TIME                     = 2004-01-28T14:57:08.113
TARGET_NAME                   = MARS
TARGET_TYPE                    = PLANET

/* TELEMETRY DATA ELEMENTS */

APPLICATION_PROCESS_ID         = 34
APPLICATION_PROCESS_NAME       = RAT
APPLICATION_PROCESS_SUBTYPE_ID = 2
EARTH_RECEIVED_START_TIME     = 2004-02-14T01:19:27.453
EARTH_RECEIVED_STOP_TIME      = 2004-02-14T03:37:16.153
EXPECTED_PACKETS              = "N/A"

```

```

PACKET_MAP_MASK           = "N/A"
RECEIVED_PACKETS        = "N/A"
SPICE_FILE_NAME          = "chronos.mer"
TELEMETRY_FORMAT_ID     = SCI
TELEMETRY_PROVIDER_ID   = "SSW MER_DP"
TELEMETRY_SOURCE_NAME   = "Input DP Filename"
TELEMETRY_SOURCE_TYPE   = "DATA PRODUCT"
TLM_INST_DATA_HEADER_ID = 3

/* HISTORY DATA ELEMENTS */

SOFTWARE_NAME            = MERTELEMPROC
SOFTWARE_VERSION_ID     = "V1.24.46"
PROCESSING_HISTORY_TEXT = "CODMAC LEVEL 1 TO LEVEL 2 CONVERSION
                          VIA JPL/MIPL MERTELEMPROC"

/* ROVER STATE */
/* COORDINATE SYSTEM STATE: ROVER AT START OF ACTIVITY */

GROUP                   = START_ROVER_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME = ROVER_FRAME
  COORDINATE_SYSTEM_INDEX = (0, 25, 54, 141, 70)
  COORDINATE_SYSTEM_INDEX_NAME = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR   = (-0.00876458, 0.0214229, 0.0172464)
  ORIGIN_ROTATION_QUATERNION = (0.999978, -0.000282336, 0.000291980,
                                -0.00663021)
  POSITIVE_AZIMUTH_DIRECTION = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION = UP
  QUATERNION_MEASUREMENT_METHOD = FINE
  REFERENCE_COORD_SYSTEM_NAME = SITE_FRAME
  REFERENCE_COORD_SYSTEM_INDEX = 0
END_GROUP              = START_ROVER_COORDINATE_SYSTEM

/* ARTICULATION DEVICE STATE: MOBILITY CHASSIS AT START OF ACTIVITY */

GROUP                   = START_CHASSIS_ARTICULATION_STATE
  ARTICULATION_DEVICE_ID = CHASSIS
  ARTICULATION_DEVICE_NAME = "MOBILITY CHASSIS"
  ARTICULATION_DEVICE_ANGLE = (0.0230152 <rad>, 0.076101 <rad>,
                                0.0230152 <rad>, 0.076101 <rad>,
                                0.0230152 <rad>, 0.076101 <rad>,
                                0.0230152 <rad>)
  ARTICULATION_DEVICE_ANGLE_NAME = ("LEFT FRONT WHEEL POTENTIOMETER",
                                     "RIGHT FRONT WHEEL POTENTIOMETER",
                                     "LEFT REAR WHEEL POTENTIOMETER",
                                     "RIGHT REAR WHEEL POTENTIOMETER",
                                     "LEFT BOGIE POTENTIOMETER",
                                     "RIGHT BOGIE POTENTIOMETER",
                                     "DIFFERENTIAL BOGIE POTENTIOMETER")
END_GROUP              = START_CHASSIS_ARTICULATION_STATE

/* ARTICULATION DEVICE STATE: HIGH GAIN ANTENNA AT START OF ACTIVITY */

GROUP                   = START_HGA_ARTICULATION_STATE
  ARTICULATION_DEVICE_ID = HGA
  ARTICULATION_DEVICE_NAME = "HIGH GAIN ANTENNA"
  ARTICULATION_DEVICE_ANGLE = (0.0230152 <rad>, -0.076101 <rad>)

```

```

ARTICULATION_DEVICE_ANGLE_NAME = (AZIMUTH, ELEVATION)
END_GROUP                       = START_HGA_ARTICULATION_STATE

/* 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       = (0.0230152 <rad>, -0.076101 <rad>,
                                0.874005 <rad>, 9.4095 <rad>,
                                0.3467 <rad>, 0.922297 <rad>,
                                -0.0165226 <rad>, -0.0413094 <rad>,
                                0.38230 <rad>, 0.456 <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        = "FREE SPACE"
ARTICULATION_DEVICE_TEMP       = (20.5986 <degC>, 21.4995 <degC>)
ARTICULATION_DEVICE_TEMP_NAME  = ("AZIMUTH JOINT 1", "TURRET JOINT 5")
ARTICULATION_DEVICE_VECTOR     = (0.000587690, 0.000560787, 1.00000)
ARTICULATION_DEV_VECTOR_NAME   = GRAVITY
CONTACT_SENSOR_STATE           = ("NO CONTACT", "NO CONTACT",
                                CONTACT, CONTACT,
                                "NO CONTACT", "NO CONTACT",
                                CLOSED, "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 = RAT
END_GROUP                       = START_IDD_ARTICULATION_STATE

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

GROUP                             = START_IDD_COORDINATE_SYSTEM
COORDINATE_SYSTEM_NAME          = RAT_FRAME
COORDINATE_SYSTEM_INDEX        = (0, 23, 54, 141, 70)
COORDINATE_SYSTEM_INDEX_NAME   = (SITE, DRIVE, IDD, PMA, HGA)
ORIGIN_OFFSET_VECTOR           = (0.973126, -0.0857320, -0.278298)
ORIGIN_ROTATION_QUATERNION     = (0.109009, -0.670247, -0.698654,
                                0.225321)
POSITIVE_AZIMUTH_DIRECTION     = CLOCKWISE
POSITIVE_ELEVATION_DIRECTION   = DOWN
REFERENCE_COORD_SYSTEM_NAME    = ROVER_FRAME
REFERENCE_COORD_SYSTEM_INDEX   = (0, 25, 54, 141, 70)
END_GROUP                       = START_IDD_COORDINATE_SYSTEM

/* ARTICULATION DEVICE STATE: PANCAM MAST ASSEMBLY AT START OF ACTIVITY */

```

```

GROUP                                = START_PMA_ARTICULATION_STATE
  ARTICULATION_DEVICE_ID             = PMA
  ARTICULATION_DEVICE_NAME           = "PANCAM MAST ASSEMBLY"
  ARTICULATION_DEVICE_ANGLE         = (-0.0799986 <rad>, -1.57088 <rad>)
  ARTICULATION_DEVICE_ANGLE_NAME    = (MAST, CAMBAR)
  ARTICULATION_DEVICE_MODE          = DEPLOYED
END_GROUP                             = START_PMA_ARTICULATION_STATE

/* COORDINATE SYSTEM STATE: PANCAM MAST ASSEMBLY AT THE START */

GROUP                                = START_PMA_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME             = MAST_FRAME
  COORDINATE_SYSTEM_INDEX            = (0, 25, 54, 141, 70)
  COORDINATE_SYSTEM_INDEX_NAME       = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR               = (0.973126, -0.0857320, -0.278298)
  ORIGIN_ROTATION_QUATERNION         = (0.109009, -0.670247, -0.698654,
                                        0.225321)
  POSITIVE_AZIMUTH_DIRECTION         = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION       = UP
  REFERENCE_COORD_SYSTEM_NAME        = ROVER_FRAME
  REFERENCE_COORD_SYSTEM_INDEX       = (0, 25, 54, 141, 70)
END_GROUP                             = START_PMA_COORDINATE_SYSTEM

/* ROVER STATE */
/* COORDINATE SYSTEM STATE: ROVER AT END OF ACTIVITY */

GROUP                                = STOP_ROVER_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME             = ROVER_FRAME
  COORDINATE_SYSTEM_INDEX            = (0, 25, 54, 141, 70)
  COORDINATE_SYSTEM_INDEX_NAME       = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR               = (-0.00876458, 0.0214229, 0.0172464)
  ORIGIN_ROTATION_QUATERNION         = (0.999978, -0.000282336, 0.000291980,
                                        -0.00663021)
  POSITIVE_AZIMUTH_DIRECTION         = CLOCKWISE
  POSITIVE_ELEVATION_DIRECTION       = UP
  QUATERNION_MEASUREMENT_METHOD      = FINE
  REFERENCE_COORD_SYSTEM_NAME        = SITE_FRAME
  REFERENCE_COORD_SYSTEM_INDEX       = 0
END_GROUP                             = STOP_ROVER_COORDINATE_SYSTEM

/* ARTICULATION DEVICE STATE: MOBILITY CHASSIS AT END OF ACTIVITY */

GROUP                                = STOP_CHASSIS_ARTICULATION_STATE
  ARTICULATION_DEVICE_ID             = CHASSIS
  ARTICULATION_DEVICE_NAME           = "MOBILITY CHASSIS"
  ARTICULATION_DEVICE_ANGLE         = (2.29090 <rad>, 2.18295 <rad>,
                                        2.30191 <rad>, 2.26317 <rad>,
                                        1.31267 <rad>, 1.67692 <rad>,
                                        0.834726 <rad>)
  ARTICULATION_DEVICE_ANGLE_NAME    = ("LEFT FRONT WHEEL POTENTIOMETER",
                                        "RIGHT FRONT WHEEL POTENTIOMETER",
                                        "LEFT REAR WHEEL POTENTIOMETER",
                                        "RIGHT REAR WHEEL POTENTIOMETER",
                                        "LEFT BOGIE POTENTIOMETER",
                                        "RIGHT BOGIE POTENTIOMETER",
                                        "DIFFERENTIAL BOGIE POTENTIOMETER")
END_GROUP                             = STOP_CHASSIS_ARTICULATION_STATE

```

```
/* ARTICULATION DEVICE STATE: HIGH GAIN ANTENNA AT END OF ACTIVITY*/
```

```
GROUP = STOP_HGA_ARTICULATION_STATE
  ARTICULATION_DEVICE_ID = HGA
  ARTICULATION_DEVICE_NAME = "HIGH GAIN ANTENNA"
  ARTICULATION_DEVICE_ANGLE = (2.55154 <rad>, 1.72436 <rad>)
  ARTICULATION_DEVICE_ANGLE_NAME = (AZIMUTH, ELEVATION)
END_GROUP = STOP_HGA_ARTICULATION_STATE
```

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

```
GROUP = STOP_IDD_ARTICULATION_STATE
  ARTICULATION_DEVICE_ID = IDD
  ARTICULATION_DEVICE_NAME = "INSTRUMENT DEPLOYMENT DEVICE"
  ARTICULATION_DEVICE_ANGLE = (0.00000 <rad>, -0.802971 <rad>,
    1.53627 <rad>, 3.50001 <rad>,
    -0.169527 <rad>, 1.50386 <rad>,
    0.124453 <rad>, -0.789206 <rad>,
    -0.369460 <rad>, 1.65011 <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 = "FREE SPACE"
  ARTICULATION_DEVICE_TEMP = (20.5986 <degC>, 21.5225 <degC>)
  ARTICULATION_DEVICE_TEMP_NAME = ("AZIMUTH JOINT 1", "TURRET JOINT 5")
  ARTICULATION_DEVICE_VECTOR = (0.000587690, 0.000560787, 1.00000)
  ARTICULATION_DEV_VECTOR_NAME = "GRAVITY"
  CONTACT_SENSOR_STATE = ("NO CONTACT", "NO CONTACT",
    CONTACT, CONTACT,
    "NO CONTACT", "NO CONTACT",
    CLOSED, "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 = RAT
END_GROUP = STOP_IDD_ARTICULATION_STATE
```

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

```
GROUP = STOP_IDD_COORDINATE_SYSTEM
  COORDINATE_SYSTEM_NAME = RAT_FRAME
  COORDINATE_SYSTEM_INDEX = (0, 25, 54, 141, 71)
  COORDINATE_SYSTEM_INDEX_NAME = (SITE, DRIVE, IDD, PMA, HGA)
  ORIGIN_OFFSET_VECTOR = (0.0230152, -0.076101, 0.874005)
  ORIGIN_ROTATION_QUATERNION = (0.922297, -0.0165226, -0.0413094,
    0.382304)
  POSITIVE_AZIMUTH_DIRECTION = CLOCKWISE
```

```

    POSITIVE_ELEVATION_DIRECTION = DOWN
    REFERENCE_COORD_SYSTEM_NAME = ROVER_FRAME
    REFERENCE_COORD_SYSTEM_INDEX = (0, 25, 54, 141, 70)
END_GROUP = STOP_IDD_COORDINATE_SYSTEM

/* ARTICULATION DEVICE STATE: PANCAM MAST ASSEMBLY AT END OF ACTIVITY */

GROUP = STOP_PMA_ARTICULATION_STATE
    ARTICULATION_DEVICE_ID = PMA
    ARTICULATION_DEVICE_NAME = "PANCAM MAST ASSEMBLY"
    ARTICULATION_DEVICE_ANGLE = (3.46789 <rad>, 5.6702 <rad>)
    ARTICULATION_DEVICE_ANGLE_NAME = (MAST, CAMBAR)
    ARTICULATION_DEVICE_MODE = DEPLOYED
END_GROUP = STOP_PMA_ARTICULATION_STATE

/* COORDINATE SYSTEM STATE: PANCAM MAST ASSEMBLY AT THE END */

GROUP = STOP_PMA_COORDINATE_SYSTEM
    COORDINATE_SYSTEM_NAME = MAST_FRAME
    COORDINATE_SYSTEM_INDEX = (0, 25, 54, 141, 70)
    COORDINATE_SYSTEM_INDEX_NAME = (SITE, DRIVE, IDD, PMA, HGA)
    ORIGIN_OFFSET_VECTOR = (0.0230152, -0.076101, 0.874005)
    ORIGIN_ROTATION_QUATERNION = (0.922297, -0.0165226, -0.0413094,
    0.382304)
    POSITIVE_AZIMUTH_DIRECTION = CLOCKWISE
    POSITIVE_ELEVATION_DIRECTION = UP
    REFERENCE_COORD_SYSTEM_NAME = ROVER_FRAME
    REFERENCE_COORD_SYSTEM_INDEX = (0, 25, 54, 141, 70)
END_GROUP = STOP_PMA_COORDINATE_SYSTEM

/* RAT REQUEST PARAMETERS */

GROUP = RAT_REQUEST_PARMS
    COMMAND_OPCODE = 2513
    ERROR_CONDITION = NONE
    ERROR_STATE = {IS_ANOMALY_REPORT}
    MAXIMUM_CURRENT_PERSISTENCE = 10
    MAXIMUM_TRAVEL_DISTANCE = 25.1260 <mm>
    SAMPLING_PARAMETER_INTERVAL = 3
    ROTATION_NOLOAD_CURRENT = 118.000
    TORQUE_CONSTANT = 0.100400
    Z_AXIS_DISTANCE = 0.250000 <mm>
END_GROUP = RAT_REQUEST_PARMS

GROUP = DIAGNOSTICS_CAL_REQUEST_PARMS
    ANGULAR_VELOCITY = 0.105000 <rad/s>
    ROTATION_VOLTAGE = 30.000 <V>
    Z_AXIS_VELOCITY = 0.500000
END_GROUP = DIAGNOSTICS_CAL_REQUEST_PARMS

GROUP = SEEK_SCAN_REQUEST_PARMS
    ANGULAR_DISTANCE = 6.28319 <rad>
    MAXIMUM_ANGULAR_VELOCITY = 0.105000 <rad/s>
    ROTATION_TORQUE_PARAMETER = 10.0000
    ROTATION_VOLTAGE = (5.00000 <V>, 5.00000 <V>)
    ROTATION_VOLTAGE_NAME = (SEEK, SCAN)
    TORQUE_GAIN = (0.0100000,

```

```

                                0.00000,
                                0.00000)
TORQUE_GAIN_NAME                = (PROPORTIONAL, DERIVATIVE, INTEGRAL)
Z_AXIS_STEP_SIZE                = 0.0510000 <mm>
Z_AXIS_VELOCITY                 = (0.400000, 0.800000)
Z_AXIS_VELOCITY_NAME            = (SEEK, SCAN)
END_GROUP                       = SEEK_SCAN_REQUEST_PARMS

GROUP                           = GRIND_REQUEST_PARMS
ANGULAR_DISTANCE                = (6.28319 <rad>, 31.4159 <rad>)
ANGULAR_DISTANCE_NAME           = ("GRIND COMPLETION", "DWELL OPERATION")
ANGULAR_VELOCITY                = 0.315000 <rad/s>
CLEARANCE_DISTANCE              = 2.00000 <mm>
MAXIMUM_ANGULAR_VELOCITY        = 0.143000 <rad/s>
ROTATION_TORQUE_PARAMETER       = 18.0000
ROTATION_VOLTAGE                = 30.0000 <V>
TORQUE_GAIN                     = (0.0102400,
                                0.000100000,
                                0.000500000)

TORQUE_GAIN_NAME                = (PROPORTIONAL, DERIVATIVE, INTEGRAL)
TIMEOUT_PARAMETER               = 90.00000 <s>
Z_AXIS_STEP_SIZE                = 0.0510000 <mm>
Z_AXIS_VELOCITY                 = 0.800000
END_GROUP                       = GRIND_REQUEST_PARMS

GROUP                           = BRUSH_REQUEST_PARMS
ANGULAR_VELOCITY                = 0.200000 <rad/s>
ROTATION_VOLTAGE                = 28.0000 <V>
Z_AXIS_POSITION                 = 23.0000 <mm>
Z_AXIS_VELOCITY                 = 1.00000
END_GROUP                       = BRUSH_REQUEST_PARMS

/* TABLE DATA ELEMENTS */

OBJECT                          = TABLE
INTERCHANGE_FORMAT              = BINARY
COLUMNS                        = 20
ROWS                            = <TBD>
ROW_BYTES                       = 96

OBJECT                          = COLUMN
COLUMN_NUMBER                   = 1
NAME                            = SCLK_SECONDS
DATA_TYPE                       = MSB_UNSIGNED_INTEGER
START_BYTE                      = 1
BYTES                           = 4
UNIT                            = "SECOND"
DESCRIPTION                      = "The whole number of seconds recorded by
                                the spacecraft clock at
                                the time the measurements were taken."
END_OBJECT                      = COLUMN

OBJECT                          = COLUMN
COLUMN_NUMBER                   = 2
NAME                            = SCLK_SUBSECONDS
DATA_TYPE                       = MSB_UNSIGNED_INTEGER
START_BYTE                      = 5

```

```

    BYTES = 2
    UNIT = "SECOND/256"
    DESCRIPTION = "The number of subseconds recorded by
                  the spacecraft clock at
                  the time the measurements were taken.
                  A subsecond is 1 / 256th of a second."
END_OBJECT = COLUMN

OBJECT = COLUMN
  COLUMN_NUMBER = 3
  NAME = SPARE
  DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BYTE = 7
  BYTES = 2
  DESCRIPTION = "These two bytes are currently unused."
END_OBJECT = COLUMN

OBJECT = COLUMN
  COLUMN_NUMBER = 4
  NAME = ROTATION_MOTOR_POSITION
  DATA_TYPE = IEEE_REAL
  START_BYTE = 9
  BYTES = 8
  UNIT = "RADIAN"
  DESCRIPTION = "The position of the z-axis relative to
                  its hardstop."
END_OBJECT = COLUMN

OBJECT = COLUMN
  COLUMN_NUMBER = 5
  NAME = ROTATION_MOTOR_CURRENT_SENSOR
  DATA_TYPE = IEEE_REAL
  START_BYTE = 17
  BYTES = 8
  UNIT = "AMP"
  DESCRIPTION = "Rotation motor current."
END_OBJECT = COLUMN

OBJECT = COLUMN
  COLUMN_NUMBER = 6
  NAME = REVOLUTION_MOTOR_POSITION
  DATA_TYPE = IEEE_REAL
  START_BYTE = 25
  BYTES = 8
  UNIT = "RADIAN"
  DESCRIPTION = "The position of the z-axis relative to
                  its hardstop."
END_OBJECT = COLUMN

OBJECT = COLUMN
  COLUMN_NUMBER = 7
  NAME = REVOLUTION_MOTOR_CURRENT_SENSOR
  DATA_TYPE = IEEE_REAL
  START_BYTE = 33
  BYTES = 8
  UNIT = "AMP"
  DESCRIPTION = "Revolution motor current."

```

```

END_OBJECT                = COLUMN

OBJECT                    = COLUMN
  COLUMN_NUMBER           = 8
  NAME                    = Z_MOTOR_POSITION
  DATA_TYPE              = IEEE_REAL
  START_BYTE              = 41
  BYTES                   = 8
  UNIT                    = "MM"
  DESCRIPTION              = "The position of the z-axis relative to
                             its hardstop."
END_OBJECT                = COLUMN

OBJECT                    = COLUMN
  COLUMN_NUMBER           = 9
  NAME                    = Z_MOTOR_CURRENT_SENSOR
  DATA_TYPE              = IEEE_REAL
  START_BYTE              = 49
  BYTES                   = 8
  UNIT                    = "AMP"
  DESCRIPTION              = "A-axis motor current."
END_OBJECT                = COLUMN

OBJECT                    = COLUMN
  COLUMN_NUMBER           = 10
  NAME                    = TEMPERATURE_SENSOR
  DATA_TYPE              = IEEE_REAL
  START_BYTE              = 57
  BYTES                   = 8
  UNIT                    = "DEGREE CELSIUS"
  DESCRIPTION              = "Temperature reading from RAT PRT."
END_OBJECT                = COLUMN

OBJECT                    = COLUMN
  COLUMN_NUMBER           = 11
  NAME                    = BUTTERFLY_SWITCH_1
  DATA_TYPE              = MSB_UNSIGNED_INTEGER
  START_BYTE              = 65
  BYTES                   = 4
  UNIT                    = "COUNT"
  DESCRIPTION              = "Cumulative state word for butterfly
                             switch #1 - add 1 if the switch is in
                             the incorrect state, add 0 if the switch
                             is in the correct state, updated at 8Hz."
END_OBJECT                = COLUMN

OBJECT                    = COLUMN
  COLUMN_NUMBER           = 12
  NAME                    = BUTTERFLY_SWITCH_2
  DATA_TYPE              = MSB_UNSIGNED_INTEGER
  START_BYTE              = 69
  BYTES                   = 4
  UNIT                    = "COUNT"
  DESCRIPTION              = "Cumulative state word for butterfly
                             switch #2 - add 1 if the switch is in
                             the incorrect state, add 0 if the switch
                             is in the correct state. Updated at 8Hz."

```

```

END_OBJECT                = COLUMN

OBJECT                    = COLUMN
  COLUMN_NUMBER           = 13
  NAME                    = RAT_OVER_CURRENT_ALARM
  DATA_TYPE              = MSB_UNSIGNED_INTEGER
  START_BYTE              = 73
  BYTES                   = 4
  UNIT                    = "COUNT"
  DESCRIPTION             = "Cumulative state word for rotate motor
                           Over current alarm - add 1 if over
                           threshold, add 0 if not. Updated at 8Hz."
END_OBJECT                = COLUMN

OBJECT                    = COLUMN
  COLUMN_NUMBER           = 14
  NAME                    = Z_AXIS_MOTOR_CONTROLLER_STATUS
  DATA_TYPE              = MSB_UNSIGNED_INTEGER
  START_BYTE              = 77
  BYTES                   = 1
  DESCRIPTION             = "Z-Axis motor controller bit status.
                           BIT 0=motor controller active
                           BIT 1=motor turning
                           BIT 2=motor not keeping up with
                           commanded profile
                           BIT 3=motor stalled
                           BIT 4=motor H-bridge over temperature
                           BIT 5=motor controller enable
                           BIT 6=motor reached commanded position
                           BIT 7=awaiting Mini-TES sync pulse
                           (should always be 0 for RAT)"
END_OBJECT                = COLUMN

OBJECT                    = COLUMN
  COLUMN_NUMBER           = 15
  NAME                    = REVOLVE_MOTOR_CONTROLLER_STATUS
  DATA_TYPE              = MSB_UNSIGNED_INTEGER
  START_BYTE              = 78
  BYTES                   = 1
  DESCRIPTION             = "Revolve motor controller bit status.
                           BIT 0=motor controller active
                           BIT 1=motor turning
                           BIT 2=motor not keeping up with
                           commanded profile
                           BIT 3=motor stalled
                           BIT 4=motor H-bridge over temperature
                           BIT 5=motor controller enable
                           BIT 6=motor reached commanded position
                           BIT 7=awaiting Mini-TES sync pulse
                           (should always be 0 for RAT)"
END_OBJECT                = COLUMN

OBJECT                    = COLUMN
  COLUMN_NUMBER           = 16
  NAME                    = GRIND_MOTOR_CONTROLLER_STATUS
  DATA_TYPE              = MSB_UNSIGNED_INTEGER
  START_BYTE              = 79

```

```

BYTES = 1
DESCRIPTION = "Grind motor controller bit status.
              BIT 0=motor controller active
              BIT 1=motor turning
              BIT 2=motor not keeping up with
                  commanded profile
              BIT 3=motor stalled
              BIT 4=motor H-bridge over temperature
              BIT 5=motor controller enable
              BIT 6=motor reached commanded position
              BIT 7=awaiting Mini-TES sync pulse
                  (should always be 0 for RAT)"

END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 17
NAME = SPARE
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 80
BYTES = 1
DESCRIPTION = "Spare field used for padding."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 18
NAME = ROVER_BUS_VOLTAGE
DATA_TYPE = IEEE_REAL
START_BYTE = 81
BYTES = 8
UNIT = "VOLT"
DESCRIPTION = "Rover bus voltage."
END_OBJECT = COLUMN

OBJECT = COLUMN
COLUMN_NUMBER = 19
NAME = ALGORITHM_STATE
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 89
BYTES = 4
UNIT = "N/A"
DESCRIPTION = "Describes the current state of the RAT.
              Valid values are:
              0=INACTIVE
              1=AWAITING_INACTIVE
              2=DEACTIVATING
              3=IDLE
              4=AWAITING_IDLE
              5=STOPPING
              6=DIAG_REQUESTING
              7=DIAG_CALIBRATING
              8=DIAG_HOMING
              9=DIAG_COLLECTING_CURRENT
              10=DIAG_COLLECTING_VOLTAGE
              11=CAL_REQUESTING
              12=CAL_CALIBRATING
              13=CAL_HOMING
              14=CAL_COLLECTING_CURRENT

```

```

15=CAL_COLLECTING_VOLTAGE
16=SEEK_SEEKING_REQUESTING
17=SEEK_SEEKING
18=SCAN_Z_STEPPING
19=SCAN_REVOLVING
20=GRIND_REQUESTING
21=GRIND_GRINDING
22=GRIND_Z_RETRACTING
23=GRIND_Z_EXTENDING
24=GRIND_DWELLING
25=BRUSH_REQUESTING
26=BRUSH_CALIBRATING
27=BRUSH_MOVING_Z
28=BRUSH_BRUSHING
29=MOVE_REQUESTING
30=MOVE_MOVING
31=HOMING
32=NO_FAULT
33=GRIND_DUMPING_DP
34=GRIND_RESUMING"
END_OBJECT = COLUMN

OBJECT = COLUMN
  COLUMN_NUMBER = 20
  NAME = ANOMALY_FLAG
  DATA_TYPE = MSB_BIT_STRING
  START_BYTE = 93
  BYTES = 4
  UNIT = "N/A"
  DESCRIPTION = "Describes the fault protection condition
that may have ended the current command
and produced an anomaly report. This is a
bit mask where 1=TRUE, 0= FALSE for these
bit fields:
BIT 0 = HBRIDGE_Z
BIT 1 = HBRIDGE_REV
BIT 2 = HBRIDGE_ROT
BIT 3 = OVERHEAT_Z
BIT 4 = OVERHEAT_REV
BIT 5 = OVERHEAT_ROT
BIT 6 = CSTALL_Z
BIT 7 = CSTALL_REV
BIT 8 = CSTALL_ROT
BIT 9 = STALL_Z
BIT 10 = STALL_REV
BIT 11 = STALL_ROT
BIT 12 = POS_Z
BIT 13 = CMAX_Z
BIT 14 = CMAX_REV
BIT 15 = CMAX_ROT
BIT 16 = CONTACT
BIT 17 = COMMAND_QUIT
BIT 18 = MAXCUR - Motor Current exceeded
maxcur argument.
BIT 19 = ANOMALY_NOW - An anomaly has
occurred in this sample.
BIT 20 = ENCODER_STALL_ROT - encoder stall

```

```
                                on the rotate motor"
END_OBJECT                      = COLUMN
END_OBJECT                      = TABLE
END
```

APPENDIX B – PDS LABEL KEYWORDS

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
ANGULAR_DISTANCE	<p>Radians to revolve.</p> <p>For MER,</p> <p>a) This is the radians around the revolve axis before the scan portion of the command completes.</p> <p>b) Radians to revolve before moving the z-axis down one step when grinding or radians to revolved when dwelling.</p>	Float array of one or more	angle in radians	-3.4e38 to +3.4e38	<p>LOCATION</p> <p>a) SEEK_SCAN_REQUEST_PARMS (group)</p> <p>b) GRIND_REQUEST_PARMS (group)</p> <p>SOURCE</p> <p>a) IDPH:rat_ss_revrad</p> <p>b) IDPH:rat_grd_revrad</p> <p> IDPH: rat_grd_dwlrad</p>
ANGULAR_DISTANCE_NAME	<p>Radians to revolve before grind completes. Radians to revolve before moving the z-axis down one step. This angle is likely to be a full revolution.</p>	String array[2]		("GRIND COMPLETION", "DWELL COMPLETION")	<p>LOCATION</p> <p>GRIND_REQUEST_PARMS (group)</p> <p>SOURCE</p> <p>Static Value</p>
ANGULAR_VELOCITY	<p>Provides the angular velocity of an instrument component or period of instrument command. (Needs work)</p> <p>For MER, this is the angular velocity for the revolve axis.</p>	Float	angular velocity in rad/sec	-3.4e38 to +3.4e38	<p>LOCATION</p> <p>a) DIAGNOSTICS_CAL_REQUEST_PARMS (group)</p> <p>b) GRIND_REQUEST_REQUEST_PARMS (group)</p> <p>c) BRUSH_REQUEST_PARMS (group)</p> <p>SOURCE</p> <p>a) IDPH:rat_dc_revel</p> <p>b) IDPH:rat_grd_dwlvvel</p> <p>c) IDPH:rat_bsh_evel</p>
APPLICATION_PROCESS_ID	<p>Identifies the source/process which created the data.</p>	integer		(see APPLICATION_PROCESS_NAME)	<p>LOCATION</p> <p>TELEMETRY (Class)</p> <p>SOURCE</p> <p>CCSDS:Primary:APID</p>

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source 																														
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)		<table border="0"> <thead> <tr> <th style="text-align: left;"><u>APID</u></th> <th style="text-align: left;"><u>NAME</u></th> </tr> </thead> <tbody> <tr><td>21</td><td>"PANCAM LEFT"</td></tr> <tr><td>22</td><td>"PANCAM RIGHT"</td></tr> <tr><td>23</td><td>"NAVCAM LEFT"</td></tr> <tr><td>24</td><td>"NAVCAM RIGHT"</td></tr> <tr><td>25</td><td>"HAZCAM LEFT FRONT"</td></tr> <tr><td>26</td><td>"HAZCAM RIGHT FRONT"</td></tr> <tr><td>27</td><td>"HAZCAM LEFT REAR"</td></tr> <tr><td>28</td><td>"HAZCAM RIGHT REAR"</td></tr> <tr><td>29</td><td>"MI"</td></tr> <tr><td>30</td><td>"DESCENT IMAGER"</td></tr> <tr><td>31</td><td>"MINITES"</td></tr> <tr><td>32</td><td>"APXS"</td></tr> <tr><td>33</td><td>"MB"</td></tr> <tr><td>34</td><td>"RAT"</td></tr> </tbody> </table>	<u>APID</u>	<u>NAME</u>	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"	<p>LOCATION TELEMETRY (Class)</p> <p>SOURCE Table Lookup CCSDS:Primary:APID</p>
<u>APID</u>	<u>NAME</u>																																		
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		<table border="0"> <thead> <tr> <th style="text-align: left;"><u>SUBTYPE</u></th> <th style="text-align: left;"><u>DESCRIPTION</u></th> </tr> </thead> <tbody> <tr><td>0</td><td>RAT Parameters</td></tr> <tr><td>1</td><td>RAT Detailed Report</td></tr> <tr><td>2</td><td>RAT Anomaly Report</td></tr> </tbody> </table>	<u>SUBTYPE</u>	<u>DESCRIPTION</u>	0	RAT Parameters	1	RAT Detailed Report	2	RAT Anomaly Report	<p>LOCATION TELEMETRY (Class)</p> <p>SOURCE CCSDS:Primary:subtype</p>																						
<u>SUBTYPE</u>	<u>DESCRIPTION</u>																																		
0	RAT Parameters																																		
1	RAT Detailed Report																																		
2	RAT Anomaly Report																																		

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
ARTICULATION_DEVICE_ANGLE	<p>Provides the value of an angle between two parts or segments of an articulated device.</p> <p>Note: MER uses radians. The PDS default unit for this keyword is degrees, so the <rad> tag is required for MER data.</p>	float array[10]	radians (<rad> unit tag required)		<p>LOCATION</p> <p>a) START_CHASIS_ARTICULATION_STATE (Group)</p> <p>b) STOP_CHASIS_ARTICULATION_STATE (Group)</p> <p>c) START_HGA_ARTICULATION_STATE (Group)</p> <p>d) STOP_HGA_ARTICULATION_STATE (Group)</p> <p>e) START_IDD_ARTICULATION_STATE (Group)</p> <p>f) STOP_IDD_ARTICULATION_STATE (Group)</p> <p>g) START_PMA_ARTICULATION_STATE (Group)</p> <p>h) STOP_PMA_ARTICULATION_STATE (Group)</p> <p>SOURCE</p> <p>Group Dependent</p> <p>a) IDPH:begin->fleht_pot, fright_pot, rleft_pot, rright_pot, bogl_pot, bogr_pot, bog_diff_pot;</p> <p>b) IDPH:end-> fleht_pot, fright_pot, rleft_pot, rright_pot, bogl_pot, bogr_pot, bog_diff_pot;</p> <p>c) IDPH:begin-> hga_gimbals.azimuth, hga_gimbals.elevation</p> <p>c) IDPH:end-> hga_gimbals.azimuth, hga_gimbals.elevation</p> <p>d) IDPH:end-> idd.q_enc[5] IDPH:end->idd.q_pot[5]</p> <p>a) IDPH:begin-> pma_cam_gimbals.mast_angle, pma_cam_gimbals.cambar_angle</p> <p>f) IDPH:end-> pma_cam_gimbals.mast_angle, pma_cam_gimbals.cambar_angle</p>

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
ARTICULATION_DEVICE_ANGLE_NAME	Provides the formal name which identifies each of the values used in ARTICULATION_DEVICE_ANGLE.	string array[10]		<p>CHASSIS ("LEFT FRONT WHEEL POTENTIOMETER", "RIGHT FRONT WHEEL POTENTIOMETER", "LEFT REAR WHEEL POTENTIOMETER", "RIGHT REAR WHEEL POTENTIOMETER", "LEFT BOGIE POTENTIOMETER", "RIGHT BOGIE POTENTIOMETER", "DIFFERENTIAL BOGIE POTENTIOMETER")</p> <p>HGA ("AZIMUTH", "ELEVATION")</p> <p>IDD ("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")</p> <p>PMA ("MAST", "CAMBAR")</p>	<p>LOCATION a) START_CHASIS_ARTICULATION_STATE (Group) b) STOP_CHASIS_ARTICULATION_STATE (Group) c) START_HGA_ARTICULATION_STATE (Group) d) STOP_HGA_ARTICULATION_STATE (Group) e) START_IDD_ARTICULATION_STATE (Group) f) STOP_IDD_ARTICULATION_STATE (Group) g) START_PMA_ARTICULATION_STATE (Group) h) STOP_PMA_ARTICULATION_STATE (Group)</p> <p>SOURCE Static Values</p>

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
ARTICULATION_DEVICE_ID	<p>Specifies the unique 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.</p>	string		<p>“CHASSIS”, “HGA”, “IDD”, “PMA”</p>	<p>LOCATION a) START_CHASIS_ARTICULATION_STATE (Group) b) STOP_CHASIS_ARTICULATION_STATE (Group) c) START_HGA_ARTICULATION_STATE (Group) d) STOP_HGA_ARTICULATION_STATE (Group) e) START_IDD_ARTICULATION_STATE (Group) f) STOP_IDD_ARTICULATION_STATE (Group) g) START_PMA_ARTICULATION_STATE (Group) h) STOP_PMA_ARTICULATION_STATE (Group)</p> <p>SOURCE Static Values</p>
ARTICULATION_DEVICE_MODE	<p>Indicates the deployment state (i.e., physical configuration) of an articulation device at the time of data acquisition.</p> <p>For MER, this is the mode of the last move:</p> <p>“FREE SPACE” – IDD arm was moved where there was no contact with a target expected.</p> <p>“GUARDED” – IDD arm was moved where contact with the target was expected.</p> <p>“RETRACTING” – IDD arm was moved where an instrument is removed from a target.</p> <p>‘PRELOAD’ – IDD arm stays in contact with the target and applies force or overtravel on an instrument.</p>	String		<p><u>IDD</u> 0=“FREE SPACE”, 1=“GUARDED”, 2=“RETRACTING”, 3=“PRELOAD”</p> <p><u>PMA</u> 0=“STOWED” 1=“DEPLOYED”</p>	<p>LOCATION a) START_IDD_ARTICULATION_STATE (Group) b) STOP_IDD_ARTICULATION_STATE (Group) c) START_PMA_ARTICULATION_STATE (Group) d) STOP_PMA_ARTICULATION_STATE (Group)</p> <p>SOURCE Group Dependent; Table Lookup a) IDPH:begin->idd.idd_mode b) IDPH:end->idd.idd_mode c) IDPH:begin->pma_deploy d) IDPH:end->pma_deploy</p>

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
ARTICULATION_DEVICE_NAME	<p>Specifies the common name of the articulation device described by the containing group.</p> <p>Note: The associated ARTICULATION_DEVICE_ID element provides an abbreviated name or acronym for the articulated device.</p>	String		"MOBILITY CHASSIS", "HIGH GAIN ANTENNA", "INSTRUMENT DEPLOYMENT DEVICE", "PANCAM MAST ASSEMBLY"	<p>LOCATION</p> <ul style="list-style-type: none"> a) START_CHASIS_ARTICULATION_STATE (Group) b) STOP_CHASIS_ARTICULATION_STATE (Group) c) START_HGA_ARTICULATION_STATE (Group) d) STOP_HGA_ARTICULATION_STATE (Group) e) START_IDD_ARTICULATION_STATE (Group) f) STOP_IDD_ARTICULATION_STATE (Group) g) START_PMA_ARTICULATION_STATE (Group) h) STOP_PMA_ARTICULATION_STATE (Group) <p>SOURCE</p> <p>Static Value</p>
ARTICULATION_DEVICE_TEMP	<p>Provides the temperature, in degrees Celsius, of an articulated device or some part of an articulated device.</p>	Float array[2]	deg C (<degC> unit tag required)	-3.4e38 to 3.4e38	<p>LOCATION</p> <ul style="list-style-type: none"> a) START_IDD_ARTICULATION_STATE (Group) b) STOP_IDD_ARTICULATION_STATE (Group) <p>SOURCE</p> <ul style="list-style-type: none"> a) IDPH:begin->idd.temp[2] b) IDPH:end->idd.temp[2]
ARTICULATION_DEVICE_TEMP_NAME	<p>An array of the formal names identifying each of the values used in ARTICULATION_DEVICE_TEMP.</p>	string array[2]		("AZIMUTH JOINT 1", "TURRET JOINT 5")	<p>LOCATION</p> <ul style="list-style-type: none"> a) START_IDD_ARTICULATION_STATE (Group) b) STOP_IDD_ARTICULATION_STATE (Group) <p>SOURCE</p> <ul style="list-style-type: none"> a) Static Value b) Static Value

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
ARTICULATION_DEV_INSTRUMENT_ID	Provides an abbreviated name or acronym which identifies an instrument mounted on the articulation device.	string(12)		<u>IDD</u> 0 = "MI" 1 = "RAT" 2 = "MB" 3 = "APXS"	<u>LOCATION</u> a) START_IDD_ARTICULATION_STATE (Group) b) STOP_IDD_ARTICULATION_STATE (Group) <u>SOURCE</u> Table Lookup; a) IDPH:bgn->idd.instrument b) IDPH:end->idd.instrument
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]			<u>LOCATION</u> a) START_IDD_ARTICULATION_STATE (Group) b) STOP_IDD_ARTICULATION_STATE (Group) <u>SOURCE</u> a) IDPH:begin->idd.tilt[3] b) IDPH:end->idd.tilt[3]
ARTICULATION_DEV_VECTOR_NAME	Provides the formal name of the vector type of the articulation device.	String		"GRAVITY"	<u>LOCATION</u> a) START_IDD_ARTICULATION_STATE (Group) b) STOP_IDD_ARTICULATION_STATE (Group) <u>SOURCE</u> Static Value
CLEARANCE_DISTANCE	Z-axis backoff distance for dwell operation after grind to clear the rat hole of dust.	Float	length in mm	-3.4e38 to +3.4e38	<u>LOCATION</u> GRIND_REQUEST_PARMS (Group) <u>SOURCE</u> IDPH:rat_grd_dwlbck
COMMAND_OPCODE	The command_opcode element provides the opcode of the command that created the instrument data product..	integer			<u>LOCATION</u> RAT_REQUEST_PARMS (Group) <u>SOURCE</u> IDPH:rat_cmd_opcode
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			<u>LOCATION</u> IDENTIFICATION (Class) <u>SOURCE</u> UPTH:ProdCmndId; Command Number

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
CONTACT_SENSOR_STATE	<p>An array of identifiers for the state of an instrument's or instrument host's contact sensors at a specified time.</p> <p>For MER, "CONTACT" or "NO CONTACT" for most values. For the value corresponding to APXS DOOR SWITCH (entry 7), values are "OPEN" or "CLOSED".</p>	String array[8]		<p>0="NO CONTACT" or "CLOSED" 1="CONTACT" or "OPEN"</p> <p>"CONTACT" or "NO CONTACT" for all array positions except for position 7, which would be "OPEN" or "CLOSED"</p>	<p>LOCATION a) START_IDD_ARTICULATION_STATE (Group) b) STOP_IDD_ARTICULATION_STATE (Group)</p> <p>SOURCE Lookup Table a) IDPH:begin->idd.contact (bit map) b) IDPH:end->idd.contact (bit map)</p>
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")	<p>LOCATION a) START_IDD_ARTICULATION_STATE (Group) b) STOP_IDD_ARTICULATION_STATE (Group)</p> <p>SOURCE Static Value</p>

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
COORDINATE_SYSTEM_INDEX	<p>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.</p> <p>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.</p> <p>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.</p> <p>Example: COORDINATE_SYSTEM_INDEX = (1,3,2,3,2)</p>	integer array[5]			<p>LOCATION</p> <ul style="list-style-type: none"> a) START_ROVER_COORDINATE_SYSTEM (Group) b) STOP_ROVER_COORDINATE_SYSTEM (Group) c) START_IDD_COORDINATE_SYSTEM (Group) d) STOP_IDD_COORDINATE_SYSTEM (Group) e) START_PMA_COORDINATE_SYSTEM (Group) f) STOP_PMA_COORDINATE_SYSTEM (Group) <p>SOURCE</p> <p>Calculated from</p> <ul style="list-style-type: none"> a, c, e) IDPH:begin->rmc[5] and COORDINATE_SYSTEM_NAME b, d, f) IDPH:end->rmc[5] and COORDINATE_SYSTEM_NAME <p>Use all 5 elements except if the COORDINAE_SYSTEM_NAME = SITE_FRAME, then only use the first element.</p>

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
COORDINATE_SYSTEM_INDEX_NAME	An array of the formal names identifying each integer specified in COORDINATE_SYSTEM_INDEX.	String array[5]		("SITE", "DRIVE", "IDD", "PMA", "HGA")	<p>LOCATION</p> <ul style="list-style-type: none"> a) START_ROVER_COORDINATE_SYSTEM (Group) b) STOP_ROVER_COORDINATE_SYSTEM (Group) c) START_IDD_COORDINATE_SYSTEM (Group) d) STOP_IDD_COORDINATE_SYSTEM (Group) e) START_PMA_COORDINATE_SYSTEM (Group) f) STOP_PMA_COORDINATE_SYSTEM (Group) <p>SOURCE</p> <p>Static Value; Group dependent Should match the number of values in the COORDINATE_SYSTEM_INDEX</p>
COORDINATE_SYSTEM_NAME	<p>Provides the full name of the coordinate system to which the state vectors are referenced.</p> <p>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.</p>	string(30)		<p>"ROVER_FRAME", "SITE_FRAME", "MAST_FRAME", "LOCAL_LEVEL_FRAME",</p> <p><u>IDD only:</u> 0="APXS_FRAME", 1="MB_FRAME", 2="MI_FRAME", 3="RAT_FRAME",</p>	<p>LOCATION</p> <ul style="list-style-type: none"> a) START_ROVER_COORDINATE_SYSTEM (Group) b) STOP_ROVER_COORDINATE_SYSTEM (Group) c) START_IDD_COORDINATE_SYSTEM (Group) d) STOP_IDD_COORDINATE_SYSTEM (Group) e) START_PMA_COORDINATE_SYSTEM (Group) f) STOP_PMA_COORDINATE_SYSTEM (Group) <p>SOURCE</p> <ul style="list-style-type: none"> a) ROVER_FRAME b) ROVER_FRAME c) One of the IDD only frames based on IDPH:bgn->idd.instrument d) One of the IDD only frames based on IDPH:end->idd.instrument e) MAST_FRAME f) MAST_FRAME

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
DATA_SET_ID	<p>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.</p> <p>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.</p>	string(40)		"MER1-M-RAT-2-EDR-OPS-V1.0", "MER2-M-RAT-2-EDR-OPS-V1.0" "SIM1-M-RAT-2-EDR-V1.0", "SIM2-M-RAT-2-EDR-V1.0"	<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE PDS Table Lookup CCSDS:Primary:APID CHDO-82:scft_id</p>
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]	<p>LOCATION TELEMETRY (Class)</p> <p>SOURCE Calculated CHDO_82:ert</p>
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]	<p>LOCATION TELEMETRY (Class)</p> <p>SOURCE Calculated CHDO_82:ert</p>
ERROR_CONDITION	Fault protection conditions to ignore.	string	n/a	0=NONE 1=CONTACT1 2=CONTACT2 3=BOTH	<p>LOCATION RAT_REQUEST_PARMS (group)</p> <p>SOURCE Lookup Table IDPH:rat_rat_ermsk</p>

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> Location in PDS Label Source 										
ERROR_STATE	RAT error conditions that occurred.	String array[32]	Valid only for anomaly report, else will be zero.	BIT00=DCFPGA_PWR BIT01=DCFPGA_SEU BIT02=POS_UNKNOWN_Z BIT03=MOT_DISABLED_Z BIT04=MOT_DISABLED_REV BIT05=MOT_DISABLED_ROT BIT06=ENC_DISABLED_Z BIT07=ENC_DISABLED_REV BIT08=ENC_DISABLED_ROT BIT09=BUSY_Z BIT10=BUSY_REV BIT11=BUSY_ROT BIT12=TIMEOUT_Z BIT13=TIMEOUT_REV BIT14=TIMEOUT_ROT BIT15=INITIAL_CONTACT BIT16=CONTACT_CHANGE BIT17=SEEK_SCAN_FAIL BIT18=GRIND BIT19=RETRACT_Z BIT20=IS_ANOMALY_REPORT	LOCATION RAT_REQUEST_PARMS (group) SOURCE Lookup Table and list only values that are true. PDS standards are to place these unordered values in curly braces, {} represents the empty set. IDPH:rat_error										
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			LOCATION TELEMETRY (Class) SOURCE UPTH:TotalParts										
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		TBD	LOCATION FILE DATA ELEMENT (Class) SOURCE Static Value										
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)		<table border="0"> <tr> <td>SCID</td> <td>Keyword Values</td> </tr> <tr> <td>252</td> <td>"MER1"</td> </tr> <tr> <td>253</td> <td>"MER2"</td> </tr> <tr> <td>254</td> <td>"SIM1"</td> </tr> <tr> <td>255</td> <td>"SIM2"</td> </tr> </table>	SCID	Keyword Values	252	"MER1"	253	"MER2"	254	"SIM1"	255	"SIM2"	LOCATION IDENTIFICATION (Class) SOURCE Table Lookup CHDO_82:scft_id
SCID	Keyword Values														
252	"MER1"														
253	"MER2"														
254	"SIM1"														
255	"SIM2"														

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
INSTRUMENT_HOST_NAME	<p>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.</p> <p>Note that mosaics may contain more than one value in an array.</p>	String		<p>“MARS EXPLORATION ROVER 1”</p> <p>“MARS EXPLORATION ROVER 2”</p> <p>“SIMULATED MARS EXPLORATION ROVER 1”</p> <p>“SIMULATED MARS EXPLORATION ROVER 2”</p>	<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE Table Lookup CHDO_82:scft_id</p>
INSTRUMENT_ID	<p>Provides an abbreviated name or acronym which identifies an instrument.</p> <p>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.</p> <p>Example values: IRTM (for Viking Infrared Thermal Mapper), PWS (for plasma wave spectrometer).</p>	string(12)		<p>29 = “MI”</p> <p>32 = “APXS”</p> <p>33 = “MB”</p> <p>34 = “RAT”</p>	<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE Table Lookup; CCSDS:Primary:APID</p>
INSTRUMENT_TYPE	<p>Identifies the type of an instrument.</p> <p>Example values: POLARIMETER, RADIOMETER, REFLECTANCE SPECTROMETER, VIDICON CAMERA.</p> <p>Note that mosaics may contain more than one value in an array.</p>	String		“DRILL”	<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE Static Value</p>
LABEL_RECORDS	<p>Indicates the number of physical file records that contain only (PDS) label information. The number of data records in a file is determined by subtracting the value of label_records from the value of file_records.</p> <p>Note: In the PDS, the use of label_records along with other file-related data elements is fully described in the Standards Reference.</p>	Integer		0 to n	<p>LOCATION FILE DATA ELEMENT (Class)</p> <p>SOURCE Calculated by size of PDS label.</p>

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
LOCAL_TRUE_SOLAR_TIME	<p>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.</p> <p>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.)</p> <p>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,</p> $LTST = (a(P) - a(TS)) * (24 / 360) + 12$ <p>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</p>	string(12)		NOTE: Value will be uncalibrated if SPICE kernels are unavailable.	<p><u>LOCATION</u></p> <ul style="list-style-type: none"> •IDENTIFICATION (Class) <p><u>SOURCE</u></p> <ul style="list-style-type: none"> •Calculation: -IDPH:begin->sctime.seconds IDPH:begin->sctime.subseconds - SCLK Kernel - Landing- Site kernel - P Kernel

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> Location in PDS Label Source
MAXIMUM_ANGULAR_VELOCITY	Maximum revolve velocity output of torque controller for the scan and grind portion of the command.	float	angular velocity in rad/sec (<rad/sec> unit tag required)	-3.4e38 to +3.4e38	LOCATION a) SEEK_SCAN_REQUEST_PARMS (group) b) GRIND_REQUEST_PARMS (group) SOURCE a) IDPH:rat_ss_kmax b) IDPH:rat_grd_kmax
MAXIMUM_CURRENT_PERSISTENCE	Persistence of the maximum current.	Integer		0-480	LOCATION RAT_REQUEST_PARMS (group) SOURCE IDPH:rat_rat_mperst
MAXIMUM_TRAVEL_DISTANCE	The maximum_length element supplies the maximum number of units associated with the representation of the data element. For MER, this is the maximum allowable travel distance (relative to the lower hardstop) along the z-axis for all MER RAT operations.	float	length in mm (<mm> unit tag required)	-3.4e38 to +3.4e38	LOCATION RAT_REQUEST_PARMS (group) SOURCE IDPH:rat_rat_ztravl
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"	LOCATION IDENTIFICATION (Class) SOURCE Static Value
MISSION_PHASE_NAME	Provides the commonly-used identifier of a mission phase.	string(30)		"CRUISE", "EXTENDED MISSION", "PRIMARY MISSION", "ATLO", "ORT1", "ORT2", "TBD"	LOCATION IDENTIFICATION (Class) SOURCE Operator Supplied Parameter
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			LOCATION IDENTIFICATION (Class) SOURCE IPDH:context_id

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
ORIGIN_OFFSET_VECTOR	<p>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.</p> <p>For MER, here is an example: 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.</p>	float array[3]	meters		<p>LOCATION</p> <ul style="list-style-type: none"> a) START_ROVER_COORDINATE_SYSTEM (Group) b) STOP_ROVER_COORDINATE_SYSTEM (Group) c) START_IDD_COORDINATE_SYSTEM (Group) d) STOP_IDD_COORDINATE_SYSTEM (Group) e) START_PMA_COORDINATE_SYSTEM (Group) f) STOP_PMA_COORDINATE_SYSTEM (Group) <p>SOURCE</p> <ul style="list-style-type: none"> a) IDPH:begin->pos.v[3] b) IDPH:end->pos.v[3] c) IDPH:begin->idd.pos[3] d) IDPH:end->idd.pos[3] e) IDPH:begin->pma_pos.v[3] f) IDPH:end->pma_pos.v[3]

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
ORIGIN_ROTATION_QUATERNION	<p>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.</p> <p>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.</p> <p>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 POSITIVE_ELEVATION_DIRECTION is declared to be "UP" or "DOWN"</p> <p>For MER, here is an example: 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.</p>	float array[4]			<p>LOCATION</p> <ul style="list-style-type: none"> a) START_ROVER_COORDINATE_SYSTEM (Group) b) STOP_ROVER_COORDINATE_SYSTEM (Group) c) START_IDD_COORDINATE_SYSTEM (Group) d) STOP_IDD_COORDINATE_SYSTEM (Group) e) START_PMA_COORDINATE_SYSTEM (Group) f) STOP_PMA_COORDINATE_SYSTEM (Group) <p>SOURCE</p> <ul style="list-style-type: none"> a) IDPH:begin->quat.q[4] b) IDPH:end->quat.q[4] c) IDPH:begin->idd.quaternion[4] d) IDPH:end->idd.quaternion[4] e) IDPH:begin->pma_quat.q[4] c) IDPH:end->pma_quat.q[4] <p>For all of the above, the quaternion is received in the order (v1, v2, v3, s)</p>

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
PACKET_MAP_MASK	<p>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.</p> <p>The number is stored in the PDS radix notation of <radix>#<value>#.</p>	non-decimal			<p>LOCATION TELEMETRY (Class)</p> <p>SOURCE Calculated UPDTH:PartNumber</p>
PDS_VERSION_ID	<p>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'.</p> <p>Examples: PDS3, PDS4.</p>	string(6)		"PDS3"	<p>LOCATION PDS required</p> <p>SOURCE PDS</p>
PLANET_DAY_NUMBER	<p>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).</p>	integer		NOTE = Value will be uncalibrated if SPICE kernels are not available.	<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE Calculated -IDPH:begin->sctime.seconds IDPH:begin->sctime.subseconds SCLK kernel</p>
POSITIVE_AZIMUTH_DIRECTION	<p>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.</p>	string		"CLOCKWISE", "COUNTERCLOCKWISE"	<p>LOCATION a) START_ROVER_COORDINATE_SYSTEM (Group) b) STOP_ROVER_COORDINATE_SYSTEM (Group) c) START_IDD_COORDINATE_SYSTEM (Group) d) STOP_IDD_COORDINATE_SYSTEM (Group) e) START_PMA_COORDINATE_SYSTEM (Group) f) STOP_PMA_COORDINATE_SYSTEM (Group)</p> <p>SOURCE Static Value</p>

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> Location in PDS Label Source
POSITIVE_ELEVATION_DIRECTION	<p>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.</p> <p>For MER, which follows the Mars Pathfinder convention, increasing elevation ("UP") moves towards the negative Z axis.</p>	string		"UP", "DOWN"	<p>LOCATION a) START_ROVER_COORDINATE_SYSTEM (Group) b) STOP_ROVER_COORDINATE_SYSTEM (Group) c) START_IDD_COORDINATE_SYSTEM (Group) d) STOP_IDD_COORDINATE_SYSTEM (Group) e) START_PMA_COORDINATE_SYSTEM (Group) f) STOP_PMA_COORDINATE_SYSTEM (Group)</p> <p>SOURCE Static Value</p>
PROCESSING_HISTORY_TEXT	Provides an entry for each processing step and program used in generating a particular data file.	string		"CODMAC LEVEL 1 TO LEVEL 2 CONVERSION VIA JPL/MIPL MERTELEMPROC"	<p>LOCATION HISTORY (Class)</p> <p>SOURCE Static Value</p>
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)		"MULTIMISSION IMAGE PROCESSING SUBSYSTEM, JET PROPULSION LAB"	<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE Static Value</p>
PRODUCT_CREATION_TIME	Defines the UTC system format time when a product was created. Formation rule: YYYY-MM-DDThh:mm:ss[.fff]Z	string			<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE Calculated</p>
PRODUCT_ID	<p>Represents a permanent, unique identifier assigned to a data product by its producer. See also: source_product_id.</p> <p>Note: In the PDS, the value assigned to product_id must be unique within its data set.</p> <p>Additional note: The product_id can describe the lowest-level data object that has a PDS label.</p>	string(40)		File less the extension.	<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE Calculated</p>
PRODUCT_TYPE	The PRODUCT_TYPE data element identifies the type or category of a data product within a data set. Examples: EDR, UDR.	string		"RAT_EDR"	<p>LOCATION IDENTIFICATION (class)</p> <p>SOURCE Static Value</p>

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
PRODUCT_VERSION_ID	<p>Identifies the version of an individual product within a data set.</p> <p>PRODUCT_VERSION_ID is intended for use within AMMOS to identify separate iterations of a given product, which will also have a unique FILE_NAME.</p> <p>For MER, PRODUCT_VERSION_ID includes a Version field that begins with "V" followed by the Version decimal number of the controlling SIS document.</p> <p>Example: "V2.0 D-22850"</p> <p>Note: This might not be the same as the data set version that is an element of the DATA_SET_ID value.</p>	string(12)		"V<vernum> D-22850"	<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE User Parameter</p>
QUATERNION_MEASUREMENT_METHOD	<p>Specifies the quality of the rover orientation estimate.</p> <p>"UNKNOWN" - The attitude should simply not be trusted. This is the initial grade given on Landing, for example.</p> <p>"TILT_ONLY" - The attitude estimate is only good for tilt determination (2-axis knowledge). Activities which require azimuth knowledge should be careful.</p> <p>"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").</p> <p>"FINE" - Sungaze completed successfully, and the attitude estimate is sufficient for pointing HGA (a.k.a. "ThreeAxisFine").</p>	string		0 = "UNKNOWN" 1 = "TILT_ONLY" 2 = "COARSE" 3 = "FINE"	<p>LOCATION a) START_ROVER_COORDINATE_SYSTEM_ (Group) b) STOP_ROVER_COORDINATE_SYSTEM_ (Group)</p> <p>SOURCE Table Lookup a) IDPH:begin->qual b) IDPH:end->qual</p>

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
RECEIVED_PACKETS	Provides the total number of telemetry packets which constitute a reconstructed data product.	integer			<p>LOCATION TELEMETRY (Class)</p> <p>SOURCE Calculated UPTH:PacketNumber</p>
RECORD_BYTES	<p>Indicates the number of bytes in a physical file record, including record terminators and separators.</p> <p>Note: In the PDS, the use of record_bytes, along with other file-related data elements is fully described in the Standards Reference.</p>	integer		0 to n	<p>LOCATION FILE DATA ELEMENT(Class)</p> <p>SOURCE Calculated</p>
RECORD_TYPE	<p>Indicates the record format of a file.</p> <p>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.</p>	string(20)		"FIXED_LENGTH"	<p>LOCATION FILE DATA ELEMENT(Class)</p> <p>SOURCE Static Value</p>

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
REFERENCE_COORD_SYSTEM_INDEX	<p>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.</p> <p>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 reference coordinate system instances. It is legal to use any number of indices to describe a reference coordinate system instance, however.</p> <p>See also REFERENCE_COORD_SYSTEM_NAME and COORDINATE_SYSTEM_INDEX.</p>	integer array[5]			<p>LOCATION</p> <ul style="list-style-type: none"> a) START_ROVER_COORDINATE_SYSTEM (Group) b) STOP_ROVER_COORDINATE_SYSTEM (Group) c) START_IDD_COORDINATE_SYSTEM (Group) d) STOP_IDD_COORDINATE_SYSTEM (Group) e) START_PMA_COORDINATE_SYSTEM (Group) f) STOP_PMA_COORDINATE_SYSTEM (Group) <p>SOURCE</p> <p>Calculated from</p> <ul style="list-style-type: none"> a, c, e) IDPH:begin->rmc[5] and REFERENCE_COORD_SYSTEM_NAME b, d, f) IDPH:end->rmc[5] and REFERENCE_COORD_SYSTEM_NAME <p>Use all five elements, except if the REFERENCE_COORD_SYSTEM_NAME = SITE_FRAME, then only use the first element.</p>

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
REFERENCE_COORD_SYSTEM_NAME	<p>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.</p> <p>For MER, the reference is usually a SITE frame.</p>	string(20)		"ROVER_FRAME", "SITE_FRAME", "MAST_FRAME", " "LOCAL_LEVEL_FRAME"	<p>LOCATION</p> <ul style="list-style-type: none"> a) START_ROVER_COORDINATE_SYSTEM (Group) b) STOP_ROVER_COORDINATE_SYSTEM (Group) c) START_IDD_COORDINATE_SYSTEM (Group) d) STOP_IDD_COORDINATE_SYSTEM (Group) e) START_PMA_COORDINATE_SYSTEM (Group) f) STOP_PMA_COORDINATE_SYSTEM (Group) <p>SOURCE</p> <ul style="list-style-type: none"> a) "SITE_FRAME" b) "SITE_FRAME" c) "ROVER_FRAME" d) "ROVER_FRAME" e) "ROVER_FRAME" f) "ROVER_FRAME"
RELEASE_ID	<p>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"</p> <p>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".</p> <p>For example, the first release of the Pancam EDR data set on MER-1 will be August 3, 2004 (according to the Archive Plan), so those products will have RELEASE_ID = "0001". The next Pancam EDR release will be October 4, 2004, so those products will have RELEASE_ID ="0002". The Pancam EDRs from the other rover are a separate data set. Those will be released August 24, 2004 (RELEASE_ID ="0001") and October 25, 2004 (RELEASE_ID ="0002").</p>	string			<p>LOCATION</p> IDENTIFICATION (class) <p>SOURCE</p> User Parameter

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> Location in PDS Label Source
ROTATION_NOLOAD_CURRENT	<p>Specifies the no load current for the rotation motor of an instrument.</p> <p>Note: Used for the MER RAT during all operations of the instrument.</p>	float	current in milliamps	-3.4e38 to +3.4e38	<p>LOCATION RAT_REQUEST_PARMS (group)</p> <p>SOURCE IDPH:rat_rat_rotnl</p>
ROTATION_TORQUE_PARAMETER	Identifies the parameter value or goal for the grinding wheel rotation torque controller for the scan operation and the grind operation.	float	torque in mN*m	-3.4e38 to +3.4e38	<p>LOCATION a) SEEK_SCAN_REQUEST_PARMS (group) b) GRIND_REQUEST_PARMS (group)</p> <p>SOURCE a) IDPH:rat_ss_rotset b) IDPH:rat_grd_rotset</p>
ROTATION_VOLTAGE	<p>Specifies the open-loop voltage supplied to the instrument rotation motor.</p> <p>For MER, this is the grinding wheel rotation motor during initialization/diagnostics, seek and scan, grinding, and brushing operations.</p>	Float array of one or more	potential in Volts	-3.4e38 to +3.4e38	<p>LOCATION a) DIAGNOSTICS_CAL_REQUEST_PARMS (group) b) SEEK_SCAN_REQUEST_PARMS (group0) c) GRIND_REQUEST_PARMS (group) d) BRUSH_REQUEST_PARMS (group)</p> <p>SOURCE a) IDPH:rat_dc_rotvol b) IDPH:rat_ss_serotv IDPH:rat_ss_scrotv c) IDPH:rat_grd_rotvol d) IDPH:rat_bsh_rotvol</p>
ROTATION_VOLTAGE_NAME	The formal name of the ROTATION_VOLTAGE when an array of values is supplied	string array[2]		(SEEK, SCAN)	<p>LOCATION SEEK_SCAN_REQUEST_PARMS (group)</p> <p>SOURCE Static Value</p>

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
ROVER_MOTION_COUNTER	<p>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.</p> <p>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.</p> <p>Conceptually, a sixth value could be added by ground processing to indicate unintentional slippage (e.g. the wind blew the rover off a rock). This sixth value will never occur in telemetry but might occur in certain RDR's. (implementation of this is TBD).</p>	integer array[5]			<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE IDPH:begin->rmc(5)</p>
ROVER_MOTION_COUNTER_NAME	An array that provides the formal names identifying each integer in ROVER_MOTION_COUNTER.	string array[5]		("SITE", "DRIVE", "IDD", "PMA", "HGA")	<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE Static Value</p>

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> Location in PDS Label Source
SAMPLING_PARAMETER_INTERVAL (PDS DD)	<p>The sampling_parameter_interval element identifies the spacing of points at which data are sampled and at which a value for an instrument or dataset parameter is available. This sampling interval can be either the original (raw) sampling or the result of some resampling process.</p> <p>For MER, this is the number of RTIs to skip between telemetry samples in the detailed report, for all RAT operations.</p>	unsigned integer	cpu_interval in RTIs	0 to 4294967295	<p>LOCATION RAT_REQUEST_PARMS (group)</p> <p>SOURCE IDPH:rat_rat_tlmskp</p>
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)			<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE UPTH:PrdCmdID:SequenceID</p>
SEQUENCE_VERSION_ID	Provides the version identifier for a particular observation sequence used during planning or data processing.	string(30)			<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE UPTH:PrdCmdID:SequenceVersion</p>
SOFTWARE_NAME	Identifies data processing software such as a program or a program library.	string(60)		i.e. "MERTELEMPOC"	<p>LOCATION HISTORY (Class)</p> <p>SOURCE User Parameter</p>
SOFTWARE_VERSION_ID	Indicates the version (development level) of a program or a program library.	string(20)			<p>LOCATION HISTORY (Class)</p> <p>SOURCE User Parameter</p>
SPACECRAFT_CLOCK_CNT_PARTITION	Indicates the clock partition active for the SPACECRAFT_CLOCK_START_COUNT and SPACECRAFT_CLOCK_STOP_COUNT elements.	integer		1	<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE Static Value</p>

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
SPACECRAFT_CLOCK_START_COUNT	<p>Provides the value of the spacecraft clock at the beginning of a time period of interest.</p> <p>Format is dddddddddd.ddd, measured in units of Seconds stored internally as a floating point number.</p> <p>Note: In the PDS, sclk_start_counts have been represented in the following ways: Voyager - Flight Data Subsystem (FDS) clock count (floating point 7.2) Mariner 9 - Data Automation Subsystem, Mariner 10 - FDS - spacecraft clock</p>	string(30)			<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE IDPH:begin->sctime.seconds IDPH:begin->sctime.subseconds</p> <p>Note: It is possible for the sclk to be earlier than the DVT time reported in the data product meta data file and the sclk reported in the data product file name.</p>
SPACECRAFT_CLOCK_STOP_COUNT	<p>Provides the value of the spacecraft clock at the end of a time period of interest.</p> <p>Format is dddddddddd.ddd, measured in units of Seconds and is stored internally as a floating point number.</p>	string(30)			<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE Calculated IDPH:end->sctime.seconds IDPH:end->sctime.subseconds</p>
SPICE_FILE_NAME	<p>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.</p>	string (180)			<p>LOCATION HISTORY (Class)</p> <p>SOURCE User parameter</p>
START_TIME	<p>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]</p>	string			<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE Calculated IDPH:begin->sctime.seconds IDPH:begin->sctime.subseconds SCLK kernel</p>
STOP_TIME	<p>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]</p>	string			<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE Calculated IDPH:end->sctime.seconds IDPH:end->sctime.subseconds SCLK kernel</p>
TARGET_NAME	<p>Identifies a target. The target may be a planet, satellite, ring, region, feature, asteroid or comet. See TARGET_TYPE.</p>	string(30)		"MARS", "CALIBRATION"	<p>LOCATION IDENTIFICATION (Class)</p> <p>SOURCE MARS</p>

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
TARGET_TYPE	Identifies the type of a named target.	string		"CALIBRATION", "DUST", "N/A", "SUN", "PLANET"	LOCATION IDENTIFICATION (Class) SOURCE Static Value – PLANET
TELEMETRY_FORMAT_ID	Telemetry format code	string		SCI (RAT SCIENCE DATA)	LOCATION TELEMETRY (Class) SOURCE Static value
TELEMETRY_PROVIDER_ID	Identifies the provider and version of the telemetry data used in the generation of this data.	string		"SSW MER_DP", "TTACS"	LOCATION TELEMETRY (Class) SOURCE User Parameter
TELEMETRY_SOURCE_NAME	Identifies the name of the telemetry source used in the creation of this data set.	string			LOCATION TELEMETRY (Class) SOURCE Name of the input data product.
TELEMETRY_SOURCE_TYPE	Classifies the source of the telemetry used in creation of this data set.	string(12)		"SFDU", "DATA PRODUCT"	LOCATION TELEMETRY (Class) SOURCE User Parameter
TIMEOUT_PARAMETER	Identifies the revolve timeout for grinding. If the grinding doesn't complete a full revolution within this time it will determine that it is not making sufficient progress and end the grinding.	unsigned integer	duration in seconds	0 to 4294967295	LOCATION GRIND_REQUEST_PARMS (group) SOURCE IDPH:rat_grd_revtime
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			LOCATION TELEMETRY (Class) SOURCE IDPH:version
TORQUE_CONSTANT	Rotate motor torque constant of an instrument.	float	mN*m/mA		LOCATION RAT_REQUEST_PARMS (group) SOURCE IDPH:rat_rat_rotcst

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> Location in PDS Label Source
TORQUE_GAIN	Torque controller proportional gain, derivative gain, integral gain	Float array[3]	(rad/(sec*m N*m), rad/(mN*m), rad*sec/(mN*m))	-3.4e38 to +3.4e38 Provide units with values.	LOCATION a) SEEK_SCAN_REQUEST_PARMS (group) b) GRIND_REQUEST_PARMS (Group) SOURCE a) IDPH:rat_ss_kp IDPH:rat_ss_kd IDPH:rat_ss_ki b) IDPH:rat_grd_kp IDPH:rat_grd_kd IDPH:rat_grd_ki
TORQUE_GAIN_NAME	Formal name of the TORQUE_GAIN element.	String array[3]		(PROPORTIONAL, DERIVATIVE, INTEGRAL)	LOCATION a) SEEK_SCAN_REQUEST_PARMS (group) b) GRIND_REQUEST_PARMS (group) SOURCE Static Value
Z_AXIS_DISTANCE	Distance of the z-axis home position from the lower motor hardstop of an instrument. For MER, this is the position to which the RAT will move after calibrating against the lower hardstop offset at the start of the RAT_DIAG or RAT_CAL commands and at the end of the RAT_GRIND, RAT_BRUSH commands.	float	length in mm	-3.4e38 to +3.4e38	LOCATION RAT_REQUEST_PARMS (group) SOURCE IDPH:rat_rat_zhome
Z_AXIS_POSITION	Specifies the z-axis offset from the lower hardstop to which the RAT will move at the start of the RAT_BRUSH command.	float	length in mm	-3.4e38 to +3.4e38	LOCATION BRUSH_REQUEST_PARMS SOURCE IDPH:rat_bsh_zpos
Z_AXIS_STEP_SIZE	Specifies the distance or step size to move the z-axis of an instrument. For MER, this is distance the RAT is moved in the negative direction once the grinding wheel is no longer able to complete a full revolution in the seek and scan operations. And, this is the distance to move the z-axis in the positive direction once the grinding wheel completes a full revolution.	float	length in mm	-3.4e38 to +3.4e38	LOCATION a) SEEK_SCAN_REQUEST_PARMS (group) b) GRIND_REQUEST_PARMS (group) SOURCE a) IDPH:rat_ss_zstep b) IDPH:rat_grd_zstep

Keyword Name	Definition	Type	Units	Valid Values	<ul style="list-style-type: none"> • Location in PDS Label • Source
Z_AXIS_VELOCITY	Specifies the z-axis velocity during an operations period of an instrument command.	Float array of one or more	velocity in mm/sec	-3.4e38 to +3.4e38	<p>LOCATION</p> <ul style="list-style-type: none"> a) DIAGNOSTICS_CAL_REQUEST_PARMs (group) b) SEEK_SCAN_REQUEST_PARMs (group) c) GRIND_REQUEST_PARMs (group) d) BRUSH_REQUEST_PARMs (group) <p>SOURCE</p> <ul style="list-style-type: none"> a) IDPH:rat_dc_zvel b) IDPH:rat_ss_sezvel <li style="padding-left: 20px;">IDPH:rat_ss_sczvel c) IDPH:rat_grd_zvel d) IDPH:rat_bsh_zvel
Z_AXIS_VELOCITY_NAME	Provides the formal name of the element of the Z_AXIS_VELOCITY element when used in an array of values.	string array[2]		(SEEK, SCAN)	<p>LOCATION</p> <ul style="list-style-type: none"> SEEK_SCAN_REQUEST_PARMs (group) <p>SOURCE</p> <ul style="list-style-type: none"> Static Value