MESSENGER Radio Science Raw Data Archive

Experiment Data Records (EDR)
Software Interface Specification (SIS)

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Document Review

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

Mark Perry, MESSENGER RS Instrument Scientist has reviewed and approved this document.

Richard Simpson, PDS RS Representative, has reviewed and approved this document.

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

Document Change Log

Revision Number	Revision Date	Author	Section	Remarks
1.0	1 Nov 2007	M. Perry	All	Initial version
1.1	24 Jun 2008	M. Reid	2.3, 3.6	Updated naming conventions for ION and WEA ancillary files. Modified description of ACK files. Other minor changes.
1.2	11 Mar 2009	M. Perry M. Reid	1.2, 3.3, 3.5, 4	Add DDOR, update descriptions.
1.3	1 Nov 2009	M. Perry M. Reid	All	Updated, reorganized, and corrected based upon comments received from the July 2009 PDS peer review.
1.4	02 Jun 2011	M. Reid	2.2, 2.3,	Replaced ACK with ANT product; added

			2.4.2	MDM product; miscellaneous edits.
1.5	16 Jun 2011	S. Ensor	Document Review	Added document review information
1.6	15 Jun 2015	M. Reid	2.2.1, Table 2, 2.4.2, 3.5,	Removed references to deprecated ACK and GDF products. The ACK products were replaced by the ANT and the GDF by the SPK included in the SPICE archive at the NAIF PDS node.

Items to be Determined

Revision Number	Description	Sections Affected	Responsibility/ Due Date
1.0	None		

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Acronyms and Abbreviations

ANT Antenna Configuration
APL Johns Hopkins University Applied Physics Laboratory
ASCII American Standard Code for Information Interchange
AU Astronomical Unit
CK Camera Kernel (as in CK file)
DDOR Delta-Differential One-way Range (file or directory)

DSCC Deep Space Communications Complex
DSN Deep Space Network
DSS DSN station identifier
G&C Guidance and Control
ICD Interface Control Document
IERS International Earth Rotation and Reference Systems Service
ION Ionosphere Calibration File (or directory)
JPL Jet Propulsion Laboratory
ksps Kilo samples per second
LTF Light Time File (or directory)
LSK Leap Seconds Kernel file
MDM Momentum Dump Maneuver
MESSENGER MErcury Surface, Space ENvironment, GEochemistry, and Ranging
Msps Mega samples per second
MPD Maneuver Performance Data (file or directory)
NAIF Navigation and Ancillary Information Facility
NASA National Aeronautics and Space Administration
NAV Navigation Subsystem/Team
ODF Orbit Data File (TRK-2-18 files) or directory
ODL Object Description Language
PCK Planetary Constants Kernel
PDS Planetary Data System
RDA Raw Data Archive
RS Radio Science
RSR Radio Science Receiver (open loop data) file or directory
RST Radio Science Team
SCLK Spacecraft Clock
SCET Spacecraft Event Time
SIS Software Interface Specification
SOC Science Operations Center
SPICE Spacecraft Planet Instrument Camera-matrix Events
SPK Spacecraft Planet Kernel file
TBD To Be Determined
TRO Troposphere Calibration Data (file or directory)
TNF Tracking And Navigation File (TRK-2-34 data) or directory
TSAC Tracking System Analytic Calibration
TXT Text
VLBI Very Long Baseline Interferometer
WEA DSN Weather data (file or directory)

Contents

1 Introduction

1.1 Purpose and Scope

This Software Interface Specification (SIS) describes the format and content of the MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) Radio Science (RS) Raw Data Archive (RDA). The MESSENGER RS RDA represents the complete archive of raw data from investigations conducted using the radio link between the MESSENGER spacecraft and stations of the NASA Deep Space Network (DSN).

The MESSENGER RS RDA is a product of the MESSENGER Radio Science Team (RST), in conjunction with the MESSENGER Science Operation Team and the NASA Planetary Data System (PDS). It is the deliverable raw data archive from the MESSENGER Project radio science investigations to PDS. The Johns Hopkins University Applied Physics Laboratory (APL) manages the MESSENGER mission and is responsible for delivering the RS data to the Planetary Data System (PDS) Geosciences Node, where these files and data are publically available.

This SIS is intended to provide enough information to enable users to understand the files and their organization in the data archive. The users for whom this SIS is intended are the scientists and

investigators who will process and analyze the data, including those associated with the MESSENGER Project.

1.2 Data Overview

The MESSENGER RS data archive is a collection of data and documentation generated by various elements of the DSN, the MESSENGER Project, the RST, and others. RS data consist of primary data and ancillary data, which are secondary data. The ancillary data are needed for the processing or interpretation of primary data but are not usually considered to have science value of their own.

Data are stored in fields of various sizes and formats. The formats vary among file types, and users should consult the appropriate SIS for details (see Section 2.3). Data that comprise MESSENGER RS RDAs are formatted in accordance with Planetary Data System specifications

The DSN closed-loop system uses a phase-lock loop in the ground receiver to track the downlink signal, reporting both amplitude and frequency at rates of 10 times per second. The raw closed-loop data are stored as TRK-2-34 files, which are labeled Tracking and Navigation Files (TNF) and also contain parameters such as the DSN receiver settings and uplink frequency. A second type of closed loop data are the TRK-2-18 files, which are labeled Orbit Data Files (ODF) and are compressed versions of TNFs, typically to one data point per 10 seconds or one data point per 60 seconds. Closed-loop data are efficient for characterizing slowly changing signals and are the input to operational navigation and orbit-determination processes. The ODF contains the most important information (range, Doppler and frequency ramps) needed by the navigation engineers, and investigators interested in determining gravity fields. Delta-Differential One-way Ranging (DDOR) data are another type of closed-loop data. They involve multiple ground stations and provide position information normal to the line of site.

In the open-loop system, the signal is simply converted to a baseband frequency range; the entire passband is sampled and recorded for later processing. Radio Science Receiver records (RSRs) are the primary data type from the open-loop system. Open-loop data (because of their much higher rate and volume) are collected only when the signal is expected to be very dynamic—such as during a spacecraft maneuver or an occultation. For MESSENGER, RSR data are used primarily to extract the planet's radius from the time of occultation.

Many of the RS data files are delivered by JPL/DSN to the "oscarx" server at JPL. These files are then transferred on a weekly schedule to APL, associated with labels, and placed into the RS directory at the APL Science Operations Center (SOC). These files are immediately accessible to the MESSENGER team and MESSENGER RS archives are produced as data become available. The archives are reviewed, validated, organized, and periodically delivered to PDS for archiving according to the MESSENGER program schedule, about once every six months.

The ancillary data, which are used to support analysis of the primary data, come from a variety of sources. They include weather data, antenna configurations, and spacecraft mass parameters. Ancillary data are stored at the PDS site, but some ancillary data useful for RS investigations are archived at other locations, primarily the NAIF site. These data and locations are described in Sections 2.2 and 4.

1.3 Applicable Documents and References

There are four groups of reference documents:
1) SIS documents for each of the primary and ancillary files delivered with the volume. `Table 2` contains a list of each data file and the accompanying SIS.
2) Files and Documents that are not in the RS data archive and are archived elsewhere. These files and documents are described in Section 4.
3) PDS standards (including the Planetary Science Data Dictionary), which are accessible from the top-level PDS site, http://pds.jpl.nasa.gov/ and following the link to "About PDS".
4) Descriptions in journal publications, listed in REF.CAT, in the CATALOG directory (Section 3.2).

2 Description of Archived Data

The data set covers the time from October 2006 (two years into the cruise phase of the mission) until six months before the most-recent delivery date. Data are delivered as per the MESSENGER program delivery schedule, usually every six months. The total volume for all RS data during the duration of the primary mission is expected to be less than 60 gigabytes.

Prior to release, each update to the MESSENGER RS data volume is evaluated internally by the MESSENGER RST and (to the extent that resources permit) by a representative of PDS.

Each data type has an identifier code. All of the data files, with the exception of TNFs, have their identifier code as part of the filename so that the data content and purpose can be readily determined. TNF file names end with "_234.DAT". (Some SPICE file names do not include their identifier code). Most identifier codes are three letters, but two identifier codes have four letters (DDOR and SCLK) and some SPICE files have codes that are two letters.

The primary data files are in binary format. Some of the ancillary files are also binary format, but many are text files. Most of the documentation files are text format, but some of the SIS documents are in PDF, HTML, or both.

2.1 Primary Data

The four primary data types are ODF, TNF, DDOR, and RSR, and are science product EDR files that are archived in binary format (.DAT suffix). The formats are described in their respective SIS documents provided in the DOCUMENT directory and/or their associated PDS labels (see Section 2.3).

The TNF is the primary output from the MESSENGER closed-loop system. In the TNF about 20 record types are defined, each designed for a particular audience, although it is frequently the case that users need more than one record type. The emphasis of the data is on phase of the transmitted and received signals, with 10 phase counts recorded each second. Each TNF is accompanied by a

PDS minimal label that points to a software specification document (TNF_SIS.TXT) in the DOCUMENT directory of the archive for detailed descriptions of the records and fields.

The ODF is a compressed version of the TNF. It contains the most important information (range, Doppler and frequency ramps) needed by spacecraft navigators and investigators interested in determining gravity fields. Each ODF is accompanied by a full PDS label which describes both the content and format of the associated file. ODF data fields include:

Narrowband spacecraft VLBI, Doppler mode (cycles)
Narrowband spacecraft VLBI, phase mode (cycles)
Narrowband quasar VLBI, Doppler mode (cycles)
Narrowband quasar VLBI, phase mode (cycles)
Wideband spacecraft VLBI (nanoseconds)
Wideband quasar VLBI (nanoseconds)
One-way Doppler (Hertz)
Two-way Doppler (Hertz)
Three-way Doppler (Hertz)
One-way total count phase (cycles)
Two-way total count phase (cycles)
Three-way total count phase (cycles)
PRA planetary operational discrete spectrum range (range units)
SRA planetary operational discrete spectrum range (range units)
RE(GSTDN) range (nanoseconds)
Azimuth angle (degrees)
Elevation angle (degrees)
Hour angle (degrees)
Declination angle (degrees)

Delta-Differential One-way Range (DDOR) measurements complement the normal Doppler and ranging data, which are best along the Earth-spacecraft line. DDOR data provide measurements that are analyzed to obtain position information that is orthogonal to the Earth-spacecraft line, a measurement that is only inferred indirectly from Doppler and ranging measurements. The DDOR measurements are largely independent of some common tracking and navigation errors such as media, station locations, UT1 and polar motion. DDORs are the difference between two Very Long Baseline Interferometer (VLBI) measurements of the spacecraft and a nearby quasar. This ties the Earth-spacecraft direction to a quasar location in the plane of the sky. This achieves highly-accurate measurements of the location of the spacecraft perpendicular to the line of sight, or the angular (not range) location of the spacecraft relative to Earth. Accuracies can be 10 nanoradians (1.5 km at 1 AU) or better. A single DDOR determines the angle along a baseline between the two VLBI antennas. To get both declination and azimuth (location in two dimensions) requires different baselines such as Madrid-Goldstone (east-west) and Goldstone-Canberra (more north-south).

Radio Science Receiver (RSR) records contain samples of open loop receiver output; the samples are complex and can have 1-16 bits in both the in-phase (I) and quadrature (Q) components, depending on sampling rate and precision requested. Sampling rates between 1 ksps and 16 Msps

may be requested. Each RSR file is accompanied by a full PDS label which describes both the format and the content at the bit level.

The JPL DSN team places the ODF closed-loop tracking data files on the "oscarx" server at DSN/JPL. APL then pulls the files to an APL server. The TNF and DDOR files are delivered to APL via a secure file transfer. APL builds labels and transfers all data to the SOC. The RSR files are created by the JPL Radio Science Systems Group and transferred to APL.

2.2 Ancillary Data

This section provides a list of the ancillary data types that are archived at either the PDS Geosciences Node or NAIF sites. For each file type stored at the Geosciences Node, the list includes a brief description of the data, the entity that generates the data, and the file extension.

2.2.1 Ancillary Data Stored at the PDS

Ancillary data files

Identifier	Description	Data Source	File Extension
ANT	Antenna Configuration file. Text file containing the antenna configuration; based on spacecraft telemetry	SOC	TXT
MPD	Maneuver Performance Data Files, which contain estimates of spacecraft mass and center of mass; moments of inertia; thruster locations, directions, and magnitudes; and propellant flow rate	G&C	TXT
MDM	Momentum Dump Maneuver file. Contains summary information on each angular momentum dump	G&C	CSV
SFF	Small forces files, contain details of each maneuver	G&C	TAB
LTF	Light time files providing the radio propagation time from the spacecraft to the Earth and from the Earth to the spacecraft vs. time	Navigation	TAB
ION	Ionosphere (media) calibration files, providing historical and predicted Earth ionospheric conditions	TSAC	TXT
TRO	Troposphere (media) calibration files, providing historical and predicted Earth troposphere conditions	TSAC	TXT
WEA	DSN weather files give weather calibration information for DSN complexes	TSAC	TXT

Table 1 Radio Science ancillary data products.

Tabular files (.TAB suffix) exist in the INDEX directory and may be present in the other directories. All tabular files are filled with ASCII characters. Some are formatted for direct reading into database management systems; they consist of data “fields” separated by spaces. Character fields are also enclosed in double quotation marks (") and are padded with spaces to keep quotation marks in the same columns of successive records. Character fields are left justified, and numeric fields are right justified. The records in tabular files have fixed length, and the last two bytes of each record contain the ASCII carriage return and line feed characters.

Catalog files (suffix .CAT) exist in the root and CATALOG directories. They are formatted in an object-oriented structure consisting of sets of "keyword=value" declarations. They are PDS standard Object Description Language (ODL) text files containing variable-length records. These files are a standard part of any PDS archive and provide specific information relating to the archive volume, the instrument, the host spacecraft, references to external documents, contact information for key personnel and the data sets.

MESSENGER RS analyses do not require the pointing angle for the high-gain (phased array) antennas or the low-gain antennas. The phase center of the low-gain antennas varies less than a centimeter over +/-90 degrees from its bore-sight angle. The angular dependence of the phase center of the high-gain antenna is not required because spacecraft attitude does not change during a DSN contact period when using either the fan beams or high-gain antennas.

2.2.2 Ancillary Data Stored at NAIF

The Navigation and Ancillary Information Facility (NAIF) is the navigation node of the PDS. NAIF archives navigation, attitude, and some instrument data for all NASA missions and provides the SPICE utility software to manipulate those data. The following is a list of SPICE kernels that are archived at NAIF and that are useful for RS gravity analysis and investigations. The list shows the identifier code and brief description of the purpose of the file. See Section 4.1 for where to find documentation to completely describe each data type.

SPICE files archived at the NAIF site:

Code: Description

SPK: Spacecraft and Planetary ephemeris

CK: Spacecraft attitude and solar array angles.

SCLK: Spacecraft clock

IK: Instrument frame kernels. The RS frame kernel provides antenna locations in spacecraft coordinates

FK: Earth orientation: topocentric locations and reference frame definitions (FK) for Earth stations

PCK: Planetary constants including shape, size, orientation, etc.

LSK: Leap seconds

2.3 Data Labels and Documentation

The Raw Data Archive (RDA) volume root directory is named as follows: MESSRS_0xxx, where xxx is sequential number starting from 001 which will be assigned by the PDS.

PDS labels provide descriptive information about the associated file. The PDS label is written in ODL, which is an object-oriented structure consisting of sets of "keyword=value" declarations. Although they are mostly self-descriptive, the format and keywords of the labels are fully described in the PDS Data Dictionary.

All files contained in MESSENGER RS RDA volume are accompanied by PDS labels. The label can either be prepended to the associated primary file, or it can be "detached", in which case the label becomes a file in its own right with the same name as the primary except for the suffix ".LBL". Detached label files are located in the same directory as the primary file. Except for the files in the root and catalog directories, all files have detached labels. Some documents in the DOCUMENT directory are provided in multiple formats (e.g., HTML, PDF, MS Word, etc.) in multiple files. And HTML documents may include separate image files. In these cases, there is one label for the given document which contains descriptions and pointers to the multiple files associated with that document.

A PDS minimal label accompanies each TNF and DDOR file.

A full PDS label accompanies each ODF and each RSR file.

For each data type, a SIS document fully describes the file contents and data formats. The next table describes the SIS documents for each data type, and includes their identifier code, which defines the type of data according to its archived format, content, or both. The “File Name” column shows the name of the file as it appears in the DOCUMENT directory. The labels for the RSR files fully document the data format, and we do not include a SIS reference document. The TRK-2-34 data format is broad and incorporates all data recorded at DSN stations except for RSR data; both TNF (primarily Doppler and range data) and DDOR files use the TRK-2-34 data format.

SIS documents

Identifier	**Applicable SIS Document**	**SIS File Name**
Primary Data		
TNF	820-013 Deep Space Mission System, External Interface Specification; JPL D-16765; TRK-2-34 Tracking System Data Archival Format	DSN_TRK_2_34_TNF_SIS.HTM
ODF	820-013 Deep Space Mission System, External Interface Specification; JPL D-16765; TRK-2-18 Orbit Data File Interface	DSN_TRK_2_18_ODF_SIS.HTM
DDOR	These DDOR files are formatted according to the TNF SIS document	DSN_TRK_2_34_TNF_SIS.HTM
RSR	No SIS required. Labels are fully documenting.	
Ancillary Data		
ANT	Antenna Configuration data with fully	

	documented label; no SIS required, ANTINFO.TXT file included.	
MPD	The Maneuver Performance Data file description; no SIS required, MPDINFO.TXT file included.	
MDM	The Momentum Dump File; no SIS required, MDMINFO.TXT file included.	
LTF	JPL Light Time File	LTF_SIS.HTM
SFF	SFF SIS Small Forces File	SFF_SIS.HTM
ION TRO	820-013 Deep Space Mission System, External Interface Specification; JPL D-16765; TRK-2-23 Media Calibration Interface	DSN_TRK_2_23_TRO_ION_SIS.HTM
WEA	820-013 Deep Space Mission System, External Interface Specification; JPL D-16765; TRK-2-24 Weather Data Interface	DSN_TRK_2_24_WEA_SIS.HTM

Table 2 Product types and the associated Software Interface Specification documents.

2.4 Naming Conventions for Data Files

Files such as index files, which do not contain primary or ancillary data, have their names and formats described in Section 3.

2.4.1 Primary Data File Names

TNF file names have the following form:

*yydddhhmm*SC236DSS*nn*_234.DAT

where 'yydddhhmm' is the start time year, day of year, hour, minutes and 'nn' is the DSS number.

ODF data file names usually have the following form:

MESS_RS_*yyddd_ddd*_ODF.DAT,
MESS_RS_*yyddd*_ODF_*tt*S.DAT or
MESS_RS_*yyddd*_ODF.DAT

where *yy* is the year, the first *ddd* is the start time day of year, the second *ddd* is the stop time day of year, and *tt* is the integration period in seconds. When the _*tt*S component is absent, the integration period is 60 seconds. Nearly all files have integration periods of 10 seconds or 60 seconds. During some of the early flybys, some files have 1-second integration periods. There are no ODFs with integration periods less than 1 second.

Some ODF file names do not follow these naming conventions. Primarily around flyby events, there are additional data collected (additional antennas and receivers) which require additional terms in the name. Other formats include

MESS_RS_*yyddd_hhmm*.DAT (replaces stop day with start hour and minute)
MESS_RS_*yyddd*_DSS*nn*_D*x*_*tt*S.DAT (where nn is the DSN station number and x is the receiver number)

Occasionally, additional characters indicating time *hhmm* or "NAV" may be included in the filenames to indicate a special collect.

DDOR file names have the following form:

*yydddhhmm*SC236DSS*nn*DDOR_234.DAT

where 'yydddhhmm' is the start time year, day of year, hour, minutes and 'nn' is the DSS number. DDOR observations involve at least two DSN stations, but the file name contains only one DSN station, the one that is identified in the original product file name.

RSR data file names have the following form:

MESS_RS_*yyyydddhhmm_ccc*_RSR.DAT

where 'yydddhhmm' is the start time year, day of year, hour, minutes of the data and 'ccc' is the RSR subchannel. Each DSN antenna has an RSR with multiple channels and subchannels, which can each cover a different frequency band, different sample rate, and different sample resolution. The observing and recording parameters are specified before recording the data.

2.4.2 Ancillary Data File Names

TRO, LTF, SFF, and MPD file names have the form:

MESS_RS_*yyyyddd_yyyyddd_sss.ppp*

where 'yyyyddd_yyyyddd' is the start and end date ('ddd' is the day of the year) of the data in the file, and 'sss' is the three-letter designator for the data type and 'ppp' is the PDS file extension for the type of data (e.g., TAB, .TXT, etc.). See `Table 2` for the three-letter designator for the files.

ANT files are cumulative files and have file names of the form:

MESS_RS_ANT_V*nn*.TXT

where *nn* is the file version number, range 01 to 99.

MDM files are cumulative files and have file names of the form:

MESS_RS_MDM_V*NN*.TXT

where *nn* is the file version number, range 01 to 99.

WEA data file names have the following form:

MESS_RS_*yyyyddd_ddd_ss*_WEA.TXT

where 'ss' is the DSCC number. The file naming convention for WEA files differs from the others in that the stop date contains only the day of year (not the year) and <ss> is the DSCC number (10 - Goldstone, 40 - Canberra, 60 - Madrid).

ION data file names have the following form:

MESS_RS_*yyyyddd_ddd_tt*_ION.TXT

where 'tt' is either 'VL' indicating Delta Differenced One-Way Ranging (VLBI) data or 'DP' indicating Doppler and Range data. The file naming convention for ION files differs from the others in that the stop date contains only the day of year (not the year) and <tt> is the data type (VLBI or Doppler).

3 Structure of Data Archive

The MESSENGER RS RDA volume contains a root directory that consists of three files and five directories.

Primary data are stored in directories TNF, ODF, DDOR, and RSR, which are subdirectories of the DATA directory. Secondary or supporting data, called ancillary data, are stored in the ANCILLARY directory or at other archival sites such as NAIF. Reference documents, which describe the contents and formats of the raw and ancillary data files, are in the DOCUMENT directory.

3.1 Root Directory

The root directory contains the following ASCII files:

File: Description
AAREADME.TXT: Contains a terse description of the RDA contents and format
ERRATA.TXT: Overview of anomalies and errors; contains a cumulative listing of comments and updates concerning the RDA in the data set as of the publication date
VOLDESC.CAT: Contains a description of the contents of the logical volume in a PDS format readable by both humans and computers. This is an ASCII file

The root directory contains the following directories, each described in a separate section, below

Directory: Description
DATA: contains subdirectories for each type of primary (science) data product
ANCILLARY: contains subdirectories for each type of ancillary data
CATALOG: files with high-level descriptions
DOCUMENT: contains the SIS documents
INDEX: a list of all files in the archive and a table of MD5 checksums

3.2 CATALOG Directory

The files in the CATALOG directory provide high-level descriptions of the mission, the spacecraft, the ground system, and the data set. All the files are ASCII files.

The catalog directory contains the following files

File: Description
CATINFO.TXT: Describes the contents of the CATALOG directory.
DATASET.CAT: A PDS high-level description and catalog information about the data set
INST.CAT: A PDS high-level description and catalog information about the spacecraft and ground elements of the radio system
INSTHOST.CAT: A PDS high-level description and catalog information about the spacecraft and ground system

MISSION.CAT: A PDS high-level description and catalog information about the MESSENGER mission and spacecraft

PERSON.CAT: A PDS high-level list and catalog information about personnel involved in creating the archive

REF.CAT: A PDS high-level list and catalog information about references describing the mission, spacecraft, and radio system

3.3 DOCUMENT Directory

In addition to the SIS documents identified in Section 2.3, the DOCUMENT directory contains general reference files. Because some product formats change during the course of the mission, the user should refer to the documents accompanying the data files being used. The DOCUMENT directory contains the following files

General reference documents

File: Description

DOCINFO.TXT: Text description of the contents of the DOCUMENT directory

MESS_RS_EDR_SIS.HTM (.PDF): This SIS document describing MESSENGER raw data

3.4 INDEX Directory

The INDEX directory contains the following files:

File:Description

INDXINFO.TXT: A description of the contents of the INDEX directory

INDEX.LBL: a detached label that completely describes INDEX.TAB

INDEX.TAB: a table listing all MESSENGER RS RDA data files included in this volume

MD5.TAB: a table containing a list of all files in the archive and MD5 checksum values for each.

MD5.LBL: a detached label that completely describes the MD5.TAB file

3.5 DATA Directory

The DATA directory contains four data directories, one for each primary data type: TNF, ODF, RSR, DDOR. These data types are described in Section 2.

The ANCILLARY directory contains the ancillary data that are usually required during analysis of the primary RS data. Each type of ancillary file is archived in a separate subdirectory. Each ancillary file has its own label.

The ANCILLARY directory also includes the following file:

ANCINFO.TXT: Description of each file in the ANCILLARY directory

4 Additional Sources of Data

Several of the ancillary data files that are used for RS analysis are archived in other data archives, NAIF and IERS. These files are stored at NAIF because they are used by investigations other than the RST.

4.1 NAIF

NAIF sites useful for MESSENGER analysis are

Site: Contents

- ftp://naif.jpl.nasa.gov/pub/naif/pds/data/mess-e_v_h-spice-6-v1.0/messsp_1000: Mercury kernels
- http://naif.jpl.nasa.gov/naif/: Documentation on SPICE and utility software
- ftp://naif.jpl.nasa.gov/pub/naif/generic_kernels/: Kernels for generic data such as leap seconds and Earth data

4.2 IERS

The International Earth Rotation and Reference Systems Service (IERS) contains data for the Earth orientation that can be used instead of the SPICE data. The IERS data and documentation are available at
www.iers.org