

**MESSENGER RADIO SCIENCE
DERIVED DATA ARCHIVE VOLUME
SOFTWARE INTERFACE SPECIFICATION**

Version 1.4
August 27, 2013
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DOCUMENT CHANGE LOG

Change	Date	Affected Portions
Initial draft	10/15/12	All
Rev. 1.1. MRR: Removed references to RSDMAP products. Added names for SH*DR products.	1/25/13	Multiple.
Rev. 1.2. MRR: Added SHADR, SHBDR, and OCC subdirectories to DATA directory. Added acronyms. Correct file names in Document directory.	2/13/13	Sec. 2.2 Data Directory Contents and Naming, Acronyms section. Sec. 2.4 Document Directory Contents
Rev. 1.3. MRR: Changed naming convention for spherical harmonics (SHADR/SHBDR) products.	2/20/13	Sec. 2.2 Data Directory Contents and Naming.
Rev. 1.4. MRR: Minor modifications from peer review.	8/27/13	Multiple.

TBD ITEMS

Section	Description
None	

ACRONYMS AND ABBREVIATIONS

ASCII	American Standard Code for Information Interchange
CD-ROM	Compact Disk - Read-Only Memory
CD-WO	Write-Once Compact Disk
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Standards Organization
JPL	Jet Propulsion Laboratory
MESSENGER	Mercury Surface, Space Environment, Geochemistry, and Ranging
MLA	Mercury Laser Altimeter
NSSDC	National Space Science Data Center
OCC	Occultation Summary
PDF	Portable Document Format
PDS	Planetary Data System
PSG	Project Science Group
RS	Radio Science
SDVT	Science Data Validation Team
SHADR	Spherical Harmonics ASCII Data Record
SHBDR	Spherical Harmonics Binary Data Record
SIS	Software Interface Specification
TBD	To Be Determined

GLOSSARY

Archive – An archive consists of one or more data sets along with all the documentation and ancillary information needed to understand and use the data. An archive is a logical construct independent of the medium on which it is stored.

Archive Volume, Archive Volume Set – A volume is a unit of media on which data products are stored; for example, one CD-ROM or DVD-ROM. An *archive volume* is a volume containing all or part of an archive; that is, data products plus documentation and ancillary files. When an archive spans multiple volumes, they are called an *archive volume set*. Usually the documentation and some ancillary files are repeated on each volume of the set, so that a single volume can be used alone.

Catalog Information – Descriptive information about a data set (e.g. mission description, spacecraft description, instrument description), suitable for loading into the PDS catalog.

Data Product – A labeled grouping of data resulting from a scientific observation, usually stored in one file. A product label identifies, describes, and defines the structure of the data. An example of a data product is a planetary image, a spectrum table, or a time series table.

Data Set – An accumulation of data products. A data set together with supporting documentation and ancillary files is an archive.

Standard Data Product – A data product generated in a predefined way using well-understood procedures, processed in "pipeline" fashion. Data products that are generated in a nonstandard way are sometimes called *special data products*.

1. Introduction

1.1. Purpose and Scope

This Software Interface Specification is intended to be used by those who wish to understand the format and content of the MESSENGER Radio Science Derived Data Archive, including Spherical Harmonics and Occultation products. Typically, these individuals would be software engineers, data analysts, or planetary scientists.

The specifications in this document apply to all MESSENGER Radio Science Derived Data standard product archive volumes that are generated by the MESSENGER Project.

1.2. Content Overview

This Software Interface Specification (SIS) describes the format, content, and generation of the MESSENGER Radio Science Derived Data Archive. Section 2, Archive Volume Generation, describes the procedure for transferring data products to archive media. Section 3, Archive Volume Contents, describes the structure of the archive volumes and the contents of each file. Section 4, Archive Volume Format, describes the file formats used on the archive volumes. Finally, Section 5, Support Staff and Cognizant Persons, lists the individuals responsible for generating the archive volumes.

1.3. Applicable Documents and Constraints

This Archive Volume SIS is intended to be consistent with the following documents:

1. *MESSENGER Data Management and Archive Plan*, Rev. B, Feb. 15, 2012, Johns Hopkins University Applied Physics Laboratory.
2. *Software Interface Specification, Spherical Harmonics ASCII Data Record (SHADR)*, Frank Lemoine, version 1.0, Jun. 29, 2006, NASA/Goddard Space Flight Center.
3. *Software Interface Specification, Spherical Harmonics Binary Data Record (SHBDR)*, Frank Lemoine, version 1.0, Jun. 29, 2006, NASA/Goddard Space Flight Center.
4. *Software Interface Specification, MESSENGER Radio Science Reduced Data Record Archive For Radio Occultation Summaries (OCCSUM) Files*, Mark Perry, version 0.91, Jan. 25, 2013, Johns Hopkins University Applied Physics Laboratory.
5. *Planetary Data System Archive Preparation Guide*, April 1, 2010, Version 1.4, JPL D-31224.
6. *Planetary Data System Standards Reference*, February 27, 2009, Version 3.8. JPL D-7669, Part 2.
7. *Planetary Science Data Dictionary Document*, October 20, 2008, JPL D-7116, Rev. F.

1.4. Relationships with Other Interfaces

This Archive Volume SIS could be affected by changes to the design of the MESSENGER Radio Science derived standard data products (Applicable Documents 2, 3, 4, and 5).

2. Archive Volume Contents

This section describes the contents of the MESSENGER Radio Science Derived Data archive volume, including the file names, file contents, file types, and organization responsible for providing the files.

2.1. Root Directory Contents

Files in the Root Directory include an overview of the archive, a description of the volume for the PDS Catalog, and a list of errata or comments about the archive. The following files are contained in the Root Directory.

File Name	File Contents	File Provided By
AAREADME.TXT	Volume content and format information	RS Team
ERRATA.TXT	A cumulative listing of comments and updates concerning all archive volumes published to date	RS Team
VOLDESC.CAT	A description of the contents of this volume in a PDS format readable by both humans and computers	Geosciences Node

2.2. Data Directory Contents and Naming

The Data Directory contains the derived Radio Science products and their PDS labels. Under the Data Directory are three subdirectories named SHADR, SHBDR, and OCC, which store the Spherical Harmonics ASCII Data Record, Spherical Harmonics Binary Data Record, and the Occultation Summary Data Record. *<nn>* in the filenames is a numeric version ID range 01...99.

File Name	File Contents	File Provided By
SHADR/GGMES_20V<nn>_SHA.TAB, SHADR/GGMES_20V<nn>_SHA.LBL	Gravity Spherical Harmonics ASCII Data Record (SHADR)	RS Team
SHBDR/GGMES_20V<nn>_SHB.DAT, SHBDR/GGMES_20V<nn>_SHB.LBL	Gravity Spherical Harmonics Binary Data Record (SHBDR)	
SHADR/GTMES_24V<nn>_SHA.TAB, SHADR/GTMES_24V<nn>_SHA.LBL	Shape Spherical Harmonics ASCII Data Record (SHADR) (ASCII product only)	MLA Team
OCC/MESS_RS_OCC_V<nn>.CSV, OCC/MESS_RS_OCC_V<nn>.LBL	Occultation Summary Product (OCC)	RS Team

2.3. Index Directory Contents

Files in the Index Directory are provided to help the user locate products on this archive volume and on previously released volumes in the archive. The following files are contained in the Index Directory.

File Name	File Contents	File Provided By
INDXINFO.TXT	A description of the contents of this directory	Geosciences Node
INDEX.TAB	A table listing all data products on this archive volume	RS Team

The index table contains one row for each product in the archive. Table 1 lists the columns of the index table.

Table 1 Index table contents.

Column Name	Description	Source
VOLUME_ID	PDS archive volume on which a data product is stored	Always MESSRS_1001
DATA_SET_ID	Unique identifier for data set to which the data product belongs	PDS label
PRODUCT_ID	Unique identifier for data product	PDS label
PRODUCT_TYPE	Type of product, e.g. SHADR, SHBDR, OCC	PDS label
FILE_SPECIFICATION_NAME	Directory path and file name of <i>label</i> file for data product	PDS label file name
PRODUCT_CREATION_TIME	Date and time of data product creation	PDS label
START_TIME	UTC date and time of start of observation	PDS label
STOP_TIME	UTC date and time of end of observation	PDS label
PRODUCT_VERSION_ID	Version number of data product	PDS label

2.4. Document Directory Contents

The Document Directory contains documentation to help the user understand and use the archive data. The following files are contained in the Document Directory.

File Name	File Contents	File Provided By
DOCINFO.TXT	A description of the contents of this directory	Geosciences Node
OCCSUM.TXT	Occultation Summary Product Software Interface Specification	RS Team
MESS_RS_RDR_OCC_AVSIS.TXT, MESS_RS_RDR_OCC_AVSIS.PDF, MESS_RS_RDR_OCC_AVSIS.LBL	Archive Volume SIS (this document) in text and PDF formats, with detached PDS label	Geosciences Node
SHADR.TXT	Spherical Harmonics ASCII Data Record Software Interface Specification	RS Team
SHBDR.TXT	Spherical Harmonics Binary Data Record Software Interface Specification	RS Team

2.5. Catalog Directory Contents

The files in the Catalog Directory provide a top-level understanding of the mission, spacecraft, instruments, and data sets. The files in this directory are coordinated with the PDS data engineer, who is responsible for loading them into the PDS catalog for online searching. The following files are found in the Catalog Directory.

File Name	File Contents	File Provided By
CATINFO.TXT	A description of the contents of this directory	Geosciences Node
RSRDR_DS.CAT	Description of the Radio Science derived data set	RS Team
INST.CAT	Description of the Radio Science subsystem	RS Team
INSTHOST.CAT	Description of the MESSENGER spacecraft	MESSENGER Project
MISSION.CAT	Description of the MESSENGER mission	MESSENGER Project
PERSON.CAT	Contact information for personnel responsible for creating this archive	Geosciences Node
REF.CAT	References mentioned in other *.CAT files	Geosciences Node

3. Archive Volume Format

This section describes the format of the MESSENGER Radio Science Derived Data Archive Volume. Data that comprise the archive will be formatted and described in accordance with Planetary Data System specifications and definitions [Applicable Documents 6 and 7].

3.1. File Formats

This section describes file formats for the kinds of files contained on Archive Volumes.

3.1.1. Document File Format

Document files with the .TXT suffix exist in the Root, Index, Catalog, and Document directories. They are ASCII files which may have embedded PDS labels. Lines in a .TXT file end with a carriage return character (ASCII 13) and a line feed character (ASCII 10). This allows the files to be readable under various operating systems.

Documents in the Document directory may contain formatting and figures that cannot be rendered as ASCII text. Such documents are also provided in PDF form. The PDF (Portable Document Format) is frequently used for distributing documents and may be read with free PDF reader software.

3.1.2. Tabular File Format

Tabular files (.TAB suffix) exist in the Index directory. Tabular files are ASCII files formatted for direct reading into many database management systems on various computers. In the case of the INDEX.TAB file, all fields are separated by commas, and character fields are enclosed in double quotation marks ("). (Character fields 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 "start byte" and "bytes" values listed in the labels do not include the commas between fields or the quotation marks surrounding character fields. The records are of fixed length, and the last two bytes of each record contain the ASCII carriage return and line feed characters. This allows a table to be treated as a fixed length record file on computers that support this file type and as a text file with embedded line delimiters on those that don't. The MD5.TAB file contains only two space-delimited fields, a numeric (hexadecimal) MD5 hash value and a file specification. The file specification is not enclosed in quotes.

All tabular files are described by detached PDS labels. Each PDS label files has the same name as the data file it describes, but with the extension .LBL; for example, the file INDEX.TAB is accompanied by the detached label file INDEX.LBL in the same directory.

3.1.3. PDS Label Format

All data files in the archive have PDS labels, either embedded at the beginning of the file or detached in a separate file. For examples of PDS labels for each type of data product, see the Data Product SISes [Applicable Documents 2, 3, and 4].

A PDS label, whether embedded or detached from its associated file, consists of lines of ASCII text in the form of keyword = value statements that provide descriptive information about the data file. The label is intended to be readable both by humans and by software. Details of the syntax and semantics of PDS labels can be found in the PDS Standards Reference [Applicable Document 6], and definitions of the keywords used in the label can be found by using the PDS Data Dictionary Lookup web service at http://pds.jpl.nasa.gov/tools/ddlookup/data_dictionary_lookup.cfm.

Lines of text in detached labels end with a carriage return character (ASCII 13) and a line feed character (ASCII 10). This allows the files to be read under various operating systems.

3.1.4. Catalog File Format

Catalog files (suffix .CAT) exist in the Root and Catalog directories. Like PDS labels, they are text files formatted as keyword = value statements. They contain descriptions of the data set, instrument, spacecraft, and mission, as well as personnel contact information and references to published literature. They are called Catalog Files because they are loaded into the PDS online catalog to make the information available to users searching for data.

3.1.5. Science Data File Formats

The Radio Science SHADR product is an ASCII text file containing two tables, a header table and a coefficient table. The SHBDR product is a binary file containing four tables: a header, a names table, a coefficients table, and a covariance matrix. The OCC product is an ASCII text table stored in Comma-Separated Value (CSV) format.

For more information about the format and content of the data products, see the relevant Data Product SIS [Applicable Documents 2, 3 and 4].

4. Archive Volume Generation

4.1. Data Transfer and Validation Methods

MESSENGER Radio Science Derived Products are generated by the MESSENGER Radio Science Team and delivered to the PDS Geosciences Node according to the schedule for data releases determined by the MESSENGER Project [Applicable Document 1]. The products are validated for PDS compliance by the Team before delivery and by PDS upon receipt.

4.2. Data Product Sizes and Delivery Rates

Table 2 summarizes expected sizes and production rates for the Radio Science Derived Products.

Table 2 Standard product sizes and delivery rates.

Product	Typical Product Size	Production Rate	Expected Total Data Volume for Entire Mission
SHADR	441 KB	Two products (gravity and shape), revised as needed (GGMES_20V<nn>_SHA.TAB,, GTMES_24V<nn>_SHA.TAB)	441 KB
SHBDR	164 MB	One product (gravity), revised as needed (GGMES_20V<nn>_SHB.DAT)	164 MB
OCC	32 KB	One product, revised as needed (MESS_RS_OCC_V<nn>.CSV)	32 KB

4.3. Interface Media Characteristics

All volumes in the archive conform to ISO 9660 standards [ISO 9660, 1988].

4.4. Backup and Duplicates

The Radio Science Team will maintain its own backup copies of the archive at least until it has been released by PDS. PDS will maintain at least three copies, including a copy at the National Space Science Data Center (NSSDC), according to PDS policy and agreements with NSSDC.

4.5. Labeling and Identification

All MESSENGER Radio Science derived data products are archived on a single PDS archive volume with the unique identifier MESSRS_1001.

5. Support Staff and Cognizant Persons

Mark Perry (Mark.Perry@jhuapl.edu) and Michael Reid (Mike.Reid@jhuapl.edu) are the MESSENGER Radio Science data providers. David Smith (dsmith@tharsis.gsfc.nasa.gov) is the MESSENGER Radio Science Principal Investigator. Susan Slavney (Susan.Slavney@wustl.edu) is the PDS Geosciences Node representative for Radio Science archives.