Mars Reconnaissance Orbiter

SHALLOW RADAR EDR AND RDR ARCHIVE VOLUME SOFTWARE INTERFACE SPECIFICATION

Version 1.1

1 June 2008

Prepared by:

Susan Slavney
PDS Geosciences Node
Washington University

Roberto Orosei
SHARAD Team
IASF-CNR

Approved by:

Roberto Seu
Principal Investigator, SHARAD

Raymond E. Arvidson
Director, PDS Geosciences Node

Edwin Grayzeck
PDS Program Manager

DOCUMENT CHANGE LOG

Change	Date	Affected Portions
Initial draft	26 Jan. 2006	All
Revised by Geosciences Node	28 Feb 2006	All
Revised by R. Orosei	1 Aug. 2007	All
Updated Table of Contents. Added PDSDD information to DOCUMENT Directory Contents. Geosciences Node	14 Aug. 2007	Table of Contents, Section 2.4
Added Browse Directory	26 Oct 2007	Section 2.3 and 2.8
Described reorganized data directories	16 Apr 2009	Section 2.2

TBD ITEMS

Section	Description	Responsibility

TABLE OF CONTENTS

1. Introduction 1
1.1. Purpose and Scope 1
1.2. Content Overview 1
1.3. Applicable Documents and Constraints 1
1.4. Relationships with Other Interfaces 1

2. Archive Volume Contents 2
2.1. Root Directory Contents 2
2.2. Data Directory Contents and Naming 2
2.2.1. EDR File Naming Scheme 2
2.2.2. RDR File Naming Scheme 4
2.3. Index Directory Contents 4
2.4. Document Directory Contents 5
2.5. Catalog Directory Contents 6
2.6. Label Directory Contents (optional) 7
2.7. Calib Directory Contents (optional) 7

3. Archive Volume Format 11
3.1. Volume Format 11
3.2. File Formats 11
3.2.1. Document File Format 11
3.2.2. Tabular File Format 12
3.2.3. PDS Label Format 12
3.2.4. Catalog File Format 12
3.2.5. Science Data File Formats 12

4. Archive Volume Generation 14
4.1. Data Transfer and Validation Methods 14
4.2. Data Product Sizes and Delivery Rates 14
4.3. Interface Media Characteristics 14
4.4. Backup and Duplicates 14
4.5. Labeling and Identification 14

5. Support Staff and Cognizant Persons 15

ACRONYMS AND ABBREVIATIONS

ASCII	American Standard Code for Information Interchange
CD-ROM	Compact Disk - Read-Only Memory
CD-WO	Write-Once Compact Disk
EDR	Experiment Data Record
ISO	International Standards Organization
JPEG	Joint Photographic Experts Group
JPL	Jet Propulsion Laboratory
MRO	Mars Reconnaissance Orbiter
NSSDC	National Space Science Data Center
PDS	Planetary Data System
PSG	Project Science Group
RDR	Reduced Data Record
SDVT	Science Data Validation Team
SHARAD	Shallow Radar
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), expressed in Object Description Language (ODL) which is suitable for loading into a 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 SHARAD Archive. Typically, these individuals would be software engineers, data analysts, or planetary scientists.

The specifications in this document apply to SHARAD EDR and RDR standard product archive volumes that are generated by the MRO Project.

1.2. Content Overview

This Software Interface Specification (SIS) describes the format, content, and generation of the SHARAD EDR and RDR Archives. Section 2, Archive Volume Contents, describes the structure of the archive volumes and the contents of each file. Section 3, Archive Volume Format, describes the file formats used on the archive volumes. Section 4, Archive Volume Generation, describes the procedure for assembling 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. Mars Exploration Program Data Management Plan, R. E. Arvidson et al., Rev. 3.0, March 20, 2002.
2. Mars Reconnaissance Orbiter Project Data Archive Generation, Validation, and Transfer Plan, Version 1.1, 26 January 2006.
3. Mars Reconnaissance Orbiter SHAllow RADar Experiment Data Record Software Interface Specification, Version 1.2, 20 July 2007.
4. Mars Reconnaissance Orbiter SHAllow RADar Reduced Data Record Software Interface Specification, Version 1.0, 30 July 2007.
5. Planetary Data System Archive Preparation Guide, Version 0.050503, 2005.
6. Planetary Data System Standards Reference, March 20, 2006, Version 3.7. JPL D-7669, Part 2.
7. ISO 9660-1988, Information Processing - Volume and File Structure of CD-ROM for Information Exchange, April 15, 1988.
8. Mars Reconnaissance Orbiter SHARAD Science Team and PDS Geosciences Node Interface Control Document, Version 1.1, 25 May 2005.

These documents are referred to in the text as [ADn], where n is their position in the list above.

1.4. Relationships with Other Interfaces

This Archive Volume SIS could be affected by changes to the design of the SHARAD standard data products (i.e. [AD3, AD4]).

2. Archive Volume Contents

This section describes the contents of the SHARAD archive volumes, 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	Geosciences Node
ERRATA.TXT	A cumulative listing of comments and updates concerning all archive volumes published to date. This file is optional.	Geosciences Node with input from SHARAD Team
VOLDESC.CAT	A description of the contents of this volume in a PDS format readable by both humans and computers	Geosciences Node

The Root Directory also contains the following subdirectories: DATA, INDEX, DOCUMENT, CATALOG, LABEL and CALIB. These subdirectories are described in the next sections.

2.2. Data Directory Contents and Naming

The DATA directory will be divided into two levels of subdirectories. The first level will have subdirectories containing 1000 orbits' worth of data, named **pppnnXXX**, where **ppp** denotes the type of data product (EDR for Experiment Data Records, RDR for Reduced Data Records) and **nnXXX** represents a set of 1000 orbits. An example directory name is EDR02XXX for a directory containing data acquired in orbits 2000 through 2999. Each of these subdirectories is further divided, each second level subdirectory containing data collected through the use of a single Operation Sequence Table (see [AD3] for an explanation of what an Operation Sequence Table is). These subdirectories will be named so as to make clear which data products they contain and when such data were collected. Their name will be in the form **pppnnnnnoo**, where **ppp** is EDR for Experiment Data Records or RDR for Reduced Data Records, **nnnnn** is the number of the orbit in which data were acquired, and **oo** is the number of the Operation Sequence Table in that orbit through which data were acquired: for example, the subdirectory named EDR0123405 will contain all EDR data products collected in orbit 1234 with the instrument settings contained in the fifth Operation Sequence Table of that orbit.

SHARAD EDR data products consist of three files each, the first of which contains instrument data, and is called a Science Telemetry file, while the second, called an Auxiliary Data file, contains geometric quantities generated on-ground from spacecraft navigation data, parameters extracted from instrument and spacecraft housekeeping telemetry, and flags describing the completeness and usability of the associated scientific telemetry. The third file is the detached PDS label describing the content of the two previous files.

SHARAD RDR data products consist of two files each, the first of which contains the processed instrument data, auxiliary scientific data, engineering parameters and geometric information used to locate observations in space and time. The second file is the detached PDS label describing the content of the previous file.

2.2.1. EDR File Naming Scheme

The file naming scheme adheres to the ISO Level II 27.3 file name convention to be compliant with PDS standard. File names are built by a concatenation of up to seven identifiers separated by underscore characters ("_"), followed by a dot and a three-letter extension. Each identifier provides one type of information on the content of the file. Identifiers are concatenated in the following order, although not all of them are necessarily present in any given file name:

<Data prod.>_<Transaction ID>_<OST line #>_<Operative mode>_<PRF>_<Version>_<File type>.<Extension>

The data product identifier is the character "E", denoting an Experimental Data Record product.

The transaction ID is a 7-digit number associated with the transaction ID (sometimes called product ID or observation ID) uniquely identifying the Operation Sequence Table (OST) used during data acquisition (see [AD3] for an explanation of what an Operation Sequence Table is). The first five digits of the transaction ID correspond to the number of the orbit in which data were acquired, while the last two digits denote the number of the OST that was used during data acquisition.

The Operation Sequence Table line number is the three-digit number of the OST line being used during data acquisition.

Operative modes have been defined in [AD3]. Operative mode identifiers consist of two letters followed by a two-digit number, the two letters being either SS (for sub-surface sounding) or RO (for receive only), while the number ranges from 01 to 21 and is associated to the number of pre-summed echoes in a data block and to the bit resolution of each sample, as illustrated in Table 1.

The Pulse Repetition Frequency (PRF) identifier is a three-digit number corresponding to the integer part of the PRF value used in acquiring data. Thus, valid values for this identifier are 335, 350, 387, 670, 700 and 775, as listed in [AD3, Section 4.1.2.4].

The version identifier is a single character denoting the current version of the data product, and ranges from A to Z.

The file type identifier denotes the type of binary file: a Science Telemetry file is denoted by the identifier S, while an Auxiliary Data file is marked by the identifier A. The associated detached PDS label has no file type identifier in its file name.

File extension defines the format of data contained in the file: the extension is ".DAT" for Science Telemetry and Auxiliary Data files, denoting that the file contains a binary table object, and ".LBL" for the associated detached PDS label.

Files belonging to the same data product have identical names except for file type identifier and extension.

Permitted values for different file name identifiers are listed in Table 1 below.

Data product	Transaction ID	OST line #	Operative mode	PRF	Version	File type	Extension
E	0000000	000	RO01	335	A	S	.DAT
	…	…	…	350	…	A	.LBL
	9999999	999	RO21	387	Z		
			SS01	670			
			…	700			
			SS21	775			

Table 1: Permitted values for identifiers used in building EDR data product file names.

For example, the first version of a data product containing all data acquired during the measurements relative to the fifth Operation Sequence Table in orbit 1234, using the first OST line, in Subsurface Sounding mode at 700.28 Hz pulse repetition frequency with no pre-summed echoes per data block and 8-bit resolution per sample, would consist of the following three files:

- Instrument data binary file: E_0123405_001_SS07_700_A_S.DAT
- Geometric information binary file: E_0123405_001_SS07_700_A_A.DAT
- Associated detached PDS label: E_0123405_001_SS07_700_A.LBL

A data product is identified by the part of the file name common to all three files of which it consists, that is

<Data product>_<Transaction ID>_<OST line #>_<Operative mode>_<PRF>_<Version>

Thus, in the previous example, the data product would be identified as

E_0123405_001_SS07_700_A

This value would be reported as the PRODUCT_ID value in the detached PDS label.

Individual EDR products may be revised during the course of the mission. A product's revision status is recorded both in the name of files constituting the data product and in its PDS label using the keyword PRODUCT_VERSION_ID. The value of this keyword is "A" for the first version of a product. The value is incremented with each product revision. Also, the label keyword PRODUCT_CREATION_TIME is updated with each product revision.

The PDS label also includes a RELEASE_ID keyword to indicate the number of the data release in which the product was included. The first release of the mission has a RELEASE_ID value of "0001"; the second release three months later has a value of "0002", and so on. This keyword is not updated for a revised product; it always shows the ID of the release in which the product first appeared.

PRODUCT_VERSION_ID, PRODUCT_CREATION_TIME, and RELEASE_ID appear in the index table for the EDR archive so that the set of revised products can be easily identified.

The minimum unit for reprocessing of data products is the release: thus, if any data products belonging to a given release need to be reprocessed, all data products belonging to that release will be reprocessed as well. Older versions of data products will be erased upon the availability of a new version, so that the EDR archive contains only one version of a given data product. Because reprocessing is handled at the release level, data products in different releases may have a different value for PRODUCT_VERSION_ID.

2.2.2. RDR File Naming Scheme

The RDR naming scheme is identical to the EDR naming scheme, except for the data product identifier, which is "R", and for the fact that no file type identifier is used, as there is only one binary file in a data product (see Section 2.2).

2.3. INDEX Directory Contents

Files in the Index Directory are provided to help the user locate products on this archive volume. 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 volume	Geosciences Node
INDEX.LBL	A PDS detached label that describes INDEX.TAB	Geosciences Node
BROWINDX.TAB	A table listing all browse data products on this volume	Geosciences Node
BROWINDX.LBL	A PDS detached label that describes BROWINDX.TAB	Geosciences Node

The SHARAD EDR and RDR index tables will contain the following columns.

Column Name	Definition	Required by PDS?
VOLUME_ID	Unique identifier for a data volume.	No
RELEASE_ID	Identifier of the MRO release to PDS in which the data product was first included	No
FILE_SPECIFICATION_NAME	Complete path and file name of a data product's PDS label	Yes
PRODUCT_ID	Unique identifier of product as it appears in the PDS label	Yes
PRODUCT_CREATION_TIME	Date and time at which data product file was created, in PDS date-time format (i.e. YYYY-DDDThh:mm:ss.mmm)	Yes
PRODUCT_VERSION_ID	Revision status of this product (e.g. A, B, C, …)	No
PRODUCT_VERSION_TYPE	Version of an individual data product that might appear in several incarnations.	No
PRODUCT_TYPE	Type or category of a data product within a data set.	No
MISSION_PHASE_NAME	Commonly-used identifier of a mission phase.	No
ORBIT_NUMBER	Number of the orbital revolution of the spacecraft around a target body.	No
START_TIME	Date and time of acquisition of the first echo in the Data Product in UTC system format.	No
STOP_TIME	Date and time of acquisition of the last echo in the Data Product in UTC system format.	No
SPACECRAFT_CLOCK_START_COUNT	Value of the spacecraft clock at the time of acquisition of the first echo in the Data Product.	No
SPACECRAFT_CLOCK_STOP_COUNT	Value of the spacecraft clock at the time of acquisition of the last echo in the Data Product.	No
MRO:START_SUB_SPACECRAFT_LATITUDE	Planetocentric latitude of the sub-spacecraft point at the beginning of data collection.	No
MRO:STOP_SUB_SPACECRAFT_LATITUDE	Planetocentric latitude of the sub-spacecraft point at the end of data collection.	No
MRO:START_SUB_SPACECRAFT_LONGITUDE	Planetocentric east longitude of the sub-spacecraft point at the beginning of data collection.	No
MRO:STOP_SUB_SPACECRAFT_LONGITUDE	Planetocentric east longitude of the sub-spacecraft point at the end of data collection.	No
INSTRUMENT_MODE_ID	Instrument-dependent designation of operating mode.	No
DATA_QUALITY_ID	Numeric key which identifies the quality of data in the data product.	No

The SHARAD browse index table will contain the following columns.

Column Name	Definition	Required by PDS?
SOURCE_PRODUCT_ID	Unique identifier of product as it appears in the PDS label	Yes
FILE_SPECIFICATION_NAME	Browse name with file path from browse directory to browse file	Yes
PRODUCT_CREATION_TIME	Browse file creation time	Yes
SOFTWARE NAME	Name of software used to generate the browse file	Yes
SOFTWARE_VERSION_ID	Version of software used t generate the browse file	Yes

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
EDRSIS.HTM	The EDR Data Product SIS as hypertext (on EDR archive volumes)	Geosciences Node
EDRSIS.PDF	The EDR Data Product SIS as a PDF file (on EDR archive volumes)	SHARAD Team
EDRSIS.LBL	A PDS detached label that describes both EDRSIS.HTM and EDRSIS.PDF (on EDR archive volumes)	Geosciences Node
RDRSIS.HTM	The RDR Data Product SIS as hypertext (on RDR archive volumes)	Geosciences Node
RDRSIS.PDF	The RDR Data Product SIS as a PDF file (on RDR archive volumes)	SHARAD Team
RDRSIS.LBL	A PDS detached label that describes both RDRSIS.HTM and RDRSIS.PDF (on RDR archive volumes)	Geosciences Node
ARCHSIS.HTM	The Archive Volume SIS (this document) as hypertext	Geosciences Node
ARCHSIS.PDF	The Archive Volume SIS (this document) as a PDF file	SHARAD Team
ARCHSIS.LBL	A PDS detached label that describes both ARCHSIS.HTM and ARCHSIS.PDF.	Geosciences Node
SHAFUM.LBL	A PDS detached label that describes SHAFUM.PDF	SHARAD Team
SHAFUM.PDF	SHARAD Flight User Manual, a SHARAD project document.	SHARAD Team
SHAOSTPTODT.LBL	A PDS detached label that describes SHAOSTPTODT.PDF	SHARAD Team
SHAOSTPTODT.PDF	SHARAD OST/PT/ODT Structure Definition, a SHARAD project document.	SHARAD Team
SHATLCTCM.LBL	A PDS detached label that describes SHATLCTCM.PDF	SHARAD Team
SHATLCTCM.PDF	SHARAD TLC/TCM Structure Definition, a SHARAD project document.	SHARAD Team

PDSDD.FUL	The PDS Data Dictionary that includes definitions of all keywords used in MRO data labels, including MRO-specific keywords (i.e. the MRO Local Data Dictionary). This is a text file that is human-readable and also usable as input to PDS label validation software.	Geosciences Node
PDSDD.IDX	An index to PDSDD.FUL, used by PDS validation software.	Geosciences Node
PDSDD.LBL	A PDS detached label that describes the above two PDSDD files.	Geosciences Node

2.5. CATALOG Directory Contents

The files in the CATALOG directory are used to store metadata for the PDS Catalog and contain information about 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. 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
SHARADEDRDS.CAT	EDR data set information for the PDS catalog (on EDR volumes)	SHARAD Team and Geosciences Node
SHARADRDRDS.CAT	RDR data set information for the PDS catalog (on RDR volumes)	SHARAD Team and Geosciences Node
INSTHOST.CAT	MRO spacecraft information for the PDS catalog	MRO Project designee
SHARADINST.CAT	SHARAD instrument information for the PDS catalog	SHARAD Team
MISSION.CAT	MRO mission information for the PDS catalog	MRO Project designee
PERSON.CAT	Personnel information for the PDS catalog (SHARAD team and PDS personnel responsible for generating the archive)	Geosciences Node with input from SHARAD Team
REF.CAT	References mentioned in other *.CAT files	Geosciences Node

2.6. LABEL Directory Contents

The LABEL directory contains files that describe data format and organization. These files are referred to in the PDS labels that accompany the data products. They are “include” files that are intended to be parsed as if they were part of the PDS labels that refer to them. The following files may appear in the Label Directory depending on the types of data files present on the volume.

File Name	File Contents	File Provided By
LABINFO.TXT	A description of the contents of this directory	Geosciences Node
AUXILIARY.FMT	A fragment of a PDS label that describes the columns in an Auxiliary Data File (EDR volume only).	SHARAD Team

SCIENCE_ANCILLARY.FMT	A fragment of a PDS label that describes the columns containing ancillary information in a Science Telemetry File (EDR volume only).	SHARAD Team
SCIENCE4BIT.FMT	A fragment of a PDS label that describes the columns in a Science Telemetry File containing 4-bit samples (EDR volume only).	SHARAD Team
SCIENCE6BIT.FMT	A fragment of a PDS label that describes the columns in a Science Telemetry File containing 6-bit samples (EDR volume only).	SHARAD Team
SCIENCE8BIT.FMT	A fragment of a PDS label that describes the columns in a Science Telemetry File containing 8-bit samples (EDR volume only).	SHARAD Team
RDR.FMT	A fragment of a PDS label that describes the columns in a Science Data File (RDR volume only).	SHARAD Team

2.7. CALIB Directory Contents

The CALIB directory contains calibration files used to process the data products. The following files are contained in the CALIB directory:

File Name	File Contents	File Provided By
CALINFO.TXT	A description of the contents of this directory	Geosciences Node
REFERENCE_CHIRP_M05TX_M20RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -5°C and the temperature of the receiver is at -20°C.	SHARAD Team
REFERENCE_CHIRP_M05TX_P00RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -5°C and the temperature of the receiver is at 0°C.	SHARAD Team
REFERENCE_CHIRP_M05TX_P20RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -5°C and the temperature of the receiver is at +20°C.	SHARAD Team
REFERENCE_CHIRP_M05TX_P40RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -5°C and the temperature of the receiver is at +40°C.	SHARAD Team
REFERENCE_CHIRP_M05TX_P60RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -5°C and the temperature of the receiver is at +60°C.	SHARAD Team
REFERENCE_CHIRP_M10TX_M20RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -10°C and the temperature of the receiver is at -20°C.	SHARAD Team
REFERENCE_CHIRP_M10TX_P00RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -10°C and the temperature of the receiver is at 0°C.	SHARAD Team
REFERENCE_CHIRP_M10TX_P20RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -10°C and the temperature of the receiver is at +20°C.	SHARAD Team

REFERENCE_CHIRP_M10 TX_P40RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -10°C and the temperature of the receiver is at +40°C.	SHARAD Team
REFERENCE_CHIRP_M10 TX_P60RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -10°C and the temperature of the receiver is at +60°C.	SHARAD Team
REFERENCE_CHIRP_M15 TX_M20RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -15°C and the temperature of the receiver is at -20°C.	SHARAD Team
REFERENCE_CHIRP_M15 TX_P00RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -15°C and the temperature of the receiver is at 0°C.	SHARAD Team
REFERENCE_CHIRP_M15 TX_P20RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -15°C and the temperature of the receiver is at +20°C.	SHARAD Team
REFERENCE_CHIRP_M15 TX_P40RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -15°C and the temperature of the receiver is at +40°C.	SHARAD Team
REFERENCE_CHIRP_M15 TX_P60RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -15°C and the temperature of the receiver is at +60°C.	SHARAD Team
REFERENCE_CHIRP_M20 TX_M20RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -20°C and the temperature of the receiver is at -20°C.	SHARAD Team
REFERENCE_CHIRP_M20 TX_P00RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -20°C and the temperature of the receiver is at 0°C.	SHARAD Team
REFERENCE_CHIRP_M20 TX_P20RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -20°C and the temperature of the receiver is at +20°C.	SHARAD Team
REFERENCE_CHIRP_M20 TX_P40RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -20°C and the temperature of the receiver is at +40°C.	SHARAD Team
REFERENCE_CHIRP_M20 TX_P60RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at -20°C and the temperature of the receiver is at +60°C.	SHARAD Team
REFERENCE_CHIRP_P00 TX_M20RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at 0°C and the temperature of the receiver is at -20°C.	SHARAD Team
REFERENCE_CHIRP_P00 TX_P00RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at 0°C and the temperature of the receiver is at 0°C.	SHARAD Team
REFERENCE_CHIRP_P00 TX_P20RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at 0°C and the temperature of the receiver is at +20°C.	SHARAD Team
REFERENCE_CHIRP_P00 TX_P40RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at 0°C and the temperature of the receiver is at +40°C.	SHARAD Team

REFERENCE_CHIRP_P00 TX_P60RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at 0°C and the temperature of the receiver is at +60°C.	SHARAD Team
REFERENCE_CHIRP_P20 TX_M20RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at +20°C and the temperature of the receiver is at -20°C.	SHARAD Team
REFERENCE_CHIRP_P20 TX_P00RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at +20°C and the temperature of the receiver is at 0°C.	SHARAD Team
REFERENCE_CHIRP_P20 TX_P20RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at +20°C and the temperature of the receiver is at +20°C.	SHARAD Team
REFERENCE_CHIRP_P20 TX_P40RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at +20°C and the temperature of the receiver is at +40°C.	SHARAD Team
REFERENCE_CHIRP_P20 TX_P60RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at +20°C and the temperature of the receiver is at +60°C.	SHARAD Team
REFERENCE_CHIRP_P40 TX_M20RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at +40°C and the temperature of the receiver is at -20°C.	SHARAD Team
REFERENCE_CHIRP_P40 TX_P00RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at +40°C and the temperature of the receiver is at 0°C.	SHARAD Team
REFERENCE_CHIRP_P40 TX_P20RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at +40°C and the temperature of the receiver is at +20°C.	SHARAD Team
REFERENCE_CHIRP_P40 TX_P40RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at +40°C and the temperature of the receiver is at +40°C.	SHARAD Team
REFERENCE_CHIRP_P40 TX_P60RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at +40°C and the temperature of the receiver is at +60°C.	SHARAD Team
REFERENCE_CHIRP_P60 TX_M20RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at +60°C and the temperature of the receiver is at -20°C.	SHARAD Team
REFERENCE_CHIRP_P60 TX_P00RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at +60°C and the temperature of the receiver is at 0°C.	SHARAD Team
REFERENCE_CHIRP_P60 TX_P20RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at +60°C and the temperature of the receiver is at +20°C.	SHARAD Team
REFERENCE_CHIRP_P60 TX_P40RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at +60°C and the temperature of the receiver is at +40°C.	SHARAD Team
REFERENCE_CHIRP_P60 TX_P60RX.DAT	Reference chirp to be used for range processing of the received signal when the temperature of the transmitter is at +60°C and the temperature of the receiver is at +60°C.	SHARAD Team

2.8. BROWSE Directory Contents

The BROWSE directory contains synoptic versions of the of RDR data products. Each browse product is a single JPEG image with a label file. There is a one-to-one correspondence between a browse product and its source RDR. Browse products are optional, not all RDRs need have a corresponding browse product.

The BROWSE directory is organized into subdirectories in a structure that parallels the DATA directory. Browse products have the same name as the corresponding RDR except with the appendage of _ browse.jpg. The browse product label has an _ browse.lbl. For example, for an RDR:

DATA\RDR0168901\r_0168901_001_ss19_700_a.dat

the browse product would be:

BROWSE\RDR0168901\r_0168901_001_ss19_700_a_br.jpg

and its label file would be:

BROWSE \RDR0168901\r_0168901_001_ss19_700_a_ br.lbl

The following files are contained in the BROWSE directory:

File Name	File Contents	File Provided By
BROWINFO.TXT	A description of the contents of this directory including a description of how the browse images are generated from the SHARAD RDRs	Geosciences Team with SHARAD Team description of how the browse images are generated

3. Archive Volume Format

This section describes the format of SHARAD Archive Volumes. Data that comprise the Archive will be formatted in accordance with Planetary Data System standards [AD5, AD6].

3.1. Volume Format

The SHARAD archives will be maintained online for electronic access, with backup copies stored offline. The online archives will be formatted as a single EDR volume and a single RDR volume to which data directories are added with each delivery during the MRO mission.

It is possible that all or part of the SHARAD archive may need to be written to physical media, e.g. CD or DVD, for delivery if electronic delivery is not desirable. Archive Volumes are formatted so that if written to CD or DVD media according to PDS policy, the media are compatible with most commonly used computer operating systems including Windows, Unix, and Macintosh systems. The CD volume format is in accordance with ISO 9660 level 2 Interchange Standard [AD7]. The DVD volume format is in accordance with the UDF Standard with ISO 9660 Level 2 compatibility.

3.2. File Formats

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

3.2.1. Document File Format

Document files with the .TXT suffix are ASCII files which may have embedded PDS labels. Each line in a .TXT file ends 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. Therefore each document is given in two formats, hypertext and PDF. The hypertext file contains ASCII text plus hypertext markup language (HTML) commands that enable it to be viewed in a Web browser such as Netscape Navigator or Microsoft Internet Explorer. The hypertext file may be accompanied by ancillary files such as images and style sheets that are incorporated into the document by the Web browser. The second format, PDF (Portable Document Format) is a proprietary format of Adobe Systems Incorporated that is frequently used for distributing documents. Adobe offers free software, Acrobat Reader, for viewing PDF files.

3.2.2. Tabular File Format

Tabular files (.TAB suffix) are ASCII files formatted for direct reading into many database management systems or spreadsheet programs on various computers. 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.

All tabular files are described by PDS labels, either embedded at the beginning of the file or detached. If detached, the PDS label file has the same name as the data file it describes, with the extension .LBL; for example, the file INDEX.TAB is accompanied by the detached label file INDEX.LBL in the same directory.

3.2.3. PDS Label Format

All data files in the archive have detached PDS labels. PDS labels are ASCII text files intended to be read by humans and by software. A PDS label consists of a series of statements in the form “keyword = value”, where keywords are defined in either the main PDS Data Dictionary or the MRO Local Data Dictionary. For examples of PDS labels for SHARAD products, see the Data Product SIS Documents [AD3, AD4].

Each line of text in a detached label ends 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.

3.2.4. Catalog File Format

Catalog files (suffix .CAT) exist in the Root and Catalog directories. They are ASCII text files formatted in an object-oriented structure consisting of sets of 'keyword=value' declarations.

Each line of text in a catalog file ends 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.

3.2.5. Science Data File Formats

A SHARAD EDR data product consists of a pair of binary tables described by a single detached PDS label. The Science Telemetry table is an aggregation of data blocks, where one row in the table contains one block. A data block is a single observation of the SHARAD instrument, a sequence of echoes along with some header

information. The Auxiliary Data table has one row for each row in the Science Telemetry table. The auxiliary data in this table include geometry information, housekeeping data, and quality flags.

A single SHARAD EDR Data Product includes all data blocks belonging to a single data take, i.e., all data that have been acquired continuously in time using the same instrument settings. A data take corresponds to a single entry in the SHARAD Operation Sequence Table. Data takes can vary in duration from a few seconds to thirty minutes or more. Thus the content of each SHARAD data product is highly variable in terms of number of data blocks, and depends on how operations for the instrument were planned during a given data collection period.

Each SHARAD RDR product contains SHARAD Experiment Data Record (EDR) data that have been Doppler filtered, range compressed and converted to complex voltages, and possesses proper engineering and spacecraft information.

Each Data Product will consist of two files: one is a binary file containing the scientific data of the instrument, that is a sequence of processed echoes, each of which is preceded by a header containing information on the collection and on-board processing of the data, and followed by parameters characterizing the ground processing of the echoes, by geometric quantities generated on-ground from spacecraft navigation data, and by parameters extracted from instrument and spacecraft housekeeping telemetry. The second file is a detached ASCII label describing the content of the data product.

For more information about the format and content of the data products, see the EDR Data Product SIS [AD3] and the RDR Data Product SIS [AD4].

4. Archive Volume Generation

4.1. Data Transfer and Validation Methods

SHARAD data products will be generated by the SHARAD Science Team and delivered to the PDS Geosciences Node according to the schedule in the MRO Archive Plan. Products will be delivered using a medium agreed upon by the SHARAD Team and the Geosciences Node, either by electronic transfer or by shipping on physical media (e.g. a "data brick"). SHARAD archive volumes will be assembled and validated by the PDS Geosciences Node and made available to the public via the Geosciences Node web site. The Geosciences Node will also transfer SHARAD archive volumes to the National Space Science Data Center (NSSDC) for long term storage, according to PDS policy, using a transfer medium agreed upon by PDS and NSSDC.

4.2. Data Product Sizes and Delivery Rates

Table 2 summarizes expected sizes and production rates for the SHARAD Standard Products (see [AD3, AD4] for a discussion).

Product	Product Size	Production Rate	Expected Number of Products for Primary Mission (731 days)	Expected Total Data Volume for Primary Mission
SHARAD-EDR	~135 MB (highly variable)	~10 per day	~8000	1 TByte
SHARAD-RDR	~270 MB (highly variable)	~10 per day	~8000	2 TBytes

Table 2: Standard Product sizes and delivery rates.

4.3. Interface Media Characteristics

All volumes in the SHARAD Standard Product Archive conform to ISO 9660 standards [AD7].

4.4. Backup and Duplicates

The SHARAD Science Team will maintain a backup copy of all data delivered to the Geosciences Node until the end of the MRO Mission. The Geosciences Node will maintain a backup copy of all SHARAD data released by PDS as part of the Node's regular data repository backups.

4.5. Labeling and Identification

The SHARAD EDR data set ID assigned by PDS is MRO-M-SHARAD-3-EDR-V1.0. The corresponding data set name is "MRO Mars SHARAD 3 Experiment Data Record V1.0".

The SHARAD RDR data set ID assigned by PDS is MRO-M-SHARAD-4-RDR-V1.0. The corresponding data set name is “MRO Mars SHARAD 4 Reduced Data Record V1.0”.

The Volume IDs assigned by PDS to SHARAD archive volumes are MROSH_0XXX for the EDR volume and MROSH_1XXX for the RDR volume.

5. Support Staff and Cognizant Persons

Daniela Biccari, SHARAD Science Team, Università di Roma "La Sapienza", d.biccari@infocom.uniroma1.it.

Anthony Egan, SHARAD Science Team, Washington University in St. Louis, anthony@levee.wustl.edu.

Emanuele Giacomoni, SHARAD Operations Team, Università di Roma "La Sapienza", emanuelegiacomoni@gmail.com

Roberto Orosei, SHARAD Science Team, Istituto Nazionale di Astrofisica, Roberto.Orosei@iasf-roma.inaf.it.

Roger J. Phillips, SHARAD Deputy Science Team Leader, Southwest Research Institute, roger@boulder.swri.edu

Roberto Seu, SHARAD Science Team Leader, Università di Roma "La Sapienza", roberto.seu@uniroma1.it.

Susan Slavney, PDS Geosciences Node, Washington University in St. Louis, Susan.Slavney@wustl.edu.

Edward Guinness, PDS Geosciences Node, Washington University in St. Louis, guinness@wunder.wustl.edu.

Dan Scholes, PDS Geosciences Node, Washington University in St. Louis, scholes@wustl.edu