Mars Reconnaissance Orbiter

CRISM ARCHIVE VOLUME SOFTWARE INTERFACE SPECIFICATION

Version 1.2.6

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DOCUMENT CHANGE LOG

Change	Date
Redefined definition of nonuniformity files	5/3/2006
Eliminated CDR6 tables of CDR4s created inflight	
Added ST CDR6s	
Added ACT and PRE CDR6s and defined their distinct nomenclature	
Refined defininition of AS CDR6	
Added BS CDR6	
Added BW CDR6	
Added HV CDR6	
Added PS CDR4	
Added RW CDR4	
Added RF CDR4	
Renamed WV CDR4 to WA CDR4, to eliminate confusion with the WV CDR6	
Added SH CDR4	
Added SL and VL CDR6s	
Renamed SR CDR4 to SS	
Added SW CDR6	
Made CDRs a component of the EDR archive volume, and ADRs a component of the TRDR archive volume	
Put local data dictionary * CAT files in LDD subdirectory of DOCUMENT directory	
Made the counter in the FDR or TRDR file name hexadecimal	
Undated nomenclature of CDR4s to include additional identifiers	
Added resampled TRDR_filetype "RTR"	
Added ADR directory	
Separated VNIR and IR frame number lavers in MRDR "DE" file	
Changed I/F in MRDRs and MTRDRs to Lambert albedo	
Clarified that I/F and Lambert albedo images may occur in TRDRs	
Undated description of BROWSE products as HTML and PNG files	
Updated description of document formats in different directories	
Updated MRDR pattern to 1964 tiles	
Made DDRs band sequential	
Modified data set ID of CDRs for level 4 and 6 to share a common data set ID	
Inserted table of data set IDs	
Renamed ACT and PRE CDR6s to BTE and ATE	7/10/2006
Replaced local data dictionary keyword MRO:FPE_ELECTRONICS_TEMPERATURE with	1110/2000
Added PARTICIPATING INSTRUMENTS and corner latitude and longitude fields to index table	
Added information on SPICE files generated by CRISM	10/1/2006
Updated providers of different files	
Added MRR MAP CAT to planned files for CATALOG directory	
Updated definition of DDR browse products	
Added AT and RT CDR4s and CT CDR6 describing wavelength-dependent atmospheric	2/5/2007
transmission, for post-calibration data processing	
Added separate catalog files defining map projection standards for equatorial and polar regions	
Redefined 'HYD" IR browse product into three separate products based on first results from Mars	
Fixed nomenclature of OTT tables in EXTRAS directory	5/16/2007
Updated descriptions of SB and NU CDRs	
Corrected character string in file names to designate EPFs	8/23/2007

Added definition of TOD observing mode	
Updated descriptions of SPICE kernels	
Updated directory structure for EDRs, DDRs, TRDRs, adn their browse products to be YEAR/YEAR_DOY	
Defined separate backplane files for I/F and Lambert albedo versions of MRDR and MTRDR because they may not be filled identically	
Updated definitions of summary products, including replace D2400 with SINDEX and add BD920	
Updated nomenclature of MRDRs to include tile number	
Deleted UR CDR6 and RA CDR4 which aren't being generated	
Added HTML files to DOCUMENT and CALIB directories	
Redefined INDEX files to cover 1-month intervals	
Replaced RA version of MRDRs, MTRDRs, and browse products with IF	11/29/2007

TBD ITEMS

Section	Description

ACRONYMS AND ABBREVIATIONS

APL Applied Physics Laboratory American Standard Code for Information Interchange ASCII Compact Disk - Read-Only Memory CD-ROM Compact Reconnaissance Imaging Spectrometer for Mars CRISM Digital Video Disk DVD International Standards Organization ISO Mars Reconnaissance Orbiter MRO National Space Science Data Center NSSDC Planetary Data System PDS Software Interface Specification SIS To Be Determined TBD TBR To Be Revised

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, a local hard disk, a CD-ROM or a 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 makes an archive.

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

Virtual Volume – A *virtual volume* refers to an archive volume on unspecified media, with the assumption that there is no size limit on the volume and therefore no need for multiple volumes.

1. Introduction

1.1. Purpose and Scope

This Archive Volume Software Interface Specification is intended to be used by those who wish to understand the format and content of the science data archive generated by the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) instrument on the Mars Reconnaissance Orbiter (MRO) mission. Typically, these individuals would be software engineers, data analysts, or planetary scientists.

The specifications in this document apply to all CRISM standard product archive volumes that are released by the MRO Project.

1.2. Content Overview

The CRISM Archive contains the raw data products, derived data products, and ancillary products listed in Table 1-1. The products are described in detail in the CRISM Data Product SIS (Applicable Document 3 below). The CRISM Science Team and the Planetary Data System (PDS) Geosciences Node work together to assemble the CRISM archive volumes as specified in the CRISM – Geosciences Node SIS (Applicable Document 4 below).

Data Set	Abbreviation	Contents		
Experiment Data Record and	EDR	Raw data from the telemetry stream rearranged but unmodified except for lossless decompression		
Calibration Data Record	CDR	Derived values needed to convert a scene-viewing EDR into units of radiance.		
Derived Data Record	DDR	A companion file for each EDR that contains physical parameters such as incidence, emission, and phase angle or surface temperature. Used to locate correction information in an ADR.		
Targeted Reduced Data Record and Ancillary Data Record	TRDR	Image data from an EDR converted to units of radiance using CDRs. A TRDR also contains a set of derived spectral parameters (summary products) that provide an overview of the data set.		
	ADR	Reference information used to correct scene measurements for photometric, thermal emission, or atmospheric effects.		
Multispectral Reduced Data Record	MRDR	One of many tiles that make up a global mosaic, an MRDR contains map-projected data in units of radiance (extracted from TRDRs), plus I/F, summary products, and the DDR data used to generate them.		
Map-Projected Targeted Reduced Data Record	MTRDR	Analogous to an MRDR, a TRDR contains hyperspectral data from a targeted, hyperspectral observation, map- projected and converted to I/F.		

Table 1-1. CRISM Data Sets

Data Set	Abbreviation	Data Set ID
Experiment Data Record and Calibration Data	EDR	MRO-M-CRISM-2-EDR-V1.0
Record	CDR	MRO-M-CRISM-4/6-CDR-V1.0
Derived Data Record	DDR	MRO-M-CRISM-6-DDR-V1.0
Targeted Reduced Data Record and	TRDR	MRO-M-CRISM-3-RDR-TARGETED-V1.0
Ancillary Data Record	ADR	MRO-M-CRISM-6-ADR-V1.0
Multispectral Reduced Data Record	MRDR	MRO-M-CRISM-5-RDR-MULTISPECTRAL-V1.0
Map-Projected Targeted Reduced Data Record	MTRDR	MRO-M-CRISM-5-RDR-MPTARGETED-V1.0

Table 1-2. CRISM Data Set IDs

This Archive Volume Software Interface Specification (SIS) describes the format and content of the CRISM Archive. Section 2, Archive Volume Structure, describes the overall structure of a CRISM archive volume. Section 3, Archive Volume Contents, describes the contents of each directory and file in the archive. 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. Mars Exploration Program Data Management Plan, R. E. Arvidson et al., Rev. 3.0, March 20, 2002.
- 2. Mars Reconnaissance Orbiter (MRO) Project Data Archive Generation, Validation, and Transfer Plan, R.E. Arvidson et al., JPL D-22246.
- 3. Mars Reconnaissance Orbiter CRISM Data Product Software Interface Specification, APL document 7398-9xxx, March 2, 2005.
- 4. Mars Reconnaissance Orbiter CRISM Science Team and PDS Geosciences Node Interface Control Document (ICD), January 25, 2005.
- 5. Planetary Data System Archive Preparation Guide (APG), R. Beebe, January 20, 2005.
- 6. *Planetary Data System Standards Reference*, June 15, 2001, Version 3.4. JPL D-7669, Part 2.
- 7. ISO 9660-1988, Information Processing Volume and File Structure of CD-ROM for Information Exchange, April 15, 1988.

1.4. Relationships with Other Interfaces

This Archive Volume SIS could be affected by changes to the design of the CRISM standard data products (Applicable Document 3). Although every attempt is made to make the two documents consistent, this one takes precedence on issues of archive structure whereas the Data Products SIS (Applicable Document 3) takes precedence in issues of archive content.

This Archive Volume SIS could be affected by changes to the PDS standards regarding the contents of archive volumes, in particular the placement of data dictionary files in the DOCUMENT directory.

2. Archive Volume Structure

This section describes the overall structure of all CRISM archive volumes.

The CRISM archive will be made available online via Web and FTP servers. This will be the primary means of distribution. Therefore the archive will be organized as a set of virtual volumes, with each data set stored online as a single volume. As new data products are released they will be added to the volume's data directory, and the volume's index table will be updated accordingly. The size of the volume will not be limited by the capacity of the physical media on which it is stored; hence the term virtual volume.

When it is necessary to transfer all or part of a data set to other media such as DVD for distribution or for offline storage, the virtual volume's contents will be written to the other media according to PDS policy, possibly dividing the contents among several physical volumes.

The following volume identifiers are assigned to CRISM data sets by the Planetary Data System. These identifiers are unique among all PDS data sets.

Data Set	Volume ID	
Experiment Data Record and		
Calibration Data Record	USA_NASA_APL_MROCR_UIIIII	
Derived Data Record	USA_NASA_APL_MROCR_1nnn	
Targeted Reduced Data Record and		
Ancillary Data Record	USA_NASA_APL_MROCR_2000	
Multispectral Reduced Data Record	USA_NASA_APL_MROCR_3nnn	
Map-Projected Targeted Reduced Data Record	USA_NASA_APL_MROCR_4nnn	

Table 2-1. CRISM Data Sets and Volume IDs

Each CRISM archive volume will contain at minimum the following directories below the root directory:

- DATA (may be named EDR, CDR, etc. based on product type)
- INDEX
- DOCUMENT
- CATALOG
- LABEL

In addition to these, a CRISM archive volume may include other directories:

- CALIB
- GEOMETRY
- BROWSE
- EXTRAS

Section 3 describes the contents and required files for each directory.

3. Archive Volume Contents

This section describes the contents of the CRISM Archive volumes, including the file names, file contents, file types, and organization responsible for providing the files. The indication that a file is required means that it is required by the PDS standards for archive volumes, as specified in the PDS Standards Reference, Applicable Document 6.

3.1. 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	Required?	File Contents	File Provided By
AAREADME.TXT	Yes	Volume content and format information	Geosciences
AAREADME.HTM	No	Hypertext version of AAREADME.TXT	Geosciences
AAREADME.LBL	Yes	A PDS detached label that describes both AAREADME.TXT and AAREADME.HTM.	Geosciences
ERRATA.TXT	No	A cumulative listing of comments and updates concerning all archive volumes published to date	Geosciences and CRISM
VOLDESC.CAT	Yes	A description of the contents of this volume in a PDS format readable by both humans and computers	Geosciences

Table 3-1. Root Directory Contents

3.2. Data Directory Contents and File Naming

Files in the data directory may contain

- raw data in unit of DN
- coefficiencts needed to calibrate the data
- non-resampled calibrated data in units of radiance, I/F, or unitless spectral parameters
- map-projected radiance, I/F, or unitless spectral parameters
- observation geometry, coordinates, or surface physical properties in sensor space used for correction from radiance to I/F, either in sensor space or map projected

The descriptions below are intended to provide a synopsis of the contents of the data directory. Users are referred to the CRISM Data Products SIS (Applicable Document 3) for a more detail description of the formats, contents, and derivation of data products.

3.2.1. EDR Directory

The EDR directory is present in the EDR archive volume. It contains CRISM VNIR and IR EDRs and information on data validation.

An EDR consists of a part or all of the output from one of the constituent command macros that make up one observation tagged by a unique observation ID. The data in one EDR represent a consistent instrument configuration (shutter position, frame rate, pixel binning, compression,

exposure time, on/off status and setting of different lamps). This is shown schematically in Figure 3-2. There is a single multiple-band image (suffix *.IMG) stored in one file, plus a detached list file in which each record has information specific to one frame of the multiple-band image (suffix *.TAB). One label points to both files.

The multiple-band image has dimensions of sample, line, and wavelength. The size of the multiple-band image varies according to the observation mode but is deterministic given the macro ID, as described in Data Products SIS. Pixels are 16-bit unsigned integer values, most significant bit first. Appended to the multiple-band image is a binary table of the detector rows that were used, as selected by the wavelength filter. This is a one-column table, with each row containing one detector row number expressed as a 16-bit unsigned integer values, most significant bit first.

The detached comma-separated ASCII file contains raw instrument housekeeping plus other frame-dependent information, one row per detector frame.



Figure 3-2. Contents of a CRISM Experiment Data Record (EDR).

EDRs are organized into subdirectories by year and DOY, e.g. 2006/2006_350. An EDR is assigned to a directory based on the start time of the observation with which an EDR is associated. Several EDRs may result from one observation, and all share a common observation ID. These EDRs are grouped into subdirectories within a YYYY_DDD subdirectory, named for the combination of class type and observation ID unique to a single observation (e.g. "FRT00001270").

In each subdirectory containing the EDRs for a single observation, there is also a text report on data validation for the EDRs generated by each detector.

The file naming convention for an EDR is as follows. See the Data Products SIS for the significance of each field in the file name.

```
(ClassType)(ObsID)_(Counter)_(Activity)(SensorID)_(Filetype)(version).(Ext)
```

where:

Class Type =

FRT (Full Resolution Targeted Observation)

HRL (Half Resolution Long Targeted Observation)

HRS (Half Resolution Short Targeted Observation)

EPF (Atmospheric Survey EPF)

TOD (Tracking Optical Depth Observation)

MSS (Multispectral Survey, lossy compressed)

MSP (Multispectral Survey, losslessly compressed)

MSW (Multispectral Window)

CAL (Radiometric Calibration)

FFC (Flat Field Calibration)

ICL (Calibration source intercalibration)

STO (Star Observation)

FUN (Functional test)

UNK (no valid EDRs within observation that indicate class type)

ObsID= nnnnnnn, Observation ID, unique for the whole CRISM mission, expressed as a hexadecimal number

Counter= nn, a monotonically increasing ordinal counter of EDRs from one Observation ID, expressed as a hexadecimal number

Activity= for an EDR, type of observation, e.g.

BInnn – Bias measurements / Macro#

DFnnn – Dark field measurements / Macro#

LPnnn – Lamp measurements / Macro #

SPnnn - Sphere measurements / Macro #

SCnnn – Scene measurements / Macro #

T1nnn - Focal plane electronics test pattern 1 / Macro #

T2nnn – Focal plane electronics test pattern 2 / Macro #

T3nnn – Focal plane electronics test pattern 3 / Macro #

T4nnn – Focal plane electronics test pattern 4 / Macro #

T5nnn – Focal plane electronics test pattern 5 / Macro #

T6nnn – Focal plane electronics test pattern 6 / Macro #

T7nnn – Focal plane electronics test pattern 7 / Macro #

UNnnn – Instrument configuration does not match macro library / Macro #

Sensor ID= S for VNIR, or L for IR

filetype = EDR

version= 0, 1,...,9, a, ..., z

Ext= IMG or TAB

The file naming convention for the validation report is as follows.

(ClassType)(ObsID)_(SensorID)_VALIDATION.TXT

3.2.2. CDR Directory

The CDR directory is also present in the EDR archive volume. It contains calibration files (Figures 3-3 and 3-4) used to process EDRs to units of radiance or I/F. More detailed information on the contents of these files can be founding the in CRISM Data Products SIS.



Figure 3-3. Contents of a CRISM level 4Figure 3-4. Contents of a CRISM level 6Calibration Data Record (CDR).Calibration Data Record (CDR).

There are two formats of CDRs. A level-6 CDR (Figure 3-4) consists of tabulated derived data needed for calibration to radiance or I/F. The different types of level-6 CDRs are given in Table 3-5. A level-4 CDR (Figure 3-3) consists of a derived image product needed for calibration to radiance or I/F. The different types of level-4 CDRs are given in Table 3-6.

The file naming convention for level-6 CDRs is as follows.

(ProductType)(Level)_(Partition)_(Time)_(Product)_(SensorID)_version.(Ext)

where:

Product Type = CDR

Level = 6

Partition = n, partition of the spacecraft clock.

Time = nnnnnnn, spacecraft start time of applicability of data product; units are spacecraft clock counts, in units of whole seconds.

Product = nn, acronym describing data product from Table 3-5

Sensor ID = S or L (or J=joint)

Version = 0, 1,..., 9, a,..., z

Ext = TAB

Also classified as level 6 CDRs are tables that contain sets of scene EDRs with the accompanying calibration EDRs needed for their calibration. These tables are used by software that processes the EDRs into CDRs or TRDRs. The file naming convention for these tables is as follows; it is different from the rest of the CDR6s to distinguish them from data-containing files.

(Product)_(Sensor)_(YYYY)_(DOY)_version

where:

```
Product Type = BTF for before-the-fact predicted, or ATF for after-the-fact actual
Sensor = VN or IR
YYYY = year
DOY = day of year
Version = nn
The file naming convention for level-4 CDRs is as follows.
```

```
(ProductType)(Level)(Partition)(Time)
```

(Product)(FrameRate)(Binning)(ExposureParameter)(WavelengthFilter)(Side)(SensorID)_version.(Ext)

where:

Product Type = CDR

Level = 4

FrameRate = n, rate in Hz at which data are taken (0=1 Hz, 1=3.75 Hz, 3=156 Hz, 4=30 Hz, 5 = N/A)

Binning = n, number of spatial pixels binned (0=unbinned, 1=2x binned, 2=5x binned, 3=10x binned, 4=N/A)

Exposure parameter = nnn, an integer 1-480 indicating commanded exposure time in units of (inverse frame rate)/480; 000 if inapplicable

Wavelength filter = n, and integer 0-3 indicating which onboard menu of rows of the detector are represented

Side = #, 1 or 2 for focal plane or sphere bulbs; or 0 if N/A

Ext = IMG

CDRs are arranged into directories based on how frequently they are updated. Files that are either invariant or expected to change only infrequently are stored in directories named using a 2-letter acronym for the product type. Files that are highly time-variable, for example the thermal background measured by the IR detector, are stored in directories named YYYY_DOY, each of which contains subdirectories named using the 2- or 3-letter acronym for the product type.

PRODUCTS	FORM FOR EACH FOCAL PLANE	PRODUCT ACRONYM		
INFREQUENTLY UPDATED PRODUCTS				
Coefficients for correcting raw housekeeping for effects of lamps, coolers, frame rate	ASCII table , 11 columns (only one file applicable to both VNIR and IR)	HD		
Coefficients for calibrating housekeeping from digital to physical units	ASCII table , 5 columns (only one file applicable to both VNIR and IR)	НК		
Coefficients to convert housekeeping voltages for perturbations due to current	ASCII table , 7 columns (only one file applicable to both VNIR and IR)	HV		
Gain and offset to use for each row for 12 to 14 bit conversion; 12 to 8 bit lookup tables used for each row	ASCII table, 4 columns, 1 per detector	PP		
Wavelength tables	ASCII table, 5 columns, 1 per detector	WV		
Bandwidth for each row (band) in central columns of each detector at which spectral smile and keystone are minimum.	ASCII table, 2 cols VNIR and 11 cols IR, 1 per detector	BW		
Center wavelength for each row (band) in central columns of each detector at which spectral smile and keystone are minimum.	ASCII table, 2 columns, 1 per detector	SW		
12 to 8 bit lookup tables	ASCII table, 1 col. of 12-bit input, 8 cols. of 8-bit output	LK		
8 to 12 bit lookup tables (inverse of 12 to 8)	ASCII table, 8 cols. of 8-bit input, 1 col. of 12-bit output	LI		
Linearity correction	ASCII table, 7 columns, 1 per detector	LC		
Bias step function as a function of frame rate and quadrant	ASCII table, 3 columns, 1 per detector	BS		
Additive correction of bias to nominal detector operating temperature	ASCII table, 3 columns, 1 per detector	DB		
Additive correction of bias to nominal focal plane electronics operating temperature	ASCII table, 3 columns, 1 per detector	EB		
Interquadrant ghost removal scaling factors	ASCII table, 6 columns, 1 per detector	GH		
Average Mars spectrum for limiting cases in different operating modes	ASCII table, 6 columns, 1 per detector	AS		
Saturation limit for each detector quadrant and frame rate	ASCII table, 3 columns, 1 per detector	SL		

Table 3-5. Descriptions of level-6 CDRs

PRODUCTS	FORM FOR EACH FOCAL PLANE	PRODUCT ACRONYM
Valid limits for each detector quadrant and frame rate for 14-bit DN level and noise	ASCII table, 5 columns, 1 per detector	VL
Atmospheric transmission for each wavelength bin averaged over IR columns 270-369 or VNIR columns 260-359, the part of each detector at which spectral smile and keystone are minimum	ASCII table, 2 columns, 1 per detector	СТ
FREQUENTLY UPDATED PRODUCTS		
Standard telemetry file: CRISM low-rate telemetry in raw counts, from the beginning of a UTC calendar day to its end. This is used in preference to the telemetry attached to each image for correction of thermal effects.	ASCII table, 224 columns	ST
Predicted EDR processing table: Predicted table of EDRs containing scene data and the corresponding EDRs containing time- dependent calibration measurements. It is constructed from uplinked commands	ASCII table, 21 columns	BTF
EDR processing table: Table of EDRs containing scene data and the corresponding EDRs containing time- dependent calibration measurements. Used to process scene EDRs to TRDRs, and calibration EDRs to CDRs. If there is a discrepancy between the actual and predicted EDRs used for calibration, the TRDRs resulting from scene EDRs are quality-flagged.	ASCII table, 6 columns	ATF

Table 3-6. Descriptions of level-4 CDRs

PRODUCTS	FORM FOR EACH FOCAL PLANE	VERSIONS FOR DIFFERENT PIXEL BINNING / CHANNEL SELECTION?	VERSIONS FOR DIFFERENT FRAME RATE?	ACRONYM	
GROUND CALIBRATION PRODUCTS					
Masks of detector dark columns, scattered light columns, scene columns	2D matrix per detector, 8 bit	Y	Ν	DM	
Nonuniformity file: time-tagged, rown-normalized measurement of detector nonuniformity	Two 2D matrices, 32 bit	Y	Y	NU	

PRODUCTS	FORM FOR EACH FOCAL PLANE	VERSIONS FOR DIFFERENT PIXEL BINNING / CHANNEL SELECTION?	VERSIONS FOR DIFFERENT FRAME RATE?	ACRONYM
Matrices to remove estimated leaked higher order light	Four 2D matrices per detector, 16 bit integer, row numbers Four 2D matrices per detector, 32 bit, weighting coefficients	Y	Ν	LL
Sphere spectral radiance at set point (pixel by pixel coefficients to a 2nd order polynomial function of optical bench temperature)	Three 2D matrices per detector, 32 bit, for each sphere bulb	Y	Ν	SS
Shutter position reproducibility correction to sphere radiance (pixel by pixel coefficients to a linear function of the ratio of corrected sphere image to sphere spectral radiance model)	2 2D matrices per detector, 32 bit, for each sphere bulb	Y	Ν	SH
Temperature dependence of detector responsivity (pixel by pixel coefficients to a 2nd order polynomial function of detector temperature)	Three 2D matrices per detector, 32 bit	Y	Ν	TD
Along-slit angle measured from slit center	2D matrix per detector, 32 bit	Y	Ν	СМ
Number of lines by which to shift each column (sample) of an image to minimize the effects of spectral smile	2D matrix per detector, 32 bit	Y	Ν	PS
Wavelength image (each pixel) determined onground	2D matrix per detector, 32 bit	Y	Ν	WA
Nearest-neighbor resampled wavelength image (each pixel) determined onground	2D matrix per detector, 32 bit	Y	N	RW
Spectral bandpass, or full width half maximum (each pixel) determined onground	One (VNIR) or ten(IR) 2D matrices per detector, 32 bit	Y	Ν	SB
Solar flux at 1 AU (for each pixel to take into account spectral smile effects)	2D matrix per detector, 32 bit	Y	Ν	SF
Nearest-neighbor resampled solar flux at 1 AU (for each pixel to take into account spectral smile effects)	2D matrix per detector, 32 bit	Y	N	RF

PRODUCTS	FORM FOR EACH FOCAL PLANE	VERSIONS FOR DIFFERENT PIXEL BINNING / CHANNEL SELECTION?	VERSIONS FOR DIFFERENT FRAME RATE?	ACRONYM
Atmospheric transmission as measured from a nadir-pointed hyperspectral scan across Olympus Mons	2D matrix per detector, 32 bit	Y	Ν	AT
Atmospheric transmission as measured from a nadir-pointed hyperspectral scan across Olympus Mons, nearest-neighbor resampled in the wavelength direction	2D matrix per detector, 32 bit	Y	N	RT
Bad pixel mask: time-tagged	2D matrix, 8 bits,	Y	Y	BP
bitmap of bad pixels Bias file: time-tagged, fitted VNIR and IR images extrapolated to zero exposure time	2D matrix, 32 bit, per detector	Y	Y	BI
Background file: time-tagged, bias- and ghost-subtracted, linearized, averaged VNIR and IR background frames	2D matrix, 32 bit, per detector	Y	Y	BK
Noise file: time-tagged, image of pixel-by-pixel uncertainties in background images	2D matrix, 32 bit, per detector	Y	Y	UB
Processed sphere image in units of DN/ms	2D matrix, 32 bit, per detector (1 for each sphere bulb)	Y	Ν	SP

3.2.3. DDR Directory

The DDR directory is present in the DDR archive volume. It contains CRISM VNIR and IR Derived Data Records (DDRs), which include information needed to process data calibrated to units of radiance or I/F into Lambert albedo corrected for photometric, atmospheric, and thermal effects.

There are two types of information in DDRs: geometric information (latitude, latitude, incidence, emission and phase angles) and information on surface physical properties (slope magnitude and azimuth, thermal inertia). The geometric information is derived from pixel spatial coordinates and the SPICE files in the GEOM directory. The physical information is derived by retrieving information from other data sets for the latitudes and longitudes corresponding to each detector element, and thus is in non-resampled sensor space.

As shown in Figure 3-7, a DDR contains a single multiple-band image. It has the same spatial dimensions as a scene EDR or the resulting TRDR. The size of the multiple-band image varies according to the observation mode but is deterministic given the macro ID. The data

values are given in 32-bit real numbers. There is one DDR per VNIR TRDR or scene EDR, and one DDR per IR TRDR or scene EDR. Although there is a one-to-one correspondence between line and line_sample coordinates in a corresponding DDR, EDR containing planetary scene information (activity=SCnnn from section 3.2.1), and TRDR (section 3.2.4), the EDR and TRDR contain uncorrected optical distortions that change the spatial scale of the image with band. Therefore the DDR is referenced to a single band for each file, that nearest to 610 nm in the VNIR, or 2300 nm in the IR.

Once image data are assembled into EDRs and calibrated into TRDRs, DDRs are created for the data. A version 0 DDR represents values based on predicted pointing, and is generated to provide quick-look information. Version 1 and subsequent versions of a DDR are based on actual, reconstructed pointing.



Creation time=within data transfer+14 days

Figure 3-7. Contents of a CRISM Derived Data Record (DDR).

For parallelism, DDRs are organized like EDRs and TRDRs into subdirectories by year and DOY, e.g. 2006/2006_350. A DDR is assigned to a directory based on the start time of the observation (observation ID) with which the DDR is associated. Multiple DDRs for a single observation are grouped into subdirectories within a YYYY_DDD subdirectory, named for the combination of class type and observation ID unique to a single observation (e.g. "FRT00001270").

The file naming convention for a DDR is as follows.

```
(ClassType)(ObsID)_(Counter)_ (Activity)(SensorID)_(Filetype)(version).(Ext)
```

where:

Class Type =

FRT (Full Resolution Targeted Observation)

HRL (Half Resolution Long Targeted Observation)

HRS (Half Resolution Short Targeted Observation)

EPF (Atmospheric Survey EPF)

TOD (Tracking Optical Depth Observation)

MSS (Multispectral Survey, lossy compressed)

MSP (Multispectral Survey, losslessly compressed)

MSW (Multispectral Window)

ObsID= nnnnnnn, Observation ID, unique for the whole CRISM mission, expressed as a hexadecimal number

Counter= nn, the ordinal counter carried through from the source EDR, expressed as a hexadecimal number

Activity= for a DDR, type of product,

DEnnn – Derived product / Macro#

Sensor ID= S or L

filetype = DDR

version= 0, 1,...,9, a, ..., z

Ext= IMG

3.2.4. TRDR Directory

The TRDR directory is present in the TRDR archive volume. It contains CRISM VNIR and IR Targeted Reduced Data Records (TRDRs), calibrated data in non-resampled sensor space. As with EDRs and DDRs, the TRDRs are organized into subdirectories by year and DOY, e.g. 2006/2006_350. A TRDR is assigned to a directory based on the start time of the observation (observation ID) with which the TRDR is associated. Multiple TRDRs from a single observation are grouped into subdirectories within a YYYY_DDD subdirectory, named for the combination of class type and observation ID unique to a single observation (e.g. "FRT00001270").

The TRDR consists of the output of one of the constituent macros associated with a target ID that contains scene data (Mars or other), as shown in Figure 3-8. Not all EDRs are processed to TRDR level; macros containing bias, background, sphere, or calibration lamp data are processed instead to CDRs (discussed in section 3.2.3).

The TRDR contains one or more multiple-band images (suffix *.IMG). One matches the dimensions of the multiple-band image of raw DN in an EDR, except that the data are in units of radiance. The size of the multiple-band image varies according to the observation mode but is deterministic given the ID of the command macro used to acquire the data. Appended to the

multible-band image is a binary table of the detector rows that were used, as selected by the wavelength filter. This is a one-column table, with each row containing one detector row number expressed as a 16-bit unsigned integer values, most significant bit first.

Other multiple-band images may contain I/F, Lambert albedo, or derived summary products, The I/F and Lambert albedo images, if present, parallel the structure of the radiance image. The summary products image has the same spatial dimensions, but a different dimension in the spectral direction and it lacks that table of row numbers.

In any of the multiple-band images, data values are given in 32-bit real numbers.

Each TRDR also contains a detached list file (suffix *.TAB) analogous to that in the EDR, in which each record has information specific to one frame of the multiple-band radiance image, except that the analog status data are in physical units.

There is at least one label per TRDR. That label points to the radiance multiband image and the list file; additional labels may point to the I/F, Lambert albedo, or summary product image.



Figure 3-8. Contents of a CRISM Reduced Data Record for a single observation (TRDR).

The file naming convention for a TRDR is as follows.

(ClassType)(ObsID) (Counter) (Activity)(SensorID) (Filetype)(version).(Ext)

where:

Class Type =

FRT (Full Resolution Targeted Observation)

HRL (Half Resolution Long Targeted Observation)

HRS (Half Resolution Short Targeted Observation)

EPF (Atmospheric Survey EPF)

TOD (Tracking Optical Depth Observation)

MSS (Multispectral Survey, lossy compressed)

MSP (Multispectral Survey, losslessly compressed)

MSW (Multispectral Window)

STO (Star Observation)

ObsID= nnnnnnn, Observation ID, unique for the whole CRISM mission, expressed as a hexadecimal number

Counter= nn, the ordinal counter carried through from the source EDR, expressed as a hexadecimal number

Activity= for a TRDR, type of product, e.g.

RAnnn – Radiance / Macro#

SUnnn – Summary Products / Macro #

IFnnn – I/F / Macro #

ALnnn – Lambert albedo / Macro #

Sensor ID= S or L

filetype = "TRR" for TRDR

version= 0, 1,...,9, a, ..., z

Ext= IMG or TAB

A TRDR subdirectory may also contain multiband images that have been resampled in the spectral or spatial direction. Three types of resampling may have occurred: (a) resampling in the wavelength direction occurs using nearest-neighbor resampling, as coded in the PS CDR; (b) resampling in the spatial direction, to remove differences in spatial scale with wavelength or band, is done with bicubic interpolation using the CM CDR; and (c) VNIR data may be rescaled to match the slightly different magnification of the IR spectrometer, also using bicubic interpolation and the CM CDR.

A resampled TRDR is distinguished by its label and file name. The label uses local data dictionary keywords to document the type of resampling that has occurred. The file name parallels that of the source TRDR except for file type, to flag resampling in the file name :

```
(ClassType)(ObsID)_(Counter)_(Activity)(SensorID)_(Filetype)(version).(Ext)
```

where:

filetype = "RTR" for resampled TRDR

3.2.5. ADR Directory

The ADR directory is also present in the TRDR archive volume. An Ancillary Data Record or ADR contains a hyperdimensional binary table of derived values, where the axes of the matrix represent values of a layer of a DDR (e.g., incidence angle, thermal inertia, etc.), the output of another ADR, or a value extracted from a TRDR. The overall objective of ADRs is to correct I/F in a TRDR for predictive atmospheric, photometric, or thermal effects to isolate the surface-reflected component of radiance as Lambert albedo. There are three types of ADRs:

- 1. The "CL" ADR is a table of climatologically predicted surface temperatures and atmospheric dust and ice opacities, given for a latitude and longitude from the DDR and Ls and local solar time from the TRDR label.
- 2. The "AC" ADR is a table of correction from I/F to Lambert albedo, for an incidence, emission, and phase angle and surface elevation from the DDR, dust and ice optical depths and surface temperature from the CL ADR, and observed I/F from a TRDR. There is a separate AC ADR for each wavelength that is corrected; nominal wavelengths are those used in multispectral mapping, in wavelength filter 1.
- 3. The "TE" ADR is a table of calculated surface temperature for latitude, thermal inertia, elevation, and slope magnitude and azimuth from the DDR, dust and ice opacity from the CL ADR, Ls and local solar time from the TRDR label, and bolometric albedo estimated from Lambert albedo at wavelengths <2300 nm. This supplants surface temperature that is returned from the CL ADR.

The file naming convention for ADRs is as follows.

```
(ProductType)_(ADR_Type)_(Wavelength)_(Partition)_(Time)_version.(Ext)
```

where:

Product Type = ADR

ADR_Type = nn, acronym in captions of Tables 3-9 to 3-11

Wavelength = nnnn, in nanometers; 0000 if not applicable

Partition = n, spacecraft clock partition.

Time = nnnnnnn, spacecraft start time of applicability of data product; units are spacecraft clock counts, in units of whole seconds.

version = 0, 1, ..., 9, a, ..., z

Ext = DAT

VARIABLE	RANGE	UNIT
Latitude	-90-90°	degrees
Longitude	-90-90°	degrees
Ls	0-360°	degrees
Local time	15	(assumed local time)r
Surface temperature	180-310	°K
Dust opacity	0-1.0	dimensionless opacity
Ice opacity	0-1.0	dimensionless opacity

Table 3-9. LUT for atmospheric opacity (ADR type = CL)

Table 3-10. LUT for predicted atmospheric / photometric / thermal correction (ADR type = AC)

VARIABLE	RANGE	WAVELENGTH
Wavelength	410-3920 nm	(separate table for each wavelength)
Incidence angle at areoid	25-75°	degrees
Emission angle at areoid	0-45°	degrees
Phase angle at areoid	45-135°	degrees
Elevation	-8000-26000	meters
Dust optical depth	0-1	dimensionless opacity
Ice optical depth	0-0.6	dimensionless opacity
Surface temperature	140-300 K	°K
Observed I/F	0.03-0.50	dimensionless

Table 3-11. LUT for local surface temperature (ADR type = TE)

VARIABLE	RANGE	UNITS
Latitude	-90-90°	degrees
Slope magnitude	0-10	degrees
Slope azimuth	0-270	degrees clockwise from north
Elevation	-8000-26000	meters
Thermal inertia	5-5000	J m^-2 K^-1 s^-0.5
Dust+ice opacity	0-1.0	dimensionless opacity
Ls	0-360°	degrees
Local time	13-17	(assumed local time)r
Bolometric albedo	0.15-0.35	dimensionless

3.2.6. MRDR Directory

The MRDR directory, present in the MRDR archive volume, contains CRISM Multispectral Reduced Data Records (MRDRs). The MRDRs are organized into 30 subdirectories named by the Mars Chart containing the MRDR, e.g. MC01. Latitude and longitude limits of Mars Charts are given in Table 3-12.

An MRDR (Figure 3-13) consists of several or more strips of multispectral survey data mosaicked into a map tile. Thus a map tile is constructed from a large number of TRDRs. The mosaic is uncontrolled (accepting existing pointing data often resulting in image mismatch at seams within a mosaic). The tile contains image data in units of I/F extracted from temporary TRDRs, plus Lambert albedo, summary products, and the DDR data used to generate them. It also contains text information that lists the wavelengths present and the SPICE files used for map projection. So, for every latitude or longitude in an MRDR, there is a radiance and all the information providing traceability to a companion I/F corrected for atmospheric, photometric, and thermal emission effects, plus the information needed to reconstruct the map projection.

A global pattern of 1964 such tiles (Figure 3-14) is being used, forming the major data product for multispectral survey observations. Multiple tiles are in each of the 30 subdirectories.

An MRDR contains several files, each with a distinct label. The file naming convention for an MRDR is as follows:

(Tile)_(ProductType)(Subtype)_ (CLat)(Hemisphere) (CLon)_(Resolution)_version.(Ext) where:

Tile = Tnnnn, tile number with tile 0000 at the south pole, increasing sprialing northward

Product Type = "MRR" for MRDR

Subtype of product, e.g.

IF – I/F

AL – Lambert albedo

SU – Summary Products

DE – Derived Products for I/F

DL - Derived Products for Lambert albedo

SP - List of observation IDs and SPICE metakernels

WV - List of wavelengths and wavelength ranges of radiance and I/F images

ULLat = nn, Planetocentric latitude of upper left corner

Hemisphere = #, N or S for north or south latitude

ULLon = nnn, East longitude of upper left corner

Resolution= nnnn, in map-projected pixels per degree, e.g. 256 pixels per degree

version= 0, 1,..., 9, a,..., z

Ext= IMG or TAB

Identifer	Chart Name	Latitude Range	Longitude Range
MC01	Mare Boreum	60 to 90	-180 to 180
MC02	Diacria	30 to 60	-180 to -120
MC03	Arcadia	30 to 60	-120 to -60
MC04	Mare Acidalium	30 to 60	-60 to 0
MC05	Ismenius Lacus	30 to 60	0 to 60
MC06	Casius	30 to 60	60 to 120
MC07	Cebrenia	30 to 60	60 to 180
MC08	Amazonis	0 to 30	-180 to -135
MC09	Tharsis	0 to 30	-135 to -90
MC10	Lunae Palus	0 to 30	-90 to -45
MC11	Oxia Palus	0 to 30	-45 to 0
MC12	Arabia	0 to 30	0 to 45
MC13	Syrtis Major	0 to 30	45 to 90
MC14	Amenthes	0 to 30	90 to 135
MC15	Elysium	0 to 30	135 to 180
MC16	Memnonia	0 to -30	-180 to -135
MC17	Phoenicis Lacus	0 to -30	-135 to -90
MC18	Coprates	0 to -30	-90 to -45
MC19	Margaritifer Sinus	0 to -30	-45 to 0
MC20	Sinus Sabaeus	0 to -30	0 to 45
MC21	lapygia	0 to -30	45 to 90
MC22	Mare Tyrrhenum	0 to -30	90 to 135
MC23	Aeolis	0 to -30	135 to 180
MC24	Phaethontis	-30 to -60	-180 to -120
MC25	Thaumasia	-30 to -60	-120 to -60
MC26	Argyre	-30 to -60	-60 to 0
MC27	Noachis	-30 to -60	0 to 60
MC28	Hellas	-30 to -60	60 to 120
MC29	Eridania	-30 to -60	120 to 180
MC30	Mare Australe	-60 to -90	-180 to 180

Table 3-12. Latitude and longitude limits of Mars Charts.

An MRDR, as shown in Figure 3-13, contains up to five multiple-band images at 256 pixels/degree, and two list files.

The first multiple-band image is map-projected I/F without any further corrections applied, taken directly from the temporary TRDR associated with a strip of multispectral data. Although in the TRDRs there are separate multiple-band images for the VNIR and IR detectors, in this case the data are merged. The size of the multiple-band image varies between map tiles. A typical multiple-band image might have 1280 pixels in the latitude direction, a variable number of pixels in the longitude direction, and approximately 72 pixels in the wavelength dimension, representing each of the selected channels in multispectral mode.

The second multiple-band image is geometrically identical to the map-projected I/F multiple-band image, except that the data have been processed using the ADR binary tables to Lambert albedo (the thermally-corrected estimated surface contribution to reflected I/F, divided by cos I).

The third and fourth multiple-band image contains map-projected data from the temporary DDR associated with a strip of multispectral data, used to derive I/F from radiance. One file corresponds to the I/F image, and one file corresponds to the Lambert albedo images. In each of these, 11 additional layers are specific to individual multispectral strips used to assemble the tile, and are thus not contained in the source DDRs.

- Solar longitude, units degrees
- Solar distance at time of measurement, units AU
- VNIR OBSERVATION_ID of constituent measurement
- IR OBSERVATION_ID of constituent measurement
- The VNIR OBSERVATION_NUMBER carried through from the source scene EDRs;
- The IR OBSERVATION_NUMBER carried through from the source scene EDRs;
- The VNIR LINE_SAMPLE carried through from the temporary TRDR used to populate the MRDR; this identifies the VNIR wavelength calibration at the spatial pixel of the MRDR
- The IR LINE_SAMPLE carried through from the temporary TRDR used to populate the MRDR; this identifies the IR wavelength calibration at the spatial pixel of the MRDR
- The LINE_SAMPLE from the source VNIR TRDR; this together with column number, observation ID, and ordinal counter provides traceability back to a spatial pixel in a source EDR
- The LINE from the source IR TRDR
- The LINE from the source VNIR TRDR

The fifth multiple-band image contains map-projected summary products from the temporary RDR associated with a strip of multispectral data.

The first listfile, in ASCII format, contains one pair of values for every observation ID used to create the tile, the observation ID and the SPICE metakernel that described the kernels required for its map projection.

The second listfile, also in ASCII format, contains wavelengths of each layer in the Lambert albedo and I/F images..



Figure 3-13. Contents of a CRISM MRDR.



Figure 3-14. Tiling scheme for MRDRs, shown in orthographic view and as a simple cylindrical map.

3.2.7. MTRDR Directory

The MTRDR directory contains CRISM Map-projected Targeted Reduced Data Records (MTRDRs). An MTRDR (Figure 3-15) contains one or more TRDRs and their corresponding DDRs, which have been resampled and map-projected. Essentially it is a local, high-resolution map tile comparable to an MRDR. The mosaic is controlled on a best-effort basis. The tile contains image data in units of radiance extracted from a temporary TRDR, plus Lambert albedo, summary products, the DDR data used to generate them, text information that lists the wavelengths present and the SPICE files used for map projection, and optionally additional information. The MTRDRs are organized into 30 subdirectories named by the Mars Chart containing the latitude and longitude of its upper left corner, e.g. MC01. Latitude and longitude limits of Mars Charts are given in Table 3-12.

The file naming convention for an MTRDR is as follows. Each MTRDR contains several files each with a distinct label.

(ProductType)(Subtype)_ (ULLat)(Hemisphere) (ULLon)_ (Counter)_ (Resolution)_(Date of creation).(Ext)

where:

Product Type = "MTR" for MTRDR

Subtype of product, e.g.

IF – I/F

AL – Lambert albedo

SU – Summary Products

DE - Derived Products for I/F

DL - Derived Products for Lambert albedo

AN – Analysis Products

SP - List of observation IDs and SPICE metakernels

WV - List of wavelengths and wavelength ranges of radiance and I/F images

IN – Text information on analysis products

ULLat = nn, Planetocentric latitude of upper left corner

Hemisphere = #, N or S for north or south latitude

ULLon = nnn, East longitude of upper left corner

Counter = nn (representing the ordinal number of the TRDR included, if multiple TRDRs are separated; otherwise if they are overlain in a single mosaic, nn = 00)

Resolution= nnnn, in map-projected pixels per degree, typically 2048 pixels per degree

Date of creation= yymmdd, when the file was written (this is to separate MTRDRs which contain different groups of map-projected TRDRs but have the same latitude and longitude)

Ext= IMG or TAB

An MTRDR contains up to six multiple-band images at 2048 or 4096 pixels/degree. All data in these multiple-band images are represented as 32-bit real numbers. Up to three text files contain supplementary information on the contents of the multiple-band images.

The first multiple-band image is map-projected I/F. A typical multiple-band image might have XX pixels in the longitude dimension, YY pixels in the latitude dimension, and ZZ pixels in the wavelength dimension, where XX and YY depend on the site(s) and ZZ is the number of channels (nominally 545).

The second multiple-band image is map-projected Lambert albedo, i.e., I/F corrected for atmospheric and thermal effects and divided by cos i. A typical multiple-band image might have XX pixels in the longitude dimension, YY pixels in the latitude dimension, and up ZZ pixels in the wavelength dimension, where XX and YY depend on the site(s) and ZZ is the number of channels (nominally 545).

The third and fourth multiple-band images are geometrically identical to the map-projected I/F and Lambert albedo multiple-band images respectively, except that they contains mapprojected data from the DDR, used to derive I/F from radiance. They are augmented with 11 additional layers that are specific to individual TRDRs used to assemble the tile, and are thus not contained in the DDR:

- Solar longitude, units degrees
- Solar distance at time of measurement, units AU
- VNIR observation ID of constituent measurement
- IR observation ID of constituent measurement
- The VNIR ordinal counter carried through from the source scene EDRs;
- The IR ordinal counter carried through from the source scene EDRs;
- The VNIR column number carried through from the temporary TRDR used to populate the MRDR; this identifies the VNIR wavelength calibration at the spatial pixel of the MRDR
- The IR column number carried through from the temporary TRDR used to populate the MRDR; this identifies the IR wavelength calibration at the spatial pixel of the MRDR
- The ordinal number of the frame from the source VNIR TRDR; this together with column number, observation ID, and ordinal counter provides traceability back to a spatial pixel in a source EDR
- The ordinal number of the frame from the source IR TRDR;
- Time of day, hhmm.ss

The fifth multiple-band image contains map-projected summary products.

The sixth multiple-band image contains map-projected outputs of the CRISM analysis tool. These are user-defined.

The seventh file, in ASCII format, is a list containing one pair of values for every observation ID used to create the tile, the observation ID and the SPICE metakernel that described the kernels required for its map projection.

The eighth file, also in ASCII format, contains wavelengths and wavelength ranges of each layer in the Lambert albedo and I/F images..

The ninth file, also in ASCII format, provides explanatory information on any additional layers in the fifth multiple-band image. This might include, for example, description of principal components or end members whose fractional abundances are represented in the fourth multiple-band image.



Figure 3-15. Contents of a CRISM MTRDR.

3.3. Index Directory Contents

Files in the Index Directory (Table 3-16) are provided to help the user locate products on this archive volume. The following files are contained in the Index Directory. If an archive is

divided among two or more physical volumes, the file INDEX.TAB lists the contents of an individual volume, and CUMINDEX.TAB lists the contents of all the volumes.

File Name	Required?	File Contents	File Provided By
INDXINFO.TXT	Yes	A description of the contents of this directory	Geosciences
YYYY_MM_INDEX.TAB	Yes	A table listing all data products on this volume, covering the time span within year YYYY and month MM	Geosciences
YYYY_MM_INDEX.LBL	Yes	A PDS detached label that describes YYYY_MM_INDEX.TAB	Geosciences
CUMINDEX.TAB	No	A cumulative listing of all data products on this volume and on previous volumes in this set	Geosciences
CUMINDEX.LBL	No	A PDS detached label that describes CUMINDEX.TAB	Geosciences

Table 3-16. Index Directory Contents.

Table 3-17 lists the columns in the index file. They are the most significant keywords pulled from labels of the various products. The list is comprehensive in the sense that it includes the important keywords for all data products. For any given data product, some of the fields are inapplicable and will be set to N/A.

Column	Format	Length, bytes	Example
VOLUME_ID	CHARACTER	12	MROCR_0001
PRODUCT_ID	CHARACTER	28	HRS00000101_07_SC173L_EDR0
PRODUCT_TYPE	CHARACTER	5	EDR
FILE_SPECIFICATION_NAME	CHARACTER	55	EDR/2006_350/FRT00001270/ FRT00001270_01_SC001S_EDR0.IMG
PRODUCT_CREATION_TIME	TIME	19	2005-03-02T00:53:38
PARTICIPATING_INSTRUMENTS	CHARACTER	6	CHXSM
SPACECRAFT_CLOCK_START_COUNT	CHARACTER	15	881332999:30121
SPACECRAFT_CLOCK_STOP_COUNT	CHARACTER	15	881333057:21547
ORBIT_NUMBER	CHARACTER	6	12345A
START_TIME	TIME	19	2005-03-02T00:53:38
STOP_TIME	TIME	19	2005-03-02T00:53:38
LOWER_RIGHT_LATITUDE	ASCII_REAL	7	-88.345
LOWER_RIGHT_LONGITUDE	ASCII_REAL	8	-189.345
LOWER_LEFT_LATITUDE	ASCII_REAL	7	-88.345
LOWER_LEFT_LONGITUDE	ASCII_REAL	8	-189.345
UPPER_RIGHT_LATITUDE	ASCII_REAL	7	-88.345
UPPER_RIGHT_LONGITUDE	ASCII_REAL	8	-189.345
UPPER_LEFT_LATITUDE	ASCII_REAL	7	-88.345
UPPER_LEFT_LONGITUDE	ASCII_REAL	8	-189.345
CENTER_LATITUDE	ASCII_REAL	7	-30.000
CENTER_LONGITUDE	ASCII_REAL	8	-130.000
OBSERVATION_TYPE	CHARACTER	3	HRS

Table 3-17. Index Table Contents.

Column	Format	Length, bytes	Example
OBSERVATION_ID	CHARACTER	8	12345678
MRO:OBSERVATION_NUMBER	ASCII_INTEGER	2	07
MRO:ACTIVITY_ID	CHARACTER	5	SC173
MRO:SENSOR_ID	CHARACTER	1	L
PRODUCT_VERSION_ID	CHARACTER	1	0
TARGET_CENTER_DISTANCE	ASCII_REAL	13	123456789.123
SOLAR_DISTANCE	ASCII_REAL	13	123456789.123
SHUTTER_MODE_ID	CHARACTER	6	CLOSED
LIGHT_SOURCE_NAME	CHARACTER	13	SPHERE LAMP 1
CALIBRATION_LAMP_STATUS	CHARACTER	11	CLOSED LOOP
CALIBRATION_LAMP_LEVEL	ASCII_INTEGER	4	1130
PIXEL_AVERAGING_WIDTH	ASCII_INTEGER	2	10
INSTRUMENT_POINTING_MODE	CHARACTER	16	DYNAMIC POINTING
SCAN_MODE_ID	CHARACTER	5	SHORT
MRO:FRAME_RATE	ASCII_REAL	5	30.00
MRO:EXPOSURE_PARAMETER	ASCII_INTEGER	3	439
SAMPLING_MODE_ID	CHARACTER	9	HYPERSPEC
COMPRESSION_TYPE	CHARACTER	5	8_BIT
MRO:WAVELENGTH_FILTER	CHARACTER	1	0
MRO:WAVELENGTH_FILE_NAME	CHARACTER	26	CDR6_000000000_WV_L_1.TAB
MRO:PIXEL_PROC_FILE_NAME	CHARACTER	26	CDR6_000000000_PP_L_1.TAB
MRO:LOOKUP_TABLE_FILE_NAME	CHARACTER	26	CDR6_000000000_LK_J_0.TAB
MRO:DETECTOR_TEMPERATURE	ASCII_REAL	8	-130.000
MRO:OPTICAL_BENCH_TEMPERATUR E	ASCII_REAL	8	-130.000
MRO:SPECTROMETER_HOUSING_TEM P	ASCII_REAL	8	-130.000
MRO:SPHERE_TEMPERATURE	ASCII_REAL	8	-130.000
MRO:FPE_TEMPERATURE	ASCII_REAL	8	-130.000
LINES	ASCII_INTEGER	4	2700
LINE_SAMPLES	ASCII_INTEGER	4	320
BANDS	ASCII_INTEGER	3	438
MAP_RESOLUTION	ASCII_INTEGER	4	4096
MAXIMUM_LATITUDE	ASCII_REAL	7	-30.000
MINIMUM_LATITUDE	ASCII_REAL	7	-30.000
WESTERNMOST_LONGITUDE	ASCII_REAL	8	-130.000
EASTERNMOST_LONGITUDE	ASCII_REAL	8	-130.000

3.4. Document Directory Contents

The Document Directory (Table 3-18) contains documentation to help the user understand and use the archive data. The following files are contained in the Document Directory.

File Name	Required?	File Contents	File Provided By
DOCINFO.TXT	Yes	A description of the contents of this directory	CRISM
CRISM_DPSIS.PDF	No	The CRISM Data Product SIS as a PDF file	CRISM
CRISM_DPSIS.HTM	No	The CRISM Data Product SIS as an HTML file	CRISM
CRISM_DPSIS.LBL	No	A PDS detached label that describes CRISM_DPSIS.PDF	CRISM
CRISM_AVSIS.PDF	No	The CRISM Archive Volume SIS (this document) as a PDF file	CRISM
CRISM_AVSIS.HTM	No	The CRISM Archive Volume SIS (this document) as an HTML file	CRISM
CRISM_AVSIS.LBL	No	A PDS detached label that describes CRISM_AVSIS.PDF and CRISM_AVSIS.HTM.	CRISM
PDSDD.FUL	Yes when a local data dictionary is used	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
PDSDD.IDX	Yes when a local data dictionary is used	An index to PDSDD.FUL, used by PDS validation software	Geosciences
PDSDD.TXT	No	A text file containing a table of MRO Local Data Dictionary keywords and definitions	Geosciences
PDSDD.LBL	Yes when a local data dictionary is used	A PDS detached label that describes the above three PDSDD files	Geosciences

 Table 3-18. Document Directory Contents.

3.5. Catalog Directory Contents

The files in the Catalog Directory (Table 3-19) provide a top-level understanding of the mission, spacecraft, instruments, and data set. The files in this directory become part of the PDS Catalog to provide background information for the user searching for data. Their format and contents are further specified in the PDS Standards Reference (Applicable Document 6). The following files are found in the Catalog Directory.

File Name	Required?	File Contents	File Provided By
CATINFO.TXT	Yes	A description of the contents of this directory	CRISM
nnnnn_DS.CAT	Yes	Data set description, where nnnnn is replaced by EDR, DDR, ADR, CDR, TRDR, MRDR, or MTRDR.	CRISM
INSTHOST.CAT	Yes	MRO instrument host (i.e., spacecraft) description	MRO Project
CRISM_INST.CAT	Yes	CRISM instrument description	CRISM
MRR_MAP.CAT	Yes	CRISM MRDR data set map projection information for equatorial region (MRDR data set only)	CRISM
MRR_POLAR_MAP.CAT	Yes	CRISM MRDR data set map projection information for polar region (MRDR data set only)	CRISM
MISSION.CAT	Yes	MRO mission description	MRO Project
PERSON.CAT	Yes	Contact information for CRISM and Geosciences personnel responsible for generating the archive	CRISM
REF.CAT	Yes	Complete citations of references mentioned in other *.CAT files	CRISM

Table 3-19. Catalog Directory Contents.

3.6. Label Directory Contents

The Label Directory (Table 3-20) contains files that describe data format and organization; for example, the definition, size, data type, etc. of each column in a table (file with a *.TAB suffix). These format files (*.FMT suffix) are referenced by PDS labels that accompany data products. They are "include" files that are intended to be parsed as if they were part of the PDS labels that point to them .The purposes of keeping this information in a separate file are (a) to keep labels short and (b) to allow the information to be updated without having to update many labels. The following files are contained in the Label Directory.

File Name	Required?	File Contents	File Provided By
LABINFO.TXT	Yes	A description of the contents of this directory	CRISM
*.FMT files	Yes	Generic descriptions of contents of EDR and RDR TAB files containing housekeeping;	CRISM

Table 3-20. Label Directory Contents.

3.7. Calib Directory Contents

The Calib directory (Table 3-21) contains various reports documenting different aspects on instrument behavior.

File Name	Required?	File Contents	File Provided By	
CALINFO.TXT	Yes	A description of the contents of this directory	CRISM	
*.PDF	No	Various calibration reports as PDF files	CRISM	
*.HTM	No	Various calibration reports as HTML files	CRISM	
*.LBL	No	PDS detached labels that describe the calibration reports.	CRISM	

Table 3-21. Calib Directory Contents

3.8. Geometry Directory Contents

The Geometry Directory contains a single file, GEOMINFO.TXT, which directs the reader to the various SPICE kernels that contain the data necessary to interpret observation geometry.

Four types of SPICE kernels are needed to calculate CRISM's pointing:

1) Frames kernel (FK). This file defines the relationships of the of CRISM's field of view to the spacecraft, with the gimbal at "nadir". These transformations in frames of reference include:

- gimbal base (MRO_CRISM_BASE) -> spacecraft (MRO_SPACECRAFT)
- optical axis at gimbal "nadir" (MRO_CRISM_OSU) -> gimbal base (MRO_CRISM_BASE)
- (the gimbal C kernel defines the relationship of optic axis at a gimbal position to the gimbal nadir)
- (the gimbal offset defines the software offset between commanded nadir and physical nadir)
- IR zero position for IK (MRO_CRISM_IR) -> optical axis (MRO_CRISM_OSU); nominal there two are coaligned and offsets of the IR FOV from the optical axis are entirely accounted for in the IK
- VNIR zero position for IK (MRO_CRISM_VNIR) -> optical axis (MRO_CRISM_OSU); nominal there two are coaligned and offsets of the VNIR FOV from the optical axis are entirely accounted for in the IK

Graphically, this is:

```
MRO_SPACECRAFT

|

MRO_CRISM_BASE

|

|<--- gimbal ck

|

|<--- gimbal offset

|

MRO_CRISM_OSU

| |

| MRO_CRISM_IR

|

MRO_CRISM_VNIR
```

The CRISM frames kernel is delivered to NAIF and is incorporated into the MRO frames kernel.

2) Instrument kernel (IK). This file describes the relationship of position of each detector element (at a row or wavelength and spatial or column position) to a zero position within the field of view. Nominally, that is in the VNIR row closest to 610 nm or the IR row closest to 2300 nm, at the column position closest to the optical axis. Due to keystone distortion, there is a different relationship for every row number of either detector.

The CRISM instrument kernel is delivered to NAIF.

3) Gimbal C kernel. This file gives a time history of the angle of the gimbal within the gimbal plane, relative to its commanded nadir. It is constructed from gimbal attitude measurements in image headers, i.e., from the TAB file part of an EDR. One file covers a 2-week time span of CRISM data.

CRISM gimbal C kernels are delivered to NAIF.

4) Metakernel. This file gives, for any time span covered by a gimbal C kernel, the MRO and CRISM SPICE kernels used to create DDRs for observations occurring during that time period. Note that kernels are loaded in the order listed., so the highest priority kernel is listed last.

CRISM metakernels are delivered with CRISM image and supporting data to the PDS Geoscience Node.

The file naming convention CRISM-generated SPICE kernels is as follows.

MRO_CRISM_(KernelType)_(YYYY_DOY)_(Filetype)_(version).(Ext)

where:

Kernel Type =

FK (frames kernel)

IK (instrument kernel)

CK (gimbal C-kernel)

MK (metakernel)

YYYY_DOY is the year and day of year of the start of a 2-week period covered in a single gimbal C kernel or metakernel; or else these fields are filled with zeroes

filetype =

P for predicted R for reconstructed N for not applicable version = 0, 1,...,9, a, ..., z Ext = TI (text-format, instrument kernel) TF (text-format, frames kernel) BC (binary-format, gimbal C kernel) BO (binary-format, gimbal offset C kernel) TM (text-format, metakernel)

3.9. Browse Directory Contents

The Browse Directory contains synoptic versions of data products to help identify products of interest. Contents of this directory are provided by the CRISM team. There are browse products for EDRs, TRDRs, DDRs, and MRDRs in the appropriate archive volumes. At the top of the directory structure, BROWINFO.TXT contains a description of the contents of this directory. Each set of browse products is organized into a separate subdirectory, named "EDR", "TRDR", "DDR", and "MRDR". Within each subdirectory the organization follows that of the directories containing the data products.

3.9.1. EDR Browse Directory

EDR browse products are organized into subdirectories in a structure that parallels that of the EDR directory. That is, by year and DOY, e.g. 2006/2006_350, with subdirectories for each observation named for the combination of class type and observation ID unique to a single observation, e.g. "FRT00001270".

In the subdirectory for the observation, there are two types of products. One is an HTML file that gives the key parameters of the component EDRs and links to PNG files for each EDR. A detached label to the HTML file describes the observation at a high level.

The browse product for each EDR is a scaled (0-255), median DN value from selected wavelengths for each spatial element in an EDR multiband image, stored in PNG format. A detached label to the PNG file describes the source EDR and the scaling between its raw data values and the PNG file.

The file naming convention for the HTML browse products is as follows.

(ClassType)(ObsID)_BROWSE_EDR(version).(Ext)

where:

Class Type =

FRT (Full Resolution Targeted Observation)

HRL (Half Resolution Long Targeted Observation)

HRS (Half Resolution Short Targeted Observation)

EPF (Atmospheric Survey EPF)

TOD (Tracking Optical Depth Observation)

MSS (Multispectral Survey, lossy compressed)

MSP (Multispectral Survey, losslessly compressed)

MSW (Multispectral Window)

CAL (Radiometric Calibration)

FFC (Flat Field Calibration)

ICL (Calibration source intercalibration)

STO (Star Observation)

FUN (Functional test)

UNK (no valid EDRs within observation that indicate class type)

ObsID= nnnnnn, Observation ID, unique for the whole CRISM mission, expressed as a hexadecimal number

version= 0, 1,...,9, a, ..., z

Ext= HTML

The file naming convention for the PNG browse products is as follows.

(ClassType)(ObsID)_(Counter)_ (Activity)(SensorID)_RAW(version).(Ext)

where:

Counter= nn, a monotonically increasing ordinal counter of EDRs from one Observation ID

Activity= for an EDR, type of observation, e.g.

BInnn - Bias measurements / Macro#

DFnnn - Dark field measurements / Macro#

LPnnn – Lamp measurements / Macro #

SPnnn - Sphere measurements / Macro #

SCnnn – Scene measurements / Macro #

T1nnn – Focal plane electronics test pattern 1 / Macro #

T2nnn – Focal plane electronics test pattern 2 / Macro #

T3nnn – Focal plane electronics test pattern 3 / Macro #

T4nnn – Focal plane electronics test pattern 4 / Macro #

T5nnn – Focal plane electronics test pattern 5 / Macro #

T6nnn – Focal plane electronics test pattern 6 / Macro #

T7nnn – Focal plane electronics test pattern 7 / Macro #

UNnnn – Instrument configuration does not match macro library / Macro #

Sensor ID= S for VNIR, or L for IR

version= 0, 1,...,9, a, ..., z

Ext= PNG

3.9.2. DDR Browse Directory

DDR browse products are organized into subdirectories in a structure that parallels that of the EDR directory. That is, by year and DOY, e.g. 2006/2006_350, with subdirectories for each observation named for the combination of class type and observation ID unique to a single observation, e.g. "FRT00001270".

In the subdirectory for the observation, there are two types of products. One is an HTML file that gives the key parameters of the scene EDRs that correspond to the DDRs, and links to PNG files that provide a synopsis of each DDR. A detached label to the HTML file describes the observation at a high level.

The browse product for each DDR is a 3-color product (browse product type DER), with each color plane scaled (0-255) and stored in PNG format:

red= solar incidence angle at areoid, degrees, scaled 90-0 to 0-250

green = Elevation, meters relative to MOLA datum, scaled -9000 - 27,000 to 0-250

blue = emission angle at areoid, degrees, scaled 0-90 to 0-250

A detached label to the PNG file describes the source EDR and the scaling between its raw data values and the PNG file.

The file naming convention for the HTML browse products is as follows.

(ClassType)(ObsID)_BROWSE_DDR(version).(Ext)

where:

Class Type =

FRT (Full Resolution Targeted Observation)

HRL (Half Resolution Long Targeted Observation)

HRS (Half Resolution Short Targeted Observation)

EPF (Atmospheric Survey EPF)

TOD (Tracking Optical Depth Observation)

MSS (Multispectral Survey, lossy compressed)

MSP (Multispectral Survey, losslessly compressed)

MSW (Multispectral Window)

FFC (Flat Field Calibration)

ObsID= nnnnnn, Observation ID, unique for the whole CRISM mission, expressed as a hexadecimal number

version= 0, 1,...,9, a, ..., z

Ext= HTML

The file naming convention for the PNG browse products is as follows.

(ClassType)(ObsID)_(Counter)_(Activity)(SensorID)_ (BrowseProductType)(version).(Ext) where:

where.

Class Type =

FRT (Full Resolution Targeted Observation)

HRL (Half Resolution Long Targeted Observation)

HRS (Half Resolution Short Targeted Observation)

EPF (Atmospheric Survey EPF)

TOD (Tracking Optical Depth Observation)

MSS (Multispectral Survey, lossy compressed)

MSP (Multispectral Survey, losslessly compressed)

MSW (Multispectral Window)

ObsID = nnnnnn, Observation ID, unique for the whole CRISM mission, expressed as a hexadecimal number

Counter = nn, the ordinal counter carried through from the source EDR

Activity = for a DDR, type of product, e.g.

DE### – Derived product / Macro#

BrowseProductType = DER

Sensor ID = S or L

Version = 0, 1, ..., 9, a, ..., z

Ext= PNG

3.9.3. TRDR Browse Directory

TRDR browse products are organized into subdirectories in a structure that parallels that of the EDR and DDR directories. That is, by year and DOY, e.g. 2006/2006_350, with subdirectories for each observation named for the combination of class type and observation ID unique to a single observation, e.g. "FRT00001270".

In the subdirectory for the observation, there are two types of products. One is an HTML file that gives the key parameters of the source TRDRs, and links to PNG files that provide a

synopsis of each TRDR. A detached label to the HTML file describes the observation at a high level.

There are up to two browse products for each VNIR TRDR, and up to five browse products for each IR TRDR. All are stored in PNG format. The dimensions of each PNG file, XX pixels in the sample (cross-track) dimension and YY pixels in the line (along-track) dimension, match the spatial dimensions of the source TRDR. A detached label to each PNG file describes the source TRDR and the scaling between its raw data values and the PNG file.

The first VNIR browse product (browse product type TRU) is a true color representation of the scene, derived from I/F after correction for atmospheric or photometric effects:

red= 600-nm I/F, scaled 0.0-1.0 to 0-250 green = 530-nm I/F, scaled 0.0-1.0 to 0-250 blue = 440-nm I/F, scaled 0.0-1.0 to 0-250

The second VNIR browse product (type FEM) shows information related to Fe minerals. It is derived from the spectral parameters stored in summary products that have been corrected for atmospheric and photometric effects:

red= 530-nm band depth (derived from summary product BD530)

green = 600-nm shoulder (derived from summary product SH600)

blue = 1-micron band depth (derived from summary product BDI1000VIS)

See the Data Products SIS for the significance of the summary products and nomenclature.

The first IR browse product (type IRA) shows I/F at 1330 nm, (derived from summary product IRA), after correction for atmospheric and photometric effects.

The second IR browse product (type MAF) shows information related to mafic mineralogy. It is derived from the spectral parameters stored in summary products that have been corrected for atmospheric and photometric effects:

red= scaled olivine index (derived from summary product OLINDEX)

green = scaled LCP index (derived from summary product LCPINDEX)

blue = scaled HCP index (derived from summary product LCPINDEX)

The third IR browse product (type HYD) shows information related to bound water in minerals. It is also derived from the spectral parameters stored in summary products that have been corrected for atmospheric and photometric effects:

red = strength of bands due to bound water (derived from summary product SINDEX); this is indicative of hydrated minerals, particularly sulfates

green = 2.1 micron H2O band depth, in monohydrated sulfate (derived from summary product BD2100)

blue = 1.9 micron H2O band depth (derived from summary products BD1900)

The fourth IR browse product (type ICE) shows information related to water or carbon dioxide frost or ice. It is also derived from the spectral parameters stored in summary products that have been corrected for atmospheric and photometric effects:

red = 1.9 micron H2O band depth (derived from summary product BD1900)

green = 1.5 micron H2O band depth (derived from summary product BD1500)

green = 1.435 micron CO2 ice band depth (derived from summary product BD1435)

The fifth IR browse product (type PHY) shows information related to hydroxylated minerals including phyllosilicate. It is also derived from the spectral parameters stored in summary products that have been corrected for atmospheric and photometric effects:

red = 2.29 micron band depth (derived from summary product D2300)

green = 2.21 micron band depth (derived from summary product BD2210)

blue = 1.9 micron H2O band depth (derived from summary products BD1900)

The file naming convention for the HTML browse products is as follows.

(ClassType)(ObsID)_BROWSE_TRR(version).(Ext)

where:

Class Type =

FRT (Full Resolution Targeted Observation)

HRL (Half Resolution Long Targeted Observation)

HRS (Half Resolution Short Targeted Observation)

EPF (Atmospheric Survey EPF)

TOD (Tracking Optical Depth Observation)

MSS (Multispectral Survey, lossy compressed)

MSP (Multispectral Survey, losslessly compressed)

MSW (Multispectral Window)

FFC (Flat Field Calibration)

ObsID= nnnnnn, Observation ID, unique for the whole CRISM mission, expressed as a hexadecimal number

version= 0, 1,...,9, a, ..., z

Ext= HTML

The file naming convention for the PNG browse products is as follows.

(ClassType)(ObsID)_(Counter)_(Activity)(SensorID)_ (BrowseProductType)(version).(Ext) where:

Counter= nn, the ordinal counter carried through from the source EDR

Activity = type of product, e.g.

IF### – I/F / Macro# SU### – Summary Products / Macro # IF### – I/F / Macro # AL### – Lambert albedo / Macro # BrowseProductType = TRU, FEM, IRA, MAF, HYD, ICE or PHY Sensor ID= S or L filetype = "TRR" for TRDR Ext= PNG

3.9.4. MRDR Browse Directory

MRDR browse products are organized in a fashion paralleling the MRDRs. That is, they are organized into 30 subdirectories named by the Mars Chart containing the latitude and longitude of its upper left corner, e.g. MC01. Latitude and longitude limits of Mars Charts are given in Table 3-12. There are five browse products for MRDRs, that parallel the image products created for TRDR browse products. Formulations are identical to those for TRDR browse products, and a detached label to the PNG file describes the source MRDR and the scaling between its raw data values and the PNG file.

The file naming convention for an MRDR browse product is as follows.

```
(Tile)_(ProductType)(BrowseProductType)_ (ULLat)(Hemisphere)
(ULLon)_(Resolution)_version.(Ext)
```

where:

Tile = Tnnnn, tile number with tile 0000 at the south pole, increasing sprialing northward

Product Type = MRR

BrowseProductType = TRU, FEM, IRA, MAF, HYD, ICE or PHY

ULLat = nn, Planetocentric latitude of upper left corner

```
Hemisphere = \#, N or S for north or south latitude
```

ULLon = nnn, East longitude of upper left corner

Resolution= nnnn, in map-projected pixels per degree, e.g. 256 pixels per degree

version= 0, 1,..., 9, a,..., z

Ext= PNG

3.10. Extras Directory Contents

The Extras Directory contains other materials that the user may find helpful, but that are beyond the scope of the required elements of the archive. This includes a time ordered history of observations and the characteristics of the sites observed, as well as the configuration-managed history of the hardware and software state of the CRISM instrument. Six subdirectories contain engineering-related files, which a format and nomenclature like that of level 6 CDRs but are maintained separately due to the difference in content. They are used in mission operations and potentially have value to troubleshooting data products, and the level 6 CDR format was used as a convenience. Hence they are called "operational CDRs." These are described in Table 3-22.

CP subdirectory: This contains a model of the lossless compressibility of CRISM data. For every combination of binning, wavelength filter, lossless on or off, lossy compression on or off, and type of scene (background or bias calibration, scene or calibration lamps, or test pattern) the expect compression ratio is given with respect to uncompressed 12-bit data.

DC subdirectory: This contains the history of values loaded into selected data structures ('alarm limits' and 'parameters' per the CRISM software specification), as well as the start times at which that update became applicable. If a set of values is planned but not yet active, that is also indicated. The alarm limits are all in calibrated form in volts, degrees Celsius, or amperes.

DR subdirectory: This contains the history of values loaded into selected data structures ('alarm limits' and 'parameters' per the CRISM software specification), as well as the start times at which that update became applicable. If a set of values is planned but not yet active, that is also indicated. The alarm limits are all in raw form corresponding to 16-bit housekeeping values to which the alarms are keyed.

EL subdirectory: This subdirectory contains time-stamped summaries of key activities during CRISM flight operations. Typical entries include major flight calibrations, power cycles, and macro loads. In addition a running total is kept of cooler on time, gimbal cycles, and shutter cycles.

SC: This subdirectory contains information on the goals and hystereses for heaters and coolers. These are all set in software and the default state is off. The files give the values as well as the start times at which an update became applicable. If a set of values is planned but not yet active, that is also indicated. The values all in calibrated form in degrees Celsius.

SR: This subdirectory contains information on the goals and hystereses for heaters and coolers. These are all set in software and the default state is off. The files give the values as well as the start times at which an update became applicable. If a set of values is planned but not yet active, that is also indicated. The values all in raw form corresponding to 16-bit housekeeping values to which the alarms are keyed.

PRODUCTS	FORM FOR EACH FOCAL PLANE	PRODUCT ACRONYM
Digital values of alarm limits and instrument parameters. Used for validation of uplinked sequences.	ASCII table with columns of start time of applicability, raw digital value, and comments	DR

Table 3-22. Descriptions of operational level-6 CDRs

PRODUCTS	FORM FOR EACH FOCAL PLANE	PRODUCT ACRONYM
	(only one file applicable to both VNIR and IR)	
Calibrated physical values of alarm limits. Used for validation of uplinked sequences.	ASCII table with columns of start time of applicability, value as Cellsius, volts, or amps, and comments (only one file appl.icable to both VNIR and IR)	DC
Digital values of heater and cooler settings. Used for validation of uplinked sequences.	ASCII table with columns of start time of applicability, raw digital value, and comments (only one file applicable to both VNIR and IR)	SR
Calibrated physical values of heater and cooler settings. Used for validation of uplinked sequences.	ASCII table with columns of start time of applicability, value as Cellsius, and comments (only one file applicable to both VNIR and IR)	SC
Expected compression ratio of data in different instrument con figurations. Used for management of solid state recorder usage.	ASCII table with columns activity, wavelength filter, binning, lossy compression setup, lossless compression setup, and expected compression ratio of data with that configuration.	СР
Mission event log. Includes times of updates to instrument software or settings, command loads, flight tests, or other notable events.	ASCII table with columns of start time and comments (only one file applicable to both VNIR and IR)	EL

Two other subdirectories that document the observing history of CRISM.

MACROS: This subdirectory contains information on the characteristics of flight macros that were active during different periods of the MRO mission. The macros have several functions: some control engineering functions like powering subsystems. Others are called by internal autonomy if certain housekeeping items exceed alarm limits. Most of the macros are used for data acquisition: observations are triggered by sequential execution of several macros. There are three files for each macro load: the macro dictionary tself, a summary of each macro's function, and a description of the image data generated by each macro.

OTT: This subdirectory contains ASCII tables (Table 3-23) that connect specific observations with regions of interest on Mars, science objectives, and specific observation conditions. There are five tables whose contents are described in detail in the Data Products SIS. For the SITE_ID, ANCILLARY, REQ_ID, and CORRESP tables there is one table for the mission, and the string YYYY_MM_DD is the date of the last update. For the OBS_ID table, there is one table covering a time span that starts at YYYY_MM_DD.

(a) A site ID table describing the locations and physical features of sites of interest on Mars, compiled by the CRISM science team. This table defines the intended targets of observations by full and half resolution targeted observations or multispectral windows (see Applicable Document 3 for definitions of each class of observation; this implies CLASS= FRT, HRS, HRL, or MSW).

- (b) An ancillary information table describing physical properties of a 0.25°x0.25° region centered on the center point of each site ID.
- (c) For each site ID, a table of request IDs. There is at least one entry specifying the desired observing conditions such as Ls. For site IDs desired to be observed repeatedly, there are multiple entries.
- (d) An observation ID table summarizing the date and characteristics of each observation actually taken.
- (e) A correpondence table in which one line gives a site ID, request ID, and target ID where there is geographic overlap. For example, all the lines containing a particular site ID include the target IDs that cover it.

File Name	File Contents	Required?	File Provided By
SITE_ID_YYYY_MM_DD.TAB	Description of the locations and physical features of sites of interest on Mars, compiled by the CRISM science team. Date is last update.	No	CRISM
SITE_ID_YYYY_MM_DD.HDR	Header record to site ID table.	No	CRISM
SITE_ID_YYYY_MM_DD.LBL	Label to site ID table.	No	CRISM
ANCILLARY_YYYY_MM_DD.TAB	Tabulated statistics on physical properties of sites of interest on Mars, compiled by the CRISM science team . Date is last update.	No	CRISM
ANCILLARY_YYYYMMDD.HDR	Header record to ancillary information table.	No	CRISM
ANCILLARY_YYYYMMDD.LBL	Label to ancillary information table.	No	CRISM
REQ_ID_MC##- ####_YYYY_MM_DD.TAB	A table of request IDs, with one or more entries, specifying the desired observing conditions such as Ls. One table per site ID (MC##-####).	No	CRISM
REQ_ID_MC##- ####_YYYY_MM_DD.HDR	Generic header record to request ID tables.	No	CRISM
REQ_ID_MC##- ####_YYYY_MM_DD.LBL	Label to request ID tables.	No	CRISM
OBS_ID_YYYY_MM_DD.TAB	Table summarizing the date and characteristics of each observation actually taken.No		CRISM
OBS_ID_YYYY_MM_DD.HDR	Header record to observation ID table.	No	CRISM
OBS_ID_YYYY_MM_DD.LBL	Label to observation ID table.	No	CRISM
CORRESP_YYYY_MM_DD.TAB	Correpondence table in which one line gives a site ID, request ID, and target ID where there is geographic overlap.	No	CRISM
CORRESP_YYYY_MM_DD.HDR	ORRESP_YYYY_MM_DD.HDR Header record to correspondence table.		CRISM
CORRESP_YYYY_MM_DD.LBL	Label to correspondence table.	No	CRISM

Table 3-23. Contents of the EXTRAS/OTT subdirectory

4. Archive Volume Format

This section describes the format of CRISM Archive Volumes.

4.1. Disk Format

Archive Volumes are formatted so that when 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 [Applicable Document 7]. The DVD volume format is in accordance with the UDF Standard with ISO 9660 Level 2 compatibility.

4.2. File Formats

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

4.2.1. Document File Formats

Document files with the .TXT suffix exist in the Root, Index, Catalog, Document, Label, Browse, Calib, and Extras 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.

Some documents in the Document and Calib directories contain formatting and figures that cannot easily be rendered as ASCII text. Therefore each document is given in PDF 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. Some type of ASCII text versions of these documents will also be included, possibly using HTML or XML, in order to meet the PDS requirement that documents must be archived as ASCII text.

Macro dictionaries in the MACROS subdirectory of the EXTRAS directory have the suffix .PY. They are text files whose lines end with a carriage return character (ASCII 13) and a line feed character (ASCII 10). These files have detached labels describing their contents.

4.2.2. Tabular File Format

Tabular files (.TAB suffix) exist in the Index, Data, Calib, and Extras directory. Tabular files are ASCII files formatted for direct reading into many database management systems on various computers. All fields are separated by commas. (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" listed in the labels indicate the starting position in bytes of each field in a record; the field length "bytes" does not include the commas between 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.

Every CRISM tabular file is described by a detached PDS label with the same name as the data file it describes, and the extension .LBL. For example, the file INDEX.TAB is accompanied by the detached label file INDEX.LBL in the same directory.

Some multicolumn CRISM tabular files (for example, in the EDR or TRDR directory) are accompanied by a format file with the same name as the data file it describes, and the extension .FMT. A *.FMT file describes the significance of the columns in its corresponding table file, as well as how to use the values listed in the columns.

4.2.3. PDS Label Format

All data files in CRISM the archive have PDS labels detached in a separate file. For examples of PDS labels for each type of data product, see the Data Product SIS [Applicable Document 3].

A PDS label provides descriptive information about the associated file. The PDS label is an object-oriented structure consisting of sets of 'keyword=value' declarations. The object to which the label refers (e.g. IMAGE, TABLE, etc.) is denoted by a statement of the form:

^object = location

in which the carat character (^, also called a pointer in this context) indicates where to find the object.In an embedded label, the location is an integer representing the starting record number of the object (the first record in the file is record 1).In a detached label, the location denotes the name of the file containing the object, along with the starting record or byte number, if there is more than one object in the file. For example:

^HEADER = ("F01.IMG",1) ^IMAGE = ("F01.IMG",1025 <BYTES>)

indicates that the IMAGE object begins at byte 1025 of the file F01.IMG, in the same directory as the detached label file.Below is a list of the possible formats for the ^object definition.

```
^object= n
^object= n<BYTES>
^object= "filename.ext"
^object= ("filename.ext",n)
^object= ("filename.ext",n<BYTES>)
```

where

n is the starting record or byte number of the object, counting from the beginning of the file (record 1, byte 1),

<BYTES> indicates that the number given is in units of bytes,

filename is the up to 28 character, alphanumeric upper-case file name,

ext is the 3 character upper-case file extension,

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 readable under various operating systems.

4.2.4. Catalog File Format

Catalog files (suffix .CAT) exist in the Root and Catalog directories. They are text files formatted in an object-oriented structure consisting of sets of 'keyword=value' declarations, so that they are readable by humans and by software.

4.2.5. Science Data File Formats

For more information about the format and content of the data products, see the discussions in section 3 and the CRISM Data Product SIS [Applicable Document 3].

5. Archive Volume Generation

5.1. Data Transfer and Validation

CRISM data products will be generated by the CRISM Science Team and delivered to the PDS Geosciences Node according to the schedule in the MRO Archive Plan. CRISM 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 CRISM 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.

5.2. Data Product Sizes and Delivery Rates [TBD]

Table 5.1 summarizes very approximate expected sizes and production rates for the CRISM Standard Products. This table is for a nominal 15 Tb downlink. The minimum expected is 7.8 Tb, and the total volume could approach 20 Tb.

Class of observation	7.8 Tb #	Approx. EDR vol per observ-	Approx. data volfor associated cal. files,	PDS deliveries	Data vol per TRDR+DDR or 1 observation or	PDS deliveries	Delivered volume, Tb
		ation, Gb	Gb				
Full-res targets	2624	3.581	0.23	1	6.363	2	44.00
Half-res long targets	1454	1.845	0.05	1	3.281	2	12.37
Half-res short targets	1598	1.126	0.05	1	1.733	2	7.50
Strips of multispectral survey	2366	3.864	0.002	1			9.14
Multispectral survey tiles	1716				8.703	4	59.74
Multispectral windows	4000	0.815	0.0014	1	2.443	2	22.82
Ridealongs	25000	0.078	0.008	1	0.204	2	12.55
Atmospheric grid EPFs	5408	0.342	0.03	1	0.211	2	4.46
Radiometric calibrations	4122	0.680	0.29	1		2	5.19
Lamp inter- calibrations	26	2.289	0.005	1		2	0.06
						Total	177.82

Table 5-1. Standard product sizes and delivery rates

5.3. Backup and Duplicates

The CRISM 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 CRISM data released by PDS as part of the Node's regular data repository backups.

6. Support Staff and Cognizant Persons

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