Cassini
Composite Infrared Spectrometer
(CIRS)

Planetary Data System (PDS)
Time Sequential Data Record (TSDR)
Archive Volume
Software Interface Specification (SIS)

July 12, 2005

IO-AR-003

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1 Preface

This document describes the format and contents of the Cassini Composite Infrared Spectrometer (CIRS) Time Sequential Data Record (TSDR) Archive Volume Collection.

1.1 Acronyms and Abbreviations

ASU	Arizona State University
ASCII	American Standard Code for Information Interchange
CD	Compact Disk
CIRS	Composite Infrared Spectrometer
DVD	Digital Video Disk or Digital Versatile Disk
FOV	File Of View
HTML	Hyper-Text Markup Language
IFM	Interferogram
MGS	Mars Global Surveyor
NAIF	Navigation and Ancillary Information Facility
NMSU	New Mexico State University
NSSDC	The National Space Sciences Data Center
ODL	Object Description Language (PDS)
PERL	Practical Extraction and Report Language
PDS	Planetary Data System
PDF	Portable Document Format
SDVT	Science Data Verification Team
SIS	Software Interface Specification
SSAI	Science Systems and Applications, Inc.
TES	Thermal Emission Spectrometer
TSDR	Time Sequential Data Record
UMD	University of Maryland
ZPD	Zero Path Difference (of IFM)

Table 1: Acronyms and Abbreviations

1.2 Glossary

Data element: a piece of data, such as a character string or integer number.

Field: a column in the data table, or species of data element.

Fragment: an individual computer file, which forms part of the logical table. A fragment is a sub-table, which when combined with all other fragments in the search path, combine to form the logical search table. Fragments come in different types. Each type stores certain fields. The fields in different fragment types do not overlap, except for 1 to 3 key fields. The key fields are scet time, detector number, and target id.

Glossary: an explanation and definition of terms used in the context of this document.

Logical table: the logical table is the effective data table which the Vanilla search program sees. Although the table is stored as many individual file fragments, it is searchable as one giant table.

Target ID: the NAIF number corresponding to a target body.

Volume: one self-contained subset of the entire data collection, such as several months worth of data together with documentation. Usually, one volume will be sized to fit on a single unit of portable media, such as a CD-ROM.

1.3 MGS TES Heritage

The authors acknowledge the substantial legacy of the Mars Global Surveyor (MGS) Thermal Emission Spectrometer (TES) instrument team's work in developing core elements of the data system now being used by the CIRS team. This includes software (Vanilla), acronyms such as the 'TSDR', many of the data file types (OBS etc), and also the documentation (SISs), which the current document follows closely. Any inaccuracies or omissions are entirely the fault of the current authors.

2 Introduction

2.1 Content Overview

The Composite Infrared Spectrometer (CIRS) is an instrument onboard the Cassini spacecraft mission to Saturn and Titan. An important scientific data set also exists for Jupiter, which Cassini flew past during a gravity assist maneouver in December 2000.

This Software Interface Specification (SIS) describes the format, content and generation of the CIRS Time Sequential Data Record (TSDR) Archive Volumes for all CIRS mission phases. The DATA area of each volume is split into months. Within each month, all the data forms a single logical table, which is composed of fragments (See Glossary).

Data fragment types:

FRV	White light fringe voltages at 2 second intervals.
DIAG	diagnostic data regarding IFM usability.
GEO	position and orientation of the spacecraft at the observation time, relative to the earth, sun, primary body and major satellites.
IFGM	raw interferogram data.
IHSK	interpolated housekeeping data.
ISPM	calibrated spectra re-gridded in wavenumber.
OBS	observation parameters.
POI	pointing of each detector on the target body or bodies during the observation.
RIN	pointing of each detector relative to a ring target.
TAR	summary of targets in the FOV.

2.2 Scope

This archive volume SIS applies to all Cassini CIRS Time Sequential Data Records.

2.3 Applicable Documents

"The CIRS Ground Data System", CIRS Team, NASA GSFC Code 693, 2000.

"Vanilla Manual: A guide for software and data users" (preliminary draft), Kelly Bender, ASU Astronomy Dept., 2000.

3 Archive Volume Contents

This section describes the contents of each volume directory.

3.1 ROOT Directory Contents

The following files are contained in the ROOT directory:

File Name	File Contents
AAREADME.LBL	PDS label for AAREADME.TXT.
AAREADME.TXT	Volume contents and format info in ASCII text format.
ERRATA.LBL	PDS label for ERRATA.TXT.
ERRATA.TXT	Cumulative listing of updates to all CIRS volumes published so far.
VOLDESC.CAT	Description of volume contents in a PDS format.

3.2 CATALOG Directory Contents

The files in the CATALOG directory provide a top-level understanding of the Cassini Mission, spacecraft, instruments and data sets in the form of completed PDS catalog objects.

`CATINFO.TXT`	ASCII description of the contents of this directory.
`CATINFO.LBL`	PDS label for previous.
`CIRSREF.CAT`	CIRS bibliographic references catalog object.
`DATASET.CAT`	Data set catalog object.
`INST.CAT`	Instrument catalog object
`INSTHOST.CAT`	Spacecraft catalog object.
`MISSION.CAT`	Mission catalog object.
`PERSON.CAT`	Personnel catalog object.
`PROJREF.CAT`	Project bibliographic references catalog object.

3.3 CALIB Directory Contents

`CALINFO.TXT` ASCII description of the contents of this directory.

`CALINFO.LBL` PDS label for previous.

`2000_nesr_fpX_NNNNcm-1.txt`
Spectral NESR file, where 'X' is the focal plane number (1, 3, 4); and NNNN is the spectral resolution in cm^{-1} (e.g. 6p6 = 6.6).

`2000_nesr_fpX_NNNNcm-1.txt`
PDS label for previous.

3.4 DOCUMENT Directory Contents

Documentation. Below are listed the most important documentation files. Others may added as required. Refer to the DOCINFO.TXT file in the DOCUMENT directory for a complete listing.

`DOCINFO.TXT` ASCII text description of the DOCUMENT directory.
`DOCINFO.LBL` PDS label for previous.
`DATASIS.PDF` PDF version of Data Product Software Interface Specification. The data product SIS describes the types of archive data produced by the instrument in each volume.
`DATASIS.TEX` LaTeX (ASCII text) version of DATASIS.PDF.
`DATASIS.LBL` PDS label for DATASIS.PDF and DATASIS.TXT.
`VOLSIS.PDF` PDF version of this document, the Volume Organisation SIS, which describes the directory layout of the archive volumes on the media.
`VOLSIS.TEX` LaTeX (ASCII text) version of VOLSIS.PDF.
`VOLSIS.LBL` PDS label for VOLSIS.PDF and VOLSIS.TXT.
`CIRS_FOV_OVERVIEW.PDF` PDF version of a document describing in-flight measurements of the CIRS fields of view.
`CIRS_FOV_OVERVIEW.TXT` ASCII text version of above. Figures will be in separate tiff files in this directory.
`CIRS_FOV_OVERVIEW.LBL` PDS Label for previous.
`cirs_cal_eqns.tex` Description of cirs calibration mathematics.
`cirs_cal_eqns.pdf` PDF version of previous.
`cirs_cal_eqns.lbl` PDS Label for previous.

Other miscellaneous graphic figures (ps, eps, tiff) and other objects in this directory may vary from cruise to tour. These will be described in the individual DOCINFO.TXT files on each archive data volume.

3.5 DATA Directory Contents

The DATA directory contains sub-directories, which contain the binary data. The top-level directory contents are:

`DATAINFO.TXT` ASCII description of the contents of this directory.
DATAINFO.LBL PDS label for previous.

APODSPEC/	subdirectory containing calibrated, apodized spectra.
DIAGDATA/	subdirectory containing diagnostic data .
HSK_DATA/	subdirectory containing tabular housekeeping data.
NAV_DATA/	subdirectory containing geometry and pointing info.
UNAPSPEC/	subdirectory containing calibrated, unapodized spectra.
UNCALIBR/	subdirectory containing uncalibrated interferograms, interpolated housekeeping data and observation parameters.

In these sub-directories are contained the actual data files. Typically, files with the `.DAT` and `.VAR` extensions are binary format data files in two parts, accessed by the Vanilla program. Hence the files `FILENAME.DAT` and `FILENAME.VAR` are two halves of a whole: the `.DAT` file is the fixed-length record part and the `.VAR` is the variable length record file.

The `FILENAME` is typically a 3 or 4 letter string followed by 8-digit number. The letter string identifies the type of information stored therin, and the 8-digit number `YYMMDDHH` gives the start date and time DD/MM/YY HH:00:00 of the period to which the data pertain.

Finally, every `.DAT` file is accompanied by a detached PDS label file (`.LBL`), containing ODL keyword definitions.

`DATASET.TXT`	Vanilla DATASET file (ASCII), listing the types of Vanilla files to search for in the directory.
`DATASET.LBL`	PDS label for DATASET.TXT.
`DIAG.FMT`	The format file contains the list of fields in the DIAG tables.
`DIAGyymmddhh.DAT`	fixed-length binary data records for DIAG diagnostic data fields.
`DIAGyymmddhh.LBL`	PDS label file.
`FRV.FMT`	The format file contains the list of fields in the FRV tables.
`FRVyymmddhh.DAT`	fixed-length binary data records for IFM fringe voltages.
`FRVyymmddhh.VAR`	variable-length binary data records associated with `FRVyymmddhh.DAT`.
`FRVyymmddhh.LBL`	PDS label file.
`GEO.FMT`	The format file contains the list of fields in the GEO tables.
`GEOyymmddhh.DAT`	fixed-length binary data records for spacecraft orientation relative to primary body, earth, sun, and moons.
`GEOyymmddhh.LBL`	PDS label file.
`IFGM.FMT`	The format file contains the list of fields in the IFGM tables.
`IFGMyymmddhh.DAT`	fixed-length binary data records for raw interferogram data.
`IFGMyymmddhh.VAR`	variable-length binary data records associated with `IFGMyymmddhh.DAT`.
`IFGMyymmddhh.LBL`	PDS label file.
`IHSK.FMT`	The format file contains the list of fields in the IHSK tables.
`IHSKyymmddhh.DAT`	fixed-length binary data records for housekeeping data interpolated onto the same time-steps as observations.
`IHSKyymmddhh.LBL`	PDS label file.
`ISPM.FMT`	The format file contains the list of fields in the ISPM tables.
`ISPMyymmddhh.DAT`	calibrated, re-sampled (interpolated) spectral data. After FFT

	transform, data as resampled onto a standard spectral grid.
`ISPMyymmddhh.VAR`	variable-length binary data records associated with `ISPMyymmddhh.DAT`.
`ISPMyymmddhh.LBL`	PDS label file.
`OBS.FMT`	The format file contains the list of fields in the OBS tables.
`OBSyymmddhh.DAT`	fixed-length binary data records for observation parameters.
`OBSyymmddhh.LBL`	PDS label file.
`POI.FMT`	The format file contains the list of fields in the POI tables.
`POIyymmddhh.DAT`	fixed-length binary data records for detector intercept location, orientation and other info on the target body. E.g. incident angle on planet, smear, and FOV filling factor.
`POIyymmddhh.LBL`	PDS label file.
`RIN.FMT`	The format file contains the list of fields in the RIN tables.
`RINyymmddhh.DAT`	fixed-length binary data records for detector intercept location, orientation and other info on rings.
`RINyymmddhh.LBL`	PDS label file.
`TAR.FMT`	The format file contains the list of fields in the TAR tables.
`TARyymmddhh.DAT`	fixed-length binary data records for target identification in the FOV of each detector.
`TARyymmddhh.LBL`	PDS label file.

Note on the DATASET files: the DATASET files are the backbone of the Vanilla system. Each DATASET file either points to data files within the directory, or to other directories, or both. See the *Vanilla Users Guide* for details.

3.6 INDEX Directory Contents

`INDEX` directory contains:

`INDXINFO.TXT`	ASCII description of the contents of this directory.
`INDXINFO.LBL`	PDS label for previous.
`INDEX.TAB`	Tabular summary of the data files in this volume.
`INDEX.LBL`	PDS label describing INDEX.TAB.
`CUMINDEX.TAB`	Cumulative tabular summary of the data files in all volumes of this set.
`CUMINDEX.LBL`	PDS label describing CUMINDEX.TAB.
`XXXXXXXX_TOL.ASC`	ASCII text file summarizing spacecraft activities in spacecraft activity sequence XXXXXXXX. An example cruise sequence is 'C22', or 'C23PHASEA'. An example tour sequence is 'S01'.
`XXXXXXXX_TOL.LBL`	PDS label describing XXXXXXXX_TOL.ASC.

3.7 SOFTWARE Directory Contents

`SOFTWARE` directory contains:

`SOFTINFO.TXT`	ASCII description of the contents of this directory.
`SOFTINFO.LBL`	PDS label for previous.
`BIN`	A directory containing binary executables for two operating systems, Linux and Solaris. In sub-directories LINUX and SOLARIS.
`DOC`	A directory containing software documentation.
`DOC/vanilla-guide.html`	Users guide to the Vanilla data extraction tool in HTML format
`DOC/vanilla-guide.pdf`	PDF version of previous.
`SRC`	A directory containing C and PERL source code and Makefiles.

4 Archive Volume Format

4.1 Disk Format

None: there is no physical format produced by CIRS. Volumes will be sized to 4.2 GB, to fit on a DVD-ROM, which will be produced by PDS. An exception is the sample volume produced during the 2003 readiness review process, which is a 700 MB CD-ROM.

4.2 File Formats

4.2.1 Catalog File Format

`.CAT` files. Found in the `ROOT` and `CATALOG` directories. Object oriented structure: 'keyword = value'. All lines terminated with carriage return and line feed characters.

4.2.2 Document File Format

`.TXT` and `.PDF` suffixes. Found in all top-level directories. TXT-suffix files are ASCII files with embedded PDS labels. Lines are terminated with carriage return and line feed characters. PDF files are binary files written in the Portable Document Format, a proprietary format of Adobe Software Inc.

4.2.3 PDS Label Format

PDS labels are object-oriented structures consisting of 'keyword = value' statements. CIRS PDS labels are all detached from the subject file and placed in a separate label file (`.LBL` extension). Some special file types contain PDS labeling elements and therefore do not require labels: examples are `.CAT` and `.FMT` file types.

For a fuller description see [1].

Lines are terminated with the carriage return and linefeed characters.

4.2.4 Software File Format

Computer code is written in ANSI C. Executable binary files are precompiled for the Linux operating system 2.4 kernel on 32-bit Pentium 4 architecture, and Solaris 9 on Sun UltraSPARC 10 hardware.

4.2.5 Tabular File Format

File suffixes are `.TAB`, `.DAT` and `.VAR`. Files are either ASCII or binary.

ASCII files (`.TAB`) are found in the INDEX directory. These files are formatted for direct reading into many database management systems on various operating systems. Fields are enclosed by double quotes, and separated by commas. Character fields are left justified and padded to a constant length with spaces if required. Numeric fields are right justified. The 'start bytes' and 'bytes' values listed in the labels count data only, not quotes, commas or external spaces. The records are fixed length and terminated by the carriage return and line-feed characters.

Binary tables end in `.DAT` (fixed length data fields) and `.VAR` (variable length data fields), and are found in the `DATA` and `CALIB` directories. If a `.VAR` data file exists, it is always accompanied by a `.DAT` file, but the latter may exist alone. `.DAT` files contain pointers to data items in the associated variable field length data files.

5 Archive Volume Generation

5.1 Data Transfer, Validation Methods, and Production

The data volumes will be created at NASA GSFC by the CIRS team. These will be electronically transferred to the PDS Atmospheres Node at NMSU and the Science data Verification Team (SDVT) members for verification.

After verification, the data will be physically copied to DVD by the PDS atmospheres node, and physical copies will be sent to the NSSDC, the PDS Central Node, and one for the Atmospheres node. Other interested parties will be able to download the volumes from the Atmospheres Node.

5.2 Data Product Sizes

The amount of data returned per downlink will be extremely variable, depending on whether the instrument is taking data or not, and what data rate it is using.

Predicted average data rates are as follows:

Product	**per month (MB)**	**over 4-year tour (GB)**
DIAG	3.0	0.14
FRV	7.0	0.30
GEO	32.0	1.50
IFGM	500.0	24.00
IHSK	4.0	0.20
ISPM	2000.0	96.00
OBS	0.7	0.03
POI	250.0	12.0
RIN	200.0	9.6
TAR	6.0	0.3
Total	3003	144.1

Table 2: Predicted Data Volumes.

Note that these rates will vary substantially from month to month, depending on activities.

5.3 Labeling and Identification

An example dataset ID is CO-J-CIRS-2/4-TSDR-V1.0. The 'J' for Jupiter will become 'S' for Saturn after January 1st 2004. The version number will also be incremented as and when required.

Volume ID will be of the form: `COCIRS_xxxx`, where 'xxxx' is a four digit number beginning with 0001. Volumes will be numbered sequentially in chronologically order.

6 Cognizant Persons and Support Staff

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Table 3: Table of Cognizant Persons

7 References

[1] Planetary Data System Standards Reference Version 3.4, JPL D-7669 Part 2, June 15, 2001.