Mars Pathfinder Project

Imager for Mars Pathfinder (IMP)
Experiment Data Record (EDR)

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Version 1.5

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ACRONYMS AND ABBREVIATIONS

AIM	Attitude and Information Management
ASCII	American Standard Code for Information Interchange
CAHV	Camera model described by four vectors C, A, H and V
CAHVOR	Camera model CAHV with CCD and non-linear distortions taken into account
CCD	Charge-Coupled Device
EDR	Experiment Data Record
FEI	File Exchange Interface
IMP	Imager for Mars Pathfinder
JPEG	Joint Photographic Experts Group
MFX	Mars Surface Fixed coordinate frame
MIPL	Multimission Image Processing Laboratory
MIPS	Multimission Image Processing Subsystem (old name for MIPL)
MPF	Mars Pathfinder
NAIF	Navigation and Ancillary Information Facility
PDS	Planetary Data System
SFDU	Standard Formatted Data Unit
SIS	Software Interface Specification
TBD	To Be Determined
VICAR	Video Image Communication and Retrieval system
WMS	Working Mission Storage

ACTION ITEMS FOR CLOSURE

Item	Pages	Assignee	Closure Date
none			

1.0 INTRODUCTION

This specification describes the image data products to be delivered to the Imager for Mars Pathfinder (IMP) Team of the Mars Pathfinder Project (MPF) by the Multimission Image Processing Laboratory (MIPL). The specifications of the software that produce the products described herein are beyond the scope of this document. Applicable documents used in producing this specification include:

1) Planetary Data System Standards Reference, JPL D-7669, Part 2.
2) Planetary Science Data Dictionary Document, JPL D-7116, Rev D.
3) IMP Flight Software Telemetry Format, University of Arizona, January 1995.
4) VICAR File Format, JPL, R. Deen, Interoffice Memorandum 384-92-196, September 1992.
5) IMP Calibration Report, University of Arizona, April 1997.
6) DISRSOFT Image Processing Document, N. Thomas, J. Stüwe, Max-Planck Institute for Aeronomie, Version 1.5, July 12, 1994.
7) Mars Pathfinder AIM Phasing and Coordinate Frame Document, JPL D-12103, PF-300-4.0-04.
8) IMP Flight Software Command Format, University of Arizona, January 1995.
9) Users Guide to The Imager for Mars Pathfinder, Version 1.3, University of Arizona, February 3, 1997

1.1 Notation

This documentation uses the "Committee on Data Management and Computation" (CODMAC) data level numbering system. The data files referred to in this document are considered "level 2" or "Edited Data" (equivalent to NASA level 0). The data files are generated from "level 1" or "Raw Data" which is the telemetry packets within the project specific Standard Formatted Data Unit (SFDU) record.

1.2 Product and Transferal Mechanism

The image data files and labels generated by MIPL software for Mars Pathfinder will be transferred electronically to the IMP Team via the File Exchange Interface (FEI). Each image file will be generated as a VICAR labelled file. A separate, Planetary Data System (PDS) data file will be associated with each image file, but delivered to or generated by the IMP Team upon request. The image data files may be generated on any one of the following platforms: Sun Sparcstation running Solaris, Sun Sparcstation running SunOS, Silicon Graphics running IRIX.

1.3 Image Data Processing

In order to understand the image processing and nomenclature of the data products, it is useful to understand how the IMP camera operates. Figure 1.1 shows a diagram of how an image is captured and retrieved by the IMP camera. The main points to note are that the stereo images are rotated differently on the CCD chip and that the flight software operates on the CCD's coordinate frame not the images'. There are also additional CCD elements that are used to help correct for dark current and shutter effects.

After the IMP "exposes" the imaging portion of the CCD, the image is shifted into a storage area of the CCD where it will not accumulate more exposure (there is no mechanical shutter on the IMP). The data in the storage area is then moved into a shift register that will read out the image data and the CCD calibration elements. The full size of the image area the flight software can process is a 256 by 256 area. In order to minimize border effects between different imaging components (left, right and dark pixel regions), only 248 lines are normally processed.

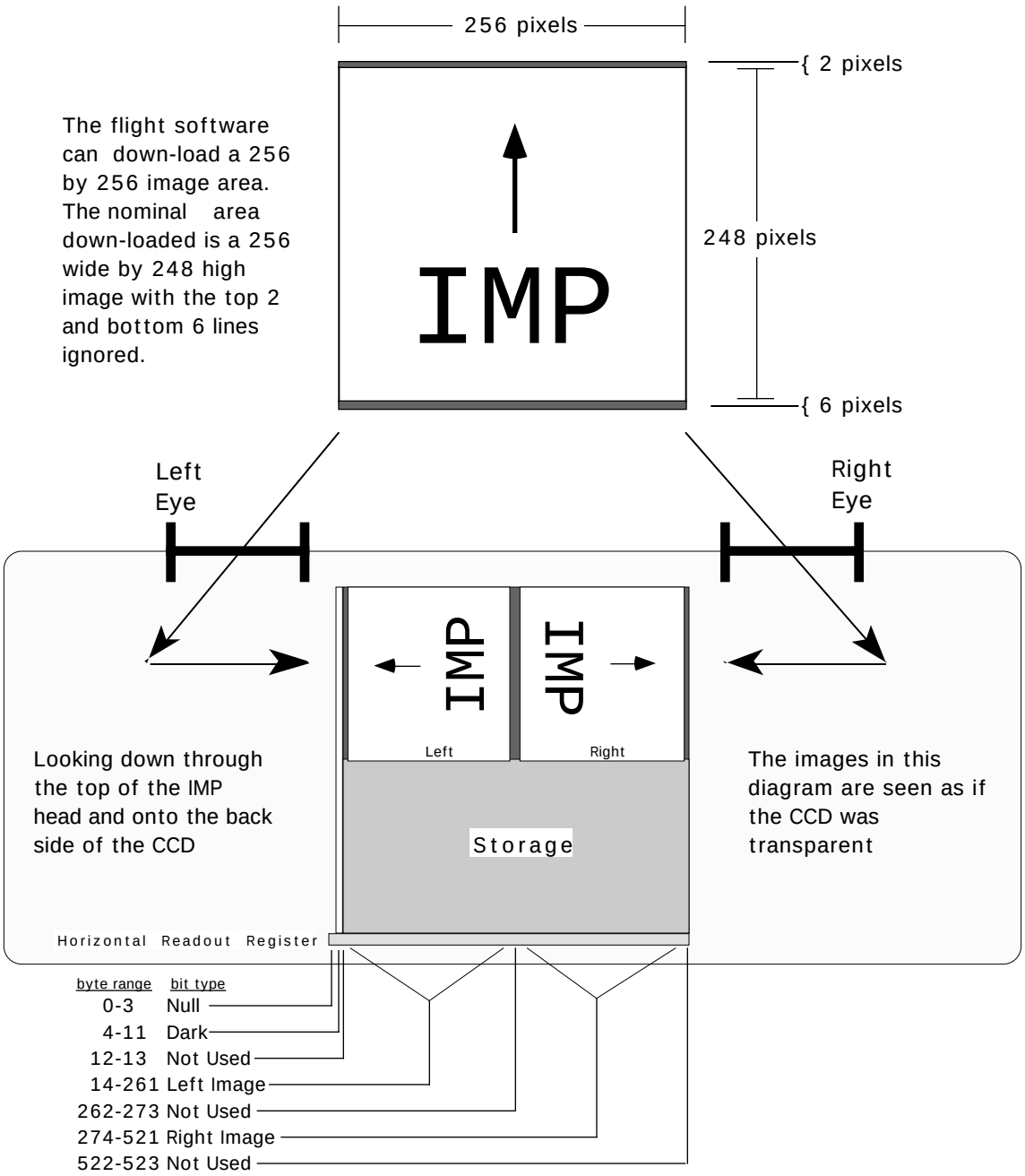

Figure 1.1 — *IMP Image Capture and Retrieval*
This diagram shows the basic structure of the IMP camera head and how a scene is imaged. Various components are shown for reference purposes. This diagram is not even close to engineering specifications, and some liberties have been taken regarding the geometry of some of the components.

The data packaged in the data files will be decoded, decompressed IMP image data in single frame form as an Experiment Data Record (EDR). The single frame form of a standard image data file has the maximum dimensions of 256 lines by 256 samples. The other image data files and their data sizes are listed in Table 1.1. Single image frames can be mosaicked to produce a larger image. The VICAR software used to generate the image data set products is described in Table 1.2.

As mentioned, the IMP commands use CCD coordinates, while the EDR refers to image coordinates. All EDR images are annotated with sub-framing information (even for full frame images). Where Line and Sample '1' are in the upper left corner of a rotated image (up is pointing up, not to a side). The nominal image frame of the IMP is a subframe starting at line 3 and sample 1, and consisting of 248 lines of 256 samples. The command system for the IMP utilizes the offset for this nominal frame as the starting point for any commanded subframe. Hence a subframe defined to start at image line 10, will actually start at image line 13 (nominal plus subframe offset). This allows for unexpected results if a commanded subframe defines the number of lines greater than the actual number of CCD lines, (i.e., nominal_offset + subframe_offset + number_of_lines can be greater than 256). This did occur on a number of observations.

Table 1.1. — *Maximum data set size for Mars Pathfinder IMP Image Data Files*

Image Type	Image Size lines x samples	Pixel Size (bits)	Description
Image Data *regular observations*	256 x 256	16	Image data is unsigned and rotated from the way it is generated in the camera. Right images have been rotated counter-clockwise, left images have been rotated clockwise.
Dark Strip	256 x 8	16	Calibration data retrieved from a covered area of the CCD.
Null Strip	256 x 4	16	Calibration data retrieved from the readout register of the IMP camera.
Flat Field *special observations used for calibration*	256 x 256	16	Flat Field data is unsigned and rotated from the way it is generated in the camera. Right images have been rotated counter-clockwise, left images have been rotated clockwise.
Dark Field *Also referred to as Dark Current; special observations used for calibration*	256 x 256	16	Dark Field data is unsigned and rotated from the way it is generated in the camera. Right images have been rotated counter-clockwise, left images have been rotated clockwise.
Histogram	1 x 4096	16	Histogram data contains a 4096 element histogram table. Each sample corresponds to the count of Dn values in the target image.
Summed	2 x 256	32	All rows and columns are summed. The first record is the result of the row summing where each sample is the sum of all the pixels from the corresponding row. The second record is the result of column summing.

NOTE: Due to on-board JPEG compression, it is possible to generate Dn values greater than 4095 (the largest value the camera electronics can generate). This is due to the lossy compression algorithm of the JPEG. The label item ERROR_PIXELS will identify the number of pixels that are greater than the nominal 4095 maximum.

Table 1.2. — *VICAR Software for Mars Pathfinder IMP Image Data Files*

Application	Description
MPFTELEMPROC	Fetches the image Standard Formatted Data Unit (SFDU) records from the Telemetry Delivery Subsystem (TDS), and reconstructs the image file from the telemetry data. If a version of this image exists in the Working Mission Storage (WMS), the image data is compared to the WMS version. If the new version has more data than the existing version, it replaces the WMS version. This application produces a VICAR image file with a subset of descriptive label items. It also accesses the catalog and SPICE kernels to supplement the ancillary image information from the telemetry data.
MPFCAT2LAB	Updates the VICAR label based on information stored in the MIPL / MPF catalog.
MPFCAHV	Updates the label of an uncorrected image to contain a corrected CAHV camera model. The program requires an accurate quaternion to generate proper results.
MPF_IMP_CHIP	Creates an index page of 16 IMP images on one 8 by 10 quick-look print. Each image is annotated with observation identification, timing, pointing, compression and filter information. This same program is capable of generating a systematic film product that also includes a standard 16 step gray wedge.
MPFMAP	Produces polar coordinate mosaics (azimuth versus elevation) from uncorrected input images using a CAHVOR camera model.
MPFMOS	Produces pinhole camera mosaics using uncorrected input images and a CAHVOR camera model.
MPFNAV	Generates an updated azimuth and elevation based on comparison with existing image data that can be directly compared.
MPFPDSLBL	Converts the VICAR EDR into a PDS compliant labelled image file.
MPFVIEW	Calculates the distance to selectable points in a stereo image data set.

1.4 Coordinate System Components

The following paragraphs describe the various types of coordinate system components. In some cases the project definitions of the coordinate systems are modified to a more standard use.

1.4.1 Coordinate Frames

The MPF Project defined six different coordinate systems to identify spacecraft origin during the different mission phases (See Mars Pathfinder AIM Phasing and Coordinate Frame Document, reference 7). The following paragraphs discuss the four coordinate systems and components used by EDR generation for supporting surface operation.

NOTE: For the identified coordinate systems, the EDR SIS and the EDR data files differ from the project definitions in that the Z-axis is positive in the “up” direction (for surface operations).

In all coordinate frames, the pointing is based on the returned science data packets. There are a number of methods used to calculate the pointing of the IMP, each with its own meaning. The ”METHOD” label items (e.g., INSTRUMENT_AZIMUTH_METHOD) should be checked to identify what was used. The default method is to use the telemetry values for the motor steps and calculate the pointing using a conversion algorithm, yielding bore-site pointing values.

1.4.1.1 Lander Frame

The Lander Frame, identified as the L Frame, is a coordinate system that is fixed to the geometry of the lander. Most of the pointing information identified in the IMP EDR label items references this coordinate system.

1.4.1.2 IMP Frame

The IMP Frame is oriented such that all of the axes are collinear to the Lander Frame. The origin of the IMP Frame is offset from the Lander frame (See the MPF AIM Phasing document for the correct offset distances).

NOTE: For the purpose of identifying camera pointing, this document treats the Lander and IMP Frames as identical. When commanding the pointing to a known object, the pointing vectors from the origins of the two coordinate systems will NOT be parallel, but converge at the object, basically an exaggerated parallax effect. See Figure 1.2. for a diagram showing the angles between the origins of collinear coordinate systems and an object.

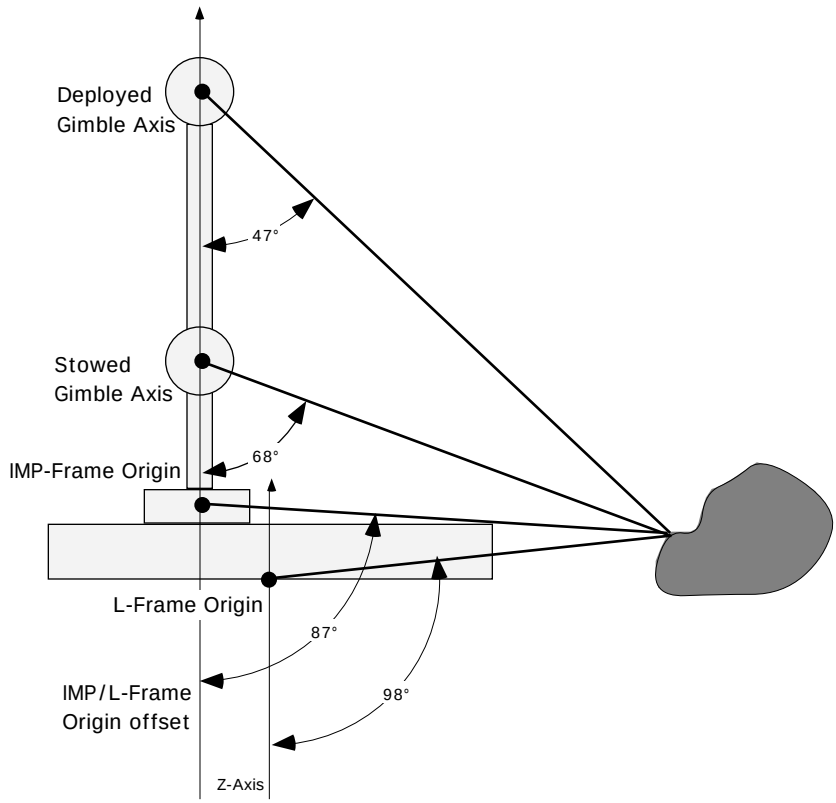

Figure 1.2 — *Pointing Parallax*

This diagram shows the pointing angles from the different reference frames if the target of the pointing is a known object. The gimbal origin is also shown in this diagram to show the true ramifications of the pointing problems. **The spacecraft coordinate systems and their origin offsets are not accurately represented**; however the concept is.

NOTE: The orientation of the Z-Axis in this drawing reflects the usage in this document and not the Project defined meaning.

1.4.1.3 Local Level Frame

The Local Level Frame, identified as the M Frame, shares the same origin as the Lander Frame. The orientation of the coordinate frame is defined relative to the Mars areocentric coordinate system.

1.4.1.4 Mars Surface Fixed Frame

The Mars Surface Fixed Frame, identified as MFX Frame, is oriented such that all of the axes are collinear to the Local Level Frame. Originally the origin of the MFX is identical to the M Frame, but can be offset due to pedal movement, air-bag settling or other translational effects.

NOTE: For the purpose of identifying camera pointing, this document treats the Local Level and Mars Surface Fixed Frames as identical. This assumption has similar parallax problems as treating the IMP- and L-Frame pointing as identical. However, the origin offset between the Local Level and Mars Surface Fixed frames is not anticipated to be as large, reducing the parallax effect.

1.4.2 Planetocentric

Center normal coordinate system. For Pathfinder, this is based on the gravitational vector derived from the lander's accelerometers.

1.4.3 Quaternion

The quaternion is the coordinate transform or rotation between the Lander Frame and the Local Level Frame. The VICAR label defines the quaternion using the NAIF notation of the cosine of the rotation angle followed by the sine of the rotation angle multiplied by each component of the unit vector of the axis of rotation.

The following brief excerpt discussing quaternions was taken from the NAIF distributed SPICELIB documentation:

> Quaternions are four dimensional vectors, on which a particular kind of arithmetic is defined. The quaternions that have norm equal to 1 are called 'unit quaternions'. Unit quaternions may be associated with rotations in the following way: if a rotation R has unit vector n = (n1, n2, n3) as an axis and w as a rotation angle, then we represent R by
>
> $$Q = (\cos(w/2),\ \sin(w/2)\, n1,\ \sin(w/2)\, n2,\ \sin(w/2)\, n3)$$
>
> As you might suspect, this association is not unique: substituting (w + 2*pi) for w, we see that -Q is also a representation for R. If we choose the rotation axis and angle of R so that the angle lies in [0, pi], then there is a unique quaternion representing R, except in the case where R is a rotation by pi radians.
>
> The main interest of quaternion multiplication is that we can actually carry out composition of rotations using the multiplication defined on the quaternions. If quaternions Q1 and Q2 represent rotations R1 and R2, then Q2*Q1 represents R2(R1). So the mapping from unit quaternions to rotations is a group homomorphism, where the 'multiplication' operation on the rotations is functional composition.

2.0 DETAILED SPECIFICATION

The following section describes in greater detail the files to be received by the IMP Team.

2.1 Structure and Organization Overview

For each archived IMP image, one file is created, an image data file with an attached PDS label. This file constitutes a set of data to be managed and archived by MIPL as one unit.

The image data will be a single image frame captured by the IMP camera . The maximum size of the image frame is 256 lines by 256 samples, however, the nominal image frame size is 248 lines by 256 samples. The construction of the IMP camera created an area of overlap between the right and left image views and the elimination of 8 lines from each removes this artifact.

2.1.1 MIPL Local Image File

An image file consists of two major parts: the image header, which describes many aspects of the image, and the image area, which contains the actual image data The image header and image area are stored as a standard VICAR image. Additional information about the basic VICAR image structure and content is described in the "VICAR File Format" document (reference 4). The line and sample numbering of the image data starts with an origin of (1,1) at the upper left of the image with increasing values both to the right and down. See figure 2.1 for a graphical representation of a nominal IMP EDR.

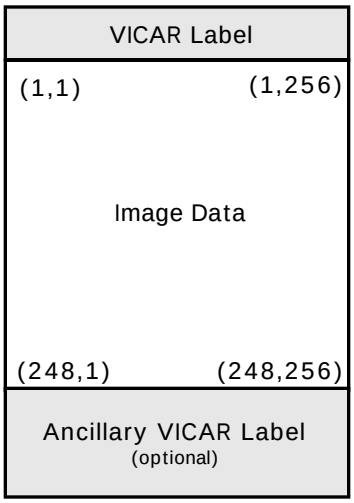

Figure 2.1 — *VICAR Image Organization*

This figure identifies the basic structure of the VICAR IMP EDR data file. There is an ASCII label at the beginning of the file followed by the image data and an optional ancillary VICAR label in cases where not enough space was allocated for the label at the beginning of the file.

2.1.2 PDS Archived Label File

Every archived image data file contains a PDS label. This label conforms to the Planetary Data System standard for ancillary data management. The label contains information regarding the observation which produced the image. This observation information includes general descriptors such as observation sequence name and time tags of the start of image acquisition, camera and spacecraft state parameters,

data compression information, viewing and lighting geometry, spacecraft position and camera pointing, image dimensions, and processing history. This PDS labelled image is the IMP Team defined standard for transferring data between home institutions.

The PDS label is an object-oriented file; the object to which the label refers is denoted by a statement of the form:

```
^object = location
```

in which the carat character '^' (also called a pointer in this context) indicates that the object starts at the given location. In an attached label, the location denotes the starting record or byte. For example:

```
^IMAGE = 3
```

indicates that the IMAGE object begins at record 3 of the file.

All labels contain 80-byte fixed-length records, with a carriage return character (ASCII 13) in the 79th byte and a line feed character (ASCII 10) in the 80th byte. This allows the files to be read by the HFS, MacOS, DOS, OS2, UNIX, and VMS operating systems. The labels are padded with NULL characters to form an integral number of records equal in length to the data file records.

Figure 2.2 is a template of the IMP EDR PDS label. See Appendix A for detailed definitions and formatting information for the label items. Also, note that label item values which are capitalized or those values enclosed in quotes but not italicized represent label item values to be written verbatim.

Text inside broken brackets, ‘<’ and ‘>’, identify the type of data that is valid for a label value.

Figure 2.2. — *Template of Mars Pathfinder IMP EDR PDS Label*

```
PDS_VERSION_ID                = PDS3

/* FILE CHARACTERISTICS */

RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = number of bytes per record in the file
FILE_RECORDS                  = total number of records in the file
LABEL_RECORDS                 = number of records in the file containing
                                only label information

/* POINTERS TO DATA OBJECTS */

^IMAGE                        = first record in file containing image data

/* IDENTIFICATION DATA ELEMENTS */

DATA_SET_ID                   = "MPFL-M-IMP-2-EDR-V1.0"
DATA_SET_NAME                 = "MPF LANDER MARS IMAGER FOR MARS PATHFINDER 2
                                 EDR V1.0"
PRODUCER_ID                   = "MIPL OF JPL"
PRODUCER_FULL_NAME            = "ALLAN J. RUNKLE"
PRODUCER_INSTITUTION_NAME     = "MULTIMISSION IMAGE PROCESSING LABORATORY,
                                 JET PROPULSION LAB"
PRODUCT_ID                    = "IMP_EDR-<sclkstrtcnt>-<image_observation_
                                 type>-<image_id>"
IMAGE_ID                      = nnnnnnnnnn
COMMAND_SEQUENCE_NUMBER       = nnnn
IMAGE_OBSERVATION_TYPE        = <REGULAR, DARK_CURRENT, FLAT_FIELD,
                                 HISTOGRAM, SUMMATION, DARK_STRIP,
                                 NULL_STRIP>
```

Figure 2.2. — *Template of Mars Pathfinder IMP EDR PDS Label (continued)*

```
FRAME_ID                        = <LEFT, RIGHT, BOTH, HALFL>
MISSION_NAME                    = "MARS PATHFINDER"
INSTRUMENT_HOST_NAME            = "MARS PATHFINDER LANDER"
INSTRUMENT_NAME                 = "IMAGER FOR MARS PATHFINDER"
INSTRUMENT_ID                   = "IMP"
TARGET_NAME                     = planetary body, feature, or region
OBSERVATION_NAME                = purpose of observation
IMAGE_TIME                      = yyyy-mm-ddThh:mm:ss.fffZ
PLANET_DAY_NUMBER               = nn
MPF_LOCAL_TIME                  = hh:mm:ss
SPACECRAFT_CLOCK_START_COUNT    = nnnnnnnnnn
EARTH_RECEIVED_START_TIME       = yyyy-mm-ddThh:mm:ss.fffZ
EARTH_RECEIVED_STOP_TIME        = yyyy-mm-ddThh:mm:ss.fffZ
PRODUCT_CREATION_TIME           = yyyy-mm-ddThh:mm:ss.fffZ

/* DESCRIPTIVE DATA ELEMENTS */

EXPECTED_PACKETS                = n
RECEIVED_PACKETS                = n
APPLICATION_PACKET_ID           = n
APPLICATION_PACKET_NAME         = group name associated with APID
EXPOSURE_DURATION               = f.ffff
EXPOSURE_TYPE                   = <AUTO, INCREMENTAL, MANUAL, PRETIMED, NONE>
EXPOSURE_COUNT                  = n
AUTO_EXPOSURE_DATA_CUT          = n
AUTO_EXPOSURE_PIXEL_FRACTION    = f.ffff
ERROR_PIXELS                    = n
FILTER_NAME                     = <"L440_R440", "L450_R670", "L885_R947",
                                   "L925_R935", "L935_R990", "L670_R670",
                                   "L800_R750", "L860_R-DIOPTER", "L900_R600",
                                   "L930_R530", "L1000_R480", "L965_R965">
FILTER_NUMBER                   = n
INSTRUMENT_TEMPERATURE          = (f.ffff, f.ffff)
INSTRUMENT_TEMPERATURE_COUNT    = (n, n)
INSTRUMENT_DEPLOYMENT_STATE     = <"STOWED", "DEPLOYED", "UNKNOWN">
DETECTOR_PIXEL_HEIGHT           = f.ffff
DETECTOR_PIXEL_WIDTH            = f.ffff
SOURCE_PRODUCT_ID               = standard SPICE kernel names for PCK, SPK, etc.
SOFTWARE_NAME                   = name of MPF telemetry processing software
SOFTWARE_VERSION_ID             = version of MPF telemetry processing software
PROCESSING_HISTORY_TEXT         = "CODMAC LEVEL 1 TO LEVEL 2 CONVERSION VIA
                                   JPL/MIPL MPFTELEMPROC"

/* GEOMETRY DATA ELEMENTS */

INSTRUMENT_AZIMUTH              = f.ffff
AZIMUTH_FOV                     = f.ffff
AZIMUTH_MOTOR_CLICKS            = n
INSTRUMENT_AZIMUTH_METHOD       = <"TELEMETRY", "MPFNAV-MIPS", "BACKLASH-UOFA">
INSTRUMENT_ELEVATION            = f.ffff
ELEVATION_FOV                   = f.ffff
ELEVATION_MOTOR_CLICKS          = n
INSTRUMENT_ELEVATION_METHOD     = <"TELEMETRY", "MPFNAV-MIPS", "BACKLASH-UOFA">
SURFACE_BASED_INST_AZIMUTH      = f.ffff
SURFACE_BASED_INST_ELEVATION    = f.ffff
SURFACE_BASED_INST_METHOD       = "L_FRAME-QUATERNION"
POSITIVE_ELEVATION_DIRECTION    = UP
SOLAR_AZIMUTH                   = f.ffff
SOLAR_ELEVATION                 = f.ffff
LANDER_SURFACE_QUATERNION       = (f.ffff, f.ffff, f.ffff, f.ffff)
```

Figure 2.2. — *Template of Mars Pathfinder IMP EDR PDS Label (continued)*

```
/* IMP FLIGHT SOFTWARE COMMAND DATA ELEMENTS */

COMMAND_DESC                    = text which describes the uplinked command
COMMAND_NAME                    = name of the uplinked command
TLM_CMD_DISCREPANCY_FLAG        = <TRUE, FALSE>
DOWNLOAD_TYPE                   = <NONE, DS, IM, DSIM, NS, DSNS, IMNS, DSIMNS>
DARK_CURRENT_DOWNLOAD_FLAG      = <TRUE, FALSE>
DARK_CURRENT_CORRECTION_FLAG    = <TRUE, FALSE>
FLAT_FIELD_CORRECTION_FLAG      = <TRUE, FALSE>
BAD_PIXEL_REPLACEMENT_FLAG      = <TRUE, FALSE>
SHUTTER_EFFECT_CORRECTION_FLAG = <TRUE, FALSE>
SQRT_COMPRESSION_FLAG           = <TRUE, FALSE>

/* COMPRESSION DATA ELEMENTS */

INST_CMPRS_BLK_SIZE             = (n, n)
INST_CMPRS_BLOCKS               = n
INST_CMPRS_MODE                 = n
INST_CMPRS_PARAM                = n
INST_CMPRS_QUALITY              = n
INST_CMPRS_QUANTZ_TBL_ID        = name or code identifying the reference table
                                  used for quantization in the frequency domain
                                  for on-board transform compression
INST_CMPRS_QUANTZ_TYPE          = TABULAR
INST_CMPRS_SYNC_BLKS            = n
INST_CMPRS_NAME                 = <"RICE ADAPTIVE VARIABLE-LENGTH CODING
                                   (RICE)", "JPEG DIRECT COSINE TRANSFORM
                                   (DCT)">
INST_CMPRS_RATE                 = f.ffff
INST_CMPRS_RATIO                = f.ffff
PIXEL_AVERAGING_HEIGHT          = n
PIXEL_AVERAGING_WIDTH           = n
RICE_START_OPTION               = n
RICE_OPTION_VALUE               = n
SQRT_MINIMUM_PIXEL              = n
SQRT_MAXIMUM_PIXEL              = n

/* IMAGE OBJECT DATA ELEMENTS */

OBJECT                          = IMAGE
  INTERCHANGE_FORMAT            = BINARY
  LINES                         = n
  LINE_SAMPLES                  = n
  BANDS                         = 1
  SAMPLE_TYPE                   = MSB_UNSIGNED_INTEGER
  SAMPLE_BITS                   = <8, 16, or 32>
  SAMPLE_BIT_MASK               = <2#11111111#, 2#0000111111111111#, or
                                   2#11111111111111111111111111111111#>
  MAXIMUM                       = n
  MEAN                          = f.ffff
  MEDIAN                        = n
  MINIMUM                       = n
  STANDARD_DEVIATION            = f.ffff
  FIRST_LINE                    = n
  FIRST_LINE_SAMPLE             = n
  CHECKSUM                      = <32 bit unsigned integer>
END_OBJECT                      = IMAGE
END
```

2.2 File Naming Conventions

The following naming convention standard for IMP image data files is to be maintained by MIPL as a means of files management.

2.2.1 VICAR Image Data File Names

For all data files stored in the MIPL Working Mission Storage (WMS), the filenames will be constructed with five parts as shown below in Figure 2.3.

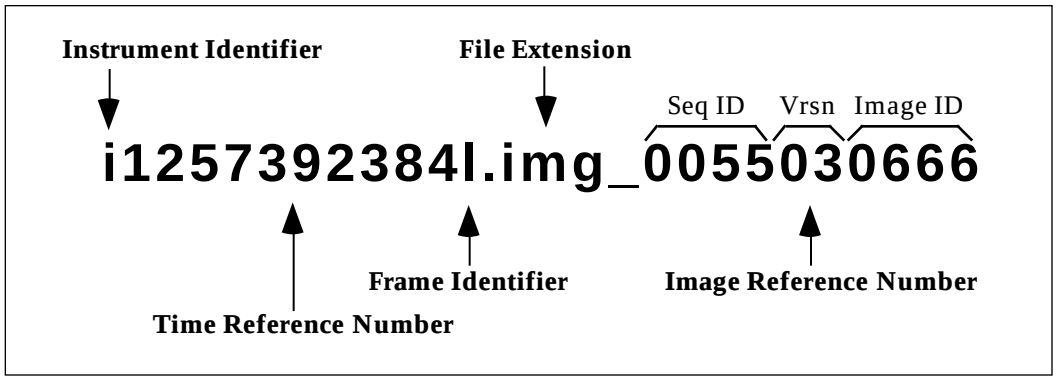

Figure 2.3. — *Sample VICAR Image File Name*

Instrument Identifier - The instrument identifier will always be the lowercase letter ‘i’, representing an EDR from the IMP camera.

Time Reference Number - The time reference number will be the 10-digit Spacecraft Clock Start Count, as described in Appendix A. The Spacecraft Clock Start Count is the same for left, right, null strip and dark strip images.

Frame Identifier - The frame identifier will be a one character letter, ‘l’, ‘r’, ‘s’, or ‘n’, referring to an image generated from the left, right, dark or null IMP frame respectively.

File Extension - The file extension is a three character mnemonic. Table 2.1 shows the possible file extensions and the data files they represent.

Table 2.1. — *File Extensions and Data File Types*

Data File Types	File Extension
Image	.img
Dark Strip	.str
Null Strip	.nul
Flat Field	.flt
Dark Current	.drk
Histogram	.hst
Summed	.sum

Image Reference Number - Finally, the image reference number is the 10-digit Image ID appended onto the file extension. The reference number is procedurally divided into three parts, the sequence ID, version and image ID. The sequence ID is the most significant 4 digits, the version the middle two digits and the image ID the least significant 4 digits.

2.2.2 PDS Data File Names

The PDS data filenames will be constructed with four of the five VICAR image data filename components as shown below in Figure 2.4.

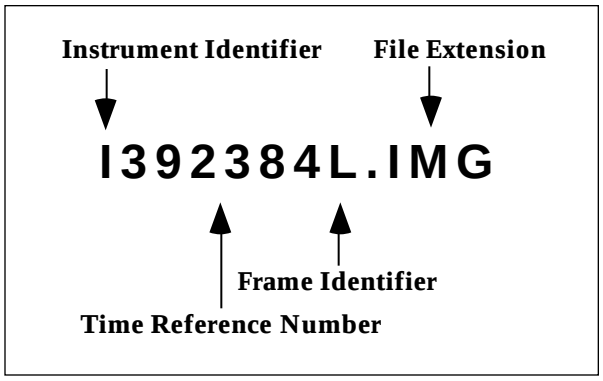

Figure 2.4. — *Sample PDS Data File Name*

Instrument Identifier - The instrument identifier will be the uppercase letter 'I'.

Time Reference Number - The time reference number will be the least significant 6-digits of the Spacecraft Clock Start Count (the 4 most significant digits will be used as part of the directory hierarchy storing the image files).

Frame Identifier - The frame identifier will be a one character letter, 'L', 'R', 'S', or 'N', referring to an image generated from the left, right, dark or null IMP frame respectively.

File Extension - Finally, the file extension will be one of seven three-character mnemonics shown in Table 2 for the VICAR Image File Extensions (except in uppercase).

APPENDIX A
IMP PDS/VICAR EDR Label Items

A.1 IMP PDS/VICAR EDR Label Items

The following pages list alphabetically the label items which are contained in the PDS attached and VICAR labels associated with each image file. The list is broken into three sections. The first section contains the label items that will be in every image file. The second section defines the additional label items that are present in the PDS distributed image files. The third section defines the label items that will be in a mosaicked VICAR image file.

Table A-1 — *Common IMP Label Items*

Label Item	Description	Data Type (organization)	Valid Values
APPLICATION_PACKET_ID	Classifies the telemetry packet from which the image data was obtained. This packet ID is extracted from the telemetry download. This value is based on a set of values specified in the Downlink Telemetry Documents (JPL). This acronym is APID.	integer	(see IMP specification, ref. 3)
AUTO_EXPOSURE_DATA_CUT	A value indicating the base for pixel values using AUTO_EXPOSURE_PIXEL_FRACTION as the percentage of pixels wanted above that value.	integer	[0, 4095]
AUTO_EXPOSURE_PIXEL_FRACTION	Fraction of pixels wanted to exceed AUTO_EXPOSURE_DATA_CUT, expressed as a percentage. This field is valid only if EXPOSURE_TYPE is AUTO.	floating point	[0, 100.0]
AZIMUTH_FOV	The angular coverage of the imaged scene measured horizontally with respect to the image plane in spacecraft coordinates. This is a simple multiplication of the number of samples by the field of view of each pixel.	floating point	[0.0, 360.0]
AZIMUTH_MOTOR_CLICKS	Azimuth received from the telemetry, measured in IMP motor step position counts from the low hard stop.	integer	[0, 1023]
BAD_PIXEL_REPLACEMENT_FLAG	Indicates whether or not bad pixel replacement processing command was issued to the flight software. If set TRUE, certain pixels of the image will be replaced based on a bad pixel table.	character (array)	TRUE, FALSE
CAMERA_ORIENTATION_QUATERNION	A set of four values that define a rotation about the IMP coordinate system origin pointing to the direction of camera boresight. the values are stored in NAIF representation of Cosine, X, Y, Z.	double (array of 4 elements)	N.A.
COMMAND_NAME	Uplinked command name as found in the Mars Pathfinder Command Dictionary, appendix A, D-12500.	varchar (20)	IMP_IMAGE_AZ_EL, IMP_IMAGE_VECTOR, IMP_IMAGE_OBJECT, IMP_IMAGE_LCLVEC, IMP_IMAGE_LCLGRD

† - *for PDS files only*
* - *for Mosaic products only*

Table A-1 — *Common IMP Label Items*

Label Item	Description	Data Type (organization)	Valid Values
DARK_CURRENT_CORRECTION_FLAG	Indicates that dark current correction processing command was issued to the flight software and the image is to be adjusted by an on-board dark current correction image.	character (array)	TRUE, FALSE
DOWNLOAD_TYPE	Command parameter identifying the image data to be downloaded; any or all of the image data (IM), dark current strip (DS), and null pixel data (NS).	varchar (10)	NONE, DS, IM, DSIM, NS, DSNS, IMNS, DSIMNS
EARTH_RECEIVED_START_TIME	Identifies the earliest time a packet was received that contained data for the image.	character array	YYYY-MM-DDThh:mm:ss.fffZ
EARTH_RECEIVED_STOP_TIME	Identifies the latest time a packet was received that contained data for the image.	character array	YYYY-MM-DDThh:mm:ss.fffZ
ELEVATION_FOV	The angular coverage of the imaged scene measured vertically with respect to the image plane in spacecraft coordinates. This is a simple multiplication of the number of lines by the field of view of each pixel.	floating point	[0.0, 90.0]
ELEVATION_MOTOR_CLICKS	Elevation received from telemetry, measured in IMP motor step position counts from the low hard stop.	integer	[0, 1023]
ERROR_PIXELS	Count of the number of pixels that are outside of the valid Dn range (0 to 4095). The count is taken after all decompression and post decompression processing has been completed.	integer	<any positive value>
EXPECTED_PACKETS	Total number of telemetry packets which constitute a complete image, an image without missing data.	integer	<any positive value>
EXPOSURE_COUNT	Maximum number of exposures to take. Valid values are dependent on EXPOSURE_TYPE.	integer	[0, 16]
EXPOSURE_DURATION	Integration time for manual and auto exposure, measured in milliseconds. Integration Time in IMP Telemetry Format specification from the U. of Arizona.	floating point	[0.5, 32767.5]

† - *for PDS files only*
* - *for Mosaic products only*

Table A-1 — *Common IMP Label Items*

Label Item	Description	Data Type (organization)	Valid Values
EXPOSURE_TYPE	Exposure type for the image: auto, manual, pre-timed, incremental or none. Auto exposure allows for adjusting the exposure time based on a previous exposure. Manual exposure is a single exposure with a set expose time. Pre-timed exposure uses the very last expose time used, regardless of what kind of exposure it was. No exposure indicates that the command moves only the camera and doesn't take an exposure.	character (array)	AUTO, INCREMENTAL MANUAL, PRETIMED, NONE *PDS limits this length to 8 characters*
FILTER_NAME	The name of the instrument filter through which the image was acquired. The number in the name refers to the effective wave length in nm of the filter for the left (L) or right (R) image.	character (array)	for flt 0, "L440_R440" for flt 1, "L450_R670" for flt 2, "L885_R947" for flt 3, "L925_R935" for flt 4, "L935_R990" for flt 5, "L670_R670" for flt 6, "L800_R750" for flt 7, "L860_R-DIOPTER" for flt 8, "L900_R600" for flt 9, "L930_R530" for flt 10, "L1000_R480" for flt 11, "L965_R965"
FILTER_NUMBER	The number of the instrument filter through which the image was acquired.	integer	[0, 11]
FIRST_LINE	Indicates the line within a source image that corresponds to the first line of the sub-image.	integer	[1, 256]
FIRST_LINE_SAMPLE	Indicates the sample within a source image that corresponds to the first sample in the sub-image.	integer	[1, 256]
FLAT_FIELD_CORRECTION_FLAG	Indicates whether or not flat field correction processing command was issued to the flight software. If set TRUE, the image is to be adjusted by an on-board flat field correction image.	character (array)	TRUE, FALSE
FOCAL_CENTER_VECTOR	Position of the entrance pupil point of the camera lens (focal center) measured relative to the Local Level coordinate frame (M Frame) [7]. Corresponds to the C vector in the CAHV camera model.	floating point (array of 3 elements)	N.A.

† - *for PDS files only*
* - *for Mosaic products only*

Table A-1 — *Common IMP Label Items*

Label Item	Description	Data Type (organization)	Valid Values
FRAME_ID	Provides an identification for a particular instrument frame. The IMP camera nominally operates in a mode where both the left and right images are exposed and transferred into the frame buffer. Then either the RIGHT, LEFT or BOTH frames are transmitted. It is also possible to quickly only transfer the left frame (HALFL) if there are concerns about the length of the shutter time.	character (array)	LEFT, RIGHT, BOTH, HALFL
HORIZONTAL_IMAGE_PLANE_VECTOR	$\mathbf{H} = \mathbf{H}' + x_C\mathbf{A}$, where $\mathbf{H}'$ is a unit vector parallel to the x-axis in the camera's image plane, and x_C is the point of intersection of a perpendicular dropped from the exit pupil point of the camera lens. **H', A', V'** are mutually orthogonal. All the vectors are defined in the Local Level coordinate frame (M Frame) [7]. Corresponds to the H vector in the CAHV camera model.	floating point (array of 3 elements)	N.A.
IMAGE_ID	10-digit number that uniquely identifies the observation parameters of an image. The most significant 4 digits identify the command sequence that contains the imaging command. If the image ID is even and non-zero, then this is the left frame from the camera. If the image ID is one greater than the left frame image ID (odd), then this is the right frame of a stereo image. NOTE: During operations, a small number of IMAGE_IDs were reused with different command parameters. This eliminates the uniqueness of the IMAGE_ID for these images. The TLM_CMD_DISCREPANCY_FLAG may be useful in identifying images that have this problem.	integer	<any positive value>

† - *for PDS files only*
* - *for Mosaic products only*

Table A-1 — *Common IMP Label Items*

Label Item	Description	Data Type (organization)	Valid Values
IMAGE_OBSERVATION_TYPE	Image data type as specified in the image packet as image information bits. The image data type defines the format and type of image data. Except for SUMMATION and HISTOGRAM, all the image observation types basically identify normal imaging data, Please refer to section 1.3 for a better discussion of the meaning of these values.	character (array)	REGULAR, DARK_CURRENT, FLAT_FIELD, HISTOGRAM, SUMMATION, DARK_STRIP, NULL_STRIP *PDS limit of 10 character length*
IMAGE_TIME	Time at which the image was acquired, recorded in UTC format. Corresponds to SPACECRAFT_CLOCK_START_COUNT.	character (array)	YYYY-MM-DDThh:mm:ss.fffZ
INST_CMPRS_BLK_SIZE	Dimension of a block for on-board compression; line dimension of the block is the first element, followed by the sample dimension of the block.	integer (array)	for Rice, (1*n) where n ranges from 4 to 24. for JPEG, (8,8)
INST_CMPRS_BLOCKS	Number of blocks used to spatially segment the image file prior to on-board compression.	integer	<any positive value that is the image number of pixels divided by the block area>
INST_CMPRS_MODE	Selects on-board compression target of image quality or compression factor in conjunction with Huffman or arithmetic entropy encoding with or without LCT. Odd modes select image quality, while even modes select compression factor as a target. Modes 1,2,5,6 use Huffman encoding; modes 3,4,7,8 use arithmetic encoding. Modes 5 through 8 use LCT; mode 9 defines RICE compression.	integer	[1, 9]
INST_CMPRS_NAME	The type of on-board compression used for data storage and transmission. Contents of this value should be the full, unabbreviated, non-acronym name of coding or compression type. Examples of encoding types include but are not limited to Integer Cosine Transform (ICT), Block Truncation Coding (BTC), Discrete Cosine Transform (DCT), Joint Photographic Experts Group (JPEG) Standard DCT.	character (array)	"Rice Adaptive Variable-length Coding (RICE)" or "JPEG Discrete Cosine Transform (DCT)" or NONE
INST_CMPRS_PARAM	JPEG specific variable. Selects on-board compression rate by image quality or by compression factor, based on selected on-board compression mode.	integer	if compression mode is odd, [1, 99]; if compression mode is even, [2, 225].

† - *for PDS files only*
* - *for Mosaic products only*

Table A-1 — *Common IMP Label Items*

Label Item	Description	Data Type (organization)	Valid Values
INST_CMPRS_QUALITY	JPEG specific variable If an odd IMP compression mode is used for on-board compression, this is the desired image quality index. If an even IMP compression mode is used, this is the resultant image quality used to reach a desired on-board compression factor.	integer	<any positive number>
INST_CMPRS_QUANTZ_TBL_ID	This name or code identifies the reference table used for quantization in the frequency domain for on-board transform compression. This name or code should be specific enough to allow the user of the data to have sufficient information to reference the quantization table used to compress the data.	character (array)	[0, 15]
INST_CMPRS_RATE	Average number of bits needed to represent a pixel for an on-board compressed image.	floating point	<any positive value>
INST_CMPRS_RATIO	Ratio in bytes of the original, uncompressed data file length to its compressed form. For example, a compression ratio of 5.00 means that on average, for every five bytes of input data, one byte of on-board compressed data was generated.	floating point	<any positive value>
INST_CMPRS_SYNC_BLKS	Rice specific variable. Number of compressed blocks between sync markers.	integer	[1, 1024]
INSTRUMENT_AZIMUTH	Azimuth of camera at which image scene was captured, measured in degrees clockwise with respect to the Y_l axis of the Mars Pathfinder Lander Coordinate Frame (L Frame). See Mars Pathfinder AIM Phasing and Coordinate Frame Document (reference 7).	floating point	[0, 360.0]
INSTRUMENT_AZIMUTH_METHOD	Identifies the method used to calculate the azimuth.	character (array)	TELEMETRY MPFNAV-MIPS BACKLASH-UOA
INSTRUMENT_DEPLOYMENT_STATE	Defines the position of the IMP mast	character (array)	STOWED, DEPLOYED, UNKNOWN

† - *for PDS files only*
* - *for Mosaic products only*

Table A-1 — *Common IMP Label Items*

Label Item	Description	Data Type (organization)	Valid Values
INSTRUMENT_ELEVATION	Elevation of camera at which image scene was captured, measured in degrees with respect to the X_l / Y_l plane of the Mars Pathfinder Lander Coordinate Frame (L Frame). Positive degrees are measured above the X_l / Y_l plane (negative Z_l direction). See Mars Pathfinder AIM Phasing and Coordinate Frame Document (reference 7).	floating point	[-90.0, 90.0]
INSTRUMENT_ELEVATION_METHOD	Identifies the method used to calculate the elevation	character (array)	TELEMETRY MPFNAV-MIPS BACKLASH-UOA
INSTRUMENT_ID	Acronym of instrument name	character (array)	IMP
INSTRUMENT_NAME	Full name of an instrument.	character (array)	“Imager for Mars Pathfinder”
INSTRUMENT_TEMPERATURE	The temperature of the sensor (CCD) array and camera head when the image was acquired, measured in degrees Celsius.	floating point (array of 2 elements)	<any positive value>
INSTRUMENT_TEMPERATURE_COUNT	The raw temperature counts of the CCD and camera head when the image was taken.	integer (array of 2 elements)	[0, 255]
LANDER_SURFACE_QUATERNION	A set of four values the define the relationship between the Lander Frame and Local Level Frame coordinate systems [7]. The values are stored in NAIF representation of cosine, X, Y, Z.	double (array of 4 elements)	N.A
MAXIMUM	The maximum Dn value in the image file, between the IMP CCD valid range (0 to 4095).	integer	[0, 4095]
MEAN	The mean pixel value for the pixels within the valid Dn range.	floating point	[0.0, 4095.0]
MEDIAN	The median pixel value for the pixels within the valid Dn range. This value will be at most 8 Dn greater than or equal to the true median value.	integer	[0, 4095]
MINIMUM	The minimum Dn value in the image file, between the IMP CCD valid range (0 to 4095).	integer	[0, 4095]

† - *for PDS files only*
* - *for Mosaic products only*

Table A-1 — *Common IMP Label Items*

Label Item	Description	Data Type (organization)	Valid Values
MISSION_NAME	A major planetary mission or project.	character (array)	MARS PATHFINDER
MLL_MFX_OFFSET_METHOD	Identifies the method used to calculate the MLL_MFX offset vector	character (array)	NOT_DETERMINED MPFVIEW-MIPS
MLL_MFX_OFFSET_VECTOR	An array of X, Y, and Z offsets in millimeters from the origin of the Lander Frame (L Frame) to the Mars Surface Fixed Frame (MFX Frame). [7]	floating point (array of 3 elements)	N.A.
MPF_LOCAL_TIME	Reference time based on the IAU standard for the Martian prime meridian. For detailed description, see the Report of the IAU/IAG/COSPAR Working Group on Cartographic Coordinates and Rotational Elements of the Planets and Satellites: 1991.	character (array)	hh:mm:ss
OBSERVATION_NAME	Identifies the purpose of the observation sequence. Obtained from the IMP e-kernel.	character (array)	N.A.
PIXEL_AVERAGING_HEIGHT	Block height for pixel averaging prior to image compression.	integer	[1, 255] required that mod(LINES / (PIXEL_AVERAGING_HEIGHT)) = 0
PIXEL_AVERAGING_WIDTH	Block width for pixel averaging prior to image compression.	integer	[1, 255] required that mod(SAMPLES / (PIXEL_AVERAGING_WIDTH)) = 0
PLANET_DAY_NUMBER	The Martian day on which the image was taken. This is a counter that starts with '1' as the first day of surface operations. '0' refers to a pre surface operations image.	integer	<any positive number>
POINTING_DIRECTION_VECTOR	A unit vector **A** in the direction in which the camera is pointed; the direction of the symmetry axis of the camera lens as measure in the Local Level coordinate frame (M Frame) [7]. Corresponds to the A vector in the CAHV camera model.	floating point (array of 3 elements)	<TBD>

† - *for PDS files only*
* - *for Mosaic products only*

Table A-1 — *Common IMP Label Items*

Label Item	Description	Data Type (organization)	Valid Values
PRODUCER_ID	Short name or acronym for the producer or producing team / group of a data set.	string (array)	MIPS OF JPL
PRODUCT_CREATION_TIME	Defines the UTC time when a product was created.	time	YYYY-MM-DDThh:mm:ss.fffZ
PRODUCT_ID	A permanent, unique identifier assigned to a data product by its producer.	character (array)	"IMP_EDR-<SCLK_start_count>-<image_observation_type>-<image id>"
RECEIVED_PACKETS	Total number of telemetry packets which constitute the reconstructed image.	integer	<any positive value>
RICE_OPTION_VALUE	RICE compressor specific variable.	integer	between 2 and (data precision - start_option + 1)
RICE_START_OPTION	RICE compressor specific variable.	integer	between 0 and the data precision of pixels
SHUTTER_EFFECT_CORRECTION_FLAG	Indicates whether or not the shutter, or fixed-pattern removal command was issued to the flight software. If set TRUE, the image is to be adjusted by an on-board algorithm.	character (array)	TRUE, FALSE
SOFTWARE_NAME	Identifies the name of the telemetry processing software used to generate the image data.	character (array)	N.A.
SOFTWARE_VERSION_ID	Identifies the version of the telemetry processing software used to generate the image data.	character (array)	N.A.
SOURCE_PRODUCT_ID	Filenames of SPICE kernels used to produce image data and derived data.	character (array)	<standard SPICE kernel names for PCK, SPK, etc.>
SPACECRAFT_CLOCK_START_COUNT	Lander time in seconds at which the image was acquired. Image Generation Time in the IMP Telemetry Format specification from the U. of Arizona. Corresponds to IMAGE_TIME.	integer	N.A.
SPACECRAFT_NAME	Full, unabbreviated name of a spacecraft.	character (array)	MARS PATHFINDER LANDER

† - *for PDS files only*
* - *for Mosaic products only*

Table A-1 — *Common IMP Label Items*

Label Item	Description	Data Type (organization)	Valid Values
SQRT_COMPRESSION_FLAG	Indicates whether or not the square root compression command was issued to the flight software. If set TRUE, the image is to be square root compressed on-board from a 12 bit pixel down to an 8 bit pixel.	character (array)	TRUE, FALSE
SQRT_MAXIMUM_PIXEL	Maximum pixel value in 12-bit image prior to square root compression.	integer	[0, 4095]
SQRT_MINIMUM_PIXEL	Minimum pixel value in 12-bit image prior to square root compression.	integer	[0, 4095]
STANDARD_DEVIATION	Standard deviation of the valid pixel values around the mean Dn value.	floating point	[0.0, 4095.0]
SURFACE_BASED_INST_AZIMUTH	Azimuth of IMP camera measured in the Mars Surface Fixed frame (MFX frame). Azimuth is measured positively in degrees clockwise from the Martian north (spin axis), projected onto the local gravity horizontal plane (plane perpendicular to the gravity vector). Also generally known as NORTH_AZIMUTH. Mars Local Level or surface fixed coordinate system. See Mars Pathfinder AIM Phasing and Coordinate Frame Document (reference 7).	floating point	[0.0, 360.0]
SURFACE_BASED_INST_ELEVATION	Elevation of IMP camera measured in the Mars Surface Fixed frame (MFX frame). Elevation is measured in degrees up from the Mars Local Level or Surface Fixed X,Y plane (negative Z direction). See Mars Pathfinder AIM Phasing and Coordinate Frame Document (reference 7).	floating point	[-90.0, 90.0]
SURFACE_BASED_INST_METHOD	Identifies the method used to calculate the surface based camera pointing.	character (array)	TELEMETRY MPFNAV-MIPS BACKLASH-UOA
TARGET_NAME	Identifies a target, be it a planetary body, region or feature.	character (array)	<Mars or some Martian feature>

† - *for PDS files only*
* - *for Mosaic products only*

Table A-1 — *Common IMP Label Items*

Label Item	Description	Data Type (organization)	Valid Values
TLM_CMD_DISCREPANCY_FLAG	Indicator of mismatch(es) found between IMP commands uplinked and IMP telemetry. The fields checked when determining this flag are: APPPLICATION_PACKET_ID EXPOSURE_TYPE FILTER_NUMBER FRAME_ID INST_CMPRS_MODE LINES LINES_SAMPLES PIXEL_AVERAGING_HEIGHT PIXEL_AVERAGING_WIDTH SQRT_COMPRESSION_FLAG	character (array)	TRUE, FALSE
VERTICAL_IMAGE_PLANE_VECTOR	$\mathbf{V} = \mathbf{V}' + y_C\mathbf{A}$, where $\mathbf{V}'$ is a unit vector parallel to the y-axis in the camera's image plane, and y_C is the point of intersection of a perpendicular dropped from the exit pupil point of the camera lens. **H', A', V'** are mutually orthogonal. All the vectors are defined in the Local Level coordinate frame (M Frame) [7]. Corresponds to the V vector in the CAHV camera model.	floating point (array of 3 elements)	N.A.

† - *for PDS files only*
* - *for Mosaic products only*

Table A-2 — *PDS IMP Label Items*

Label Item	Description	Data Type (organization)	Valid Values
^IMAGE†	Pointer to the first record of the image data portion in a PDS file.	integer	<any positive number>
APPLICATION_PACKET_NAME	Group name associated with APID. An example is "Lander image of the Rover" for APID #26.	character (array)	<any descriptive text>
BANDS	Indicates the number of spectral bands in the image.	integer	1
CHECKSUM	An unsigned 32-bit sum of every byte of data in the image data object.	integer	<any positive value>
COMMAND_DESC	Text which describes the uplinked command as found in COMMAND_NAME element.	varchar (200)	<text taken directly from the Mars Pathfinder Command Dictionary, appendix A, D-12500>
DARK_CURRENT_DOWNLOAD_FLAG	Indicates if a dark current strip of the CCD was downlinked along with the image data.	character (array)	TRUE, FALSE
DATA_SET_ID	A unique alphanumeric identifier for a data set or a data product. This identifier consists of the identifiers for spacecraft, target, instrument, processing level, product acronym, and version number.	character (array)	"MPFL-M-IMP-2-EDR-V1.0"
DATA_SET_NAME	Full name given to a data set or product. This is an unabbreviated version of the DATA_SET_ID.	character (array)	“MPF Lander Mars Imager for Mars Pathfinder 2 EDR V1.0”
DETECTOR_PIXEL_HEIGHT	Height of pixel spacing measured in microns.	floating point	23.0
DETECTOR_PIXEL_WIDTH	Width of pixel spacing measured in microns.	floating point	23.0
FILE_RECORDS†	Number of physical file records in a PDS data file.	integer	<any positive value>
INST_CMPRS_DESC	Textual description of the instrument compression type, which should include a reference to a journal paper, published text or some other publicly available, published material which definitively describes the on-board compression type.	character (array)	N.A.
INST_CMPRS_QUANTZ_TYPE	Method of quantization used for the output of transform coders.	character (array)	TABULAR

† - *for PDS files only*
* - *for Mosaic products only*

Table A-2 — *PDS IMP Label Items*

Label Item	Description	Data Type (organization)	Valid Values
INTERCHANGE_FORMAT	Manner in which data elements are stored.	character (array)	BINARY
LABEL_RECORDS†	Number of physical file records in a PDS data file that contain only label information.	integer	<any positive value>
LINES	Total number of pixels along the vertical axis of an image.	integer	<any positive value>
LINE_SAMPLES	Total number of pixels along the horizontal axis of an image.	integer	<any positive value>
PDS_VERSION_ID	The version number of the PDS standards documents that is valid when a data product is created.	character (array)	PDS3
POSITIVE_ELEVATION_DIRECTION†	The direction in which elevation is measured in positive degrees for an observer on the surface of a body. The elevation is measured with respect to the azimuthal reference plane. A value of UP indicates that the elevation is measured positively upwards, i.e., the zenith point would be at +90 degrees and the nadir point at -90 degrees. DOWN indicates that the elevation is measured positively downwards; the zenith point would be at -90 degrees and the nadir point at +90 degrees.	character (array)	UP
PROCESSING_HISTORY_TEXT	Textual summation that provides an entry for each processing step and program used in generating a particular data file in the context of the Ground Data System.	character (array)	N.A.
PRODUCER_FULL_NAME	Full, unabbreviated name of the individual mainly responsible for the production of the data set.	string (array)	"Allan J. Runkle"
PRODUCER_INSTITUTION_NAME	Identifies the institution associated with the production of the data set.	string (array)	"Multi-mission Image Processing Subsystem, Jet Propulsion Lab"
RECORD_BYTES†	Number of bytes in a physical file record, including record terminators and separators.	integer	<number _samples> * <bytes / pixel> * <number_bands>
RECORD_TYPE†	Record format of a file.	character (array)	FIXED_LENGTH

† - *for PDS files only*
* - *for Mosaic products only*

Table A-2 — *PDS IMP Label Items*

Label Item	Description	Data Type (organization)	Valid Values
SAMPLE_BITS	Indicates the stored number of bits, or units of binary information, contained in a line_sample value.	integer	16, 32
SAMPLE_BIT_MASK	Identifies the active bits in a sample.	character	2#0000111111111111# or mask of 32 bits(all on)
SAMPLE_TYPE	Data storage representation of sample value.	character (array)	MSB_UNSIGNED_ INTEGER
SOLAR_AZIMUTH	The angular distance in a horizontal direction of the sun relative to north for a particular image, measured in degrees clockwise in a spherical coordinate system.	floating point	[0, 360.0]
SOLAR_ELEVATION	The angular distance in a vertical direction of the sun relative to the horizon as seen by the camera, measured in degrees up in a spherical coordinate system.	floating point	[-90.0, 90.0]

† - *for PDS files only*
* - *for Mosaic products only*

Table A-3 — *Mosaic IMP Label Items*

Label Item	Description	Data Type (organization)	Valid Values
AZIMUTH_OF_SAMPLE_ONE*	Identifies azimuth of the first column in the local Level coordinate frame (L-Frame).	floating point	<any positive number>
MAP_PROJECTION_TYPE*	Identifies the type of projection characteristic of a given map.	character (array)	SIMPLE_ CYLINDRICAL, POLAR_SIMPLE _CYLINDRICAL
MOSAIC_REFERENCE_AZIMUTH*	Recomputed commanded azimuth of camera used to construct the image mosaic in the local Level coordinate frame (L-Frame).	floating point	<TBD>
MOSAIC_REFERENCE_ELEVATION*	Recomputed commanded elevation of camera used to construct the image mosaic in the local Level coordinate frame (L-Frame).	floating point	<TBD>
MOSAIC_REFERENCE_LINE*	Line number of the upper left corner of the mosaic in CAHV pixel coordinates.	floating point	<TBD>
MOSAIC_REFERENCE_SAMPLE*	Sample number of the upper left corner of the mosaic in CAHV pixel coordinates.	floating point	<TBD>
MOSAIC_RESOLUTION*	The ratio of one pixel to the distance measured in degrees between any two adjacent rows or two adjacent columns in a mosaicked image.	floating point	N.A.
NADIR_LINE*	Line to which the nadir projects provided the horizon is level in the image. Otherwise, it is the line to which -90 degrees elevation projects in local camera coordinates.	floating point	N.A.
NADIR_SAMPLE*	Sample to which the nadir projects provided the horizon is level in the image. Otherwise, it is the sample to which -90 degrees elevation projects in local camera coordinates.	floating point	N.A.
ORIENTATION*	Textual description of mosaicked image orientation with respect to the North pole of the target body.	character (array)	"zero azimuth is up"
RADIAL_MOSAIC_RESOLUTION*	The number of pixels per degree in the direction out from the nadir point.	floating point	N.A.

† - *for PDS files only*
* - *for Mosaic products only*

Table A-3 — *Mosaic IMP Label Items*

Label Item	Description	Data Type (organization)	Valid Values
ZERO_ELEVATION_IMAGE_LINE*	Line in image at which zero elevation is found.	integer	N.A.

NOTE: Mosaic images do not contain any other property labels other than the Mosaic Property label. The other property labels would not contain accurate information and would be more misleading than helpful.

† - *for PDS files only*
* - *for Mosaic products only*

APPENDIX B
IMP VICAR Property Labels

B.1 IMP VICAR Property Labels

The following pages contain alphabetical listings of the VICAR label items which are placed in the header of each image file. The listings are arranged by VICAR property name.

VICAR LABEL ITEM

CAMERA_MODEL Property

AZIMUTH_FOV
AZIMUTH_MOTOR_CLICKS
CAMERA_ORIENTATION_QUATERNION
ELEVATION_FOV
ELEVATION_MOTOR_CLICKS
FOCAL_CENTER_VECTOR
HORIZONTAL_IMAGE_PLANE_VECTOR
INSTRUMENT_AZIMUTH
INSTRUMENT_AZIMUTH_METHOD
INSTRUMENT_ELEVATION
INSTRUMENT_ELEVATION_METHOD
LANDER_SURFACE_QUATERNION
MLL_MFX_OFFSET_METHOD
MLL_MFX_OFFSET_VECTOR
POINTING_DIRECTION_VECTOR
SURFACE_BASED_INST_AZIMUTH
SURFACE_BASED_INST_ELEVATION
SURFACE_BASED_INST_METHOD
VERTICAL_IMAGE_PLANE_VECTOR

COMPRESSION Property

INST_CMPRS_BLK_SIZE
INST_CMPRS_BLOCKS
INST_CMPRS_MODE
INST_CMPRS_NAME
INST_CMPRS_PARAM
INST_CMPRS_QUALITY
INST_CMPRS_QUANTZ_TBL_ID
INST_CMPRS_RATE
INST_CMPRS_RATIO
INST_CMPRS_SYNC_BLKS
PIXEL_AVERAGING_HEIGHT
PIXEL_AVERAGING_WIDTH
RICE_OPTION_VALUE
RICE_START_OPTION
SQRT_MAXIMUM_PIXEL
SQRT_MINIMUM_PIXEL

VICAR LABEL ITEM

IMP_COMMANDS Property

AUTO_EXPOSURE_DATA_CUT
AUTO_EXPOSURE_PIXEL_FRACTION
BAD_PIXEL_REPLACEMENT_FLAG
COMMAND_NAME
DARK_CURRENT_CORRECTION_FLAG
DOWNLOAD_TYPE
EXPOSURE_COUNT
FLAT_FIELD_CORRECTION_FLAG
SHUTTER_EFFECT_CORRECTION_FLAG
SQRT_COMPRESSION_FLAG

MOSAIC Property
(valid for mosaics only)

AZIMUTH_OF_SAMPLE_ONE
MAP_PROJECTION_TYPE
MOSAIC_REFERENCE_AZIMUTH
MOSAIC_REFERENCE_ELEVATION
MOSAIC_REFERENCE_LINE
MOSAIC_REFERENCE_SAMPLE
MOSAIC_RESOLUTION
NADIR_LINE
NADIR_SAMPLE
ORIENTATION
RADIAL_MOSAIC_RESOLUTION
ZERO_ELEVATION_IMAGE_LINE

MPFTELEMPROC Property

EARTH_RECEIVED_START_TIME
EARTH_RECEIVED_STOP_TIME
EXPECTED_PACKETS
INSTRUMENT_ID
INSTRUMENT_NAME
MISSION_NAME
PRODUCER_ID
PRODUCT_CREATION_TIME
PRODUCT_ID
RECEIVED_PACKETS
SOFTWARE_NAME
SOFTWARE_VERSION_ID
SOURCE_PRODUCT_ID
SPACECRAFT_NAME
TLM_CMD_DISCREPANCY_FLAG

VICAR LABEL ITEM

OBSERVATION Property

APPLICATION_PACKET_ID
ERROR_PIXELS
EXPOSURE_DURATION
EXPOSURE_TYPE
FILTER_NAME
FILTER_NUMBER
FIRST_LINE
FIRST_LINE_SAMPLE
FRAME_ID
IMAGE_ID
IMAGE_OBSERVATION_TYPE
IMAGE_TIME
INSTRUMENT_DEPLOYMENT_STATE
INSTRUMENT_TEMPERATURE
INSTRUMENT_TEMPERATURE_COUNT
MAXIMUM
MEAN
MEDIAN
MINIMUM
MPF_LOCAL_TIME
OBSERVATION_NAME
PLANET_DAY_NUMBER
SPACECRAFT_CLOCK_START_COUNT
STANDARD_DEVIATION
TARGET_NAME

VICAR LABEL ITEM

PDS Label items

APPLICATION_PACKET_NAME
BANDS
CHECKSUM
COMMAND_DESC
DARK_CURRENT_DOWNLOAD_FLAG
DATA_SET_ID
DATA_SET_NAME
DETECTOR_PIXEL_HEIGHT
DETECTOR_PIXEL_WIDTH
INST_CMPRS_DESC
INST_CMPRS_QUANTZ_TYPE
INTERCHANGE_FORMAT
LINES
LINE_SAMPLES
PDS_VERSION_ID
PROCESSING_HISTORY_TEXT
PRODUCER_FULL_NAME
PRODUCER_INSTITUTION_NAME
SAMPLE_BITS
SAMPLE_BIT_MASK
SAMPLE_TYPE
SOLAR_AZIMUTH
SOLAR_ELEVATION

APPENDIX C
IMPSOFT Label Description

C.1 IMPSOFT Label Description

The following pages describe the sequence of IMP DISRSOFT header fields.

IMPSOFT LABEL Item & Name	Description and / or FSW Structure Element (PDS keyword in **boldface**)
0 H_TYPE	Header type (D=DISR, I=IMP)='I'
1 H_DIRECTORY	Directory file was last stored in
2 H_FILENAME	Filename file was stored as
3 H_FILETIME	Time file was last written by D_WRITE
4 H_LENGTH	Length of header string array
5 H_DIMENSION	Number of dimensions in data ='2'
6 H_XSIZE	Number of columns (default(256, strip=8), or cmd->col_max - ->col_min +1) telem->num_rows PDS **LINE_SAMPLES**
7 H_YSIZE	Number of rows (default(256, strip=8), or cmd->row_max - cmd->row_min +1) telem->num_cols PDS **LINES**
8 H_ZSIZE	Number of images unused
9 H_DATATYPE	Type of data = DB_WORD PDS **SAMPLE_BITS**
10 H_EXTENSION	Position in header where extension area starts
11 H_EXTRA	Position in header where extra area starts
12 H_PROCESS	Position in header where processing area starts PDS **PROCESSING_HISTORY_TEXT** <end of required DISRSOFT header fields>
13 H_PURPOSE	Purpose of observation bce d_purpose PDS **APPLICATION_PACKET_NAME**
14 H_SUBJECT	Subject of observation bce d_subject PDS **TARGET_NAME**
15 H_DATE	Date observation made PDS **IMAGE_TIME**

IMPSOFT LABEL Item & Name	Description and / or FSW Structure Element (PDS keyword in **boldface**)
16 H_ENGINEER	Engineer responsible bce d_operator PDS **PRODUCER_FULL_NAME**
17 H_SITE	Site of observation bce d_site PDS **PRODUCER_INSTITUTION_NAME**
18 H_SET_NAME	Text description of data set bce PDS **DATA_SET_NAME**
19 H_PRODUCT_ID	Unique identifier of image amongst all PDS products PDS **PRODUCT_ID**
20 H_EXPOSURE_COUN	Multiple exposure loop counter for auto expose, flat fields, dark fields cmd->expose_count PDS **EXPOSURE_COUNT**
21 H_OPTICS_TEMP	Camera optics temperature in [K]
22 H_CCDTEMP	On chip CCD temperature in [K] bce computed from telem->ccd_temperature PDS **INSTRUMENT_TEMPERATURE**
23 H_REF_TEMP	CCD electronics reference temperature (MPAE field)
24 H_ELEVATION_R0	obsolete field for camera elevation (raw counts)
25 H_FRAME	CCD frame number cmd->frame (NOTE: overall exposure frame, not image frame) PDS **FRAME_ID**
26 H_EXPOSURE_TYPE	CCD exposure type cmd->expose_type PDS **EXPOSURE_TYPE**
27 H_AUTO_DATA_CUT	Auto Exposure cutoff pixel value cmd->data_num PDS **AUTO_EXPOSURE_DATA_CUT**
28 H_AUTO_PERCENT	Auto Exposure target % of pixels above cutoff value cmd->pixel_frac PDS **AUTO_EXPOSURE_PIXEL_FRACTION**
29 H_AUTO_DFLT_TIM	Auto Exposure initial exposure time cmd->integration_time
30 H_DETECTOR	Detector type (CCD, IR, PHOTOMETER) (MPAE field)

IMPSOFT LABEL Item & Name	Description and / or FSW Structure Element (PDS keyword in **boldface**)
31 H_SENSOR_ID	Sensor ID number (MPAE field)
32 H_COL_MIN	starting column of subframe cmd->col_min (if subframing) PDS **FIRST_LINE_SAMPLE**
33 H_COL_MAX	last column of subframe cmd->col_max (if subframing) PDS **FIRST_LINE_SAMPLE+ SAMPLES- 1**
34 H_ROW_MIN	top row of subframe cmd->row_min (if subframing) PDS **LINE_SAMPLE**
35 H_ROW_MAX	bottom row of subframe cmd->row_max (if subframing) PDS **FIRST_LINE+ LINES - 1**
36 H_EXPTIME	integration time [sec] for CCD measurement (float)cmd->integration_time / 2000. (S.B. telem->) PDS **EXPOSURE_DURATION**
37 H_IMAGE_TIME	start time of exposure PDS **IMAGE_TIME**
38 H_ABSCAL	Absolute calibration factor used
39 H_LOCAL_TIME	PDS **LOCAL_TIME**
40 H_COMP_RATE	bits / pixel (only if compression is used) PDS **INST_CMPRS_RATE**
41 H_COMP_TYPE	compression type "None", "Lossless","Huffman | Arithmetic Quality | Ratio" cmd->compression_type (convert to string) PDS **INST_CMPRS_NAME**
42 H_COMP_QUALITY	quality factor for compression cmd->compression_value (if jpeg quality compression) (telem->cmpr_data_1 if jpeg compression) PDS **INST_CMPRS_QUALITY**
43 H_COMP_RATIO	compression ratio cmd->compression_value (if jpeg ratio compression) PDS **INST_CMPRS_RATIO**
44 H_Q_TABLE	Q table for compression cmd->Q_table (if doing jpeg compression) PDS **INST_CMPRS_QUANTZ_TBL_ID**

IMPSOFT LABEL Item & Name	Description and / or FSW Structure Element (PDS keyword in **boldface**)
45 H_AC_TABLE	AC table for Huffman compression cmd->AC_table (if doing jpeg huffman compression)
46 H_DC_TABLE	DC table for Huffman compression cmd->DC_table (if doing jpeg huffman compression)
47 H_SQRT_COMPRESS	Square root compression / correction type cmd->sqrt_type (if used) (telem->image_info[1:3]) PDS **SQRT_COMPRESSION_FLAG**
48 H_BLOCK_SIZE	Obsolete??
49 H_CCD_SIDE	CCD side exposed for this image cmd->frame PDS **FRAME_ID**
50 H_COORD_XL	image coordinates (lower x) (MPAE field)
51 H_COORD_YL	image coordinates (lower y) (MPAE field)
52 H_COORD_XU	image coordinates (upper x) (MPAE field)
53 H_COORD_YU	image coordinates (upper y) (MPAE field)
54 H_FILTER	filter number in use cmd->filter_num (telem->filter_num) PDS **FILTER_NUMBER**
55 H_GAIN	gain factor (MPAE)
56 H_DC_OFFSET	DC offset (MPAE)
57 H_FILTER_NAME	filter in use PDS **FILTER_NAME**
58 H_PIXEL_AVG_H	block height for pixel averaging prior to image compression PDS **PIXEL_AVERAGING_HEIGHT**
59 H_PIXEL_AVG_W	block width for pixel averaging prior to image compression PDS **PIXEL_AVERAGING_WIDTH**
60 H_TIMING_GEN	timing generator code (MPAE)
61 H_CAMERA	BB / EM / FM model (MPAE)
62 H_VACUUM	vacuum or not (yes or no) (MPAE)
63 H_OPTICS	additional optics on bench (MPAE)

IMPSOFT LABEL Item & Name	Description and / or FSW Structure Element (PDS keyword in **boldface**)
64 H_TESTLAMP	external test lamp (MPAE)
65 H_SHUT_TIME	opening time of CCD test shutter (MPAE)
66 H_LED_TIME	LED on time (MPAE)
67 H_SC_LAT	Latitude on target body at which the spacecraft rests
68 H_SC_LON	Longitude on target body at which the spacecraft rests
69 H_SPIKE_CORRECT	
70 H_DARK_CORRECT	dark correction flag PDS **DARK_CURRENT_CORRECTION_FLAG**
71 H_FLAT_CORRECT	flat field correction flag PDS **FLAT_FIELD_CORRECTION_FLAG**
72 H_BADPIX_CORRECT	bad pixel correction flag PDS **BAD_PIXEL_REPLACEMENT_FLAG**
73 H_SHUTTER_CORRE	shutter effect correction flag PDS **SHUTTER_EFFECT_CORRECTION_FLAG**
74 H_IMAGE_MIN	Minimum pixel value on the image telem->min_val (only if doing sqrt compression) PDS **SQRT_MINIMUM_PIXEL_VALUE**
75 H_IMAGE_MAX	Maximum pixel value on the image telem->max_val (only if doing sqrt compression) PDS **SQRT_MAXIMUM_PIXEL_VALUE**
76 H_RICE_BLOCK	Block size for Rice compression telem->block PDS **INST_CMPRS_BLK_SIZE** (for RICE only)
77 H_RICE_OPTION	Start option for Rice compression telem->cmpr_data_1 PDS **RICE_START_OPTION**
78 H_RICE_NUMBER	Number of options in Rice compression telem->cmpr_data_2 PDS **RICE_OPTION_VALUE**
79 H_SYNC_INTERVAL	Compression synchronization interval telem->sync PDS **INST_CMPRS_SYNC_BLK**
80 H_GSE_REV	GSE revision creating data set

IMPSOFT LABEL Item & Name	Description and / or FSW Structure Element (PDS keyword in **boldface**)
81 H_CONFIG_FILE	configuration file associated with data set
82 H_TEST_LOG	test log filename generating data
83 H_REC_BEG	first record of this data set in test log
84 H_REC_END	last record of this data set in test log
85 H_PIXEL_UNITS	units of pixels
86 H_SET_ID	data set id PDS **DATA_SET_ID**
87 H_SET_NUMBER	sequential number of this data set telem->image_id (cmd->image_id)
88 H_MISSION_TIME	mission time in seconds PDS **SPACECRAFT_CLOCK_START_COUNT**
89 H_CYCLE_NUMBER	sequential number of cycles
90 H_CYCLE_TYPE	cycle type
91 H_SOLAR_AZIMUTH	sun azimuth (degrees) PDS **SOLAR_AZIMUTH**
92 H_SOLAR_ELEV	sun elevation (degrees) PDS **SOLAR_ELEVATION**
93 H_NORTH_AZIMUTH	Angle between north pole and image center
94 H_IR_MEAS	number of IR sets performed during cycle
95 H_VIOLET_MEAS	number of violet sets performed during cycle
96 H_AZIMUTH	camera azimuth (degrees) relative to IMP frame base PDS **INSTRUMENT_AZIMUTH**
97 H_ELEVATION	camera elevation (degrees) relative to IMP frame base PDS **INSTURMENT_ELEVATION**
98 H_AZIMUTH_FOV	azimuth field-of-view of scene (degrees) PDS **AZIMUTHAL_FOV**
99 H_ELEVATION_FOV	elevation field-of-view of image (degrees) PDS **ELEVATIONAL_FOV**
100 H_FOCAL_LENGTH	Camera focal length (mm)
101 H_PIXEL_HEIGHT	height of a pixel (microns)

IMPSOFT LABEL Item & Name	Description and / or FSW Structure Element (PDS keyword in **boldface**)
	PDS **DETECTOR_PIXEL_HEIGHT**
102 H_PIXEL_WIDTH	width of a pixel (microns) PDS **DETECTOR_PIXEL_WIDTH**
103 H_COMP_TIME	DCT compression time (seconds)
104 H_COMP_RECORD	DCT compression records
105 H_PACKET_ID	JPL telemetry packet id cmd ->packet_id PDS **APPLICATION_PACKET_ID**
106 H_PACKETS_SENT	number of packets expected in image telem->of_total PDS **EXPECTED_PACKETS**
107 H_PACKETS_RCVD	number of packets actually received bce packet count PDS **RECEIVED_PACKETS**
108 H_DEPLOY_STATE	PDS deploy state
109 H_PARAMETER_TBL	
110 H_FLAT_FIELD_TBL	
111 H_BADPIXEL_TBL	
112 H_DARKCURRENT_I	
113 H_MFX_FRAME_AZ	camera azimuth measured in the Mars Surface Fixed frame (MFX frame) PDS **SURFACE_BASED_INST_AZIMUTH**
114 H_MFX_FRAME_EL	camera elevation measured in the Mars Surface Fixed frame (MFX frame) PDS **SURFACE_BASED_INST_ELEVATION**
115 H_COMP_ACTUAL	PDS **INST_CMPRS_RATIO**
116 H_MOSAIC_LINE	mosaic pointing reference line PDS **MOSAIC_REFERENCE_LINE**
117 H_MOSAIC_SAMPLE	mosaic pointing reference sample PDS **MOSAIC_REFERENCE_SAMPLE**
118 H_MOSAIC_AZIMUT	recomputed camera azimuth of mosaic PDS **MOSAIC_REFERENCE_AZIMUTH**

IMPSOFT LABEL Item & Name	Description and / or FSW Structure Element (PDS keyword in **boldface**)
119 H_MOSAIC_ELEV	recomputed camera elevation of mosaic PDS **MOSAIC_REFERENCE_ELEVATION**
120 H_PROJECTION	projection type of map PDS **MAP_PROJECTION_TYPE**
121 H_ORIENTATION	mosaic orientation relative to North pole PDS **ORIENTATION**
122 H_RESOLUTION	mosaic resolution PDS **MOSAIC_RESOLUTION**
123 H_RADIAL_RES	pixels per degree at nadir point in mosaic PDS **RADIAL_MOSAIC_RESOLUTION**
124 H_FIRST_AZIMUTH	
125 H_ZERO_ELEV	image line for zero elevation PDS **ZERO_ELEVATION_IMAGE_LINE**
126 H_NADIR_LINE	image line where nadir projects PDS **NADIR_LINE**
127 H_NADIR_SAMPLE	image sample where nadir projects PDS **NADIR_SAMPLE**
128 H_CAL_TMP_SORS	cal. source voltage
129 H_CCDLUG_TEMP	CCD thermal lug temperature [K}
130 H_COORD_TYPE	coordinate system used in image request cmd->coor_type
131 H_DIRECTION_VEC	camera pointing direction vector cmd { x_az, y_el, z_z } iff coor_type == COOR_UNIT_VEC PDS **POINTING_DIRECTION_VECTOR**
132 H_DIR_Y	camera pointing, y component of vector cmd { x_az, y_el, z_z } iff coor_type == COOR_UNIT_VEC
133 H_DIR_Z	camera pointing, z component of vector cmd { x_az, y_el, z_z } iff coor_type == COOR_UNIT_VEC
134 H_L_FRAME_AZ	camera azimuth measured in the Lander frame
135 H_L_FRAME_EL	camera elevation measured in the Lander frame
136 H_AUX_BRD_VOLT	divided 12V in volts
137 H_CPU_BRD_VOLT	divided 5V in volts

IMPSOFT LABEL Item & Name	Description and / or FSW Structure Element (PDS keyword in **boldface**)
138 H_ADC_OFFSET	0V input; ADC offset
139 H_ADC_GAIN	2.5 input; gain of ADC
/* Calibration Header Fields */	
140 H_TEST_TYPE	calibration test type string bce: ?
141 H_TARGET_DISTAN	calibration distance to target (cm) float bce: ?
142 H_SERIES	calibration LSF / MSF Series string bce: ?
143 H_ENV_CHAMBER	calibration environmental chamber string bce: ?
144 H_CAL_CCD_TEMP	calibration external ccd temperature [K] bce: ?
145 H_BASEPLATE_TEMP	calibration baseplate temperature [K] float bce: ?
146 H_PRESSURE	calibration pressure (Torr) float bce: ?
147 H_STAGE_POSITN	calibration linear stage position (mm) float bce: ?
148 H_STAGE_ROT	calibration rotary stage position (degrees) float bce: ?
149 H_TARGET_TYPE	calibration target type string bce: ?
150 H_MONO_WAVELEN	calibration monochromoeter wavelength (nm) float bce: ?
151 H_MONO_BANDWID	calibration monochrometer bandwidth (nm)

IMPSOFT LABEL Item & Name	Description and / or FSW Structure Element (PDS keyword in **boldface**)
	float bce: ?
152 H_STD_DETECTOR	calibration standard detector float bce: ?
153 H_POLARIZATION	calibration polarization angle (degrees) float bce: ?
154 H_SLIT_WIDTH	calibration slit width (mm) float bce: ?
155 H_HW_MODEL	hardware model (flight, proto, engineer)
156 H_NUM_BINS	number of IR bins for data collection
157 H_SURF_LAMP_REP	surface lamp rep. number
158 H_SUN_LAMP_REP	sun sensor LED rep. number
159 H_CAL1_VOLT1	voltage on cal. lamp 1
160 H_QUATERNION	camera orientation quaternion (first array element) PDS **LANDER_SURFACE_QUATERNION**
161 H_Q_Y	second array element of quaterion PDS **LANDER_SURFACE_QUATERNION**
162 H_Q_Z	third array element of quaterion PDS **LANDER_SURFACE_QUATERNION**
163 H_Q_W	fourth array element of quaterion PDS **LANDER_SURFACE_QUATERNION**
164 H_FOCAL_VECTOR	camera model focal center position (first element of vector) PDS **FOCAL_CENTER_VECTOR**
165 H_F_Y	second element of focal center vector PDS **FOCAL_CENTER_VECTOR**
166 H_F_Z	third element of focal center vector PDS **FOCAL_CENTER_VECTOR**
167 H_HORIZONTAL_V	image plane horizontal direction vector (first element of vector) PDS **HORIZONTAL_IMAGE_PLANE_VECTOR**
168 H_H_Y	second element of horizontal direction vector

IMPSOFT LABEL Item & Name	Description and / or FSW Structure Element (PDS keyword in **boldface**)
	PDS **HORIZONTAL_IMAGE_PLANE_VECTOR**
169 H_H_Z	third element of horizontal direction vector PDS **HORIZONTAL_IMAGE_PLANE_VECTOR**
170 H_VERTICAL_VEC	image plane vertical direction vector (first element of vector) PDS **VERTICAL_IMAGE_PLANE_VECTOR**
171 H_V_Y	image plane vertical direction vector (second element of vector) PDS **VERTICAL_IMAGE_PLANE_VECTOR**
172 H_V_Z	image plane vertical direction vector (third element of vector) PDS **VERTICAL_IMAGE_PLANE_VECTOR**
173 H_NUM_HEAT	number of heaters tested
174 H_NUM_TRIPLET	number of sun triplets in data set
175 H_NUM_TIME_PAIRS	number of time data pairs
176 H_DUMP_START	address of first word in dump
177 H_DUMP_LEN	number of words in dump set
178 H_DUMP_FLAG	packing flag
179 H_MESSAGE	message type code
180 H_MESSAGE_ID	additional information code
181 H_NUM_BAD	number of bad ranges in RAM or EEPROM
182 H_LOTS_BAD	flag - lots bad RAM or EEPROM areas
183 H_CCDTEMP_R	raw CCD temperature telem->ccd_temperature PDS **INST_TEMPERATURE**
184 H_EXPTIME_R	raw exposure time reading telem-> integration_time (cmd->integration_time) PDS **EXPOSURE_DURATION**
185 H_MISSION_TIME_R	raw mission time reading telem -> image_time PDS **SPACECRAFT_CLOCK_START_COUNT**
186 H_AZIMUTH_R	raw azimuth reading cmd->azimuth (telem->azimuth) PDS **AZIMUTHAL_MOTOR_CLICKS**

IMPSOFT LABEL Item & Name	Description and / or FSW Structure Element (PDS keyword in **boldface**)
187 H_ELEVATION_R	raw elevation counts cmd->elevation (telem->elevation) PDS **ELEVATIONAL_MOTOR_CLICKS**
188 H_SPIN_R	raw spin rate reading
189 H_TARGET_AZ_R	raw target azimuth
190 H_ACTUAL_AZ_R	raw actual azimuth
191 H_IR_CHP_TMPB_R	raw IR chip temperature start
192 H_IR_CHP_TMPE_R	raw IR chip temperature end
193 H_PRECHARGE_R	raw average precharge voltage
194 H_IR_COL_TIME_R	raw IR collection time used
195 H_CAL_TMP_SORS_R	raw cal. source voltage
196 H_CCDLUG_TEMP_R	raw CCD thermal lug temperature
197 H_STRAP_TEMP_R	raw strap temperature
198 H_OPTICS_TEMP_R	raw conduit temperature
199 H_VIOLET_TEMP_R	raw violet temperature
200 H_SH_AUX_TEMP_R	raw SH aux board temp
201 H_SH_BOX_TEMP_R	raw SH box temperature
202 H_EA_BOX_TEMP_R	raw EA box temperature
203 H_AUX_BRD_VOLT_R	raw divided 12V
204 H_CPU_BRD_VOLT_R	raw divided 5V
205 H_ADC_OFFSET_R	raw 0V input
206 H_ADC_GAIN_R	raw 2.5V input
207 H_CAL1_VOLT1_R	raw cal. lamp 1 voltage
208 H_CAL1_VOLT2_R	raw cal. lamp 1 voltage
209 H_CAL2_VOLT1_R	raw cal. lamp 2 voltage
210 H_CAL2_VOLT2_R	raw cal. lamp 2 voltage

IMPSOFT LABEL Item & Name	Description and / or FSW Structure Element (PDS keyword in **boldface**)
211 H_CAL3_VOLT1_R	raw cal. lamp 3 voltage
212 H_CAL3_VOLT2_R	raw cal. lamp 3 voltage
213 H_SURF_VOLT1_R	raw surf. lamp voltage
214 H_SURF_VOLT2_R	raw surf. lamp voltage
215 H_SUN_LED_VLT1_R	raw sun sensor LED volt
216 H_SUN_LED_VLT2_R	raw sun sensor LED volt
217 H_OBJECTIVE	objective of test
218 H_DUMMY	flag for dummy detector
219 H_MODEL	DISR model for MMC
220 H_DCOFFSETU_R	raw ADC value of DC offset voltage, ULIS
221 H_DCOFFSETD_R	raw ADC value of DC offset voltage, DLIS
222 H_IMP_FRM_ORG_X	X offset in meters from the Mars Surface Fixed Frame (MFX frame) to the origin of the IMP Frame. PDS **MLL_MFX_OFFSET_VECTOR**
223 H_IMP_FRM_ORG_Y	Y offset in meters from the Mars Surface Fixed Frame (MFX frame) to the origin of the IMP Frame. PDS **MLL_MFX_OFFSET_VECTOR**
224 H_IMP_FRM_ORG_Z	Z offset in meters from the Mars Surface Fixed Frame (MFX frame) to the origin of the IMP Frame. PDS **MLL_MFX_OFFSET_VECTOR**
225 H_SUN_SOURCE	source of spin data
226 H_OGSE_STATUS	status of OGSE
227 H_OGSE_MSG	last msg from EGSE displayed on OGSE
228 H_OGSE_LAMP	lamp current
229 H_OGSE_SUNFILE1	path of sun pulse file
230 H_OGSE_SUNFILE2	path of sun pulse file
231 H_OGSE_SAMP	sun amplitude current
232 H_OGSE_SUNTABLE	sun table

IMPSOFT LABEL Item & Name	Description and / or FSW Structure Element (PDS keyword in **boldface**)
233 H_OGSE_RPM	sun pulse RPM
234 H_OGSE_SPAN	sun pulse span value
235 H_OGSE_SIDEC	Si detector reference
236 H_OGSE_GEDEC	Ge detector reference
237 H_OGSE_EXTDEC	external detector reference
238 H_OGSE_5V	5V reference
239 H_OGSE_TEMP	internal temperature
240 H_OGSE_SSS_TEMP	sun sensor stimulator temp.
241 H_OGSE_GN	analog ground noise
242 H_TELEM_SOFT	PDS **SOFTWARE_NAME**
243 H_IMAGE_TYPE	Image data type as specified in the image packet (regular image, dark current, flat field, etc.) PDS **IMAGE_OBSERVATION_TYPE**
244 through 252	(*not used*)