

# **Thermal Emission Spectrometer**

## **TES-TSDR Standard Data Product Software Interface Specification**

**N. Gorelick**  
**Arizona State University**

Approved by:

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P. Christensen, Principal Investigator

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G. Mehall, Instrument Manager

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## **1. Introduction**

### **1.1. Purpose and Scope of Document**

This document describes the format and content of the Thermal Emission Spectrometer (TES) Time Sequential Data Records (TSDR) standard data products.

### **1.2. Applicable Documents**

*TES Software Specification Document* 642-441, Vol. 5

*TES Operation User's Guide*, 642-444 Vol. 5

*PDS Data Dictionary*, July 15, 1996, JPL D-7116, Rev D

*PDS Data Preparation Workbook*, Feb. 1995, Version 3.1, JPL D-7669, Part 1

*Planetary Data System Standards Reference*, July 1995, Version 3.2, JPL D-7669, Part 2

## **2. Data Product Characteristics and Environment**

### **2.1. Instrument Overview**

The TES instrument uses a Michelson interferometer to make infrared spectrometric measurements, and uses two sets of broad-band bolometric detectors to cover the thermal and visible bands. Each of the three bands has a co-aligned array of 6 detectors arranged in a 3x2 configuration and each detector has a field of view of 8.3 mrad square.

In normal operation the TES completes a scan of the Michelson mirror every 2 seconds and each of the spectrometer detectors measures the spectral radiance of the target at 143 wavelengths with 10-wavenumber spacing. The visual and thermal bolometers integrate during the entire scan and produce one measurement per detector. This 2-second scan is called a "single length" scan.

The TES has a second operating mode in which the Michelson mirror is scanned twice as far over a 4-second period. This mode is referred to as a "double length" scan and produces 286 spectral points with 5-wavenumber spacing for each of the spectrometer detectors. During double scans the two bolometric channels integrate twice as long, but still produce only a single value per detector.

The instrument also contains software to optionally perform spectral, spatial, and temporal averaging of the spectrometer data. None of these post-processing steps are applied to the bolometric data.

The TES has a rotating pointing mirror that allows the instrument to take measurements ranging from the nadir position up to and past the planet's limb in both the fore and aft directions. Additionally, the pointing mirror can be positioned to take measurements of space and of the internal reference surfaces and lamps contained within the body of the TES instrument.

### **2.2. Data Product Overview**

The TES Standard Data Product contains the raw and calibrated thermal IR radiance spectra, the visual and thermal bolometric radiance measurements, and several atmospheric and surface properties derived from this data. Also included are the parameters that describe each observation, some downlinked diagnostic information, and the derived pointing and positional information calculated from the project's SPICE kernels.

The TES data are divided into the following 10 tables:

OBS - Observation Parameters

RAD - Raw and Calibrated Radiance Data

BOL - Bolometer Data

GEO - Derived Positional & Geometric Values

POS - Raw Positional & Geometric Data

TLM - Auxiliary Observation Parameters  
IFG - Raw Interferogram Data  
CMP - Raw Complex Data  
SRF - Derived Properties - Surface Observations  
LMB - Derived Properties - Atmospheric Limb Observations

Each table is stored in a separate file with a PDS TABLE structure (i.e., using fixed-length binary records with extensions to handle the variable length spectra). Every record is stored with the spacecraft time, and related records can be retrieved from each table using time as a common key. In some tables up to 6 records can be stored for a given time, one for each detector. In these cases these records also include a field named “detector”, that with the time field uniquely identifies the record.

Each scan of the instrument always produces the following data records:

1 record in the OBS table, 6 records in the BOL table. Because the instrument is capable of spatially and temporally averaging the spectral data, the number of records in the RAD table can vary from 0 to 6 for each scan. There are 7 spatial averaging combinations that combine together the data from different detectors. This has the net effect of reducing the number of active detectors, and consequently fewer spectra are downlinked. One RAD record is produced for each spectrum downlinked. The spatial masks are described in the DETMASK.TXT document. If temporal averaging is applied to the spectrometer data, then the averaged data are associated with the first scan. The other scans in the average contain no spectrometer data, but still have OBS and BOL records associated with them.. All other tables, with the exception of the OBS and BOL tables, also treat temporally averaged data as belonging to the first scan. Each scan (or set of scans if temporal averaging is applied) may generate the following records as well:

1 record in the IFG table,  
1 record in the CMP table,  
1 record in the TLM table.

The data contained in these tables are downlinked from the instrument only upon request.

If a scan targets the planet (as opposed to targeting space or an internal reference surface) then the following records are also generated:

6 records in the GEO table  
0 to 6 records in the SRF table

The SRF records are only generated for those scans that actually observe the planet’s surface.

## **2.3. Standards Used in Generating Data Products**

### **2.3.1. Time Standards**

The time value stored with each TES-TSDR data record is the value of the spacecraft clock at the start of the observation, truncated to an integer value. This number is equal to the number of seconds since 12:00 a.m. 1/1/1980 GMT.

### **2.3.2. Coordinate Systems**

All of the derived geometry fields that relate to longitude and latitude on the surface of Mars are computed using an areocentric coordinate system with west longitudes.

### **2.3.3 Orbit Numbers**

The attached PDS labels for TES data files include the fields START\_ORBIT\_NUMBER and STOP\_ORBIT\_NUMBER. These fields refer to the beginning and ending orbits during which the data were acquired, using the TES Team orbit numbering system, also known as the Orbit Counter Keeper (ock). During the Orbit Insertion Phase TES ock numbers and MGS Project orbit numbers were identical, except that the Project counted orbits from one periapsis to the next, while TES considered an orbit to begin at the spacecraft nameuver preceding periapsis, usually a difference of no more than twenty minutes. However, the MGS Project reset its orbit count to 1 at the beginning of the Mapping Phase. TES ock numbers were not reset, in order to preserve the unique orbit identifier. For TES data products

acquired during mapping, the MGS Project mapping orbit number can be determined by subtracting 1683 from the TES ock number. During mapping, both TES and the MGS Project consider the beginning of an orbit to occur at the descending equator crossing.

#### 2.3.4. Data Storage Conventions

All the TES-TSDR records are stored in binary form. Numerical fields are stored using the most significant byte first (MSB), and real numbers are stored using standard IEEE floating-point format. Character and string fields are space padded but not null terminated.

### 3. Detailed Data Product Specifications

Each table is stored with a PDS TABLE structure using fixed-length binary records sorted time-sequentially. Each table file is prefixed with an ASCII header that describes the contents and format of the table, and a pointer that indicates where the binary table data start. The description identifies each column in the table, detailing its name, starting position (in bytes), size (in bytes), data type, description, and scaling factors if applicable. In some cases the column being described is a fixed-length array of related, homogeneous values (such as temperatures or voltages). For that case, the column description also includes the number of items in the array and the size of each item. A typical column description follows:

|                |  |
|----------------|--|
| OBJECT         | = COLUMN   |
| NAME           | = PNT_ANGLE  |
| DATA_TYPE      | = MSB_INTEGER  |
| START_BYTE     | = 12   |
| BYTES          | = 2  |
| SCALING_FACTOR | = .046875  |
| DESCRIPTION    | = "Scan mirror pointing angle,<br>degrees from nadir." |
| END_OBJECT     | = COLUMN   |

The RAD, SRF, CMP, and IFG tables store some variable-length data. These variable length records are stored in a file separate from the fixed-length records and are addressed from the fixed-length records with a "pointer" column. Pointer columns contain the position of the variable length data, in bytes, from the start of the file in which it is listed. A position value of -1 in a pointer column indicates that there are no variable length data for that record. Additional keywords in a column's description are used to identify it as a pointer to a variable length column, and describe the data in the variable length records. These keywords are:

```
VAR_DATA_TYPE
VAR_ITEM_BYTES
VAR_RECORD_TYPE
```

The VAR\_DATA\_TYPE and VAR\_ITEM\_BYTES keywords are similar to the PDS keywords DATA\_TYPE and ITEM\_BYTES, but refer to the structure of the variable-length data. The VAR\_RECORD\_TYPE keyword identifies the overall format of the variable-length record. This keyword has two possible values:

```
VAR_RECORD_TYPE = VAX_VARIABLE_LENGTH
VAR_RECORD_TYPE = Q15
```

The value VAX\_VARIABLE\_LENGTH indicates that the variable-length record has the size of the record in bytes, as a 2-byte integer, both before and after the record. This corresponds to the VAX/VMS variable-length record format.

Figure 1 illustrates the use of variable-length records, and how they relate to the fixed-length records. In this example, the table contains 2 columns, one of which is a pointer to the variable-length records. The table shows 6 rows, but only 5 of the rows actually point to variable-length records. The fourth record contains -1 in the pointer column, indicating that there are no variable-length data for that row.

|           |                 |
|-----------|-----------------|
| OBJECT    | = COLUMN        |
| NAME      | = KEY           |
| DATA_TYPE | = ASCII_INTEGER |

|                 |                       |
|-----------------|-----------------------|
| NAME            | = VDATA               |
| DATA_TYPE       | = ASCII_INTEGER       |
| BYTES           | = 2                   |
| VAR_ITEM_BYTES  | = 1                   |
| VAR_RECORD_TYPE | = CHARACTER           |
| VAR_DATA_TYPE   | = VAX_VARIABLE_LENGTH |
| END_OBJECT      | = COLUMN              |

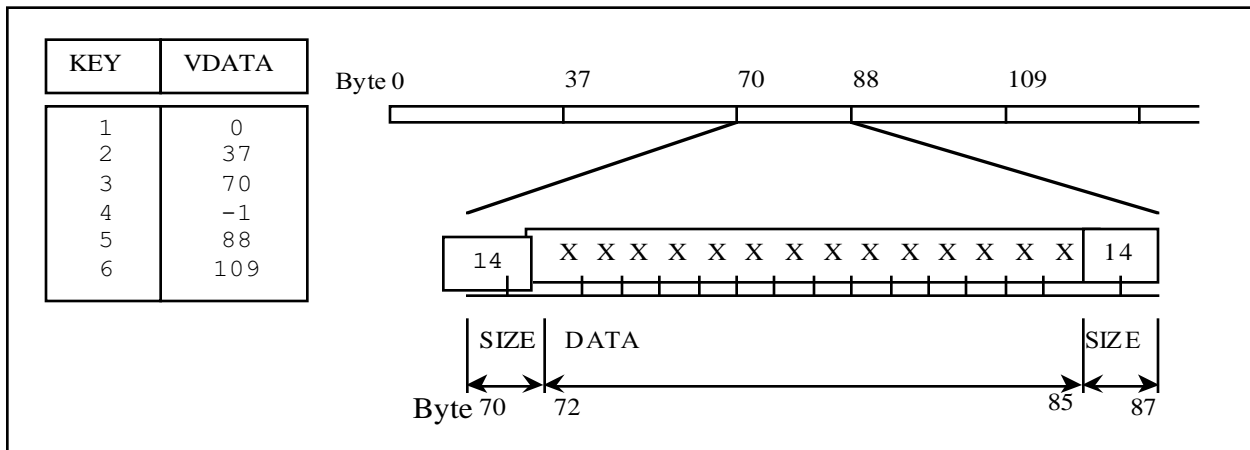


Figure 1. An example of a variable length

The Q15 format is very similar to the VAX\_VARIABLE\_LENGTH format; however it is only used to store floating point values in a compact representation. This format is an array of floating point mantissas stored as 2-byte signed integers. These mantissas share a scaling exponent that is stored as the first item in the record as another 2-byte signed integer. All the elements in the array must be scaled by the exponent, by multiplying them by 2 to the power (exp-15). Just like the VAX\_VARIABLE\_LENGTH records, the Q15 records are also stored with the size of the record in bytes, as a 2-byte integer, both before and after the record. A diagram of a complete Q15 variable length record is shown in figure 2.

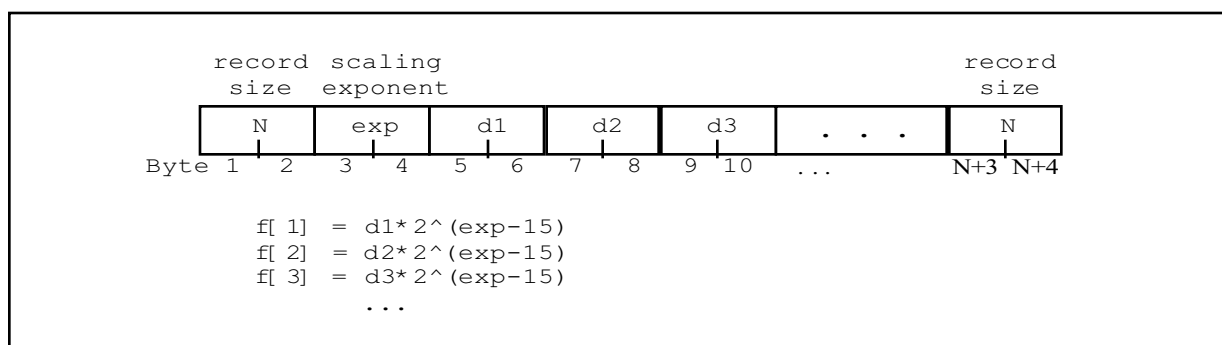


Figure 2. A Q15 record

The fixed-length records are stored in files with a .DAT extension. The variable length records that are referenced by an individual .DAT file can be found in a file with the same name, but with a .VAR extension.

### 3.1. Label and Header Descriptions

Each .DAT file is prefixed with an ASCII header in PDS 3.0 format. The format of this header consists of sets of keyword=value pairs, followed by the keyword END. A sample header is given below:

```
PDS_VERSION_ID      = PDS3
FILE_NAME            = "OBS04101.DAT"
RECORD_TYPE          = FIXED_LENGTH
RECORD_BYTES         = 39
FILE_RECORDS         = 1245
LABEL_RECORDS        = 35
TABLE                = 36
SPACECRAFT_ID        = MGS
INSTRUMENT_ID        = TES
MISSION_PHASE_NAME    = "MAPPING"
TARGET_NAME          = MARS
PRODUCT_ID           = "TES04101"
PRODUCER_ID          = MGS_TES_TEAM
DATA_SET_ID          = "MGS-M-TES-3-TSDR-V1.0"
PRODUCT_RELEASE_DATE  = 1998-08-18
PRODUCT_CREATION_TIME = 1998-08-18T17:30:00
START_TIME           = 1997-10-26T08:33:44.293
STOP_TIME            = 1997-10-29T06:43:30.274
SPACECRAFT_CLOCK_START_COUNT = 562322042
SPACECRAFT_CLOCK_STOP_COUNT = 562574628
START_ORBIT_NUMBER    = 28
```

```

STOP_ORBIT_NUMBER          = 29

OBJECT                      = TABLE
  NAME                     = OBS
  INTERCHANGE_FORMAT       = BINARY
  PRIMARY_KEYS              = ( "SPACECRAFT_CLOCK_START_COUNT",
                                "DETECTOR_NUMBER" )
  START_PRIMARY_KEY         = ( 562322042, 1 )
  STOP_PRIMARY_KEY          = ( 562574628, 6 )
  ROWS                      = 1210
  STRUCTURE                 = "OBS.FMT"
END_OBJECT                  = TABLE
END

```

The above header consists of three primary parts: a description of the whole file, a pointer to the binary table data, and a set of nested PDS objects that identify the contents and layout of the table.

The first few lines of the header describe the overall structure of the file and in this case indicate that the file consists of 1,245 fixed-length records, 39 bytes in length. These lines include the entire ASCII header which is padded with white space to occupy an integral number of records of this length.

The keyword TABLE is a pointer to the start of the binary data. The number given with this keyword is the record number of the start of the table data. In this case the record number is 36, which starts at byte 1404 counting from byte zero (35 records \* 39 bytes/record).

The remainder of the header identifies the origin of the data and describes the table contained in the file. The data are identified by the time they were acquired, as shown in the SPACECRAFT\_CLOCK\_START\_TIME and SPACECRAFT\_CLOCK\_STOP\_TIME keywords which contain the time on the first and last record in the file, respectively. These times are also given as UTC time strings in the START\_TIME and STOP\_TIME fields

The columns within the table are specified as a collection of PDS COLUMN objects. A sample column definition follows:

```

OBJECT                      = COLUMN
  NAME                     = POINTING_MIRROR_ANGLE
  ALIAS_NAME               = PNT_ANGLE
  DATA_TYPE               = MSB_INTEGER
  START_BYTE               = 10
  BYTES                    = 2
  SCALING_FACTOR           = .046875
  DESCRIPTION              = "Scan mirror pointing angle,
                              degrees from nadir."
END_OBJECT                  = COLUMN

```

The column definitions give the name, type, and size of every field in the table. In the case of this field, "pnt\_angle", a scaling factor is also given to convert from the stored value to useful units. A scaling offset may also be included, but if not included, should be assumed to be zero. Scaling factors and offsets should be applied as follows:

$$\text{scaled\_value} = (\text{stored\_value} * \text{scaling\_factor}) + \text{scaling\_offset}$$

Descriptions are provided for every column as well. These descriptions are surrounded by quotes and may span several lines. In the case of a fixed-length array, the BYTES term indicates the size of the array, and the two fields ITEMS and ITEM\_SIZE are included to describe the number and size of a single element in the array.

This following column description indicates the column "interferogram\_maximum" and is a homogeneous array of 6, 2-byte integers.

```

OBJECT                      = COLUMN
  NAME                     = INTERFEROGRAM_MAXIMUM
  DATA_TYPE               = MSB_INTEGER

```



|                |   |
|----------------|---|
| START_BYTE     | = 29  |
| BYTES          | = 12  |
| ITEMS          | = 6   |
| ITEM_BYTES     | = 2   |
| SCALING_FACTOR | = .000152587890625                          |
| DESCRIPTION    | = "Array of 6 interferogram maximum values" |
| END_OBJECT     | = COLUMN                                    |

## **4. Applicable Software**

### **4.1. Utility Programs**

The TES project has produced a software tool that not only reads the PDS table and the variable-length records, but is also capable of joining the related records among multiple tables. This piece of software is called 'vanilla' and is included on every volume. In addition the software is available via anonymous ftp from <ftp://east.la.asu.edu/pub/software/vanilla/vanilla.tar.Z>.

The vanilla program was developed for use on UNIX machines with integers in MSB\_INTEGER format, and for PCs.

### **4.2. Applicable PDS Software Tools**

The TES team uses no PDS software to view, manipulate or process the data. However, the tables are stored using the PDS TABLE standard structure and any tool that understands that structure should be able to read all of the data except the variable-length spectra.

## A. Appendices

### A.1 TLM Table

|             |       |
|-------------|-------|
| NAME        | = TLM |
| COLUMNS     | = 31  |
| ROW_BYTES   | = 113 |
| DESCRIPTION | = “   |

The TLM table stores the auxiliary observation parameters downlinked with the long packet format (see OBS Table, DATA\_PACKET\_TYPE). Records in the TLM table occur at a frequency less than or equal to the frequency of OBS records; that is, one (or none) per observation.”

|             |   |
|-------------|---|
| OBJECT      | = COLUMN  |
| NAME        | = SPACECRAFT_CLOCK_START_COUNT  |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER  |
| START_BYTE  | = 1   |
| BYTES       | = 4   |
| ALIAS_NAME  | = sclk_time   |
| DESCRIPTION | = “The value of the spacecraft clock at the beginning of the observation” |
| END_OBJECT  | = COLUMN  |

|                |  |
|----------------|--|
| OBJECT         | = COLUMN   |
| NAME           | = AUXILIARY_DIAGNOSTIC_TEMPS   |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER   |
| START_BYTE     | = 5  |
| BYTES          | = 24   |
| ITEMS          | = 12   |
| ITEM_BYTES     | = 2  |
| SCALING_FACTOR | = 0.01   |
| ALIAS_NAME     | = aux_temps  |
| DESCRIPTION    | = “Array of 12 auxiliary temperatures,<br>Read from internal instrument thermistors.<br>1: T5 - Black Body 1<br>2: T6 - Black Body 2<br>3: T7 - Black Body 3<br>4: T8 - Bolometric Black Body Reference (spare)<br>5: T9 - Electronics<br>: T10 - Power Supply<br>7: T11 - Telescope Field Stop<br>8: T12 - Interferometer Fixed Mirror<br>9: T13 - Interferometer Beamsplitter<br>10: T14 - Interferometer Motor<br>11: T15 - Primary Mirror<br>12: T16 - Secondary Mirror” |
| UNIT           | = “K”  |
| END_OBJECT     | = COLUMN   |

|        |          |
|--------|----------|
| OBJECT | = COLUMN |
|--------|----------|

|                |   |
|----------------|---|
| NAME           | = INTERFEROGRAM_MAXIMUM   |
| DATA_TYPE      | = MSB_INTEGER   |
| START_BYTE     | = 29  |
| BYTES          | = 12  |
| ITEMS          | = 6   |
| ITEM_BYTES     | = 2   |
| SCALING_FACTOR | = 0.000152587890625   |
| ALIAS_NAME     | = ifgm_max  |
| DESCRIPTION    | = "Array of 6 interferogram maximum values,<br>one for each spectrometer detector.<br>Scaling factor is 5.0/32768 V"                      |
| UNIT           | = "VOLTS"   |
| END_OBJECT     | = COLUMN  |
| OBJECT         | = COLUMN  |
| NAME           | = INTERFEROGRAM_MINIMUM   |
| DATA_TYPE      | = MSB_INTEGER   |
| START_BYTE     | = 41  |
| BYTES          | = 12  |
| ITEMS          | = 6   |
| ITEM_BYTES     | = 2   |
| SCALING_FACTOR | = 0.000152587890625   |
| ALIAS_NAME     | = ifgm_min  |
| DESCRIPTION    | = "Array of 6 interferogram minimum values,<br>one for each spectrometer detector.<br>Scaling factor is 5.0/32768 V"                      |
| UNIT           | = "VOLTS"   |
| END_OBJECT     | = COLUMN  |
| OBJECT         | = COLUMN  |
| NAME           | = ONBOARD_PROCESSING_EVENT_LOG  |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER  |
| START_BYTE     | = 53  |
| BYTES          | = 12  |
| ITEMS          | = 6   |
| ITEM_BYTES     | = 2   |
| ALIAS_NAME     | = dsp_log   |
| DESCRIPTION    | = "Array of digital signal processor event logs,<br>16-bit mask, one for each spectrometer detector.<br>See TES User's Guide for details" |
| END_OBJECT     | = COLUMN  |
| OBJECT         | = COLUMN  |
| NAME           | = DIAGNOSTIC_TELEMETRY_1  |
| DATA_TYPE      | = MSB_INTEGER   |
| START_BYTE     | = 65  |
| BYTES          | = 1   |
| SCALING_FACTOR | = 3.90625   |
| ALIAS_NAME     | = V1  |
| DESCRIPTION    | = "Electronic power supply load current"  |
| UNIT           | = "mA"  |
| END_OBJECT     | = COLUMN  |
| OBJECT         | = COLUMN  |
| NAME           | = DIAGNOSTIC_TELEMETRY_2  |
| DATA_TYPE      | = MSB_INTEGER   |
| START_BYTE     | = 66  |

```

        BYTES                = 1
        SCALING_FACTOR       = 1.95312
        ALIAS_NAME           = V2
        DESCRIPTION          = "Mechanic power supply load current"
        UNIT                 = "mA"
    END_OBJECT              = COLUMN

```

```

OBJECT                = COLUMN
    NAME              = DIAGNOSTIC_TELEMETRY_3
    DATA_TYPE        = MSB_INTEGER
    START_BYTE        = 67
    BYTES              = 1
    SCALING_FACTOR     = 0.278906
    ALIAS_NAME         = V3
    DESCRIPTION        = "Diagnostic voltage P26V2.
+26v: Pointing mirror motor."
    UNIT              = "VOLTS"
END_OBJECT            = COLUMN

```

```

OBJECT                = COLUMN
    NAME              = DIAGNOSTIC_TELEMETRY_4
    DATA_TYPE        = MSB_INTEGER
    START_BYTE        = 68
    BYTES              = 1
    SCALING_FACTOR     = 0.278906
    ALIAS_NAME         = V4
    DESCRIPTION        = "Diagnostic voltage P28V2.
+28v: Interferometer motor."
    UNIT              = "VOLTS"
END_OBJECT            = COLUMN

```

```

OBJECT                = COLUMN
    NAME              = DIAGNOSTIC_TELEMETRY_5
    DATA_TYPE        = MSB_INTEGER
    START_BYTE        = 69
    BYTES              = 1
    SCALING_FACTOR     = 4.45312
    OFFSET             = -17.00000
    ALIAS_NAME         = V5
    DESCRIPTION        = "Pointing mirror motor current"
    UNIT              = "mA"
END_OBJECT            = COLUMN

```

```

OBJECT                = COLUMN
    NAME              = DIAGNOSTIC_TELEMETRY_6
    DATA_TYPE        = MSB_INTEGER
    START_BYTE        = 70
    BYTES              = 1
    SCALING_FACTOR     = 0.652344
    ALIAS_NAME         = V6
    DESCRIPTION        = "Interferometer motor current"
    UNIT              = "mA"
END_OBJECT            = COLUMN

```

```

OBJECT                = COLUMN
    NAME              = DIAGNOSTIC_TELEMETRY_7
    DATA_TYPE        = MSB_INTEGER

```

|                |   |
|----------------|---|
| START_BYTE     | = 71  |
| BYTES          | = 1   |
| SCALING_FACTOR | = 0.119457  |
| ALIAS_NAME     | = V7  |
| DESCRIPTION    | = "Diagnostic voltage P10V1.<br>+10v: Servo Electronics"  |
| UNIT           | = "VOLTS"   |
| END_OBJECT     | = COLUMN  |
| OBJECT         | = COLUMN  |
| NAME           | = DIAGNOSTIC_TELEMETRY_8                                  |
| DATA_TYPE      | = MSB_INTEGER   |
| START_BYTE     | = 72  |
| BYTES          | = 1   |
| SCALING_FACTOR | = -0.103067   |
| ALIAS_NAME     | = V8  |
| DESCRIPTION    | = "Diagnostic voltage N10V1.<br>-10v: Servo Electronics"  |
| UNIT           | = "VOLTS"   |
| END_OBJECT     | = COLUMN  |
| OBJECT         | = COLUMN  |
| NAME           | = DIAGNOSTIC_TELEMETRY_9                                  |
| DATA_TYPE      | = MSB_INTEGER   |
| START_BYTE     | = 73  |
| BYTES          | = 1   |
| SCALING_FACTOR | = 0.15576   |
| ALIAS_NAME     | = V9  |
| DESCRIPTION    | = "Diagnostic voltage P16V1.<br>+16v: Analog MUX and A/D" |
| UNIT           | = "VOLTS"   |
| END_OBJECT     | = COLUMN  |
| OBJECT         | = COLUMN  |
| NAME           | = DIAGNOSTIC_TELEMETRY_10                                 |
| DATA_TYPE      | = MSB_INTEGER   |
| START_BYTE     | = 74  |
| BYTES          | = 1   |
| SCALING_FACTOR | = -0.15625  |
| ALIAS_NAME     | = V10   |
| DESCRIPTION    | = "Diagnostic voltage N16V1.<br>-16v: Analog MUX and A/D" |
| UNIT           | = "VOLTS"   |
| END_OBJECT     | = COLUMN  |
| OBJECT         | = COLUMN  |
| NAME           | = DIAGNOSTIC_TELEMETRY_11                                 |
| DATA_TYPE      | = MSB_INTEGER   |
| START_BYTE     | = 75  |
| BYTES          | = 1   |
| SCALING_FACTOR | = 0.0976055   |
| ALIAS_NAME     | = V11   |
| DESCRIPTION    | = "Diagnostic voltage P10V2.<br>+10v: Heaters"            |
| UNIT           | = "VOLTS"   |
| END_OBJECT     | = COLUMN  |

|                |  |
|----------------|--|
| OBJECT         | = COLUMN   |
| NAME           | = DIAGNOSTIC_TELEMETRY_12                                      |
| DATA_TYPE      | = MSB_INTEGER  |
| START_BYTE     | = 76   |
| BYTES          | = 1  |
| SCALING_FACTOR | = -0.0985813   |
| ALIAS_NAME     | = V12  |
| DESCRIPTION    | = "Diagnostic voltage N10V2.<br>-10v: Heaters"                 |
| UNIT           | = "VOLTS"  |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = DIAGNOSTIC_TELEMETRY_13                                      |
| DATA_TYPE      | = MSB_INTEGER  |
| START_BYTE     | = 77   |
| BYTES          | = 1  |
| SCALING_FACTOR | = 0.976562   |
| ALIAS_NAME     | = V13  |
| DESCRIPTION    | = "Albedo Calibration Lamps current"                           |
| UNIT           | = "mA"   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = DIAGNOSTIC_TELEMETRY_14                                      |
| DATA_TYPE      | = MSB_INTEGER  |
| START_BYTE     | = 78   |
| BYTES          | = 1  |
| SCALING_FACTOR | = 0.0648437  |
| ALIAS_NAME     | = V14  |
| DESCRIPTION    | = "Neon lamps current"   |
| UNIT           | = "mA"   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = DIAGNOSTIC_TELEMETRY_15                                      |
| DATA_TYPE      | = MSB_INTEGER  |
| START_BYTE     | = 79   |
| BYTES          | = 1  |
| SCALING_FACTOR | = 0.045727   |
| ALIAS_NAME     | = V15  |
| DESCRIPTION    | = "Diagnostic voltage P5V1.<br>+5v: Servo electronics and DSP" |
| UNIT           | = "VOLTS"  |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = DIAGNOSTIC_TELEMETRY_16                                      |
| DATA_TYPE      | = MSB_INTEGER  |
| START_BYTE     | = 80   |
| BYTES          | = 1  |
| SCALING_FACTOR | = 0.0480992  |
| ALIAS_NAME     | = V16  |
| DESCRIPTION    | = "Diagnostic voltage P5V2.<br>Control processor and BIU."     |
| UNIT           | = "VOLTS"  |
| END_OBJECT     | = COLUMN   |

|                |  |
|----------------|--|
| OBJECT         | = COLUMN   |
| NAME           | = DIAGNOSTIC_TELEMETRY_17  |
| DATA_TYPE      | = MSB_INTEGER  |
| START_BYTE     | = 81   |
| BYTES          | = 1  |
| SCALING_FACTOR | = 0.0478277  |
| ALIAS_NAME     | = V17  |
| DESCRIPTION    | = "Diagnostic voltage P5V3.<br>+5v: Analog MUX, A/D, Timing sequencer" |
| UNIT           | = "VOLTS"  |
| END_OBJECT     | = COLUMN   |

|                |   |
|----------------|---|
| OBJECT         | = COLUMN  |
| NAME           | = DIAGNOSTIC_TELEMETRY_18                                   |
| DATA_TYPE      | = MSB_INTEGER   |
| START_BYTE     | = 82  |
| BYTES          | = 1   |
| SCALING_FACTOR | = 0.0488039   |
| ALIAS_NAME     | = V18   |
| DESCRIPTION    | = "Diagnostic voltage P5V4.<br>+5v: Fringe and ZPD circuit" |
| UNIT           | = "VOLTS"   |
| END_OBJECT     | = COLUMN  |

|                |  |
|----------------|--|
| OBJECT         | = COLUMN   |
| NAME           | = DIAGNOSTIC_TELEMETRY_19                        |
| DATA_TYPE      | = MSB_INTEGER                                    |
| START_BYTE     | = 83   |
| BYTES          | = 1  |
| SCALING_FACTOR | = 0.141966                                       |
| ALIAS_NAME     | = V19  |
| DESCRIPTION    | = "Diagnostic voltage P15V1.<br>+15v Amplifiers" |
| UNIT           | = "VOLTS"  |
| END_OBJECT     | = COLUMN   |

|                |  |
|----------------|--|
| OBJECT         | = COLUMN   |
| NAME           | = DIAGNOSTIC_TELEMETRY_20                        |
| DATA_TYPE      | = MSB_INTEGER                                    |
| START_BYTE     | = 84   |
| BYTES          | = 1  |
| SCALING_FACTOR | = -0.149688                                      |
| ALIAS_NAME     | = V20  |
| DESCRIPTION    | = "Diagnostic voltage N15V1.<br>-15v Amplifiers" |
| UNIT           | = "VOLTS"  |
| END_OBJECT     | = COLUMN   |

|             |  |
|-------------|--|
| OBJECT      | = COLUMN   |
| NAME        | = NEON_LAMP  |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER   |
| START_BYTE  | = 85   |
| BYTES       | = 1  |
| ALIAS_NAME  | = neon_lamp  |
| DESCRIPTION | = "Control interferometer neon lamp in use,<br>primary (1) or backup(2)" |

|             |  |
|-------------|--|
| END_OBJECT  | = COLUMN   |
| OBJECT      | = COLUMN   |
| NAME        | = NEON_GAIN  |
| DATA_TYPE   | = CHARACTER  |
| START_BYTE  | = 86   |
| BYTES       | = 1  |
| ALIAS_NAME  | = neon_gain  |
| DESCRIPTION | = "Control interferometer neon lamp gain,<br>(L)ow or (H)igh"  |
| END_OBJECT  | = COLUMN   |
| OBJECT      | = COLUMN   |
| NAME        | = NEON_AMPLITUDE   |
| DATA_TYPE   | = MSB_INTEGER  |
| START_BYTE  | = 87   |
| BYTES       | = 1  |
| ALIAS_NAME  | = neon_amp   |
| DESCRIPTION | = "Control interferogram signal amplitude at zero<br>path difference (zpd)"                            |
| END_OBJECT  | = COLUMN   |
| OBJECT      | = COLUMN   |
| NAME        | = NEON_ZPD   |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER   |
| START_BYTE  | = 88   |
| BYTES       | = 2  |
| ALIAS_NAME  | = neon_zpd   |
| DESCRIPTION | = "Control interferogram zero path difference (zpd)<br>location measured in counts from start of scan" |
| END_OBJECT  | = COLUMN   |
| OBJECT      | = COLUMN   |
| NAME        | = INTERFEROGRAM_ZPD  |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER   |
| START_BYTE  | = 90   |
| BYTES       | = 12   |
| ITEMS       | = 6  |
| ITEM_BYTES  | = 2  |
| ALIAS_NAME  | = ifgm_zpd   |
| DESCRIPTION | = "IR interferogram zero path difference (zpd) location<br>measured from start of scan"                |
| END_OBJECT  | = COLUMN   |
| OBJECT      | = COLUMN   |
| NAME        | = INTERFEROGRAM_END  |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER   |
| START_BYTE  | = 102  |
| BYTES       | = 12   |
| ITEMS       | = 6  |
| ITEM_BYTES  | = 2  |
| ALIAS_NAME  | = ifgm_end   |
| DESCRIPTION | = "Number of extra counts at end of each IR<br>interferogram"  |
| END_OBJECT  | = COLUMN   |



## A.2 BOL Table

|             |       |
|-------------|-------|
| NAME        | = BOL |
| COLUMNS     | = 10  |
| ROW_BYTES   | = 28  |
| DESCRIPTION | = “   |

The BOL table contains the raw and calibrated visual and thermal bolometer measurements, and several properties derived from these measurements.

Six BOL records are generated for each instrument scan, one for each detector. When spectrometer data are temporally averaged, there can be up to 4 scans of bolometer data.”

|             |   |
|-------------|---|
| OBJECT      | = COLUMN  |
| NAME        | = SPACECRAFT_CLOCK_START_COUNT  |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER  |
| START_BYTE  | = 1   |
| BYTES       | = 4   |
| ALIAS_NAME  | = sclk_time   |
| DESCRIPTION | = “The value of the spacecraft clock at the beginning of the observation” |
| END_OBJECT  | = COLUMN  |

|             |  |
|-------------|--|
| OBJECT      | = COLUMN   |
| NAME        | = DETECTOR_NUMBER  |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER   |
| START_BYTE  | = 5  |
| BYTES       | = 1  |
| ALIAS_NAME  | = detector   |
| DESCRIPTION | = “The number of the detector that made the observation. Detectors are numbered from 1 to 6” |
| END_OBJECT  | = COLUMN   |

|             |  |
|-------------|--|
| OBJECT      | = COLUMN   |
| NAME        | = TEMPORAL_INTEGRATION_SCAN_NUMBER                                   |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER   |
| START_BYTE  | = 6  |
| BYTES       | = 1  |
| ALIAS_NAME  | = tic_count  |
| DESCRIPTION | = “The number of the scan from the set of temporally averaged scans” |
| END_OBJECT  | = COLUMN   |

|                |   |
|----------------|---|
| OBJECT         | = COLUMN                                    |
| NAME           | = RAW_VISUAL_BOLOMETER                      |
| DATA_TYPE      | = MSB_INTEGER                               |
| START_BYTE     | = 7   |
| BYTES          | = 2   |
| SCALING_FACTOR | = .000152587890625                          |
| ALIAS_NAME     | = vbol                                      |
| DESCRIPTION    | = “Raw visual bolometer data, per detector. |

|                |  |
|----------------|--|
| UNIT           | Scaling factor is $5.0/2^{15}$ .   |
| END_OBJECT     | = "VOLTS"  |
|                | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = RAW_THERMAL_BOLOMETER  |
| DATA_TYPE      | = MSB_INTEGER  |
| START_BYTE     | = 9  |
| BYTES          | = 2  |
| SCALING_FACTOR | = .000152587890625   |
| ALIAS_NAME     | = tbol   |
| DESCRIPTION    | = "Raw thermal bolometer data, per detector,<br>Scaling factor is $5.0/2^{15}$ ."                      |
| UNIT           | = "VOLTS"  |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = CALIBRATED_VISUAL_BOLOMETER  |
| DATA_TYPE      | = IEEE_REAL  |
| START_BYTE     | = 11   |
| BYTES          | = 4  |
| ALIAS_NAME     | = cal_vbol   |
| DESCRIPTION    | = "Calibrated visual bolometric radiance."   |
| UNIT           | = "watt cm-2 stradian-1 micron-1"  |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = LAMBERT_ALBEDO   |
| DATA_TYPE      | = IEEE_REAL  |
| START_BYTE     | = 15   |
| BYTES          | = 4  |
| ALIAS_NAME     | = lambert_alb  |
| DESCRIPTION    | = "Lambertian albedo, derived from visual bolometer"   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = BOLOMETRIC_THERMAL_INERTIA   |
| DATA_TYPE      | = IEEE_REAL  |
| START_BYTE     | = 19   |
| BYTES          | = 4  |
| ALIAS_NAME     | = ti_bol   |
| DESCRIPTION    | = "Thermal inertia, derived from thermal bolometer"  |
| UNIT           | = "J m-2 s-1/2 K-1"  |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = BOLOMETRIC_BRIGHTNESS_TEMP   |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER   |
| START_BYTE     | = 23   |
| BYTES          | = 2  |
| SCALING_FACTOR | = 0.01   |
| ALIAS_NAME     | = brightness_temp_bol  |
| DESCRIPTION    | = "Temperature observed by the thermal bolometer,<br>assuming the target is radiating as a black body" |
| UNIT           | = "K"  |
| END_OBJECT     | = COLUMN   |

|             |   |
|-------------|---|
| OBJECT      | = COLUMN  |
| NAME        | = BOLOMETER_CALIBRATION_ID                              |
| DATA_TYPE   | = CHARACTER   |
| START_BYTE  | = 25  |
| BYTES       | = 4   |
| ALIAS_NAME  | = version_id  |
| DESCRIPTION | = "Calibration algorithm version ID for bolometer data" |
| END_OBJECT  | = COLUMN  |

### A.3 CMP Table

|             |       |
|-------------|-------|
| NAME        | = CMP |
| COLUMNS     | = 3   |
| ROW_BYTES   | = 9   |
| DESCRIPTION | = “   |

The CMP table contains the real and complex data from the FFT.  
The complex data is only downlinked when requested and can only be requested for a single detector per observation.

The CMP array contains 286 points (143 real, 143 complex) for a short scan (OBS Table, SCAN\_LENGTH = 1), and 572 points (286 real, 286 complex) for a long scan (OBS Table, SCAN\_LENGTH = 2).”

|             |   |
|-------------|---|
| OBJECT      | = COLUMN  |
| NAME        | = SPACECRAFT_CLOCK_START_COUNT  |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER  |
| START_BYTE  | = 1   |
| BYTES       | = 4   |
| ALIAS_NAME  | = sclk_time   |
| DESCRIPTION | = “The value of the spacecraft clock at the beginning of the observation” |
| END_OBJECT  | = COLUMN  |

|             |   |
|-------------|---|
| OBJECT      | = COLUMN  |
| NAME        | = DETECTOR_NUMBER   |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER  |
| START_BYTE  | = 5   |
| BYTES       | = 1   |
| ALIAS_NAME  | = detector  |
| DESCRIPTION | = “The number of the spectrometer detector that made the observation. Detectors are numbered from 1 to 6” |
| END_OBJECT  | = COLUMN  |

|                 |  |
|-----------------|--|
| OBJECT          | = COLUMN   |
| NAME            | = FFT_COMPLEX_DATA   |
| DATA_TYPE       | = MSB_UNSIGNED_INTEGER   |
| START_BYTE      | = 6  |
| BYTES           | = 4  |
| VAR_DATA_TYPE   | = MSB_INTEGER  |
| VAR_ITEM_BYTES  | = 2  |
| VAR_RECORD_TYPE | = Q15  |
| ALIAS_NAME      | = complex  |
| DESCRIPTION     | = “The real and imaginary parts of the FFT. This column is the pointer to the data.” |
| UNIT            | = “Transformed Volts”  |
| END_OBJECT      | = COLUMN   |

#### A.4 GEO Table

|             |       |
|-------------|-------|
| NAME        | = GEO |
| COLUMNS     | = 20  |
| ROW_BYTES   | = 43  |
| DESCRIPTION | = “   |

The GEO table contains information about the sun/spacecraft/target geometry in a format that is easily searchable. These values are computed for every scan other than those used to calibrate the instrument. If a viewing vector does not intersect the target body (i.e., an atmospheric observation), then most of the geometry is calculated relative to the point on the viewing vector closest to the body (i.e., the tangent point). If the closest point lies behind the spacecraft, fill values are used.”

|             |   |
|-------------|---|
| OBJECT      | = COLUMN  |
| NAME        | = SPACECRAFT_CLOCK_START_COUNT  |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER  |
| START_BYTE  | = 1   |
| BYTES       | = 4   |
| ALIAS_NAME  | = sclk_time   |
| DESCRIPTION | = “The value of the spacecraft clock at the beginning of the observation” |
| END_OBJECT  | = COLUMN  |

|             |   |
|-------------|---|
| OBJECT      | = COLUMN  |
| NAME        | = DETECTOR_NUMBER   |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER  |
| START_BYTE  | = 5   |
| BYTES       | = 1   |
| ALIAS_NAME  | = detector  |
| DESCRIPTION | = “The number of the spectrometer detector that made the observation. Detectors are numbered from 1 to 6” |
| END_OBJECT  | = COLUMN  |

|                |  |
|----------------|--|
| OBJECT         | = COLUMN                                       |
| NAME           | = LONGITUDE                                    |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER                         |
| START_BYTE     | = 6  |
| BYTES          | = 2  |
| SCALING_FACTOR | = 0.01   |
| DESCRIPTION    | = “Areocentric west longitude of target point” |
| UNIT           | = “DEGREE”                                     |
| END_OBJECT     | = COLUMN                                       |

|                |  |
|----------------|--|
| OBJECT         | = COLUMN                                 |
| NAME           | = LATITUDE                               |
| DATA_TYPE      | = MSB_INTEGER                            |
| START_BYTE     | = 8                                      |
| BYTES          | = 2                                      |
| SCALING_FACTOR | = 0.01                                   |
| DESCRIPTION    | = “Areocentric latitude of target point” |

|                |  |
|----------------|--|
| UNIT           | = "DEGREE"   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = PHASE_ANGLE  |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER   |
| START_BYTE     | = 10   |
| BYTES          | = 2  |
| SCALING_FACTOR | = 0.01   |
| ALIAS_NAME     | = phase  |
| DESCRIPTION    | = "Angle between the spacecraft, the target point and the sun"                                 |
| UNIT           | = "DEGREE"   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = EMISSION_ANGLE   |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER   |
| START_BYTE     | = 12   |
| BYTES          | = 2  |
| SCALING_FACTOR | = 0.01   |
| ALIAS_NAME     | = emission   |
| DESCRIPTION    | = "Angle between the spacecraft, the target point and the surface normal vector at the target" |
| UNIT           | = "DEGREE"   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = INCIDENCE_ANGLE  |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER   |
| START_BYTE     | = 14   |
| BYTES          | = 2  |
| SCALING_FACTOR | = 0.01   |
| ALIAS_NAME     | = incidence  |
| DESCRIPTION    | = "Angle between the sun, the target point and the surface normal vector at the target"        |
| UNIT           | = "DEGREE"   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = PLANETARY_PHASE_ANGLE  |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER   |
| START_BYTE     | = 16   |
| BYTES          | = 2  |
| SCALING_FACTOR | = 0.01   |
| ALIAS_NAME     | = planetary_phase  |
| DESCRIPTION    | = "Angle between the spacecraft, the center of the target body and the sun"                    |
| UNIT           | = "DEGREE"   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = SOLAR_LONGITUDE  |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER   |
| START_BYTE     | = 18   |
| BYTES          | = 2  |
| SCALING_FACTOR | = 0.01   |

|                |  |
|----------------|--|
| DESCRIPTION    | = "Planetocentric longitude of the sun"                |
| UNIT           | = "DEGREE"   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = SUB_SPACECRAFT_LONGITUDE                             |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER                                 |
| START_BYTE     | = 20   |
| BYTES          | = 2  |
| SCALING_FACTOR | = 0.01   |
| ALIAS_NAME     | = sub_sc_lon   |
| DESCRIPTION    | = "Areocentric west longitude of sub-spacecraft point" |
| UNIT           | = "DEGREE"   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = SUB_SPACECRAFT_LATITUDE                              |
| DATA_TYPE      | = MSB_INTEGER  |
| START_BYTE     | = 22   |
| BYTES          | = 2  |
| SCALING_FACTOR | = 0.01   |
| ALIAS_NAME     | = sub_sc_lat   |
| DESCRIPTION    | = "Areocentric latitude of sub-spacecraft point"       |
| UNIT           | = "DEGREE"   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = SUB_SOLAR_LONGITUDE                                  |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER                                 |
| START_BYTE     | = 24   |
| BYTES          | = 2  |
| SCALING_FACTOR | = 0.01   |
| ALIAS_NAME     | = sub_solar_lon  |
| DESCRIPTION    | = "Areocentric west longitude of the sub-solar point"  |
| UNIT           | = "DEGREE"   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = SUB_SOLAR_LATITUDE                                   |
| DATA_TYPE      | = MSB_INTEGER  |
| START_BYTE     | = 26   |
| BYTES          | = 2  |
| SCALING_FACTOR | = 0.01   |
| ALIAS_NAME     | = sub_solar_lat  |
| DESCRIPTION    | = "Areocentric latitude of the sub-solar point"        |
| UNIT           | = "DEGREE"   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = TARGET_DISTANCE                                      |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER                                 |
| START_BYTE     | = 28   |
| BYTES          | = 2  |
| DESCRIPTION    | = "Distance from the spacecraft to the target point"   |
| UNIT           | = "KM"   |
| END_OBJECT     | = COLUMN   |

|                |  |
|----------------|--|
| OBJECT         | = COLUMN   |
| NAME           | = TARGET_ALTITUDE  |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER   |
| START_BYTE     | = 30   |
| BYTES          | = 2  |
| SCALING_FACTOR | = 0.01   |
| ALIAS_NAME     | = height   |
| DESCRIPTION    | = "Distance from the surface to the target point.<br>This value is non-zero only for atmospheric<br>targets" |
| UNIT           | = "KM"   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = SPACECRAFT_ALTITUDE  |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER   |
| START_BYTE     | = 32   |
| BYTES          | = 2  |
| ALIAS_NAME     | = altitude   |
| DESCRIPTION    | = "Distance from the spacecraft to the sub-spacecraft<br>point on the surface"                               |
| UNIT           | = "KM"   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = LOCAL_TIME   |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER   |
| START_BYTE     | = 34   |
| BYTES          | = 2  |
| SCALING_FACTOR | = 0.001  |
| DESCRIPTION    | = "Local time at target, in decimal Martian hours.<br>The Martian day is divided into 24 equal hours."       |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = SOLAR_DISTANCE   |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER   |
| START_BYTE     | = 36   |
| BYTES          | = 2  |
| SCALING_FACTOR | = 10000  |
| DESCRIPTION    | = "Distance from the center of the sun to the center<br>of the target body"                                  |
| UNIT           | = "KM"   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = PLANETARY_ANGULAR_RADIUS   |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER   |
| START_BYTE     | = 38   |
| BYTES          | = 2  |
| SCALING_FACTOR | = 0.01   |
| ALIAS_NAME     | = angular_semidiometer   |
| DESCRIPTION    | = "Smallest angular radius of Mars as viewed from<br>the spacecraft."  |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |



|             |   |
|-------------|---|
| NAME        | = GEOMETRY_CALIBRATION_ID                 |
| DATA_TYPE   | = CHARACTER                               |
| START_BYTE  | = 40                                      |
| BYTES       | = 4                                       |
| ALIAS_NAME  | = version_id                              |
| DESCRIPTION | = “Version ID of geometry algorithm used” |
| END_OBJECT  | = COLUMN                                  |

## A.5 IFG Table

|             |       |
|-------------|-------|
| NAME        | = IFG |
| COLUMNS     | = 3   |
| ROW_BYTES   | = 9   |
| DESCRIPTION | = “   |

The IFG table contains the raw interferogram data. The interferogram data is only downlinked when requested and can only be requested for a single detector per observation.

The IFG array contains 1600 points for a short scan (OBS Table, SCAN\_LENGTH = 1), and 3200 points for a long scan (OBS Table, SCAN\_LENGTH = 2).”

|             |   |
|-------------|---|
| OBJECT      | = COLUMN  |
| NAME        | = SPACECRAFT_CLOCK_START_COUNT  |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER  |
| START_BYTE  | = 1   |
| BYTES       | = 4   |
| ALIAS_NAME  | = sclk_time   |
| DESCRIPTION | = “The value of the spacecraft clock at the beginning of the observation” |
| END_OBJECT  | = COLUMN  |

|             |   |
|-------------|---|
| OBJECT      | = COLUMN  |
| NAME        | = DETECTOR_NUMBER   |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER  |
| START_BYTE  | = 5   |
| BYTES       | = 1   |
| ALIAS_NAME  | = detector  |
| DESCRIPTION | = “The number of the spectrometer detector that made the observation. Detectors are numbered from 1 to 6” |
| END_OBJECT  | = COLUMN  |

|                 |                            |
|-----------------|----------------------------|
| OBJECT          | = COLUMN                   |
| NAME            | = INTERFEROGRAM_DATA       |
| DATA_TYPE       | = MSB_UNSIGNED_INTEGER     |
| START_BYTE      | = 6                        |
| BYTES           | = 4                        |
| VAR_DATA_TYPE   | = MSB_INTEGER              |
| VAR_ITEM_BYTES  | = 2                        |
| VAR_RECORD_TYPE | = Q15                      |
| ALIAS_NAME      | = ifgm                     |
| DESCRIPTION     | = “Raw interferogram data” |
| UNIT            | = “VOLTS”                  |
| END_OBJECT      | = COLUMN                   |

## A.6 LMB Table

|             |        |
|-------------|--------|
| NAME        | = LMB  |
| COLUMNS     | = 8    |
| ROW_BYTES   | = 1592 |
| DESCRIPTION | = “    |

The LMB table contains values derived from spectra that look at the limb of Mars. It contains one record for each limb set - sequential observations that view the limb at different altitudes. See the limb parameters quality word for information on the validity of calculated variables. The aerosol information may include data from surface observations taken at other times of the same geographic location.

The uncertainty array provides error information for surface radiance spectrum values taken near the same time.”

|             |   |
|-------------|---|
| OBJECT      | = COLUMN  |
| NAME        | = SPACECRAFT_CLOCK_START_COUNT  |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER  |
| START_BYTE  | = 1   |
| BYTES       | = 4   |
| ALIAS_NAME  | = sclk_time   |
| DESCRIPTION | = “The value of the spacecraft clock at the beginning of the observation” |
| END_OBJECT  | = COLUMN  |

|                |   |
|----------------|---|
| OBJECT         | = COLUMN  |
| NAME           | = AEROSOL_OPACITY_PROFILE_LIMB  |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER  |
| START_BYTE     | = 5   |
| BYTES          | = 76  |
| ITEMS          | = 38  |
| ITEM_BYTES     | = 2   |
| SCALING_FACTOR | = 0.001   |
| ALIAS_NAME     | = opacity_profile   |
| DESCRIPTION    | = “Aerosol integrated normal optical depth from infinity to each of 38 pressures at TBD microns.” |
| END_OBJECT     | = COLUMN  |

|                |  |
|----------------|--|
| OBJECT         | = COLUMN   |
| NAME           | = AEROSOL_OPACITY_SPECTRUM_LIMB                      |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER                               |
| START_BYTE     | = 81   |
| BYTES          | = 572  |
| ITEMS          | = 286  |
| ITEM_BYTES     | = 2  |
| SCALING_FACTOR | = 0.001  |
| ALIAS_NAME     | = opacity_spectrum                                   |
| DESCRIPTION    | = “Aerosol column optical depth spectrum to surface” |
| END_OBJECT     | = COLUMN   |

|           |                                 |
|-----------|---------------------------------|
| OBJECT    | = COLUMN                        |
| NAME      | = AEROSOL_SNG_SCAT_ALB_SPECTRUM |
| DATA_TYPE | = MSB_UNSIGNED_INTEGER          |

|                |  |
|----------------|--|
| START_BYTE     | = 653  |
| BYTES          | = 572  |
| ITEMS          | = 286  |
| ITEM_BYTES     | = 2  |
| SCALING_FACTOR | = 0.001  |
| ALIAS_NAME     | = ss_albedo  |
| DESCRIPTION    | = "Aerosol single scattering albedo spectrum at pressure level indicated in aerosol_sng_scat_pres_level_ind column."   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = AEROSOL_SNG_SCAT_PRES_LEVEL_IND  |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER   |
| START_BYTE     | = 1225   |
| BYTES          | = 1  |
| ALIAS_NAME     | = ss_pressure  |
| DESCRIPTION    | = "Pressure Level index (1-38) of the pressure level to which the single scattering albedo spectrum pertains.<br>Pressure level is chosen where the tangent optical depth is approximately unity." |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = LIMB_TEMPERATURE_PROFILE   |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER   |
| START_BYTE     | = 1226   |
| BYTES          | = 76   |
| ITEMS          | = 38   |
| ITEM_BYTES     | = 2  |
| SCALING_FACTOR | = 0.01   |
| ALIAS_NAME     | = limb_pt  |
| DESCRIPTION    | = "Atmospheric temperature profile at 38 pressures derived from limb set observation"  |
| UNIT           | = "K"  |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = SURFACE_RAD_SPECTRUM_UNCERTAINTY   |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER   |
| START_BYTE     | = 1302   |
| BYTES          | = 286  |
| ITEMS          | = 286  |
| ITEM_BYTES     | = 1  |
| ALIAS_NAME     | = srs_uncertainty  |
| DESCRIPTION    | = "Percent uncertainty in surface radiance spectrum."  |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = LIMB_PARAMETERS_QUALITY  |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER   |
| START_BYTE     | = 1588   |
| BYTES          | = 4  |
| ALIAS_NAME     | = lmb_quality  |
| DESCRIPTION    | = "32-bit data quality word. Bits TBD"   |
| END_OBJECT     | = COLUMN   |

## A.7 OBS Table

|             |       |
|-------------|-------|
| NAME        | = OBS |
| COLUMNS     | = 20  |
| ROW_BYTES   | = 42  |
| DESCRIPTION | = “   |

The OBS table stores the state of the instrument at the start of each observation. One OBS record is generated for each observation.”

|             |   |
|-------------|---|
| OBJECT      | = COLUMN  |
| NAME        | = SPACECRAFT_CLOCK_START_COUNT  |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER  |
| START_BYTE  | = 1   |
| BYTES       | = 4   |
| ALIAS_NAME  | = sclk_time   |
| DESCRIPTION | = “The value of the spacecraft clock at the beginning of the observation” |
| END_OBJECT  | = COLUMN  |

|             |  |
|-------------|--|
| OBJECT      | = COLUMN                               |
| NAME        | = ORBIT_NUMBER                         |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER                 |
| START_BYTE  | = 5                                    |
| BYTES       | = 2                                    |
| ALIAS_NAME  | = orbit                                |
| DESCRIPTION | = “The project supplied orbit number.” |
| END_OBJECT  | = COLUMN                               |

|             |   |
|-------------|---|
| OBJECT      | = COLUMN  |
| NAME        | = ORBIT_COUNTER_KEEPER  |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER  |
| START_BYTE  | = 7   |
| BYTES       | = 2   |
| ALIAS_NAME  | = ock   |
| DESCRIPTION | = “Sequential count of the number of orbital revolutions since orbit insertion. This number is identical to the project supplied orbit number up until the first time it is reset to zero.” |
| END_OBJECT  | = COLUMN  |

|             |  |
|-------------|--|
| OBJECT      | = COLUMN   |
| NAME        | = INSTRUMENT_TIME_COUNT  |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER   |
| START_BYTE  | = 9  |
| BYTES       | = 4  |
| ALIAS_NAME  | = ick  |
| DESCRIPTION | = “The number of two-second intervals that have elapsed since the start of the orbit. The two-second interval is the smallest time unit defined by the instrument and equals the time to complete a single length scan.” |
| END_OBJECT  | = COLUMN   |

|                |  |
|----------------|--|
| OBJECT         | = COLUMN   |
| NAME           | = TEMPORAL_AVERAGE_COUNT   |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER   |
| START_BYTE     | = 13   |
| BYTES          | = 1  |
| ALIAS_NAME     | = tic  |
| DESCRIPTION    | = "The number of two-second scans averaged into this observation. Valid values are 1, 2 and 4"   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = MIRROR_POINTING_ANGLE  |
| DATA_TYPE      | = MSB_INTEGER  |
| START_BYTE     | = 14   |
| BYTES          | = 2  |
| SCALING_FACTOR | = .046875  |
| ALIAS_NAME     | = pnt_angle  |
| DESCRIPTION    | = "Scan mirror pointing angle, degrees from nadir about the spacecraft's +Y axis."   |
| UNIT           | = "DEGREE"   |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = IMC_COUNT  |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER   |
| START_BYTE     | = 16   |
| BYTES          | = 1  |
| ALIAS_NAME     | = pnt_imc  |
| DESCRIPTION    | = "The number of image motion compensation steps used."  |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = OBSERVATION_TYPE   |
| DATA_TYPE      | = CHARACTER  |
| START_BYTE     | = 17   |
| BYTES          | = 1  |
| ALIAS_NAME     | = pnt_view   |
| DESCRIPTION    | = "The observation classification. Coarsely identifies the type of observation as one of the following:<br>B=Internal black body reference surface,<br>1=Visual Bolometer calibration lamp 1,<br>2=Visual Bolometer calibration lamp 2,<br>D=Planet, Day side,<br>N=Planet, Night side,<br>L=Planet, limb,<br>S=Space" |
| END_OBJECT     | = COLUMN   |
| OBJECT         | = COLUMN   |
| NAME           | = SCAN_LENGTH  |
| DATA_TYPE      | = CHARACTER  |
| START_BYTE     | = 18   |
| BYTES          | = 1  |
| ALIAS_NAME     | = scan_len   |
| DESCRIPTION    | = "Length of scan<br>1 = single length scans (~10 wavenumber spacing),   |

2 = double length scans (~5 wavenumber spacing)"

END\_OBJECT = COLUMN

OBJECT = COLUMN

NAME = DATA\_PACKET\_TYPE

DATA\_TYPE = CHARACTER

START\_BYTE = 19

BYTES = 1

ALIAS\_NAME = pkt\_type

DESCRIPTION = "Downlink packet format  
S = short packets (no auxiliary info)  
L = long packets (auxiliary info included)"

END\_OBJECT = COLUMN

OBJECT = COLUMN

NAME = SCHEDULE\_TYPE

DATA\_TYPE = CHARACTER

START\_BYTE = 20

BYTES = 1

ALIAS\_NAME = schedule\_type

DESCRIPTION = "Schedule type being executed:  
T = Real time plan,  
C = Record plan,  
O = Overlay"

END\_OBJECT = COLUMN

OBJECT = COLUMN

NAME = SPECTROMETER\_GAIN

DATA\_TYPE = CHARACTER

START\_BYTE = 21

BYTES = 1

ALIAS\_NAME = spc\_gain

DESCRIPTION = "Spectrometer amplifier gain channel number,  
1 = ~1  
2 = ~2  
3 = ~4  
4 = ~8"

END\_OBJECT = COLUMN

OBJECT = COLUMN

NAME = VISUAL\_BOLOMETER\_GAIN

DATA\_TYPE = CHARACTER

START\_BYTE = 22

BYTES = 1

ALIAS\_NAME = vbol\_gain

DESCRIPTION = "Visual bolometer amplifier gain setting,  
L = Low setting,  
H = High setting"

END\_OBJECT = COLUMN

OBJECT = COLUMN

NAME = THERMAL\_BOLOMETER\_GAIN

DATA\_TYPE = CHARACTER

START\_BYTE = 23

BYTES = 1

ALIAS\_NAME = tbol\_gain

DESCRIPTION = "Thermal bolometer amplifier gain setting,

L = Low setting,  
H = High setting”

END\_OBJECT = COLUMN

OBJECT = COLUMN  
NAME = PREPROCESSOR\_DETECTOR\_NUMBER  
DATA\_TYPE = MSB\_UNSIGNED\_INTEGER  
START\_BYTE = 24  
BYTES = 1  
ALIAS\_NAME = comp\_pp  
DESCRIPTION = “Precompressor reference detector number. The spectrum from each detector within a single ICK is subtracted from the spectrum of this detector prior to data compression to reduce signal entropy”

END\_OBJECT = COLUMN

OBJECT = COLUMN  
NAME = DETECTOR\_MASK  
DATA\_TYPE = MSB\_UNSIGNED\_INTEGER  
START\_BYTE = 25  
BYTES = 1  
ALIAS\_NAME = det\_mask  
DESCRIPTION = “Spatial detector mask number, one of eight possible combinations in which the spectra from the six TES detectors can be co-added prior to transmission to Earth. Varies from no combination (all detectors separate) to all detectors co-added into a single spectrum. See TES Software User’s Guide for details”

END\_OBJECT = COLUMN

OBJECT = COLUMN  
NAME = OBSERVATION\_CLASSIFICATION  
DATA\_TYPE = MSB\_UNSIGNED\_INTEGER  
START\_BYTE = 26  
BYTES = 4  
ALIAS\_NAME = class  
DESCRIPTION = “Numeric classification of intended target. See ancillary Class table for specific values”

END\_OBJECT = COLUMN

OBJECT = COLUMN  
NAME = OBSERVATION\_QUALITY  
DATA\_TYPE = MSB\_UNSIGNED\_INTEGER  
START\_BYTE = 30  
BYTES = 4  
ALIAS\_NAME = quality  
DESCRIPTION = “32-bit observation quality word. Bits TBD”

END\_OBJECT = COLUMN

OBJECT = COLUMN  
NAME = PRIMARY\_DIAGNOSTIC\_TEMPERATURES  
DATA\_TYPE = MSB\_UNSIGNED\_INTEGER  
START\_BYTE = 34  
BYTES = 8  
ITEMS = 4  
ITEM\_BYTES = 2



|                |   |
|----------------|---|
| SCALING_FACTOR | = 0.01  |
| ALIAS_NAME     | = temps   |
| DESCRIPTION    | = "Primary diagnostic temperatures:<br>temps[1] = T1 = Visual Bolometer Detector Package<br>temps[2] = T2 = Thermal Bolometer Detector Package<br>temps[3] = T3 = Spectrometer Detector Package<br>temps[4] = T4 = Thermal Bolometer Black Body<br>Reference" |
| UNIT           | = "K"   |
| END_OBJECT     | = COLUMN  |
| OBJECT         | = COLUMN  |
| NAME           | = FFT_START_INDEX   |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER  |
| START_BYTE     | = 42  |
| BYTES          | = 1   |
| ALIAS_NAME     | = fft_start_index   |
| DESCRIPTION    | = "This parameter specifies the index into the FFT output<br>array that was used as the first band of the downlinked<br>spectral range."  |
| END_OBJECT     | = COLUMN  |

## A.8 POS Table

|             |       |
|-------------|-------|
| NAME        | = POS |
| COLUMNS     | = 7   |
| ROW_BYTES   | = 70  |
| DESCRIPTION | = “   |

The POS table stores the positions of the spacecraft and sun relative to the planet, the spacecraft’s orientation quaternion, and the Mars body quaternion, all relative to the J2000 system.

These data are initially derived from the project’s SPICE kernels, but may be corrected from various other sources. This table may also include interpolated values where SPICE data were unavailable.”

|             |   |
|-------------|---|
| OBJECT      | = COLUMN  |
| NAME        | = SPACECRAFT_CLOCK_START_COUNT  |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER  |
| START_BYTE  | = 1   |
| BYTES       | = 4   |
| ALIAS_NAME  | = sclk_time   |
| DESCRIPTION | = “The value of the spacecraft clock at the beginning of the observation” |
| END_OBJECT  | = COLUMN  |

|             |  |
|-------------|--|
| OBJECT      | = COLUMN                                   |
| NAME        | = EPHEMERIS_TIME                           |
| DATA_TYPE   | = IEEE_REAL                                |
| START_BYTE  | = 5  |
| BYTES       | = 8  |
| ALIAS_NAME  | = et                                       |
| DESCRIPTION | = “Ephemeris time, seconds since 1/1/2000” |
| UNIT        | = “Seconds”                                |
| END_OBJECT  | = COLUMN                                   |

|             |  |
|-------------|--|
| OBJECT      | = COLUMN   |
| NAME        | = SPACECRAFT_POSITION  |
| DATA_TYPE   | = IEEE_REAL  |
| START_BYTE  | = 13   |
| BYTES       | = 12   |
| ITEMS       | = 3  |
| ITEM_BYTES  | = 4  |
| ALIAS_NAME  | = pos  |
| DESCRIPTION | = “Spacecraft position vector relative to Mars in the J2000 reference frame” |
| UNIT        | = “KM”   |
| END_OBJECT  | = COLUMN   |

|            |                |
|------------|----------------|
| OBJECT     | = COLUMN       |
| NAME       | = SUN_POSITION |
| DATA_TYPE  | = IEEE_REAL    |
| START_BYTE | = 25           |
| BYTES      | = 12           |

|             |  |
|-------------|--|
| ITEMS       | = 3  |
| ITEM_BYTES  | = 4  |
| ALIAS_NAME  | = sun  |
| DESCRIPTION | = "Sun position vector relative to Mars in the J2000 reference frame"  |
| UNIT        | = "KM"   |
| END_OBJECT  | = COLUMN   |
| OBJECT      | = COLUMN   |
| NAME        | = SPACECRAFT_QUATERNION  |
| DATA_TYPE   | = IEEE_REAL  |
| START_BYTE  | = 37   |
| BYTES       | = 16   |
| ITEMS       | = 4  |
| ITEM_BYTES  | = 4  |
| ALIAS_NAME  | = quat   |
| DESCRIPTION | = "Spacecraft pointing quaternion in the J2000 reference frame"  |
| END_OBJECT  | = COLUMN   |
| OBJECT      | = COLUMN   |
| NAME        | = MARS_QUATERNION  |
| DATA_TYPE   | = IEEE_REAL  |
| START_BYTE  | = 53   |
| BYTES       | = 16   |
| ITEMS       | = 4  |
| ITEM_BYTES  | = 4  |
| ALIAS_NAME  | = qbody  |
| DESCRIPTION | = "Mars body quaternion in the J2000 reference frame"  |
| END_OBJECT  | = COLUMN   |
| OBJECT      | = COLUMN   |
| NAME        | = POSITION_SOURCE_ID   |
| DATA_TYPE   | = CHARACTER  |
| START_BYTE  | = 69   |
| BYTES       | = 2  |
| ITEMS       | = 2  |
| ITEM_BYTES  | = 1  |
| ALIAS_NAME  | = id   |
| DESCRIPTION | = "2-character source ID.<br>First character is source of positions.<br>Second character is source of pointing.<br>See ancillary table for details." |
| END_OBJECT  | = COLUMN   |

## A.9 RAD Table

|             |       |
|-------------|-------|
| NAME        | = RAD |
| COLUMNS     | = 9   |
| ROW_BYTES   | = 24  |
| DESCRIPTION | = “   |

The RAD table contains the raw and calibrated observed radiances. For each observation there can be up to 6 RAD records, one for each active spectrometer detector. If the Temporal Integration Count (OBS Table, TEMPORAL\_AVERAGE\_COUNT) is greater than 1, then the data represent the average of the measurements from that many scans.

The instrument can apply a programmable spectral mask to the raw data causing neighboring channels to be averaged; however, this feature is used only when downlink bandwidth is limited. When spectrally masked data are received, the averaged-out channels are replaced with the averaged value to expand the spectra back to its original size. The spectral-mask that was used to perform the averaging is kept in this table.

The raw spectra are compressed for downlink. The original bit-packed compression header, containing the size of the compressed data and the compression mode used, is kept in this table in order to be used to evaluate the performance of the compressor.”

|             |   |
|-------------|---|
| OBJECT      | = COLUMN  |
| NAME        | = SPACECRAFT_CLOCK_START_COUNT  |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER  |
| START_BYTE  | = 1   |
| BYTES       | = 4   |
| ALIAS_NAME  | = sclk_time   |
| DESCRIPTION | = “The value of the spacecraft clock at the beginning of the observation” |
| END_OBJECT  | = COLUMN  |

|             |   |
|-------------|---|
| OBJECT      | = COLUMN  |
| NAME        | = DETECTOR_NUMBER   |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER  |
| START_BYTE  | = 5   |
| BYTES       | = 1   |
| ALIAS_NAME  | = detector  |
| DESCRIPTION | = “The number of the spectrometer detector that made the observation. Detectors are numbered from 1 to 6” |
| END_OBJECT  | = COLUMN  |

|             |  |
|-------------|--|
| OBJECT      | = COLUMN                               |
| NAME        | = SPECTRAL_MASK                        |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER                 |
| START_BYTE  | = 6                                    |
| BYTES       | = 1                                    |
| ALIAS_NAME  | = spectral_mask                        |
| DESCRIPTION | = “ID number of spectral mask applied. |

|                 |   |
|-----------------|---|
| END_OBJECT      | See ancillary Masks table"<br>= COLUMN  |
| OBJECT          | = COLUMN  |
| NAME            | = COMPRESSION_MODE  |
| DATA_TYPE       | = MSB_UNSIGNED_INTEGER  |
| START_BYTE      | = 7   |
| BYTES           | = 2   |
| ALIAS_NAME      | = cmode   |
| DESCRIPTION     | = "16-bit compression header of original data<br>containing the size and compression mode of the<br>original compressed data. See TES Users Guide." |
| END_OBJECT      | = COLUMN  |
| OBJECT          | = COLUMN  |
| NAME            | = RAW_RADIANCE  |
| DATA_TYPE       | = MSB_UNSIGNED_INTEGER  |
| START_BYTE      | = 9   |
| BYTES           | = 4   |
| VAR_DATA_TYPE   | = MSB_INTEGER   |
| VAR_ITEM_BYTES  | = 2   |
| VAR_RECORD_TYPE | = Q15   |
| ALIAS_NAME      | = raw_rad   |
| DESCRIPTION     | = "Raw spectral radiance"   |
| UNIT            | = "transformed volts"   |
| END_OBJECT      | = COLUMN  |
| OBJECT          | = COLUMN  |
| NAME            | = CALIBRATED_RADIANCE   |
| DATA_TYPE       | = MSB_UNSIGNED_INTEGER  |
| START_BYTE      | = 13  |
| BYTES           | = 4   |
| VAR_DATA_TYPE   | = MSB_INTEGER   |
| VAR_ITEM_BYTES  | = 2   |
| VAR_RECORD_TYPE | = Q15   |
| ALIAS_NAME      | = cal_rad   |
| DESCRIPTION     | = "Calibrated spectral radiance"  |
| UNIT            | = "watts cm-2 steradian-1 wavenumber-1"   |
| END_OBJECT      | = COLUMN  |
| OBJECT          | = COLUMN  |
| NAME            | = DETECTOR_TEMPERATURE  |
| DATA_TYPE       | = MSB_UNSIGNED_INTEGER  |
| START_BYTE      | = 17  |
| BYTES           | = 2   |
| ALIAS_NAME      | = tdet  |
| DESCRIPTION     | = "Derived temperature of the detector, used to<br>remove instrument radiance in calibration<br>algorithm"  |
| UNIT            | = "K"   |
| END_OBJECT      | = COLUMN  |
| OBJECT          | = COLUMN  |
| NAME            | = TARGET_TEMPERATURE  |
| DATA_TYPE       | = MSB_UNSIGNED_INTEGER  |
| START_BYTE      | = 19  |
| BYTES           | = 2   |

|             |   |
|-------------|---|
| ALIAS_NAME  | = target_temp   |
| DESCRIPTION | = “Derived temperature of the observed target”          |
| UNIT        | = “K”   |
| END_OBJECT  | = COLUMN  |
| OBJECT      | = COLUMN  |
| NAME        | = RADIANCE_CALIBRATION_ID                               |
| DATA_TYPE   | = CHARACTER   |
| START_BYTE  | = 21  |
| BYTES       | = 4   |
| ALIAS_NAME  | = version_id  |
| DESCRIPTION | = “Calibration algorithm version id for spectral data.” |
| END_OBJECT  | = COLUMN  |

## A.10 SRF Table

|             |       |
|-------------|-------|
| NAME        | = SRF |
| COLUMNS     | = 11  |
| ROW_BYTES   | = 109 |
| DESCRIPTION | = “   |

The SRF table contains values derived from spectra that include Mars in the field of view. It contains one record for each valid calibrated radiance spectrum that includes the planet and for which any valid quantities could be derived. See the surface parameters quality word for information on the validity of calculated variables.

The surface spectrum with the atmosphere removed is contained in a variable length array. See the SURFACE\_RAD\_SPECTRUM\_UNCERTAINTY column in the LMB table at the time nearest the observation for a measure of the error in these values.

For observations that target a body other than Mars (e.g., Phobos and Deimos), there will be no data in this table.”

|             |   |
|-------------|---|
| OBJECT      | = COLUMN  |
| NAME        | = SPACECRAFT_CLOCK_START_COUNT  |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER  |
| START_BYTE  | = 1   |
| BYTES       | = 4   |
| ALIAS_NAME  | = sclk_time   |
| DESCRIPTION | = “The value of the spacecraft clock at the beginning of the observation” |
| END_OBJECT  | = COLUMN  |

|             |   |
|-------------|---|
| OBJECT      | = COLUMN  |
| NAME        | = DETECTOR_NUMBER   |
| DATA_TYPE   | = MSB_UNSIGNED_INTEGER  |
| START_BYTE  | = 5   |
| BYTES       | = 1   |
| ALIAS_NAME  | = detector  |
| DESCRIPTION | = “The number of the spectrometer detector that made the observation. Detectors are numbered from 1 to 6” |
| END_OBJECT  | = COLUMN  |

|             |   |
|-------------|---|
| OBJECT      | = COLUMN  |
| NAME        | = SPECTRAL_THERMAL_INERTIA                          |
| DATA_TYPE   | = IEEE_REAL   |
| START_BYTE  | = 6   |
| BYTES       | = 4   |
| ALIAS_NAME  | = ti_spc  |
| DESCRIPTION | = “Thermal inertia, derived from spectrometer data” |
| UNIT        | = “J m-2 s-1/2 K-1”                                 |
| END_OBJECT  | = COLUMN  |

|            |                     |
|------------|---------------------|
| OBJECT     | = COLUMN            |
| NAME       | = DOWN_WELLING_FLUX |
| DATA_TYPE  | = IEEE_REAL         |
| START_BYTE | = 10                |
| BYTES      | = 4                 |
| ALIAS_NAME | = dw_flux           |

|                |   |
|----------------|---|
| DESCRIPTION    | = "Atmospheric down-welling flux"   |
| UNIT           | = "watts cm-2"  |
| END_OBJECT     | = COLUMN  |
| OBJECT         | = COLUMN  |
| NAME           | = SURFACE_PRESSURE  |
| DATA_TYPE      | = IEEE_REAL   |
| START_BYTE     | = 14  |
| BYTES          | = 4   |
| ALIAS_NAME     | = srf_pressure  |
| DESCRIPTION    | = "Surface pressure estimate from lookup table,<br>based on topography and seasonal pressure variation"                         |
| UNIT           | = "mBar"  |
| END_OBJECT     | = COLUMN  |
| OBJECT         | = COLUMN  |
| NAME           | = SPECTRAL_SURFACE_TEMPERATURE  |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER  |
| START_BYTE     | = 18  |
| BYTES          | = 2   |
| SCALING_FACTOR | = 0.01  |
| ALIAS_NAME     | = srf_temp_spc  |
| DESCRIPTION    | = "Surface temperature, derived from spectrometer data.<br>See users guide (process.asc or process.pdf) for more information. " |
| UNIT           | = "K"   |
| END_OBJECT     | = COLUMN  |
| OBJECT         | = COLUMN  |
| NAME           | = NADIR_TEMPERATURE_PROFILE   |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER  |
| START_BYTE     | = 20  |
| BYTES          | = 76  |
| ITEMS          | = 38  |
| ITEM_BYTES     | = 2   |
| SCALING_FACTOR | = 0.01  |
| ALIAS_NAME     | = nadir_pt  |
| DESCRIPTION    | = "Atmospheric pressure/temperature profile from<br>Nadir observation. Array of temperatures at<br>38 given pressures"          |
| UNIT           | = "K"   |
| END_OBJECT     | = COLUMN  |
| OBJECT         | = COLUMN  |
| NAME           | = AEROSOL_OPACITY_NADIR   |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER  |
| START_BYTE     | = 96  |
| BYTES          | = 2   |
| SCALING_FACTOR | = 0.001   |
| ALIAS_NAME     | = optical_depth   |
| DESCRIPTION    | = "Aerosol normal optical depth to surface at TBD<br>microns. Use surface pressure to scale to surface."                        |
| END_OBJECT     | = COLUMN  |
| OBJECT         | = COLUMN  |
| NAME           | = SURFACE_PARAMETERS_QUALITY  |
| DATA_TYPE      | = MSB_UNSIGNED_INTEGER  |
| START_BYTE     | = 98  |



|                 |   |
|-----------------|---|
| BYTES           | = 4   |
| ALIAS_NAME      | = srf_quality   |
| DESCRIPTION     | = "32-bit data quality word, per detector.<br>Bits TBD" |
| END_OBJECT      | = COLUMN  |
| OBJECT          | = COLUMN  |
| NAME            | = SURFACE_RADIANCE                                      |
| DATA_TYPE       | = MSB_UNSIGNED_INTEGER                                  |
| START_BYTE      | = 102   |
| BYTES           | = 4   |
| VAR_DATA_TYPE   | = MSB_INTEGER   |
| VAR_ITEM_BYTES  | = 2   |
| VAR_RECORD_TYPE | = Q15   |
| ALIAS_NAME      | = srf_radiance  |
| DESCRIPTION     | = "Derived surface radiance"                            |
| UNIT            | = "watts cm-2 steradian-1 wavenumber-1"                 |
| END_OBJECT      | = COLUMN  |
| OBJECT          | = COLUMN  |
| NAME            | = SURFACE_CALIBRATION_ID                                |
| DATA_TYPE       | = CHARACTER   |
| START_BYTE      | = 106   |
| BYTES           | = 4   |
| ALIAS_NAME      | = version_id  |
| DESCRIPTION     | = "Surface Atmosphere Separation Algorithm version ID"  |
| END_OBJECT      | = COLUMN  |