

# **Thermal Emission Spectrometer**

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

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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
- ATM - Derived Properties - Atmospheric 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 ATM table

The ATM 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 maneuver 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, degrees from nadir."
END_OBJECT     = COLUMN

```

The RAD, ATM, 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
BYTES            = 1
END_OBJECT       = COLUMN

OBJECT           = COLUMN
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
    
```

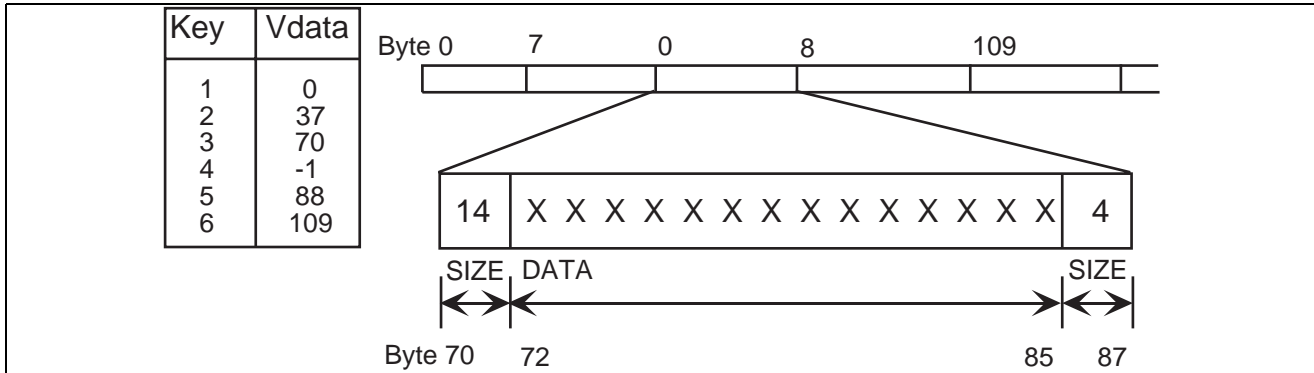


Figure 1. An example of a variable length record.

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

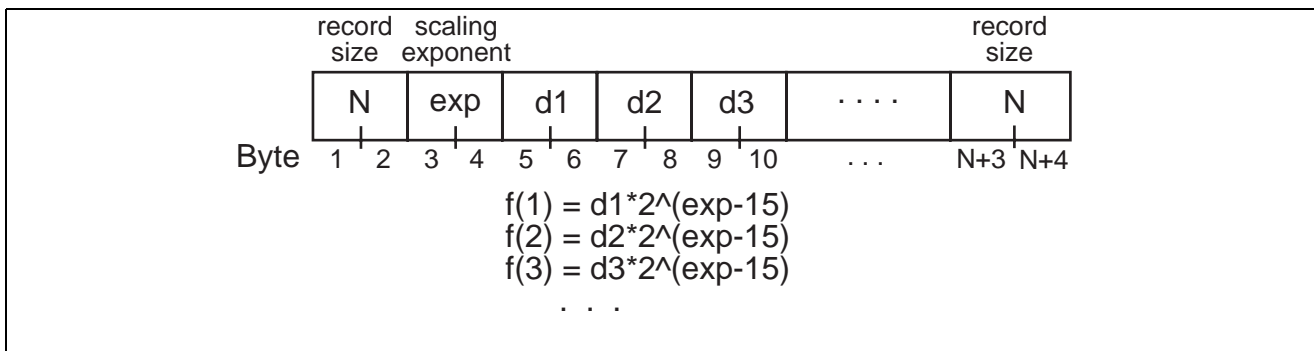


Figure 2. A Q15 record

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_KEY             = ( "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       = 0000152587890625
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 ATM Table

NAME	= ATM
COLUMNS	= 13
ROW_BYTES	= 130
INTERCHANGE_FORMAT	= BINARY
PRIMARY_KEY	= ( "SPACECRAFT_CLOCK_START_COUNT" )
DESCRIPTION	= "

The ATM table contains temperature profiles, aerosol opacities, and related elements derived from the TES calibrated data. Derived values are based on the average spectra of all six detectors measured while TES is operating in the nadir observation mode. Only data with the following quality flags are included for atmospheric evaluation:

RAD.QUALITY:MAJOR\_PHASE\_INVERSION = 0;  
 RAD.QUALITY:SPECTROMETER\_NOISE = 0-1;  
 RAD.QUALITY:DETECTOR\_MASK\_PROBLEM = 0.

Observations that target a body other than Mars (e.g., Phobos and Deimos), or do not include Mars in the field of view, do not have correlating data in this table.

The ATM:QUALITY product contains information on the quality of the calculated quantities (see DOCUMENT/QUALITY.TXT for more information). Users should also be aware of the following data quality issues:

Significant problems in temperature retrieval are known to occur over topographic highs, e.g., the Tharsis volcanoes. Over regions of high surface temperature, retrieved atmospheric temperatures in the lowest scale height may be inaccurate. However, large RMS radiance residuals (TEMPERATURE\_PROFILE\_RESIDUAL) usually occur in these cases.

TES collects data in either of two spectral resolution modes: "double scan" and "single scan" (see DATA/WAVNUMDS.TAB and DATA/WAVNUMSS.TAB for specific wavenumbers). We have observed that the RMS radiance residual values (TEMPERATURE\_PROFILE\_RESIDUAL) associated with the double scan mode temperature profiles are higher than those associated with the single scan mode data. However, there appears to be no bias or other distortion present in the two sets of profiles that is outside of the expected temperature uncertainty of ~2K.

Negative dust, water ice, and CO<sub>2</sub> opacity values (NADIR\_OPACITY[1:2]) are known to exist even for data with a QUALITY:ATM\_OPACITY\_RATING equal to zero. The estimated uncertainty for any one retrieval of aerosol optical depth is about +/- 0.05. Therefore, we have chosen to include all retrieved NADIR\_OPACITY[1:2] values greater than -0.05. A retrieved optical depth in the range 0 to -0.05 is consistent with an actual optical depth of zero. Additionally, we require that the retrieved CO<sub>2</sub> optical depth (NADIR\_OPACITY[3]) be in the range -0.01 to 0.05 for QUALITY:ATM\_OPACITY\_RATING to be zero. A retrieved CO<sub>2</sub> optical depth greater than 0.05 is unphysical and an optical depth in the range 0 to -0.01 is consistent with zero. No constraints or quality checks are made for the basalt surface component (NADIR\_OPACITY[4]).

The opacity algorithm fails when the thermal contrast between the atmosphere and the ground is too small. Experience indicates that results may be unreliable if the surface temperature drops below about 220K. We suggest that opacity users limit their searches to include only those values for which the CO<sub>2</sub> CONTINUUM\_TEMP is greater than 220K, and the quality bits QUALITY:TEMPERATURE\_PROFILE\_RATING and QUALITY:ATMOSPHERIC\_OPACITY\_RATING are both equal to zero.

Further discussion of the values in this table is available in DOCUMENT/PROCESS; questions about the content of the data should be directed to Michael Smith at Michael.D.Smith@gsfc.nasa.gov or John Pearl at John.Pearl@gsfc.nasa.gov."

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	= SURFACE_PRESSURE
DATA_TYPE	= MSB_UNSIGNED_INTEGER
START_BYTE	= 5
BYTES	= 2
SCALING_FACTOR	= 0.001
NOT_APPLICABLE_CONSTANT	= 444.4
ALIAS_NAME	= srf_pressure
DESCRIPTION	= "Surface pressure is calculated from the altitudes given by the MGS-Mars Orbiter Laser Altimeter (MOLA) 1/4 degree x 1/4 degree topographic map, the hydrostatic law assuming a 10 km scale height, and an adjustment for the seasonal CO2 sublimation cycle. Proper normalization is obtained by fitting the pressures observed by the Viking and Pathfinder landers. For more information, see DOCUMENT/PROCESS."
UNIT	= "mbar x1000"
END_OBJECT	= COLUMN
OBJECT	= COLUMN
NAME	= NADIR_TEMPERATURE_PROFILE
DATA_TYPE	= MSB_UNSIGNED_INTEGER
START_BYTE	= 7
BYTES	= 76
ITEMS	= 38
ITEM_BYTES	= 2
SCALING_FACTOR	= 0.01
NOT_APPLICABLE_CONSTANT	= 444.4
ALIAS_NAME	= nadir_pt
DESCRIPTION	= "Array of temperatures from nadir observations corresponding to the 38 atmospheric pressure levels, given in millibars, shown below. The fill value (NOT_APPLICABLE_CONSTANT) is inserted when (1) the temperature retrieval fails, or (2) the pressure either exceeds the local surface pressure, or is less than 0.1 mbar. 1: 16.5815200 2: 12.9137000 3: 10.0572000 4: 7.8325550 5: 6.1000000 6: 4.7506850 7: 3.6998370 8: 2.8814360 9: 2.2440650 10: 1.7476790

```

11: 1.3610940
12: 1.0600210
13: 0.8255452
14: 0.6429352
15: 0.5007185
16: 0.3899599
17: 0.3037011
18: 0.2365227
19: 0.1842040
20: 0.1434582
21: 0.1117254
22: 0.0870000
23: 0.0678000
24: 0.0528000
25: 0.0411000
26: 0.0320000
27: 0.0249000
28: 0.0194000
29: 0.0151000
30: 0.0118000
31: 0.0091700
32: 0.0071400
33: 0.0055600
34: 0.0043300
35: 0.0033700
36: 0.0026300
37: 0.0020500
38: 0.0015900"
UNIT = "degK x100"
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = CO2_CONTINUUM_TEMP
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 83
BYTES = 2
SCALING_FACTOR = 0.01
ALIAS_NAME = co2_cont_temp
DESCRIPTION = "Mean of brightness temperature just outside the wings of the 667 cm-1
CO2 absorption band. For10 cm-1 and 5 cm-1 data, all wavenumbers
between 508 to 531 cm-1 and 805 to 827 cm-1 are used with a total of 6 and
10 wavenumbers used in the calculation, respectively."
UNIT = "degK x100"
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = SPECTRAL_SURFACE_TEMPERATURE
DATA_TYPE = MSB_UNSIGNED_INTEGER
START_BYTE = 85
BYTES = 2
SCALING_FACTOR = 0.01
ALIAS_NAME = srf_temp_est
DESCRIPTION = "Mean of derived temperatures for each detector of the observed target."
UNIT = "degK x100"
END_OBJECT = COLUMN

```

OBJECT = COLUMN  
 NAME = TEMPERATURE\_PROFILE\_RESIDUAL  
 DATA\_TYPE = IEEE\_REAL  
 START\_BYTE = 87  
 BYTE = 4  
 NOT\_APPLICABLE\_CONSTANT = 444.4  
 ALIAS\_NAME = rms\_pt  
 DESCRIPTION = "RMS difference between radiances measured within the 667 cm-1 CO2 band, and the radiances calculated within that band using the derived pressure- temperature profile."  
 UNIT = "watts cm-2 steradian-1 wavenumber-1"  
 END\_OBJECT = COLUMN

OBJECT = COLUMN  
 NAME = NADIR\_OPACITY  
 DATA\_TYPE = MSB\_INTEGER  
 START\_BYTE = 91  
 BYTES = 18  
 ITEMS = 9  
 ITEM\_BYTES = 2  
 SCALING\_FACTOR = 0.001  
 NOT\_APPLICABLE\_CONSTANT = 22.22  
 ALIAS\_NAME = best\_fit\_opacities  
 DESCRIPTION = "Array of scaling factors that when multiplied by standard spectral shapes gives a best fit for aerosol opacities, CO2 hot and isotope bands, and a reference surface spectral emissivity. The standard spectral shapes are archived in DATA/STDSHAPES.TAB.  
 Spectral shapes represented in array elements:  
 1: dust  
 2: water ice  
 3: CO2 hot and isotope bands  
 4: surface  
 5-9: not used"  
 END\_OBJECT = COLUMN

OBJECT = COLUMN  
 NAME = NADIR\_OPACITY\_RESIDUAL  
 DATA\_TYPE = IEEE\_REAL  
 START\_BYTE = 109  
 BYTE = 4  
 NOT\_APPLICABLE\_CONSTANT = 444.4  
 ALIAS\_NAME = rms\_opacities  
 DESCRIPTION = "RMS opacity residual between opacities retrieved point by point across the spectrum and the opacities computed using the best-fit opacity scaling factors."  
 END\_OBJECT = COLUMN

OBJECT = COLUMN  
 NAME = CO2\_DOWNWELLING\_FLUX  
 DATA\_TYPE = IEEE\_REAL  
 START\_BYTE = 113  
 BYTE = 4  
 NOT\_APPLICABLE\_CONSTANT = 444.4  
 ALIAS\_NAME = co2\_dw\_flux  
 DESCRIPTION = "Down-welling flux from 667 cm-1 CO2 band."  
 UNIT = "watts cm-2"

```

END_OBJECT                = COLUMN

OBJECT                    = COLUMN
  NAME                    = TOTAL_DOWNWELLING_FLUX
  DATA_TYPE              = IEEE_REAL
  START_BYTE              = 117
  BYTE                    = 4
  NOT_APPLICABLE_CONSTANT = 444.4
  ALIAS_NAME              = total_dw_flux
  DESCRIPTION             = "Down-welling flux from CO2 and atmospheric aerosols."
  UNIT                    = "watts cm-2"
END_OBJECT                = COLUMN

OBJECT                    = COLUMN
  NAME                    = QUALITY
  DATA_TYPE              = MSB_BIT_STRING
  START_BYTE              = 121
  BYTES                   = 2
  ALIAS_NAME              = quality
  DESCRIPTION             = "16-bit atmosphere quality word. Bit column description and code
                           definitions follow; see also quality.txt for more information"

OBJECT                    = BIT_COLUMN
  NAME                    = TEMPERATURE_PROFILE_RATING
  BIT_DATA_TYPE           = MSB_UNSIGNED_INTEGER
  START_BIT               = 1
  BITS                    = 2
  ALIAS_NAME              = atm_pt_rating
  DESCRIPTION             = "Identifies quality of nadir pressure-temperature profile values:
                           0 = nadir values are good
                           1 = nadir values are questionable
                           2 = nadir values are bad
                           3 = nadir values are not available (N/A)"
END_OBJECT                = BIT_COLUMN

OBJECT                    = BIT_COLUMN
  NAME                    = ATMOSPHERIC_OPACITY_RATING
  BIT_DATA_TYPE           = MSB_UNSIGNED_INTEGER
  START_BIT               = 3
  BITS                    = 2
  ALIAS_NAME              = atm_opacity_rating
  DESCRIPTION             = "Identifies quality of opacity values:
                           0 = nadir values are good
                           1 = nadir values are questionable
                           2 = nadir values are bad
                           3 = nadir values are not available (N/A)"
END_OBJECT                = BIT_COLUMN

END_OBJECT                = COLUMN

OBJECT                    = COLUMN
  NAME                    = SURFACE_RADIANCE
  DATA_TYPE              = MSB_INTEGER
  START_BYTE              = 123
  BYTES                   = 4
  VAR_DATA_TYPE           = MSB_INTEGER

```

```

VAR_ITEM_BYTES           = 2
VAR_RECORD_TYPE         = Q15
ALIAS_NAME              = srf_radiance
DESCRIPTION              = "Derived surface radiance; this field is not used in this release."
UNIT                    = "watts cm-2 steradian-1 wavenumber-1"
END_OBJECT              = COLUMN

OBJECT                   = COLUMN
NAME                    = ATMOSPHERIC_CALIBRATION_ID
DATA_TYPE               = CHARACTER
START_BYTE              = 127
BYTES                   = 4
ALIAS_NAME              = version_id
DESCRIPTION              = "Version ID of nadir temperature and aerosol retrieval algorithm."
END_OBJECT              = COLUMN

```

## A.2 BOL Table

```

NAME                    = BOL
COLUMNS                = 12
ROW_BYTES               = 30
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.
Scaling factor is 5.0/2^15."
UNIT = "VOLTS"
END_OBJECT = 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,
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 steradian-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, assuming the target is radiating
                  as a black body"
  UNIT          = "K"
END_OBJECT      = COLUMN

OBJECT          = COLUMN
  NAME          = VISUAL_BOL_CALIBRATION_ID
  DATA_TYPE    = CHARACTER
  START_BYTE    = 25
  BYTES         = 2
  ALIAS_NAME     = vbol_version_id
  DESCRIPTION   = "Calibration algorithm version ID for visual bolometer data"
END_OBJECT      = COLUMN

OBJECT          = COLUMN
  NAME          = THERMAL_BOL_CALIBRATION_ID
  DATA_TYPE    = CHARACTER
  START_BYTE    = 27
  BYTES         = 2
  ALIAS_NAME     = tbol_version_id
  DESCRIPTION   = "Calibration algorithm version ID for thermal bolometer data"
END_OBJECT      = COLUMN

OBJECT          = COLUMN
  NAME          = QUALITY
  DATA_TYPE    = MSB_BIT_STRING
  START_BYTE    = 29
  BYTES         = 2
  ALIAS_NAME     = quality
  DESCRIPTION   = "16-bit thermal inertia quality word. Bit column description and code definitions
                  follow; see also index/quality.txt for more information"

OBJECT          = BIT_COLUMN
  NAME          = BOLOMETRIC_INERTIA_RATING
  BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BIT     = 1
  BITS         = 3
  ALIAS_NAME     = ti_bol_rating
  DESCRIPTION   = "Values of 0 to 3 rate the uncertainty of the modeled bolometer thermal
                  inertia based on design-specified instrument noise levels; additional sources of
                  uncertainty are present, see document/process.asc or process.pdf.
                  Values of 5 to 7 rate the reasons why valid bolometer thermal inertia could not
                  be modeled.
                  0 = best quality
                  1 = good quality
                  2 = medium quality
                  3 = low quality
                  4 = not assigned
                  5 = lowest quality - observed temperature outside of model-predicted range"

```

	6 = lowest quality - no model temperature variation as a function of thermal inertia
	7 = lowest quality - thermal inertia value not computed due to lack of necessary data"
END_OBJECT	= BIT_COLUMN
OBJECT	= BIT_COLUMN
NAME	= BOLOMETER_LAMP_ANOMALY
BIT_DATA_TYPE	= MSB_UNSIGNED_INTEGER
START_BIT	= 4
BITS	= 1
ALIAS_NAME	= bol_ref_lamp
DESCRIPTION	= "Visual bolometer calibration requires regular sampling of one of the two internal reference lamps; when the reference lamp looks are unavailable for a significant period of time, the calibration may be adversely affected and the calibrated data products should be used with caution. This bit is specifically designed to track the bolometer reference lamp gap spanning ocks 12064 to 12688. 0 = reference lamp looks routinely sampled 1 = reference lamp looks missing"
END_OBJECT	= BIT_COLUMN
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 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
COLUMN	= 20
ROW_BYTES	= 43
DESCRIPTION	= "

The GEO table contains information about the sun/spacecraft/target geometry in a format that is easily searched. 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 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\_UNSIGNED\_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.
                        This value is non-zero only for atmospheric 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 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.
                        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 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_semidiameter
  DESCRIPTION   = "Smallest angular radius of Mars as viewed from 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 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.
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	= 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	= 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 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: B=Internal black body reference surface, 1=Visual Bolometer calibration lamp 1, 2=Visual Bolometer calibration lamp 2, D=Planet, Day side, N=Reference observation NOT used in calibration, L=Planet, limb, 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  
 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,  
 Channel 1 = ~1  
 Channel 2 = ~2  
 Channel 3 = ~4  
 Channel 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\_BIT\_STRING  
START\_BYTE = 26  
BYTES = 4  
ALIAS\_NAME = class  
DESCRIPTION = "32-bit observation classification word. Bit column descriptions and code  
definitions follow; see class.txt for more information"

OBJECT = BIT\_COLUMN  
NAME = MISSION\_PHASE  
BIT\_DATA\_TYPE = MSB\_UNSIGNED\_INTEGER  
START\_BIT = 1  
BITS = 3  
ALIAS\_NAME = phase  
DESCRIPTION = "Identifies MGS Mission Phase:  
0 = Error  
1 = Aerobraking Phase 1 (AB-1)  
2 = Science Phasing Orbit 1 (SPO-1)"

```

3 = Science Phasing Orbit 2 (SPO-2)
4 = Aerobraking Phase 2 (AB-2)
5 = Mapping Phase
>5 = Error"
END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
  NAME = INTENDED_TARGET
  BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BIT = 4
  BITS = 4
  ALIAS_NAME = type
  DESCRIPTION = "Description of observation type, including various physical targets and
various tests conducted
0 = No Target
1 = Surface Observation
2 = Atmospheric Observation
3 = Phobos Observation
4 = Deimos Observation
5 = Reference Observation
6 = Space and Global Mars Observations
7 = Test Data
8 = Less Than Ick 15
9 = PROM Data "
END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
  NAME = TES_SEQUENCE
  BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BIT = 8
  BITS = 4
  ALIAS_NAME = sequence
  DESCRIPTION = "Description of observation sequence performed, must be used in
conjunction with OBSERVATION_TYPE; see class.txt for bit codes and
definitions"
END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
  NAME = NEON_LAMP_STATUS
  BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BIT = 12
  BITS = 2
  ALIAS_NAME = lamp_status
  DESCRIPTION = "Describes the status of the neon lamp, and by correlation, defines when
spectra are collected
0 = Neon lamp on, spectra collected
1 = Neon lamp off, spectra not collected"
END_OBJECT = BIT_COLUMN

OBJECT = BIT_COLUMN
  NAME = TIMING_ACCURACY
  BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BIT = 14
  BITS = 1
  ALIAS_NAME = timing

```

DESCRIPTION = "Describes the accuracy of observation timing, based on availability of equator crossing broadcasts  
0 = most accurate timing, MGS-PDS equator crossing broadcast received  
1 = timing drifts present, MGS-PDS equator crossing broadcast not received"

END\_OBJECT = BIT\_COLUMN

OBJECT = BIT\_COLUMN  
NAME = SPARE  
BIT\_DATA\_TYPE = MSB\_UNSIGNED\_INTEGER  
START\_BIT = 15  
BITS = 2  
ALIAS\_NAME = spare  
DESCRIPTION = "Reserved for future use "  
END\_OBJECT = BIT\_COLUMN

OBJECT = BIT\_COLUMN  
NAME = CLASSIFICATION\_VALUE  
BIT\_DATA\_TYPE = MSB\_INTEGER  
START\_BIT = 17  
BITS = 16  
ALIAS\_NAME = class\_value  
DESCRIPTION = "One of the following signed numerical details:  
latitude coordinates  
timing before or after periapsis (seconds)  
ANS roll number relative to periapsis  
Must be used in conjunction with TES\_SEQUENCE and OBSERVATION\_TYPE"  
END\_OBJECT = BIT\_COLUMN

END\_OBJECT = COLUMN

OBJECT = COLUMN  
NAME = QUALITY  
DATA\_TYPE = MSB\_BIT\_STRING  
START\_BYTE = 30  
BYTES = 4  
ALIAS\_NAME = quality  
DESCRIPTION = "32-bit observation quality word. Bit column description and code definitions follow; see also quality.txt for more information"

OBJECT = BIT\_COLUMN  
NAME = HGA\_MOTION  
BIT\_DATA\_TYPE = MSB\_UNSIGNED\_INTEGER  
START\_BIT = 1  
BITS = 2  
ALIAS\_NAME = hga\_motion  
DESCRIPTION = "Identifies motion and rate of High Gain Antenna;  
0 = HGA motion unknown  
1 = HGA not moving  
2 = HGA moving at 0.05 deg/sec (autotrack)  
3 = HGA moving at 0.51 deg/sec (rewind)"  
END\_OBJECT = BIT\_COLUMN

OBJECT = BIT\_COLUMN



```

NAME                = SOLAR_PANEL_MOTION
BIT_DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BIT           = 3
BITS                = 3
ALIAS_NAME          = pnl_motion
DESCRIPTION          = "Identifies motion and rate of both Solar Panels;
                      0 = panel motion unknown
                      1 = panels not moving
                      2 = panels moving at 0.051 deg/sec (autotrack)
                      3 = panels moving at 0.120 deg/sec (prior to ock 3859)
                      4 = panels moving at 0.240 deg/sec (starting at ock 3859)
                      5 = panels moving at 0.400 deg/sec (aerobraking only)
                      6 = panels moving & changing between rates
                      7 = not assigned"
END_OBJECT          = BIT_COLUMN

OBJECT               = BIT_COLUMN
NAME                 = ALGOR_PATCH
BIT_DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BIT           = 6
BITS                = 1
ALIAS_NAME          = algor_patch
DESCRIPTION          = "Status of algor flight software patch;
                      0 = Algor flight software patch not onboard TES
                      1 = Algor flight software patch onboard TES"
END_OBJECT          = BIT_COLUMN

OBJECT               = BIT_COLUMN
NAME                 = IMC_PATCH
BIT_DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BIT           = 7
BITS                = 1
ALIAS_NAME          = imc_patch
DESCRIPTION          = "Status of IMC flight software patch;
                      0 = imc moving in forward direction (IMC patch not onboard)
                      1 = imc moving in reverse direction (IMC patch onboard)"
END_OBJECT          = BIT_COLUMN

OBJECT               = BIT_COLUMN
NAME                 = MOMENTUM_DESATURATION
BIT_DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BIT           = 8
BITS                = 1
ALIAS_NAME          = moment
DESCRIPTION          = "Occurrence of autonomous angular momentum desaturation;
                      0 = angular momentum desaturation not occurring on spacecraft
                      1 = angular momentum desaturation occurring on spacecraft"
END_OBJECT          = BIT_COLUMN

OBJECT               = BIT_COLUMN
NAME                 = EQUALIZATION_TABLE
BIT_DATA_TYPE       = MSB_UNSIGNED_INTEGER
START_BIT           = 9
BITS                = 1
ALIAS_NAME          = equal_tab
DESCRIPTION          = "Status of equalization tables;

```

	0 = equalization tables not onboard TES 1 = equalization tables onboard TES"
END_OBJECT	= BIT_COLUMN
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: temps[1] = T1 = Visual Bolometer Detector Package temps[2] = T2 = Thermal Bolometer Detector Package temps[3] = T3 = Spectrometer Detector Package temps[4] = T4 = Thermal Bolometer Black Body Reference"
UNIT	= "K"
END_OBJECT	= COLUMN
OBJECT	= COLUMN
NAME	= FFT_START_INDEX
DATA_TYPE	= MSB_UNSIGNED_INTEGER
START_BYTE	= 42
BYTES	= 1
ALIAS_NAME	= ffti
DESCRIPTION	= "This parameter specifies the starting wavenumber of the spectra. The wavenumber of the first data channel is 10.58 times the index number. This value also defines how the spectral mask is to the channels."
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.
                        First character is source of positions.
                        Second character is source of pointing.
                        See ancillary table for details."
END_OBJECT           = COLUMN

```

## A.9 RAD Table

```

NAME                 = RAD
COLUMNS             = 11
ROW_BYTES            = 32
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 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. See ancillary Masks table"
END_OBJECT	= 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 containing the size and compression mode of the 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 remove instrument radiance in
    calibration 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"
    SCALING_FACTOR = 0.01
END_OBJECT = COLUMN

OBJECT = COLUMN
    NAME = SPECTRAL_THERMAL_INERTIA
    DATA_TYPE = IEEE_REAL
    START_BYTE = 21
    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 = RADIANCE_CALIBRATION_ID
    DATA_TYPE = CHARACTER
    START_BYTE = 25
    BYTES = 4
    ALIAS_NAME = version_id
    DESCRIPTION = "Calibration algorithm version id for spectral data."
END_OBJECT = COLUMN

OBJECT = COLUMN
    NAME = QUALITY
    DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BYTE = 29
    BYTES = 4
    ALIAS_NAME = quality
    DESCRIPTION = "32-bit observation quality word. Bit column description and code definitions
    follow; see also quality.txt for more information"

OBJECT = BIT_COLUMN
    NAME = MAJOR_PHASE_INVERSION
    BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
    START_BIT = 1
    BITS = 1
    ALIAS_NAME = phase_inversion
    DESCRIPTION = "Identifies data that contains major phase inversions;
    0 = data does not contain major phase inversions
    1 = data does contain major phase inversions"
END_OBJECT = BIT_COLUMN

```

```

OBJECT          = BIT_COLUMN
  NAME          = ALGOR_RISK
  BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BIT     = 2
  BITS          = 1
  ALIAS_NAME    = algor_risk
  DESCRIPTION   = "Identifies whether data is at low or high risk for algor phase inversions;
                  0 = data at low risk of algor phase inversion
                  1 = data at high risk of algor phase inversion"
END_OBJECT     = BIT_COLUMN

OBJECT          = BIT_COLUMN
  NAME          = CALIBRATION_QUALITY
  BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BIT     = 3
  BITS          = 3
  ALIAS_NAME    = calib_quality
  DESCRIPTION   = "These bits are reserved for future use; value of these bits currently set to 0"
END_OBJECT     = BIT_COLUMN

OBJECT          = BIT_COLUMN
  NAME          = SPECTROMETER_NOISE
  BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BIT     = 6
  BITS          = 2
  ALIAS_NAME    = spect_noise
  DESCRIPTION   = "Identifies noise level in data based on space observations made at least once
                  every 12 orbits;
                  0 = instrument noise not calculated
                  1 = instrument noise at nominal levels
                  2 = instrument noise at anomalously high levels
                  3 = not assigned"
END_OBJECT     = BIT_COLUMN

OBJECT          = BIT_COLUMN
  NAME          = SPECTRAL_INERTIA_RATING
  BIT_DATA_TYPE = MSB_UNSIGNED_INTEGER
  START_BIT     = 8
  BITS          = 3
  ALIAS_NAME    = ti_spc_rating
  DESCRIPTION   = "Values of 0 to 3 rate the uncertainty of the modeled spectral thermal inertia
                  based on design-specified instrument noise levels; additional sources of
                  uncertainty are present, see document/process.asc or process.pdf.
                  Values of 5 to 7 rate the reasons why valid spectral thermal inertia could not be
                  modeled.
                  0 = best quality
                  1 = good quality
                  2 = medium quality
                  3 = low quality
                  4 = not assigned
                  5 = lowest quality - observed temperature outside of model-predicted range
                  6 = lowest quality - no model temperature variation as a function of thermal
                  inertia
                  7 = lowest quality - thermal inertia value not computed due to lack of
                  necessary data"

```

```

END_OBJECT          = BIT_COLUMN

OBJECT              = BIT_COLUMN
  NAME              = DETECTOR_MASK_PROBLEM
  BIT_DATA_TYPE     = MSB_UNSIGNED_INTEGER
  START_BIT        = 11
  BITS              = 1
  ALIAS_NAME        = det_mask_problem
  DESCRIPTION       = "Identifies spectra affected by onboard detector (spatial) mask processing;
                    use spectra with extreme caution.
                    0 = spectrum not affected
                    1 = spectrum affected by the detector mask 1 problem"

END_OBJECT          = BIT_COLUMN

END_OBJECT          = COLUMN

```

## A.10 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,
                    Read from internal instrument thermistors.
                    1: T5 - Black Body 1
                    2: T6 - Black Body 2
                    3: T7 - Black Body 3
                    4: T8 - Bolometric Black Body Reference (spare)
                    5: T9 - Electronics
                    6: T10 - Power Supply

```



```

7: T11 - Telescope Field Stop
8: T12 - Interferometer Fixed Mirror
9: T13 - Interferometer Beamsplitter
10: T14 - Interferometer Motor
11: T15 - Primary Mirror
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, one for each spectrometer detector.
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, one for each spectrometer detector.
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, 16-bit mask, one for each
spectrometer detector. See TES User's Guide for details"
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = DIAGNOSTIC_TELEMETRY_1
DATA_TYPE = MSB_INTEGER
START_BYTE = 65
BYTE = 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
BYTE            = 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
BYTE            = 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
BYTE            = 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
BYTE            = 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
BYTE            = 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
BYTE           = 1
SCALING_FACTOR = 0.119457
ALIAS_NAME     = V7
DESCRIPTION    = "Diagnostic voltage P10V1. +10v: Servo Electronics"
UNIT           = "VOLTS"
END_OBJECT      = COLUMN

OBJECT           = COLUMN
NAME            = DIAGNOSTIC_TELEMETRY_8
DATA_TYPE      = MSB_INTEGER
START_BYTE     = 72
BYTE           = 1
SCALING_FACTOR = -0.103067
ALIAS_NAME     = V8
DESCRIPTION    = "Diagnostic voltage N10V1. -10v: Servo Electronics"
UNIT           = "VOLTS"
END_OBJECT      = COLUMN

OBJECT           = COLUMN
NAME            = DIAGNOSTIC_TELEMETRY_9
DATA_TYPE      = MSB_INTEGER
START_BYTE     = 73
BYTE           = 1
SCALING_FACTOR = 0.15576
ALIAS_NAME     = V9
DESCRIPTION    = "Diagnostic voltage P16V1. +16v: Analog MUX and A/D"
UNIT           = "VOLTS"
END_OBJECT      = COLUMN

OBJECT           = COLUMN
NAME            = DIAGNOSTIC_TELEMETRY_10
DATA_TYPE      = MSB_INTEGER
START_BYTE     = 74
BYTE           = 1
SCALING_FACTOR = -0.15625
ALIAS_NAME     = V10
DESCRIPTION    = "Diagnostic voltage N16V1. -16v: Analog MUX and A/D"
UNIT           = "VOLTS"
END_OBJECT      = COLUMN

OBJECT           = COLUMN
NAME            = DIAGNOSTIC_TELEMETRY_11
DATA_TYPE      = MSB_INTEGER
START_BYTE     = 75
BYTE           = 1
SCALING_FACTOR = 0.0976055
ALIAS_NAME     = V11

```

```

DESCRIPTION      = "Diagnostic voltage P10V2. +10v: Heaters"
UNIT             = "VOLTS"
END_OBJECT      = COLUMN

OBJECT           = COLUMN
NAME            = DIAGNOSTIC_TELEMETRY_12
DATA_TYPE      = MSB_INTEGER
START_BYTE     = 76
BYTE           = 1
SCALING_FACTOR = -0.0985813
ALIAS_NAME     = V12
DESCRIPTION    = "Diagnostic voltage N10V2. -10v: Heaters"
UNIT          = "VOLTS"
END_OBJECT    = COLUMN

OBJECT           = COLUMN
NAME            = DIAGNOSTIC_TELEMETRY_13
DATA_TYPE      = MSB_INTEGER
START_BYTE     = 77
BYTE           = 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
BYTE           = 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
BYTE           = 1
SCALING_FACTOR = 0.045727
ALIAS_NAME     = V15
DESCRIPTION    = "Diagnostic voltage P5V1. +5v: Servo electronics and DSP"
UNIT          = "VOLTS"
END_OBJECT    = COLUMN

OBJECT           = COLUMN
NAME            = DIAGNOSTIC_TELEMETRY_16
DATA_TYPE      = MSB_INTEGER
START_BYTE     = 80
BYTE           = 1
SCALING_FACTOR = 0.0480992
ALIAS_NAME     = V16
DESCRIPTION    = "Diagnostic voltage P5V2. Control processor and BIU."

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UNIT = "VOLTS"
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = DIAGNOSTIC_TELEMETRY_17
DATA_TYPE = MSB_INTEGER
START_BYTE = 81
BYTE = 1
SCALING_FACTOR = 0.0478277
ALIAS_NAME = V17
DESCRIPTION = "Diagnostic voltage P5V3. +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
BYTE = 1
SCALING_FACTOR = 0.0488039
ALIAS_NAME = V18
DESCRIPTION = "Diagnostic voltage P5V4.
+5v: Fringe and ZPD circuit"
UNIT = "VOLTS"
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = DIAGNOSTIC_TELEMETRY_19
DATA_TYPE = MSB_INTEGER
START_BYTE = 83
BYTE = 1
SCALING_FACTOR = 0.141966
ALIAS_NAME = V19
DESCRIPTION = "Diagnostic voltage P15V1. +15v Amplifiers"
UNIT = "VOLTS"
END_OBJECT = COLUMN

OBJECT = COLUMN
NAME = DIAGNOSTIC_TELEMETRY_20
DATA_TYPE = MSB_INTEGER
START_BYTE = 84
BYTE = 1
SCALING_FACTOR = -0.149688
ALIAS_NAME = V20
DESCRIPTION = "Diagnostic voltage N15V1. -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, primary (1) or backup(2)"
END_OBJECT = COLUMN

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OBJECT          = COLUMN
  NAME          = NEON_GAIN
  DATA_TYPE    = CHARACTER
  START_BYTE    = 86
  BYTES         = 1
  ALIAS_NAME    = neon_gain
  DESCRIPTION   = "Control interferometer neon lamp gain, (L)ow or (H)igh"
END_OBJECT

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 path difference (zpd)"
END_OBJECT

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) location measured in counts
from start of scan"
END_OBJECT

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 measured from start of
scan"
END_OBJECT

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 interferogram"
END_OBJECT

```