MIRO

Experimenter to Planetary Science Archive Interface Control Document

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MIRO
Experimenter to Planetary Science Archive Interface Control Document

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Distribution List

Recipient	Organization	Recipient

Change Log

Date	Sections Changed	Description
2003-Aug-12	All	Initial version
2003-Sep-09	Many	Edits as a result of PDS telecon
2003-Nov	2, 4	
2003-Dec	Changed doc.ID from UoB-IF-1234 to MIR-IF-0001. Updated keywords in 4.2 & App.1 per latest Archive Plan.	
2004-Jul	3-6	Corrections after review of sample label
2005-Dec	All	Revisions for delivery of ground testing archive
2006-Nov	All	Revisions after PDS Internal Review and for delivery of calibrated data.
2006-Dec-11	Section 3.4.2l	Updated delivery dates and added items per email from Maud Barthelemy
2007-May-09	Sections 3.2.3 and 4.2	Added documentation of coordinate systems used.
	Section 5	Changed VOLUME keywords per revised Archive Conventions
2007-Oct-22	1.5, 2.3.4, 3.2.2, 3.4, 4.2, 6, 5	Added explanation of Times in data files, changes to labels and delivery contents, and revised structure files.
2008-Sep-02	Section 4.4 added, Section 7 revised	PDS review requested more documentation of data formats.
2009-May-15	6.4	Removed GMT field from Level-3 continuum files
2010-Nov-04	2.3.3.4	Added reference to Geometry files.
	3.4.2	Updated list of archive datasets
	4.4	Updated for change to Level-3 files (UTC added)
	6.2, 6.4	Added UTC field to Level-3 data files
2012-Apr-30	6.1, 6.2, 6.3, 6.4, 6.5	Corrected MIRPOS codes (2=warm, 3=cold)
	6.5	Fixed typo in LDFRQ description.
2015-May-19	Many	Delivery of first post-hibernation data, utilizing Pipeline data generation software version 1.0.
2017-Aug-31	Many	Changes associated with 2017 August data delivery to PSA/PDS. Updates to discussions of the calibration algorithm, file content and format, contact information, and clarifications/additional information in all sections.
2017-Sep-20	Appendix B	Version 4.2 corrects the descriptions of local_solha, scene_eff_solha, and the flag value used for undefined geometric quantities.
2017-Oct-05	3.4.2, Appendix B	Version 4.3 adds reference to Level 4 files delivered for PRL through ESC3.
2018-Jan-31	Many	Update name of CTS Frequency Calibration document. Clarify discussion of geometry records. Update link to READPDS in Appendix C. Table 3.1 now identifies a data gap in Version 1.0 files. Section 2.3.4 provides additional calibration details. Updates/corrections to Appendices B and C..

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1 INTRODUCTION

1.1 PURPOSE AND SCOPE

The purpose of this EAICD (Experimenter to Planetary Science Archive Interface Control Document) is twofold. First, it provides users of the MIRO instrument with detailed description of the products and a description of how they were generated, including data sources and destinations. Secondly, the EAICD describes the interface to the Planetary Science Archive (PSA) of ESA and is the official document between each experimenter team and the PSA.

1.2 ARCHIVING AUTHORITIES

The Planetary Data System (PDS) Standard is used as archiving standard by

- NASA for U.S. planetary missions, implemented by PDS
- ESA for European planetary missions, implemented by the Research and Scientific Support Department (RSSD) of ESA

ESA's online Planetary Science Archive (PSA) was implemented

- to support and ease data ingestion
- to offer additional services to the scientific user community and science operations teams as e.g.
    - search queries that allow searches across instruments, missions and scientific disciplines
    - several data delivery options as
        - direct download of data products, linked files and data sets
        - ftp download of data products, linked files and data sets

The PSA aims for online ingestion of logical archive volumes and will offer the creation of physical archive volumes on request.

1.3 CONTENTS

This document describes the data flow of the MIRO instrument on Rosetta from the s/c until the insertion into the PSA. It includes information on how data were processed, formatted, labelled and uniquely identified. The document discusses general naming schemes for data volumes, data sets, data and label files. Standards used to generate the product are explained.

The design of the data set structure and the data product is given. Examples of these are given in the appendix.

1.4 INTENDED READERSHIP

The MIRO science, software development and engineering team, the staff of the Planetary Science Archive design team, and any potential user of MIRO data.

1.5 APPLICABLE DOCUMENTS

AD1 Rosetta Archive Generation, Validation and Transfer Plan, 10 January 2006, RO-EST-PL-5011, Issue 2, Revision 3

AD2 Planetary Data System Standards Reference, 1 August 2003, Version 3.6, JPL D-7669, Part 2

AD3 Planetary Data System Data Dictionary Document, 28 August 2002, Revision E, JPL D-7116

AD4 MIRO Users Manual, RO-MIR-PR-0030, issue 6.1

AD5 Acton, C.H.; "Ancillary Data Services of NASA's Navigation and Ancillary Information Facility;" Planetary and Space Science, Vol. 44, No. 1, pp. 65-70, 1996.

AD6 Backus, C. and Gulkis, S., "CTS: Frequency Response as a Function of Temperature", included in MIRO PDS/PSA document directory as CTS_FREQUENCY_CALIBRATION.PDF

AD7 Rosetta Time Handling, 28 February 2006, RO-EST-TN-3165, Issue 1, Revision 1

1.6 RELATIONSHIPS TO OTHER INTERFACES

The controlling document of the interfaces discussed here is AD1. For further details on the MIRO instrument and its usage, see AD4.

1.7 ACRONYMS AND ABBREVIATIONS

bps	bits per second
CCSDS	Consultative Committee for Space Data Systems
CODMAC	Committee on Data Management and Computation
CTS	Chirp Transform Spectrometer
DBMS	Database Management System
DDS	Data Distribution System (Darmstadt, Germany)
DVD	Digital Video Disk
ESA	European Space Agency
GHz	GigaHertz (10^9 Hz)
HSK	Housekeeping
IFP	Intermediate Frequency Processor
JPL	Jet Propulsion Laboratory (Pasadena, CA)
kHz	kiloHertz (10^3 Hz)
LO	Local Oscillator
MHz	MegaHertz (10^6 Hz)

MM	millimeter
MIRO	Microwave Instrument for the Rosetta Orbiter
NAIF	Navigation and Ancillary Information Facility
NaN	“Not a Number,” digital representation of an undefined or unrepresentable value
NASA	National Aeronautics and Space Agency (USA)
OBT	On-Board Time
PDS	Planetary Data System
PSA	Planetary Science Archive
rms	root mean square
SUBMM	submillimeter
TDB	Barycentric Dynamical Time
USO	Ultra Stable Oscillator
UTC	Coordinated Universal Time

1.8 CONTACT NAMES AND ADDRESSES

Table 1-1: Primary Contacts for Archiving Purposes.

Last Name	First Name	Institution	Phone	Email
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2 OVERVIEW OF PROCESS AND PRODUCT GENERATION

2.1 MIRO OVERVIEW AND OBJECTIVES

The MIRO investigation addresses the nature of the cometary nucleus, outgassing from the nucleus, and development of the coma (both gas and dust) as strongly interrelated aspects of cometary physics. MIRO also performed searches for outgassing activity on asteroids. MIRO is configured both as a continuum and a very high spectral resolution line receiver. Center-band operating frequencies are near 190 GHz (1.6 mm) and 562 GHz (0.5 mm). Spatial resolution of the instrument at 562 GHz is approximately 50 m at a distance of 20 km from the nucleus; spectral resolution is sufficient to observe individual, thermally broadened, line shapes at all temperatures down to 10 K or less.

MIRO continuum channels at millimeter and submillimeter wavelengths sense the subsurface temperature of the nucleus to depths of several centimeters or more. Model studies relate these measurements to electrical and thermal properties of the nucleus and address issues connected to the sublimation of ices, ice and dust mantle thickness, and the formation of gas and dust jets. The global nature of these measurements will allow in situ lander data to be extrapolated globally, while the long duration of the mission allows us to follow the time variability of surface temperatures and gas production. MIRO is highly complementary to the IR mapping instrument on the orbiter (VIRTIS), having similar spatial resolution but greater depth penetration.

MIRO's spectrometer only operates at submillimeter wavelengths, and observes four key volatile species simultaneously: H_2O, CO, CH_3OH, and NH_3. The three main oxygen isotopologues of water ($H_2{}^{16}O$, $H_2{}^{17}O$, and $H_2{}^{18}O$) are all measured, as are three different CH_3OH transitions. The primary retrieved products are abundance and velocity of each species, along with their spatial and temporal variability. This information is used to infer coma structure and processes, including the nature of the nucleus/coma interface.

2.2 INSTRUMENT DESCRIPTION SUMMARY

The MIRO instrument provides both very sensitive continuum capability for temperature determination and extremely high-resolution spectroscopy for observation of molecular species. The instrument consists of two heterodyne radiometers, one at millimeter wavelengths (1.6 mm) and one at submillimeter wavelengths (0.5 mm). The millimeter and the submillimeter radiometers have continuum bandwidths of 0.5 GHz and 1.0 GHz respectively. The submillimeter receiver has a total spectroscopic bandwidth of 180 MHz and a spectral resolution of 44 kHz. In the spectroscopic mode, 4,096 channels, each having a bandwidth of 44 kHz, are observed simultaneously.

The performance parameters that govern the MIRO instrument design include system sensitivity, spatial resolution, radiometric accuracy (both absolute and relative), beam pattern and pointing accuracy, together with the mass, power, volume envelope, and environmental conditions available within the spacecraft. The MIRO instrument performance characteristics are summarised in Table 2-1. More detailed information can be found in the MIRO User Manual (AD4).

Table 2-1: MIRO Instrument Performance Characteristics.

Equipment	Property	Millimeter-Wave	Submillimeter-
Telescope	Primary Diameter Primary F/D Sidelobes Spatial Resolution Footprint size (at 10 km)	30 cm 1 –30 dB 23.8 arcmin ~75 m	30 cm 1 –30 dB 7.5 arcmin ~25 m
Spectral Performance	Sky Frequency Band (Double Sideband) 1st IF Bandwidth 1st IF Frequency Range Radiometer Bandwidth Spectral Resolution Allocated Spectral Range per line Accuracy	186.7–189.7 GHz 550 MHz 1–1.5 GHz 0.5 GHz n/a n/a n/a	547.6–579.2 GHz 11 GHz 5.5-16.5 GHz 1.0 GHz 44 kHz nominally ~20 MHz 10 kHz
Spectrometer	Center Frequency/Bandwidth Number of channels	n/a n/a	1350/180 MHz 4096
Radiometric Performance	DSB Receiver Noise Temperature SSB Spectroscopic Sensitivity (300 KHz, 2 min) : relative absolute Continuum Sensitivity (1 sec): relative absolute	~2000 K n/a n/a 1 K rms 3 K rms	~4000 K 2 K rms 3 K rms 1 K rms 3 K rms
Data Rates	Continuum Mode Spectroscopic Mode On-board Storage	<1 kbps 2.5 kbps 0.2 GB (one day's data volume, Mode 3, 100% duty cycle)	

2.3 DATA PRODUCTS DESCRIPTION

2.3.1 INTRODUCTION

The MIRO instrument has 6 major modes of operation and data-taking that reflect operational combinations of its two continuum radiometers and the spectrometer: engineering mode, millimeter continuum mode, submillimeter continuum mode, dual continuum mode, CTS/submillimeter continuum mode, and CTS/dual continuum mode. In addition, a special mode has been designed for planetary and asteroid flybys. A number of data compression options are obtained in each mode by varying the data-taking rate (integration time per sample) and/or spectral resolution of the radiometers and spectrometer. The specific parameters for each mode are described in more detail in the MIRO User Manual (AD4), but are summarized below.

All engineering (housekeeping) data, continuum and spectroscopic data (both raw and calibrated) are table files, consisting of time sequences of measured data. The detailed structure of these files is defined by the Structure Files listed in Appendix B. It is anticipated that, in the future, derived products will be generated in image, cube or map format, but these formats have not yet been defined.

2.3.2 MAJOR DATA MODES

ENGINEERING MODE

In engineering mode the MIRO software is collecting engineering data from 56 internal sensors. The sampling of these sensors is at a 5 Hz rate, but only the latest sample available at the time a telemetry packet is generated is returned by the instrument. All engineering measurements are 12-bit A/D converted values. The engineering mode telemetry is sent to the spacecraft in the form of a housekeeping telemetry packet. One engineering telemetry packet is typically generated every 11 seconds. This is the maximum rate possible, which results in the most stable calibration of the instrument. Early and late in the mission, slower engineering telemetry rates were used to minimize data volume. The frequency of housekeeping packet generation is controlled by the Housekeeping Cycle Skip telecommand; see the Users Manual (AD4) for details.

MILLIMETER CONTINUUM MODE

In millimeter continuum mode continuum data are collected from the millimeter radiometer at a 20 Hz rate. All continuum data consist of 16-bit values. The millimeter continuum data are returned in science telemetry packets usually containing 200 continuum samples. At the nominal collection rate of 20 Hz, a millimeter packet is generated every 10 seconds. A ‘summing value’ parameter can cause the MIRO software to sum either 1, 2, 5, 10 or 20 separate radiometer measurements prior to putting them into the telemetry packet. This feature can reduce the data rate to as little as one millimeter continuum packet every 200 seconds, with each of the 200 samples representing a 1-second integration. The continuum data records contain a parameter called “ND” which provides the number of continuum data samples in the packet.

While the vast majority of the time there are 200 continuum samples in a packet, increasing the continuum summing parameter can result in occasional smaller packets, as can operating in modes that do not collect spectrometer data (i.e., Millimeter Continuum, Submillimeter Continuum, and Dual Continuum modes). These smaller packets occur just before a calibration sequence, and are the result of the timing and prioritization of various tasks the instrument must execute. Packets containing less than 200 continuum samples are valid and contain good data.

SUBMILLIMETER CONTINUUM MODE

Sub-millimeter continuum mode is identical to the millimeter continuum mode in data collection and packing except that a different set of electronics is powered on. Millimeter and submillimeter continuum data are contained in separate science telemetry packets, identified by a field in the source data header.

DUAL CONTINUUM MODE

In dual continuum mode, the millimeter and submillimeter continuum receivers are collected simultaneously. When running in dual continuum mode, the summing value parameter mentioned earlier is applied to both sets of data, causing equal amounts of millimeter and submillimeter data to be generated.

CTS / SUBMILLIMETER CONTINUUM MODE

This mode adds the collection of chirp transform spectrometer (CTS) data to Submillimeter Continuum Mode. Normal CTS science data is "frequency switched" (described below), with one spectrum generated from 30 seconds of data. Selectable integration times are 30, 60, 90, and 120 seconds.

Frequency switching is a calibration technique that removes frequency-dependent artifacts from the data. To utilize it, the CTS is programmed to collect data in paired, 5-second periods. An internal LO frequency generator is switched every 5 seconds, introducing a small shift in frequency between the two 5-second periods in a pair. These paired LO observations are repeated 3, 6, 9, or 12 times to produce 30-, 60, 90, or 120-second spectra. Each LO setting is integrated separately over the requested interval, and then the data from the two LO frequencies are subtracted from each other to provide a single 4096-element difference spectrum. Thus, a 30-second frequency-switched spectrum consists of a 15 second integration with the LO set to +5 MHz (LO=1) subtracted from a 15-second integration with the LO set to -5 MHz (LO=0). This subtraction results in 1) many instrument-caused frequency-dependent features being eliminated from the spectrum, and 2) the spectral line generated by the comet appearing twice in the spectrum; once as a positive feature and 10 MHz away as a negative feature. (A future MIRO data product will "fold" the frequency-switched data so that the two comet spectral features are combined, reducing the noise level.) Frequency switching is only performed when the CTS is powered on.

CTS data collection and the LO frequency switching is coordinated with the collection of continuum data. Exactly 100 continuum samples are taken during each LO setting, and only one LO setting is in place during each CTS 5-second internal integration period. This assures that it is known at which LO frequency each of the measurements are made.

To reduce instrument data volume, the 4,096 spectrometer channels can be smoothed on board, resulting in telemetered spectra with 4096, 2046, 1364, or 1022 channels. See the Users Manual (AD4) Section 6.1.2.1.4.2 for details of the smoothing function applied. *Regardless of whether smoothing is applied, all uncalibrated spectra in the archive have 4096 channels, with NaN's (or in some Version 1 files 0.0 or -999) padding the higher channel numbers when smoothing is applied.*

The CTS channel-to-frequency conversion is temperature dependent (see the Users Manual [AD4] Section 9.4). While the CTS is temperature-controlled, for operational reasons temperature settings were occasionally changed. Temperatures also varied during instrument warm-up. To preserve the native resolution of the spectrometer (approximately 44 kHz) while also making it convenient to compare spectra taken at different temperatures, *when reporting calibrated spectra on an absolute frequency scale, two spectra are provided in files generated by MIRO Pipeline software Version 2.0. One contains the intrinsic 4096 channels, with channel frequencies indicated for the current temperature of the CTS. The second calibrated spectrum is interpolated to a common frequency grid containing 4152 channels*. This second spectrum allows all spectra collected during the course of the mission to be provided in a common format. Each calibrated spectrum on the common frequency grid will have either the lowest, highest, or both the lowest and highest channel numbers reported as NaN, indicating those frequencies were not sampled at the current CTS temperature. (In Version 1.0 and 1.1 calibrated CTS data sets, only one calibrated spectrum is provided, it contains 4,250 channels, and 0.0 or -999 can be used instead of NaN.)

A mask is applied to the CTS data and only 12 bits of each resulting measurement are returned to Earth.

CTS / DUAL CONTINUUM MODE

This is the same as the CTS / SMM continuum mode except that the millimeter data are also collected.

ASTEROID MODE

This special data-taking mode has been implemented for the asteroid and planetary encounters to enable MIRO to follow the rapid and large Doppler shift of spectral lines that may be visible. The primary characteristic of this mode is that LO frequency switching is turned off. The LO is set to either +5 MHz or - 5 MHz from the nominal frequency prior to the encounter. At a specified time (typically closest approach to the target so the Doppler shift is zero), the LO frequency is switched to the opposite value. Each spectrum of Asteroid Mode CTS data consists of a single 5-second integration with all 32 bits returned for each of the 4,096 channels.

Continuum data are collected at 20 Hz during Asteroid Mode.

This mode was not used during comet observations. During other mission phases, one must look at the “asteroidmode” parameter in the CTS data records to determine if the instrument was in this mode.

SOME NOTES ON FREQUENCY SWITCHING AND THE TIMING OF CONTINUUM DATA

When in a CTS data collection mode, frequency switching (described earlier in this section) is applied. This has several impacts on the continuum data.

- Instrument performance is slightly different at the two LO settings, requiring the data with LO=0 to be calibrated independently from data with LO=1. This is possible because calibration data are collected separately at each LO setting when frequency switching is active (Section 2.3.4).
- Consideration of the Power and Summation parameters in the continuum data records allows one to determine the LO state for every continuum sample in a packet except when in Asteroid Mode (discussed below). Power is used to identify when the instrument is in a CTS mode and frequency switching is

active. The Summation parameter indicates if each reported continuum measurement integrates for 0.05, 0.1, 0.25, 0.5, or 1 second, indicating that there are 100, 50, 20, 10, or 5 samples during each 5-second LO setting.

- Because LO switching is synchronized with data collection, the first continuum samples (except when in Asteroid Mode) are collected with LO=0 (the -5 MHz setting), which then alternates with LO=1 (+5 MHz) every 5 seconds.
- The time required to perform a frequency switch is slightly variable (by about 5 msec). To guarantee accurate timing of every sample in a continuum packet (primarily needed for geometry calculations during rapid slews or flybys), several time stamps are provided.
    - Time is always the start of integration of the first sample in a packet, which is collected with LO=0.
    - The time interval between samples at a given LO setting is determined by the Summation parameter.
    - Time1 marks the beginning of the first integration with LO=1 when Summation=0 or 1 (the 101st or 50th sample in the packet, respectively). For all other Summation values, Time1 is zero.
    - Time2 marks the beginning of the second LO=0 integration when Summation=1(the 101st sample). For all other Summation values, Time2 is zero.
    - Time3 marks the beginning of the second LO=1 integration when Summation=1 (the 151st sample). For all other Summation values, Time3 is zero.
    - For Summation=2 or 3, the integration time of each sample is large enough (0.5 and 1 second, respectively), that the timing uncertainty during a 200-sample packet due to LO switching is negligible. In these modes, only Time along with the nominal integration period is needed to time-tag each continuum sample.
- Asteroid Mode was not used at the comet, but for completeness we point out that because LO-switching is suppressed in this mode, timing uncertainties in a continuum packet are negligible in spite of the Summation parameter being 0. In this mode, the Time and Summation parameters are sufficient to determine the time of each sample. Note also that a user must look in the CTS data packets at the “Asteroidmode” parameter to determine whether or not the instrument is in this mode.

2.3.3 GROUND TEST DATA

Ground tests in a thermal-vacuum chamber were carried out at JPL from 15 May to 29 June 2001 and were intended to determine characteristics of the MIRO instrument in vacuum conditions and as a function of temperature. The emphasis was on deriving parameters that cannot be obtained under ambient conditions, such as the noise figures of various electronic components, the frequency response of the instrument and the linearity of the response, and the stability of several features. The data obtained from these tests and the accompanying log files are delivered as the first MIRO archive dataset.

2.3.4 CALIBRATION

2.3.4.1 Radiometric Calibration

See the MIRO Users Manual (AD4) Section 9.5 for a detailed discussion of MIRO radiometric calibration.

The MIRO instrument is calibrated on a periodic basis and immediately following every mode change. An automatic calibration will take place every 1895 seconds (approximately 32 minutes), if not interrupted by a mode change command, which triggers a calibration immediately. The normal interval of 1895 seconds allows 95 seconds for the calibration and 1800 seconds (30 minutes) for the data collection period. The 1800 seconds allows for complete CTS integration periods of 30, 60, 90, and 120 seconds (60, 30, 20, and 15 output spectra respectively). The 95 seconds of calibration data are distributed as follows:

Table 2-2: Allocation of Time in a Calibration Sequence.

Time	Activity
5	3 mirror movements/no data collection
30	Warm load position- CTS + continuum + engineering
30	Cold load position - CTS + continuum + engineering
30	Sky position - CTS + continuum + engineering

These calibration data are included in the level-2 data files as part of the time sequence. They are flagged by a Calibration field in the header columns (see the Structure files in Appendix B).

Each calibration sequence includes collecting 30 seconds of data on an internal warm calibration target, 30 seconds on an internal cold calibration target, and 30 seconds on the sky wherever the instrument boresight is pointed during the sequence. The continuum Summation parameter and, if in a spectroscopic mode, the CTS Smoothing parameter, are applied during calibration observations. If the CTS is on, frequency switching is performed during calibration observations but—unlike during normal science observations—the two LO settings are not subtracted from each other. Instead one spectrum is returned for each of the two LO settings (each representing a 15-second integration). Thus there are two spectra returned on the warm load, two from the cold load, and two on the sky. The number of continuum packets returned on each calibration target depend on the Summation parameter: three are returned for Summation=0, two for Summation=1, and one for Summation=2 or 3. These data are used to determine the relation between instrument counts and absolute flux units. Flux is reported as a Rayleigh-Jeans brightness temperature in Kelvin. The brightness temperature is related to, but not the same as, the physical temperature of the target (see AD4 Section 9.2 for a detailed discussion).

The instrument response is assumed to be linear, so that the relation between recorded counts, D, and brightness temperature, T, is

$$D = g * T + I \quad \text{(Eq. 1)}$$

where g is the gain in counts per Kelvin, and I is the intercept in counts. Since the physical and hence the brightness temperatures of the warm and cold calibration targets are known (see below), and using the subscript H to refer to the warm load and C to the cold, a calibration sequence can be used to determine the gain and intercept by these equations:

$$g = (D_H - D_C)/(T_H - T_C) \quad \text{(Eq. 2)}$$

and

$$I = \bar{T} * (1 - g) \quad \text{(Eq. 3)}$$

where $\bar{T}$ is $(T_H - T_C)/2.0$. We will refer to the gain and offset collectively as the calibration parameters.

The above equations are used to determine the calibration parameters at the time of each calibration cycle. These will be referred to as the "instantaneous calibration parameters." For continuum data, the *"D"* in Equations 1 and 2 is the average number of counts reported while observing each load (and hence may average multiple packets depending on the Summation value), with LO0 and LO1 data averaged separately. For spectroscopic data, the two LO settings are averaged together, but calibration parameters for each channel are calculated independently.

Instantaneous gains are not calculated when there is no engineering data from within ±1 minute of the calibration cycle. In addition, instantaneous continuum gains whose values deviate significantly from expected values are not used (mm gains < 4.0 counts/K or > 6.0 counts/K; submm gains < 1.45 counts/K or > 1.7 counts/K).

As discussed in AD4, Section 9.5, smoothing the calibration parameters over time results in better science data. Later in this section we describe how the instantaneous calibration parameters are applied to the data.

THE BRIGHTNESS TEMPERATURE OF THE CALIBRATION TARGETS

The mounting of the cold calibration target extends outside the spacecraft and radiates to cold space, keeping its temperature below that of the general spacecraft interior. The internally mounted hot load is heated to keep it above the ambient temperature of the spacecraft. These temperatures are not controlled, but are measured. Each calibration target has two thermistors within it, and their temperatures are reported in the Engineering data as indicated in Appendix B, Section B.5. At the time of a calibration sequence, the physical temperature of each calibration target is taken to be the average of the reading of its two thermistors in the engineering packet collected at the time closest to the beginning of the calibration sequence. This physical temperature is not the brightness temperature to be used in the calibration equations, however. As discussed in AD4 Section 9.2, a correction needs to be applied

$$T_B = \frac{h\nu}{k} * \frac{1}{e^{\frac{h\nu}{kT_{Phys}}}-1} \quad \text{(Eq. 4)}$$

where T_B is the brightness temperature, T_{Phys} is the physical temperature of that load, h is the Planck constant, k is Boltzmann's constant, and ν is the frequency of observation.

A further correction is required for the millimeter-wavelength cold load brightness temperature. This is due to a design error which allows the millimeter receiver to pick up some signal from the mounting structure of the cold target. The final cold-load brightness temperature to use in Eq.'s 2 and 3 is

$$T_C = T_B * 0.925 + T_{OB} * 0.075$$

where T_B in the above equation is the cold-load brightness temperature from Eq. 4 and T_{OB} is the brightness temperature of the optical bench from Eq. 4. The physical temperature of the optical bench is found in the engineering data along with the calibration target physical temperatures.

CONTINUUM RADIOMETRIC CALIBRATION

Software Version 1

In Versions 1.0 and 1.1 of the continuum calibration software (used in generating Level 3 Version 1.0 products in the PSA/PDS), gain and offset as a function of time are found from a linear interpolation between the instantaneous calibration immediately preceding a science observation and the instantaneous calibration immediately after. When in a spectroscopic mode (which means frequency-switching is applied), the calibration parameters for LO0 and LO1 are calculated separately and applied separately to the LO0 and LO1 continuum science data. For simplicity, even when not in a spectroscopic mode, the continuum gains are calculated and applied as if frequency switching were active.

This calibration algorithm adds noise to the calibrated data because the instrument gain is more stable than the measurement precision of an instantaneous gain calculation. For this reason, Version 1.0 of Level 3 products should not be used when Version 2.0 is available.

Note that observations of empty sky calibrated with Version 1 software typically show a brightness of about 1.6 K in the submm, and -0.5 K in the mm channel. Expected values of the cosmic microwave background are about 0 and 0.5 K in the submm and mm, respectively, so the MIRO values are in error. These offsets are believed to be due to a slight non-linearity in the MIRO detectors, creating errors when observing targets much cooler than the calibration loads. Such errors should be negligible (less than 0.2 K) for all comet and asteroid observations except those of the night side (where temperatures can drop well below 150 K). An improved algorithm to account for this is planned for a later delivery.

Software Version 2

For calibrated continuum science data generated by MIRO Pipeline software Version 2.0 (used in generating Level 3 and 4 Version 2.0 products in the PSA/PDS), gain as a function of time is calculated in a two-step process. First, the instantaneous gains are box-car smoothed: at the time of a calibration, 16 instantaneous gains before and 16 after are averaged with the instantaneous gain at that time. This results in an averaged-gain at the time of each calibration cycle. Second, for the start time of each continuum science packet, a least-squares quadratic fit is made to the 16 box-car-smoothed gains nearest the start time (nominally 8 before and 8 after) to determine a gain versus time curve, and that gain curve is used in the calibration equation. A single gain value is used for all continuum science values in a packet. A similar process is used to determine the intercept as a function of time, except that 1) The instantaneous intercepts are not box-car smoothed, 2) The box-car smoothed gain values are used in Eq. 3 to generate a new instantaneous intercept, and 3) A linear fit to the 4 nearest instantaneous intercepts is used (nominally 2 before and 2 after the science data). When in a spectroscopic mode (which means frequency-switching is applied), the calibration parameters for LO0 and LO1 are calculated separately and applied separately to the LO0 and LO1 continuum science data. For simplicity, even when not in a spectroscopic mode, the continuum gains are calculated and applied as if frequency switching were active.

Note that the Version 2 algorithm contains the same non-linearity errors when observing targets below 150 K as described in the Version 1 algorithm.

CTS RADIOMETRIC CALIBRATION

Software Version 1

The following description applies to calibrated CTS science data generated by MIRO Pipeline software Versions 1.0 and 1.1 (used in generating Level 3 and 4 Version 1.0 products in the PSA/PDS). Each of the 4096 CTS channels is calibrated independently. For reasons discussed in AD4 Section 9.5, the Intercept in Eq. 1 is taken to be zero. Because of frequency switching, a science spectrum incorporates data at both LO settings, so for CTS purposes the instantaneous gain is taken to be the average gain of the two LO settings.

The CTS gain at the time of a science observation is taken to be one-half of the gain determined by a linear interpolation in time between the instantaneous gains calculated just prior to and after the science observation. The factor of 1/2 (effectively increasing the reported brightness temperature) is due to the fact that MIRO is a double-sideband system. (MIRO measures the total power received in two frequency bands, an upper and a lower sideband. When looking at a continuum target, such as the comet nucleus or a calibration target, roughly equal amounts of power are received in each sideband. A spectral line, however, only exists in one of the sidebands, so the effective CTS gain for that line is only half of what it is for the calibration signal which exists in both sidebands.)

In a perfect instrument, frequency-switched spectra would have a baseline brightness (where there is no spectral feature from the comet) of 0 K. Due to a systematic offset between the calibration parameters at each LO setting, differenced spectroscopic data typically have a small positive bias, with the baseline being at about 2 K. This baseline also can vary in some bands (bands are defined in AD4 Section 9.3) due to an amplifier instability. We leave these nonzero baselines in the calibrated data because they may be of interest for future engineering uses. For science purposes, however, it is appropriate to estimate the baseline around each spectral feature in a band and subtract that value from all channels in the band, giving it a zero baseline.

As was discussed for continuum calibration, the instrument gain is actually more stable than the precision of an instantaneous calibration measurement. The linear interpolation in gain just described therefore adds noise to the calibrated data. Later software versions improve upon this by averaging the CTS gains over time. For this reason, Version 1.0 of Level 3 products should not be used when a higher version is available.

Software Version 2
The following description applies to calibrated CTS science data generated by MIRO Pipeline software Version 2.0 (used in generating Level 3 and 4 Version 2.0 products in the PSA/PDS). As described for Version 1, each of the 4096 CTS channels is calibrated independently, the Intercept in Eq. 1 is taken to be zero, and the instantaneous gain is taken to be the average gain of the two LO settings.

The gain at the time of a science observation is taken to be one-half of the average gain of the nearest 32 instantaneous gains. (See the description of Version 1 for an explanation of the factor of ½.) As explained above, differenced spectroscopic data typically have a small positive bias. For science use it is appropriate to estimate the baseline around each spectral feature in a band and subtract that value from all channels in the band, giving it a zero baseline.

2.3.4.2 Frequency Calibration

The frequency calibration of the CTS is a complex subject, described in AD6, and summarized in AD4, Section 9.4. The Receiver Frequency of the radiation entering the instrument (in the range 547.5 – 580.5 GHz, see Table 2-1) is translated by a series of mixers in the IFP to the frequency range of the CTS, centered at 1350 MHz. The relationship between IFP output frequency and channel number is a function of the CTS temperature. In the calibrated data (as well as in the engineering data) the SPECT_T1 field (see Appendix B, Section B.2) gives this temperature. In Version 2 of the calibrated CTS data, spectra are interpolated to a common frequency grid, allowing spectra to be directly compared regardless of the value of SPECT_T1. (In Versions 1.0 and 1.1 of the calibration, all spectra were interpolated to a frequency grid corresponding to a 67.9 C temperature, and SPECT_T1 within the calibrated data file was reported as 67.9 C, regardless of what the true temperature was at that time.)

2.3.5 GEOMETRY INFORMATION

CODMAC Level 3 and 4 files generated by MIRO Pipeline software Version 2.0 contain geometry information calculated using a shape model for the nucleus and SPICE library routines. See the Users Manual [AD4] Section 9.6 for additional information on the geometry calculations. (In the older Version 1.0 and 1.1 files, geometry information—when provided—is of limited use, as it assumes the comet nucleus is a tri-axial ellipsoid.)

2.3.6 OPERATIONAL SCENARIOS AND MISSION PHASES

MIRO collected scientific and calibration data prior to entering deep space hibernation in June 2011, which was described in previous archive deliveries.

For most of its time at comet 67P, the MIRO instrument operated in CTS/Dual Continuum mode (see Section 2.3.2), with frequency-switching turned on, continuum science data collected at 20 Hz, and CTS spectra generated every 30 seconds. The spacecraft was power-limited in the earliest and latest mission phases at the comet. Stringent data-volume limitations also existed near solar conjunction (February 2015) and at the end of mission. At those times, other instrument modes and longer integration times were frequently applied. If the instrument is in a continuum-only mode, frequency switching is turned off.

Numerous observing sequences were utilized during the mission to optimize science return given various operational constraints. It is beyond the scope of this document to describe the sequences in detail, but in general they include long stares at the center of the nucleus, scans over portions of the nucleus (which may or may not include parts of the surrounding coma), scans over the entire nucleus (which may or may not include significant parts of the coma), stares or scans in parts of the coma, and scans over large regions of the coma.

The instrument mode called “Asteroid Mode” was used only for asteroid and planetary encounters, and was not use during the mission phases at the comet.

Archived MIRO data on comet 67P are divided into time-based mission phases as indicated below. The time ranges specified are defined by the Rosetta Project. In some cases, due to MIRO not being turned on or missing data packets, MIRO data may not be available in the entire time range specified.

PRL: Pre-landing covers the time period from 2014 January 21 (science-instrument recommissioning after hibernation exit) through 2014 November 18 (the end of lander operations). MIRO post-hibernation re-commissioning and check-out occurred on 27-29 April 2014. Early in the PRL phase the spacecraft was power-constrained, requiring MIRO to be switched off much of the time. By August 2014, however, power levels were such that MIRO could be on continuously.

ESC1: Escort 1, the first period of operations after landing operations, covers 2014 November 19 through 2015 March 10. Solar conjunction occurred in February 2015, drastically reducing data rates within ~1 month of that time.

ESC2: Escort 2 covers 2015 March 11 through 2015 June 30. The spacecraft entered a safemode (switching MIRO off for several days) in late March 2015.

ESC3: Escort 3 covers 2015 July 01 through 2015 October 20.

ESC4: Escort 4 is the last phase of the primary mission, covering 2015 October 21 through 2015 December 31.

EXT1: Extended 1, the first block of time in the extended mission covers 2016 January 01 through 2016 April 05.

EXT2: Extended 2 covers 2016 April 06 through 2016 June 28. The spacecraft entered a safemode (switching MIRO off for several days) in May 2016.

EXT3: Extended 3 covers 2016 June 29 through 2016 September 30 (end of mission).

2.3.7 DATA FLOWS

The MIRO telemetry packets coming from the spacecraft were retrieved from the ESOC Data Distribution System (DDS) at Darmstadt by PI-controlled workstations located at the Jet Propulsion Laboratory in Pasadena, CA, under the direct responsibility of the PI. The telemetry records are written in their original SFDU formats for permanent safekeeping in the MIRO archival system at JPL. These telemetry records will be kept in the MIRO project but are not considered part of the formal science archive. The Data Archive has the following characteristics:

1) The MIRO Data Archive system is located at JPL in Pasadena, CA.
2) The Data Archive system has the capability to store and maintain all the data coming from ESA (instrument/science data, housekeeping data, auxiliary data, navigation data, command logs) in their original format (SFDU format where applicable).
3) The Data Archive system is capable of transferring data to the MIRO data base management system (DBMS) for further processing.
4) The Data Archive system has the capability to store and maintain all the data in PSA/PDS format that will be delivered to ESA's Planetary Science Archive and NASA's Small Bodies Node of the PDS.

All data (science, housekeeping and auxiliary) in the MIRO Raw Data Archive at JPL are capable of being ingested into the MIRO DBMS. This DBMS is the means of access to the data for team members doing science analysis of these data.

Delivery of data to the Rosetta Mission Archive of the PSA of ESA and the Small Bodies Node of the PDS of NASA is done by extracting data from the MIRO DBMS into file formats defined by this document and generating PDS labels for these files. These files are placed in directory trees in the MIRO Data Archive, along with all associated documentation and index tables. Compressed copies of these directories are delivered to the PSA and PDS for external archival and will also remain online in the MIRO Data Archive. The MIRO team will support the peer reviews of MIRO-related data that are conducted by the ESA-PDS archiving team and will correct or otherwise appropriately resolve any liens identified by the peer review(s).

The Small Bodies Node of PDS will work jointly with the archiving scientists at ESA to prepare the complete ROSETTA archive within ESA consistent with all PDS standards (see AD2). The ROSETTA archive resides both at ESA and with

NASA's PDS. PDS and the ESA archiving scientists will carry out the peer review of all data to ensure that outside users can make good scientific use of the data from the archive. The final archive will be maintained electronically both by the PDS Small Bodies Node and by ESA. ESA will prepare CD ROM (or successor media such as DVD ROM) copies of the archive for distribution both through ESA and through PDS.

As refinements to the primary MIRO data products are made (e.g. improved calibration algorithms, higher-level data products), they will be stored in the MIRO database at JPL and, when appropriate, delivered to the PSA/PDS public archives.

Members of the MIRO science team will also produce at their home institutions data products as needed to perform their science tasks.

3 ARCHIVE FORMAT AND CONTENT

3.1 FORMAT

This section describes the format of the MIRO Instrument Team Archive volumes. Data in the archive will be formatted in accordance with Planetary Data System specifications (AD2).

3.1.1 VOLUME FORMAT

This document will not be concerned with any particular media formats such as DVD's because data will be delivered electronically. When applicable, media formats will be determined by the PDS. Also, for present purposes, datasets will be regarded as equivalent to volumes.

3.1.2 DATA SET NAMING

The informal Dataset Names used in this document are formed by appending the mission phase descriptor to the instrument name. Examples are:

MIRO_THERMALVAC

MIRO_PRL

MIRO_EXT3

The formal PDS values for DATA_SET_NAME and DATA_SET_ID are formed according to the rules defined in AD1:

DATA_SET_NAME = "ROSETTA-ORBITER <target name> MIRO <processing level> <mission phase> <description> <version>".

DATA_SET_ID = "RO-<target ID>-MIRO-<processing level>-<mission phase>-<description>-<version>".

Examples of DATA_SET_NAME are:

"ROSETTA-ORBITER CAL MIRO 2 GRND THERMAL-VAC V1.0"

"ROSETTA-ORBITER EARTH MIRO 2 EAR1 Earth-1 V1.0"

Examples of DATA_SET_ID are:

"RO-E-MIRO-2-EAR1-EARTH1-V1.0"

"RO-C-MIRO-3-4-ESC4-67P-V1.0"

See AD1 for allowed values for these items.

3.1.3 FILE NAME FORMATS

The following scheme will be used for names of files containing data products:

MIRO_<level>_<detector>_begindate.<ext>

The level field is the CODMAC processing level.

Valid names for the detector field include:

MM

SUBMM

CTS

HSK

MMCAL

SUBMMCAL

CTSCALIBRATEDSPECTRA

File extensions can be at least:

DAT	binary data
TXT	acsii data, lines of variable length, delimited typically with <CR>
LBL	ascii detached label file
DOC	text description where necessary

In data file names, begindate format will be yyyyddd, where ddd is 1-based Julian day, i.e. Jan 1 is day 1.

3.2 STANDARDS USED IN DATA PRODUCT GENERATION

3.2.1 PDS STANDARDS

The MIRO Data Products comply with the Planetary Data System standards for file formats and labels, as specified in the PDS Standards Reference (AD2).

3.2.2 TIME STANDARDS

The MIRO Data Products are intended to comply with the CCSDS Time Code Format Standard (CCSDS 301.0-B-2).

The On-Board Time (OBT) of the Rosetta spacecraft is used in the PDS keywords SPACECRAFT_CLOCK_START_COUNT and SPACECRAFT_CLOCK_STOP_COUNT. The format of this time (as defined in RO-EST-TN-3165, Rosetta Time Handling) is:

"i/mmmmmmmm[.nnnnn]"

where:

i = integer signifying which zero point is in use. (Currently, all OBTs have i=1, signifying that the zero point is at 2003-01-01T00:00:00 UTC. This integer will change if the clock is ever reset, which is not planned but may happen as a result of unforeseen circumstances.)

mmmmmmmm = integer seconds since the zero point.

nnnnn = (optional) fractional seconds in units of 1/65536 sec.

Therefore, the floating-point time since the zero point represented by a given OBT is:

time = mmmmmmmm + nnnnn/65536.

The OBT is not used internally in any MIRO data files. Instead, table entries are marked by Sun Modified Julian Time (SMJT) or "unix time", which is elapsed seconds since 1970-01-01T00:00:00 UTC. This takes leap seconds into account and is therefore in the UTC system. The conversion from SMJT to Ephemeris Time (ET2000), which is the standard TDB time system used by NAIF, is given by:

$$ET2000 = SMJT - 946727958.816 + LEAPSECS + O(0.0017)$$

where the last term represents a sinusoidal correction for the Earth's motion that never exceeds 0.0017 seconds, and LEAPSECS is the number of leap seconds that have been added between 1970 and the relevant date. A Fortran-77 program, named UTCCON, that converts between SMJT and the ISO standard UTC representation, is provided in the DOCUMENT directory. See AD7 for further discussion and conversions to other time systems.

3.3 Data Validation and Flagging

Data validation on MIRO archive products consists of basic checks on the completeness of Continuum packets and CTS spectra, automated flagging of some suspect data, and statistical analyses of the entire data set to confirm expected behaviors.

CODMAC Level 2 archive products (de-commutated telemetry values) only have completeness checks performed on them.

Version 2.0 CODMAC Level 3 (radiometrically calibrated) and Level 4 (calibrated and resampled) data products have warning flags set to indicate when the applied calibration is suspect and, for CTS data, if the frequency stability of the instrument is in question. In addition, products were tested in aggregate to check that noise statistics were approximately Gaussian (e.g. by making histograms of calibrated radiances looking at empty space), and that relatively few non-physical radiances were being generated (e.g. brightness temperatures less than -5 K or above 400 K).

3.4 Content

This section describes the directories and contents of the MIRO Data Product volumes, including the file names, file contents, file types, and organization responsible for providing the files. The data described herein appear on each volume of the MIRO Data Product volume series.

3.4.1 Volume Set

Since the Rosetta Project plans for electronic delivery and there is no need to bundle several datasets into one volume set, as a general rule, a volume shall be a dataset.

3.4.2 Data Set

The following table shows data set name (informal), DATA_SET_ID, delivery date, and data types contained, for each volume of the MIRO Data Product volume series, as of October 2017. The naming follows section 3.1.2. Many data sets have been delivered with two or more version numbers (e.g. MIRO Level 3

Commissioning data has V1.0 and V1.1). In general, the highest version number is the best data set to use for most purposes.

Regarding CODMAC Level 3 (reversibly calibrated) and Level 4 (irreversibly calibrated) data sets for Comet 67P with version number 1.0. There exist data sets whose ID indicates they are Level 3 data (e.g. RO-C-MIRO-3-ESC1-67P-V1.0), Level 4 data (RO-C-MIRO-4-ESC1-67P-V1.0), or combined Level 3 and 4 (e.g. RO-C-MIRO-3-4-ESC4-67P-V1.0). When version number is not a discriminator, the best calibrated radiances to use are from data sets with the highest CODMAC data level. So if both Level 3 and combined Level 3-4 data sets exist, both Version 1.0, the combined 3-4 one is superior. Similarly, if Level 3 and Level 4 data sets exist, both Version 1.0, use the Level 4.

Table 3-1: Data Sets Delivered.

Dataset Name and DATA_SET_ID	Delivery Date	Description
MIRO_Thermalvac RO-CAL-MIRO-2-GRND-THERMALVAC-V1.0	Nov 2006	Science Files, Engineering Files
MIRO_Commissioning (raw) RO-X-MIRO-2-CVP-COMMISSIONING-V1.0	Nov 2006	Science Files, Engineering Files
MIRO_Commissioning (calibrated) RO-X-MIRO-3-CVP-COMMISSIONING-V1.0	Nov 2006	Science Files, Geometry Files
MIRO_Commissioning (calibrated) RO-X-MIRO-3-CVP-COMMISSIONING-V1.1	Nov 2011	Science Files, Geometry Files
MIRO_Earth1 (raw) RO-E-MIRO-2-EAR1-EARTH1-V1.0	Nov 2006	Science Files, Engineering Files
MIRO_Earth1 (calibrated) RO-E-MIRO-3-EAR1-EARTH1-V1.0	Nov 2006	Science Files, Geometry Files
MIRO_Earth1 (calibrated) RO-E-MIRO-3-EAR1-EARTH1-V1.1	Nov 2011	Science Files, Geometry Files
MIRO_Tempel1 (raw) RO-C-MIRO-2-CR2-9P-TEMPEL1-V1.0	Dec 2006	Science Files, Engineering Files
MIRO_Tempel1 (calibrated) RO-C-MIRO-3-CR2-9P-TEMPEL1-V1.0	Dec 2006	Science Files, Geometry Files
MIRO_Tempel1 (calibrated) RO-C-MIRO-3-CR2-9P-TEMPEL1-V1.1	Nov 2011	Science Files, Geometry Files
MIRO_Earth2 (raw) RO-E-MIRO-2-EAR2-EARTH2-V1.0	Jun 2008	Science Files, Engineering Files
MIRO_Earth2 (calibrated) RO-E-MIRO-3-EAR2-EARTH2-V1.0	Jun 2008	Science Files, Geometry Files
MIRO_Steins (raw) RO-A-MIRO-2-AST1-STEINS-V1.0	Jul 2009	Science Files, Engineering Files
MIRO_Steins (calibrated) RO-A-MIRO-3-AST1-STEINS-V1.0	Jul 2009	Science Files, Geometry Files
MIRO_Earth3 (raw) RO-E-MIRO-2-EAR3-EARTH3-V1.0	Nov 2010	Science Files, Engineering Files
MIRO_Earth3 (calibrated) RO-E-MIRO-3-EAR3-EARTH3-V1.0	Nov 2010	Science Files, Geometry Files

Table 3-1 (Continued): Data Sets Delivered.

Dataset Name and DATA_SET_ID	Delivery Date	Description
MIRO_Lutetia (raw) RO-A-MIRO-2-AST2-LUTETIA-V1.0	Mar 2011	Science Files, Engineering Files
MIRO_Lutetia (calibrated) RO-A-MIRO-3-AST2-LUTETIA-V1.0	Mar 2011	Science Files, Geometry Files
MIRO_Prelanding (raw) RO-C-MIRO-2-PRL-67P-V1.0	May 2015	Science Files, Engineering Files Note that continuum data from 20-26 October 2014 are missing
MIRO_Prelanding (calibrated) RO-C-MIRO-3-PRL-67P-V1.0	May 2015	Science Files Note that continuum data from 20-26 October 2014 are missing
MIRO_Prelanding (calibrated) RO-C-MIRO-4-PRL-67P-V1.0	October 2017	Science Files
MIRO_Escort1 (raw) RO-C-MIRO-2-ESC1-67P-V1.0	May 2016	Science Files, Engineering Files
MIRO_Escort1 (calibrated) RO-C-MIRO-3-ESC1-67P-V1.0	May 2016	Science Files
MIRO_Escort1 (calibrated) RO-C-MIRO-4-ESC1-67P-V1.0	October 2017	Science Files
MIRO_Escort2 (raw) RO-C-MIRO-2-ESC2-67P-V1.0	August 2016	Science Files, Engineering Files
MIRO_Escort2 (calibrated) RO-C-MIRO-3-ESC2-67P-V1.0	August 2016	Science Files
MIRO_Escort2 (calibrated) RO-C-MIRO-4-ESC2-67P-V1.0	October 2017	Science Files
MIRO_Escort3 (raw) RO-C-MIRO-2-ESC3-67P-V1.0	October 2016	Science Files, Engineering Files
MIRO_Escort3 (calibrated) RO-C-MIRO-3-ESC3-67P-V1.0	October 2016	Science Files
MIRO_Escort3 (calibrated) RO-C-MIRO-4-ESC3-67P-V1.0	October 2017	Science Files
MIRO_Escort4 (raw) RO-C-MIRO-2-ESC4-67P-V1.0	June 2017	Science Files, Engineering Files
MIRO_Escort4 (calibrated) RO-C-MIRO-3-ESC4-67P-V1.0	June 2017	Science Files
MIRO_Escort4 (calibrated) RO-C-MIRO-3-4-ESC4-67P-V1.0	August 2017	Science Files, Geometry Files
MIRO_Extended1 (raw) RO-C-MIRO-2-EXT1-67P-V1.0	June 2017	Science Files, Engineering Files
MIRO_Extended1 (calibrated) RO-C-MIRO-3-EXT1-67P-V1.0	June 2017	Science Files
MIRO_Extended1 (calibrated) RO-C-MIRO-3-4-EXT1-67P-V1.0	August 2017	Science Files, Geometry Files
MIRO_Extended2 (raw) RO-C-MIRO-2-EXT2-67P-V1.0	June 2017	Science Files, Engineering Files
MIRO_Extended2 (calibrated) RO-C-MIRO-3-EXT2-67P-V1.0	June 2017	Science Files

Table 3-1 (Continued): Data Sets Delivered.

Dataset Name and DATA_SET_ID	Delivery Date	Description
MIRO_Extended2 (calibrated) RO-C-MIRO-3-4-EXT2-67P-V1.0	August 2017	Science Files, Geometry Files
MIRO_Extended3 (raw) RO-C-MIRO-2-EXT3-67P-V1.0	June 2017	Science Files, Engineering Files
MIRO_Extended3 (calibrated) RO-C-MIRO-3-EXT3-67P-V1.0	June 2017	Science Files
MIRO_Extended3 (calibrated) RO-C-MIRO-3-4-EXT3-67P-V1.0	August 2017	Science Files, Geometry Files

3.4.3 DIRECTORIES

This section describes the contents of each directory in a Data Product dataset.

3.4.3.1 Root Directory

The following table lists the files located in the root directory.

Table 3-2: Files in Root Directory.

File Name	File Contents
AAREADME.TXT	Introductory information about the contents and format of the volume.
CATALOG	Directory containing catalog files: mission, instrument, and dataset Descriptions which are duplicated in the PDS higher-level catalog.
DATA	Root directory for each data type present in this volume: Science (Spectroscopic and Continuum) Engineering, and Geometry.
DOCUMENT	Directory containing basic documentation.
ERRATA.TXT	Cumulative listing of comments and corrections.
INDEX	Directory containing index tables for the data files in this volume.
LABEL	Directory containing structure files references by PDS labels.
VOLDESC.CAT	Description of the contents of this volume in a PDS-labelled format.

Appendix A contains a listing of the VOLDESC.CAT file for one of the datasets listed in 3.4.2. All others are similar.

3.4.3.2 Catalog Directory

This directory contains files providing a top-level description of the Rosetta mission and spacecraft, the MIRO instrument and its team, and its data products. The following table describes the files in the Catalog Directory.

Table 3-3: Files in Catalog Directory.

File Name	File Contents
CATINFO.TXT	A description of the contents of this directory.
DATASET.CAT	PDS data set catalog information about the MIRO Data Product data sets.
INSTHOST.CAT	PDS instrument catalog information about the Rosetta Spacecraft.
INST.CAT	PDS instrument catalog information about the MIRO instrument.
MISSION.CAT	PDS mission catalog information about the Rosetta.
PERSONNEL.CAT	PDS personnel catalog information about the MIRO Team members responsible for generating the data products.
REF.CAT	PDS references mentioned in other files.

SOFTWARE.CAT	PDS software information about provided software (if any).
TARGET.CAT	PDS catalog information about the target bodies observed by Rosetta.

3.4.3.3 Data Directory

This directory contains three sub-directories. For CODMAC Level 2 data sets, the directories are Spectroscopic, Continuum, and Engineering, which each contain all the data files for the corresponding data type in the data set. For CODMAC Level 3 and 4 data sets, the three directories are Spectroscopic, Continuum, and Geometry, except for Version 1.0 of the Level 3 data sets. For those data sets, no Geometry files are provided.

3.4.3.3.1 Continuum Data Directory

This directory contains science data files containing Continuum (MM and SMM) data, and their detached labels.

3.4.3.3.2 Engineering Data Directory

This directory (only in CODMAC Level 2 data sets) contains files containing Engineering data, and their detached labels.

3.4.3.3.3 Spectroscopic Data Directory

This directory contains science data files containing Spectroscopic (CTS) data, and their detached labels.

3.4.3.3.4 Geometry Data Directory

This directory (when present) contains geometry data files containing geometry data and their detached labels. Separate geometry files are generated for the millimeter continuum, submillimeter continuum, and spectroscopic data. When geometry files are in a Data Set, there is a one-to-one correspondence between science data files and geometry data files, and all time tags within science data records are found in geometry data records. (Note that continuum data records contain more than one time tag—see Section 2.3.2—and geometry calculations are provided for each time tag, so there are more continuum geometry records than continuum data records.)

3.4.3.4 Index Directory

This directory contains index files providing summary information for all the data products in this data set.

The following table describes the files in the Index Directory.

Table 3-4: Files in Index Directory.

File Name	File Contents
INDEX.LBL	A volume index file.
INDXINFO.TXT	A description of the contents of this directory.
INDEX.TAB	Index table file for all data products.

3.4.3.5 Label Directory

This directory includes files referenced by data files on this volume, e.g. FMT files containing header descriptions. Sample structure files used in MIRO PDS labels are given in Appendix B.

3.4.3.6 Document Directory

This directory contains various files documenting the contents of this data set. Software is also in this directory. The following table describes the files in the Document Directory.

Table 3-5: Files in Document Directory.

File Name	File Contents
DOCINFO.TXT	A description of the contents of this directory.
MIRO_READ_DATA.ASC	A Fortran-77 program to list selected parts of MIRO data files, intended primarily as additional documentation for the structure files in Appendix B.
UTCCON.ASC	A Fortran-77 program that converts between the time system used in the data files and standard UTC notation.
RO_MIR_IF_001.PDF	This interface document.
USER_MANUAL.PDF	The MIRO User Manual [AD4].

Other documents, as available, including log files, ascii versions of documents, and corresponding LBL files.

3.4.4 DATA AND LABEL FILES

Science and Engineering data files are placed in the appropriate subdirectories of the data directory (3.4.3.4), together with their detached labels. Other data files shall be placed in their appropriate directories, all with detached PDS label.

4 DETAILED INTERFACE SPECIFICATIONS

In this chapter, detailed information about the archive design at instrument and detector level is given.

4.1 DATA PRODUCT IDENTIFICATION

The basic MIRO data product is a binary file containing scientific or ancillary data in table format, and an associated detached label file in PDS format describing the data. The file naming convention for these files is given in 3.1.3.

A data file contains a continuous stream of data for one of the MIRO instruments (CTS, MM radiometer, or SUBMM radiometer), for Engineering data, or for geometry information (see section 2.3). Note that the Data Mode in which the data were taken (section 2.3.2) is not relevant to the type of the data product, although the mode information for each row of the table is stored in the file. The length of a data file is arbitrary, being defined by the process of obtaining the data from the database, but it shall not exceed an observing time of one week.

4.2 PDS LABEL STRUCTURE, DEFINITION AND FORMAT

The following keywords are used in the PDS labels for MIRO data products (with the values given when these will be invariant):

PDS_VERSION_ID = PDS3
LABEL_REVISION_NOTE
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES
FILE_RECORDS
^TABLE
DATA_SET_NAME
DATA_SET_ID
MISSION_NAME = "INTERNATIONAL ROSETTA MISSION"
MISSION_ID = ROSETTA
INSTRUMENT_HOST_NAME = "ROSETTA ORBITER"
INSTRUMENT_HOST_ID = RO
INSTRUMENT_NAME = "MICROWAVE INSTRUMENT FOR THE ROSETTA ORBITER"
INSTRUMENT_ID = MIRO
INSTRUMENT_TYPE = {"RADIOMETER","SPECTROMETER"}
^INSTRUMENT_DESCRIPTION = "RO-MIR-IF-0001_16.TXT"
INSTRUMENT_MODE_ID
INSTRUMENT_MODE_DESC
TARGET_NAME
TARGET_TYPE
MISSION_PHASE_NAME
ORBIT_NUMBER
SPACECRAFT_CLOCK_START_COUNT
SPACECRAFT_CLOCK_STOP_COUNT
START_TIME
STOP_TIME
SC_SUN_POSITION_VECTOR

SC_TARGET_POSITION_VECTOR
SC_TARGET_VELOCITY_VECTOR
SUB_SPACECRAFT_LATITUDE
SUB_SPACECRAFT_LONGITUDE
SPACECRAFT_ALTITUDE
NOTE = "
The values of the keywords SC_SUN_POSITION_VECTOR,
SC_TARGET_POSITION_VECTOR and
SC_TARGET_VELOCITY_VECTOR are related to the ECLIPJ2000 reference frame.
The values of SUB_SPACECRAFT_LATITUDE and
SUB_SPACECRAFT_LONGITUDE
are northern latitude and eastern longitude in the standard planetocentric IAU <TARGET_BODY> frame.
All values are computed for the time 20xx-xx-xxTxx:xx:xx.xxx, the midpoint of the observations.
Distances are given in <km>, velocities in <km/s>, angles in <deg>."
PRODUCT_CREATION_TIME
PRODUCT_ID
PRODUCT_TYPE
PROCESSING_LEVEL_ID
PRODUCER_FULL_NAME = {"Dr. Samuel Gulkis", "Dr. Mark Hofstadter"}
PRODUCER_INSTITUTION_NAME = "JET PROPULSION LABORATORY"
PRODUCER_ID = JPL
DATA_QUALITY_ID
DATA_QUALITY_DESC = "1 = nominal, 2 = problematical"
OBJECT = TABLE
INTERCHANGE_FORMAT = BINARY
COLUMNS
ROWS
ROW_BYTES
^STRUCTURE = "xxxx.FMT"
END_ OBJECT = TABLE
END

The FMT file pointed to by the ^STRUCTURE keyword will be one of the six files in Appendix B (see 3.4.3.6). These contain the detailed specification of the contents of the data.

The file pointed to by the ^INSTRUMENT_DESCRIPTION resides in the Document directory (3.4.3.7). No mission-specific keywords will be used. All keywords are defined in the PDS data dictionary (AD3 or online at https://pds.jpl.nasa.gov/tools/dd-search/).

The coordinate system used for the geometric items in the label (SC...VECTOR) is the J2000 system, which is an inertial Cartesian frame based on the Earth mean equator of Epoch J2000.

4.3 OVERVIEW OF DETECTORS

4.3.1 SPECTROMETER DATA

The contents of the spectrometer (CTS) level-2, -3, and -4 data products are fully defined by the structure files listed in Appendix B.

For further details, see MIRO User Manual (AD4) 7.1.3.

4.3.2 RADIOMETER (CONTINUUM) DATA

The contents of the mm and submm radiometer level-2, -3 and -4 data products are fully defined by the structure files listed in Appendix B.

For further details, see MIRO User Manual (AD4) 7.1.4 and 7.1.5.

4.3.3 ENGINEERING DATA

The contents of the Engineering data products are fully defined by the structure file ENG_LEVEL_2_FORMAT.FMT, listed in Appendix B.

For further details, see MIRO User Manual (AD4) 7.1.2.

4.4 DATA FORMAT DESCRIPTION

The contents of the MIRO data files are fully defined by the *.FMT files in the LABEL directories of the archives. Here, a brief explanation is provided of the science-data portion of CTS and Continuum files. Additional information is in section 2.3. (The Engineering files are not discussed further as they are not likely to be of interest to the general user.)

It is important to understand that the Data column(s) and, in CTS files, frequency columns, of the data products contain large data arrays. In the CTS files, the arrays contain a complete spectrum, whereas in the Continuum files this is a packet of data in time order. The name of the Data column is simply D in Level 2 files. It is also D in Level 3 continuum files. In Level 3 CTS files, the data arrays are D in Versions 1.0 and 1.1. In Version 2.0 Level 3-4 CTS files, the data arrays are D and D_INTERPFREQ.

In Level 3-4 and Level 4 CTS files generated by software version 2.0 there are also frequency arrays for each spectrum, named IFREQ and IFREQ_INTERP.

A very important item is the Cal flag in the data products. When this flag is 0, then the spectrum is for a calibration sequence. When the flag is 1, then the data are science observations. It is unfortunate that Cal=0 means calibration, but this is a historical accident which, if changed, risks greater confusion. Note that calibration data is only included in CODMAC Level 2 files. Level 3 and 4 files only contain science data (Cal=1).

See Appendix C for a description of an IDL-based tool to read MIRO data that is provided by PDS, called READPDS. A python program called MIRO_READ_DATA is present in the DOCUMENT directory within some MIRO data sets. It is not maintained, but serves as an example of how to read all data formats used by MIRO. See Appendix C for details.

Frequency calibration: the total bandwidth of MIRO's CTS is 180 MHz, with the frequency going inversely with the bin (channel) number of the spectra, in an approximately linear fashion. The exact dependence is dependent on the temperature, which is why the number of bins are increased from 4096 for the raw data to 4152 for the calibrated data generated by Pipeline software Version 2.0 files (4250 in earlier software versions). This is described in Section 9.4 of the Users Manual (AD4), which is included in the DOCUMENT directory of the archive. This also describes how the true frequencies of the lines observed (which span 33 GHz, far more than the nominal bandwidth) are mapped into the CTS spectrum. Discontinuities between the eight regions of the different mappings appear as smooth transitions, because of the design of the CTS. Data in the transition regions between these bands are not usable.

Appendix A,
VOLDESC.CAT

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A. VOLDESC.CAT

```
PDS_VERSION_ID = PDS3
RECORD_TYPE    = "STREAM"
LABEL_REVISION_NOTE = "2017-06-26 L.Pan Created"

OBJECT     = VOLUME
  DATA_SET_ID                = "RO-C-MIRO-3-4-ESC4-67P-V1.0"
  VOLUME_SERIES_NAME         = "ROSETTA SCIENCE ARCHIVE"
  VOLUME_SET_NAME            = "ROSETTA: MIRO DATA"
  VOLUME_SET_ID              = "USA_NASA_JPL_ROMIR_1036"
  VOLUME_NAME                = "CALIBRATED MIRO DATA FOR THE ROSETTA COMET ESCORT 4  PHASE"
  VOLUME_ID                  = "ROMIR_1036"
  VOLUME_VERSION_ID          = "VERSION 1"
  VOLUMES                    = 1
  VOLUME_FORMAT              = "ISO-9660"
  MEDIUM_TYPE                = "ELECTRONIC"
  PUBLICATION_DATE           = 2017-06-26
  DESCRIPTION                = "This volume contains the data from the Microwave Instrument for the
                               Rosetta Orbiter (MIRO).  It contains calibrated data obtained during the
                               ROSETTA COMET ESCORT 4 Mission phase."

  OBJECT     = DATA_PRODUCER
    INSTITUTION_NAME         = "JET PROPULSION LABORATORY"
    FACILITY_NAME            = "MIRO DATA PROCESSING TEAM"
    FULL_NAME                = "MARK HOFSTADTER"
    ADDRESS_TEXT             = "JET PROPULSION LABORATORY \N
                               4800 OAK GROVE DRIVE \n
                               MAILSTOP 183-301 \n
                               PASADENA, CA 91109 \n
                               USA"
  END_OBJECT = DATA_PRODUCER

  OBJECT     = CATALOG
    ^MISSION_CATALOG         = "MISSION.CAT"
    ^INSTRUMENT_HOST_CATALOG = "INSTHOST.CAT"
    ^INSTRUMENT_CATALOG      = "INST.CAT"
    ^DATA_SET_CATALOG        = "DATASET.CAT"
    ^REFERENCE_CATALOG       = "REF.CAT"
    ^PERSONNEL_CATALOG       = "PERSONNEL.CAT"
    ^SOFTWARE_CATALOG        = "SOFTWARE.CAT"
    ^TARGET_CATALOG          = "TARGET.CAT"
  END_OBJECT = CATALOG

END_OBJECT = VOLUME

END
```

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Appendix B,
Structure Files

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B. STRUCTURE FILES

B.1. SPECTROMETER LEVEL 2 DATA (SEE SECTION 4.3.1)

Filename: CTS_LEVEL_2_FORMAT.FMT

Rosetta/miro cts raw data structure

This structure label gives the data structure for the data decommutated from the telemetry for the uncalibrated (raw) data from the MIRO Chirp Transform Spectrometer (CTS).

```
OBJECT              = COLUMN
  NAME                          = TIME
  COLUMN_NUMBER                 = 1
  DATA_TYPE                     = IEEE_REAL
  FORMAT                        = F16.5
  START_BYTE                    = 1
  BYTES                         = 8
  DESCRIPTION                   = "Time of acquisition of the spectrum in elapsed UTC seconds after 1-Jan-
                                  1970 (see EAICD Section 3.2.2)."
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                          = MIRPOS
  COLUMN_NUMBER = 2
  DATA_TYPE                      = MSB_UNSIGNED_INTEGER
  FORMAT                        = I1
  START_BYTE                    = 9
  BYTES                         = 1
  DESCRIPTION                   = "Mirror position: 1: sky, 2: warm target, 3: cold target"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                          = POWERMODE
  COLUMN_NUMBER = 3
  DATA_TYPE                     = MSB_UNSIGNED_INTEGER
  FORMAT                        = I1
  START_BYTE                    = 10
  BYTES                         = 1
  DESCRIPTION                   = "Values 1-6 as described in MIRO User Manual 6.1.2.1""
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                          = INTEGRATION
  COLUMN_NUMBER = 4
  DATA_TYPE                     = MSB_UNSIGNED_INTEGER
   FORMAT                       = I1
  START_BYTE                    = 11
  BYTES                         = 1
  DESCRIPTION                   = "Values 0-3 as described in MIRO User Manual 6.1.2.1""
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                          = SMOOTHING
  COLUMN_NUMBER = 5
  DATA_TYPE                     = MSB_UNSIGNED_INTEGER
```

```
   FORMAT                      = I1
   START_BYTE                  = 12
   BYTES                       = 1
   DESCRIPTION                 = "Values 0-3 as described in MIRO User Manual 6.1.2.1""
END_OBJECT            = COLUMN

OBJECT                = COLUMN
   NAME                        = CAL
   COLUMN_NUMBER               = 6
   DATA_TYPE                   = MSB_UNSIGNED_INTEGER
   FORMAT                      = I1
   START_BYTE                  = 13
   BYTES                       = 1
   DESCRIPTION                 = "0: Calibration in progress, 1: No calibration in progress""
END_OBJECT            = COLUMN

OBJECT                = COLUMN
   NAME                        = LO
   COLUMN_NUMBER               = 7
   DATA_TYPE                   = MSB_UNSIGNED_INTEGER
   FORMAT                      = I1
   START_BYTE                  = 14
   BYTES                       = 1
   DESCRIPTION                 = "LO designation, 0 or 1"
END_OBJECT            = COLUMN

OBJECT                = COLUMN
   NAME                        = NUMPLL
   COLUMN_NUMBER               = 8
   DATA_TYPE                   = MSB_UNSIGNED_INTEGER
   FORMAT                      = I2
   START_BYTE                  = 15
   BYTES                       = 1
   DESCRIPTION                 = "Number of used pll (phased-lock-loop) bytes"
END_OBJECT            = COLUMN

OBJECT                = COLUMN
   NAME                        = PLL_DATA
   COLUMN_NUMBER               = 9
   DATA_TYPE                   = MSB_UNSIGNED_INTEGER
   FORMAT                      = 24I1
   START_BYTE                  = 16
   BYTES                       = 24
   ITEMS                       = 24
   ITEM_BYTES                  = 1
   DESCRIPTION                 = "pll (phased-lock-loop) status bytes as described in MIRO User Manual
                                 7.1.3."
END_OBJECT            = COLUMN

OBJECT                = COLUMN
   NAME                        = ASTEROID
   COLUMN_NUMBER               = 10
   DATA_TYPE                   = MSB_UNSIGNED_INTEGER
   FORMAT                      = I1
   START_BYTE                  = 40
   BYTES                       = 1
```

```
   DESCRIPTION            = "Asteroid mode: 0: in asteroid mode, 1: not in asteroid mode, 4 as
                            described in MIRO User Manual 6.1.2.2."
END_OBJECT          = COLUMN

OBJECT              = COLUMN
   NAME                   = SPECTRAL_DATA
   COLUMN_NUMBER          = 11
   DATA_TYPE              = MSB_INTEGER
   FORMAT                 = 4096I9
   START_BYTE             = 41
   BYTES                  = 16384
   ITEMS                  = 4096
   ITEM_BYTES             = 4
   DESCRIPTION            = "Uncalibrated brightness temperature as signed integer"
END_OBJECT          = COLUMN
```

The following is an example of the first record of a Level-2 Spectroscopic file, with just 4 of the 4,250 data fields shown, in both hex and formatted representations:

```
Listing of rows     1 to     1 for file RO-E-MIRO-2-EAR1-EARTH1-
V1.0/DATA/SPECTROSCOPIC/MIRO_2_CTS_20050630809.DAT

 COL.#:          1          2  3  4  5  6  7  8  9
                       10     11
 ITEMS:  41D08A0D4F32378B 02 01 00 00 00 00 06 80 80 80 80 80 80 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00974000 009A8000 0097C000 009B4000

COL.#:          1           2    3    4    5    6    7    8    9
                                                               10       11
 ITEMS:   1.109931325E+09   2    1    0    0    0    0    6 128 128 128 128 128 128   0    0    0    0
  0   0    0   0   0    0    0    0    0    0    0    0    0    0    0      9912320     10125312
9945088    10174464
```

B.2. SPECTROMETER LEVEL 3 DATA GENERATED BY MIRO PIPELINE VERSION 1.0 AND 1.1 (SEE SECTION 4.3.1)

Filename: CTS_LEVEL_3_FORMAT.FMT

Rosetta/miro cts calibrated data structure

This structure label gives the data structure for the calibrated data from the MIRO Chirp Transform Spectrometer (CTS).

```
OBJECT              = COLUMN
   NAME                   = TIME
   COLUMN_NUMBER          = 1
   DATA_TYPE              = IEEE_REAL
   FORMAT                 = F16.5
   UNIT                   = SECOND
   START_BYTE             = 1
   BYTES                  = 8
   DESCRIPTION            = "Time of acquisition of the spectrum in elapsed UTC seconds after 1-Jan-
                            1970 (see EAICD Section 3.2.2)."
END_OBJECT          = COLUMN

OBJECT              = COLUMN
   NAME                   = UTC
   COLUMN_NUMBER          = 2
```

```
   DATA_TYPE                    = TIME
   FORMAT                       = A19
   START_BYTE                   = 9
   BYTES                        = 19
   DESCRIPTION                  = "Absolute time of acquisition of the spectrum in the UTC system.”
END_OBJECT            = COLUMN

OBJECT                = COLUMN
    NAME                        = MIRPOS
   COLUMN_NUMBER                = 3
   DATA_TYPE                    = MSB_UNSIGNED_INTEGER
   FORMAT                       = I1
   START_BYTE                   = 28
   BYTES                        = 1
   DESCRIPTION                  = "Mirror position: 1: sky, 2: warm target, 3: cold target"
END_OBJECT            = COLUMN

OBJECT                = COLUMN
   NAME                         = POWERMODE
   COLUMN_NUMBER                = 4
   DATA_TYPE                    = MSB_UNSIGNED_INTEGER
   FORMAT                       = I1
   START_BYTE                   = 29
   BYTES                        = 1
   DESCRIPTION                  = "Values 1-6 as described in MIRO User Manual 6.1.2.1""
END_OBJECT            = COLUMN

OBJECT                = COLUMN
   NAME                         = INTEGRATION
   COLUMN_NUMBER = 5
   DATA_TYPE                    = MSB_UNSIGNED_INTEGER
   FORMAT                       = I1
   START_BYTE                   = 30
   BYTES                        = 1
   DESCRIPTION                  = "Values 1-3 as described in MIRO User Manual 6.1.2.1""
END_OBJECT            = COLUMN

OBJECT                = COLUMN
   NAME                         = SMOOTHING
   COLUMN_NUMBER                = 6
   DATA_TYPE                    = MSB_UNSIGNED_INTEGER
   FORMAT                       = I1
   START_BYTE                   = 31
   BYTES                        = 1
   DESCRIPTION                  = "Values 1-4 as described in MIRO User Manual 6.1.2.1""
END_OBJECT            = COLUMN

OBJECT                = COLUMN
    NAME                        = CAL
   COLUMN_NUMBER                = 7
   DATA_TYPE                    = MSB_UNSIGNED_INTEGER
   FORMAT                       = I1
   START_BYTE                   = 32
   BYTES                        = 1
   DESCRIPTION                  = "0: Calibration in progress, 1: No calibration in progress""
END_OBJECT            = COLUMN
```

```
OBJECT                  = COLUMN
  NAME                        = LO
  COLUMN_NUMBER = 8
  DATA_TYPE                   = MSB_UNSIGNED_INTEGER
  FORMAT                      = I1
  START_BYTE                  = 33
  BYTES                       = 1
  DESCRIPTION                 = "LO designation, 0 or 1"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                        = ASTEROID
  COLUMN_NUMBER               = 9
  DATA_TYPE                   = MSB_UNSIGNED_INTEGER
  FORMAT                      = I1
  START_BYTE                  = 34
  BYTES                       = 1
  DESCRIPTION                 = "Asteroid mode: 0: in asteroid mode, 1: not in asteroid mode."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                        = SPECT_T1
  COLUMN_NUMBER               = 10
  DATA_TYPE                   = IEEE_REAL
  FORMAT                      = F6.2
  START_BYTE                  = 35
  BYTES                       = 4
  DESCRIPTION                 = "Engineering temperature of CTS (degrees C)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                        = TYPE
  COLUMN_NUMBER = 11
  DATA_TYPE                   = CHARACTER
  FORMAT                      = A1
  START_BYTE                  = 39
  BYTES                       = 1
  DESCRIPTION                 = "Type of calibration data used: C = cold, S = sky"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                        = STATUS
  COLUMN_NUMBER               = 12
  DATA_TYPE                   = MSB_UNSIGNED_INTEGER
  FORMAT                      = I1
  START_BYTE                  = 40
  BYTES                       = 1
  DESCRIPTION                 = "Status flag: 0 = nominal, <0 = problematical, >0 = TBD"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                        = METHOD
  COLUMN_NUMBER               = 13
  DATA_TYPE                   = CHARACTER
  FORMAT                      = A1
  START_BYTE                  = 41
```

```
  BYTES                       = 1
  DESCRIPTION                 = "Method of calibration: A = average, I = interpolate, N = nearest
                              neighbor"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                        = PLL
  COLUMN_NUMBER               = 14
  DATA_TYPE                   = MSB_UNSIGNED_INTEGER
  FORMAT                      = I4
  START_BYTE                  = 42
  BYTES                       = 1
  DESCRIPTION                 = "Logical OR of the PLL bytes in the raw record, indicating phased-lock
                              loop status"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                        = RA
  COLUMN_NUMBER               = 15
  DATA_TYPE                   = IEEE_REAL
  FORMAT                      = F7.3
  UNIT                        = DEGREE
  START_BYTE                  = 43
  BYTES                       = 4
  DESCRIPTION                 = "Right Ascension of the MIRO boresight”
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                        = DEC
  COLUMN_NUMBER               = 16
  DATA_TYPE                   = IEEE_REAL
  FORMAT                      = F7.3
  UNIT                        = DEGREE
  START_BYTE                  = 28
  BYTES                       = 4
  DESCRIPTION                 = "Declination of the MIRO boresight”
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                        = VEL
  COLUMN_NUMBER               = 17
  DATA_TYPE                   = IEEE_REAL
  FORMAT                      = E11.3
  UNIT                        = KILOMETER_PER_SECOND
  START_BYTE                  = 51
  BYTES                       = 4
  DESCRIPTION                 = "Relative velocity”
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                        = S0
  COLUMN_NUMBER               = 18
  DATA_TYPE                   = IEEE_REAL
  FORMAT                      = E11.3
  START_BYTE                  = 55
  BYTES                       = 4
```

```
  DESCRIPTION = "Spare"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                           = S1
  COLUMN_NUMBER                  = 19
  DATA_TYPE                      = IEEE_REAL
  FORMAT                         = E11.3
  START_BYTE                     = 59
  BYTES                          = 4
  DESCRIPTION                    = "Spare"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                           = SPECTRAL_DATA
  COLUMN_NUMBER                  = 20
  DATA_TYPE = IEEE_REAL FORMAT   = 4250F6.0
  UNIT                           = KELVIN
  START_BYTE                     = 63
  BYTES                          = 17000
  ITEMS                          = 4250
  ITEM_BYTES                     = "Antenna temperatures"
END_OBJECT              = COLUMN
```

The following is an example of the first record of a Level-3 Spectroscopic file, with just 4 of the 4250 data fields shown, in both hex and formatted representations:

```
Listing of rows     1 to     1 for file RO-E-MIRO-3-EAR1-EARTH1-
V1.0/DATA/SPECTROSCOPIC/MIRO_3_CTS_20050631015.DAT

 COL.#:         1                 2         3  4  5  6  7  8  9     10   11 12 13 14     15
     16       17       18        19       20
 ITEMS:  41D08A0D4F32378B 2005-03-04T10:15:25 02 01 00 00 00 00 00 4287CCCD 53 30 4E 80
00000000 00000000 00000000 00000000 00000000 467EDF40 4685B133 46879D24 468A3874

 COL.#:          1                  2          3   4    5   6   7   8   9     10     11  12 13 14
     15          16          17          18          19          20
 ITEMS:   1.109931325E+09 2005-03-04T10:15:25   2   1   0   0   0   0   0  6.790E+01 S  48 N
128  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  1.631E+04  1.711E+04  1.736E+04
1.769E+04
```

B.3. SPECTROMETER LEVEL 3 DATA, LEVEL 3/4 DATA, AND LEVEL 4 DATA GENERATED BY MIRO PIPELINE VERSION 2.0 (SEE SECTION 4.3.1)

Filename: CTS_LEVEL_3_FORMAT_2.FMT or CTS_LEVEL_4_FORMAT.FMT

Rosetta/miro cts calibrated data structure

This structure label gives the data structure for the calibrated data from the MIRO Chirp Transform Spectrometer (CTS) generated by Version 2.0 of the MIRO Pipeline processing software.

```
OBJECT       = COLUMN
 NAME             = TIME
 COLUMN_NUMBER       = 1
 DATA_TYPE          = PC_REAL
 FORMAT           = "F16.5"
```

```
 UNIT              = SECOND
 START_BYTE        = 1
 BYTES             = 8
 DESCRIPTION       = "Time of start of cts data collection.  Units are elapsed UTC seconds after 1-Jan-1970 (see
                      EAICD Section 3.2.2).  "
END_OBJECT    = COLUMN

OBJECT        = COLUMN
 NAME              = GMT
 COLUMN_NUMBER     = 2
 DATA_TYPE         = TIME
 FORMAT            = "A13"
 START_BYTE        = 9
 BYTES             = 13
 DESCRIPTION       = "Absolute UTC time of start of cts data collection.  Format is YYYYDDDHHMMSS
                      where YYYY is the year DDD is the day of year HH is the hour MM is the minute and
                      SS is the second.  Refer to TIME field for fractional seconds."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
 NAME              = POWER
 COLUMN_NUMBER     = 3
 DATA_TYPE         = LSB_UNSIGNED_INTEGER
 FORMAT            = "I1"
 START_BYTE        = 22
 BYTES             = 2
 DESCRIPTION       = "Power mode: values 1-6 as described in MIRO User Manual 6.1.2.1.2."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
 NAME              = INTEGRATION
 COLUMN_NUMBER     = 4
 DATA_TYPE         = LSB_UNSIGNED_INTEGER
 FORMAT            = "I1"
 START_BYTE        = 24
 BYTES             = 2
 DESCRIPTION       = "Integration mode: values 0-3 as described in MIRO User Manual 6.1.2.1.2."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
 NAME              = SMOOTHING
 COLUMN_NUMBER     = 5
 DATA_TYPE         = LSB_UNSIGNED_INTEGER
 FORMAT            = "I1"
 START_BYTE        = 26
 BYTES             = 2
 DESCRIPTION       = "Smoothing mode: values 0-3 as described in MIRO User Manual 6.1.2.1.2."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
 NAME              = CAL
 COLUMN_NUMBER     = 6
 DATA_TYPE         = LSB_UNSIGNED_INTEGER
 FORMAT            = "I1"
 START_BYTE        = 28
 BYTES             = 2
```

```
 DESCRIPTION        = "Calibration status: 0=calibration in progress; 1=no calibration in progress (note the non-
                        standard use of 0/1).  MIRO calibrated data generated by sw_version=2.0 only contain
                        cal=1 spectra."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME               = LO
 COLUMN_NUMBER      = 7
 DATA_TYPE          = LSB_UNSIGNED_INTEGER
 FORMAT             = "I1"
 START_BYTE         = 30
 BYTES              = 2
 DESCRIPTION        = "Local oscillator mode: values are 0 or 1 as described in MIRO User Manual 6.1.2.1.1.
                        This parameter  is only applicable for cal=0 spectra and can be ignored in
                        sw_version=2.0 calibrated MIRO spectra."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME               = ASTEROIDMODE
 COLUMN_NUMBER      = 8
 DATA_TYPE          = LSB_UNSIGNED_INTEGER
 FORMAT             = "I1"
 START_BYTE         = 32
 BYTES              = 2
 DESCRIPTION        = "Asteroid mode: 0=no asteroid mode; 1=asteroid mode in progress."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME               = SPECT_T1
 COLUMN_NUMBER      = 9
 DATA_TYPE          = PC_REAL
 FORMAT             = "F6.2"
 UNIT               = CELSIUS
 START_BYTE         = 34
 BYTES              = 8
 DESCRIPTION        = "CTS Temperature Sensor #1 Branch A."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME               = SW_VERSION
 COLUMN_NUMBER      = 10
 DATA_TYPE          = PC_REAL
 FORMAT             = "F6.2"
 START_BYTE         = 42
 BYTES              = 8
 DESCRIPTION        = "Identifier for MIRO software used to generate this record."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME               = D
 COLUMN_NUMBER      = 11
 DATA_TYPE          = PC_REAL
 FORMAT             = "F6.2"
 UNIT               = KELVIN
 START_BYTE         = 50
 BYTES              = 32768
```

```
 DESCRIPTION        = "Array of antenna temperatures of 4096 CTS bins (see MIRO User Manual Section 9.2)."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME              = IFREQ
 COLUMN_NUMBER       = 12
 DATA_TYPE          = PC_REAL
 FORMAT            = "F12.5"
 UNIT              = MHz
 START_BYTE         = 32818
 BYTES             = 32768
 DESCRIPTION        = "Array of intermediate frequencies of 4096 CTS bins. "
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME              = D_INTERPFREQ
 COLUMN_NUMBER       = 13
 DATA_TYPE          = PC_REAL
 FORMAT            = "F6.2"
 UNIT              = KELVIN
 START_BYTE         = 65586
 BYTES             = 33216
 DESCRIPTION        = "Array of antenna temperatures interpolated to a standard intermediate frequency grid of
                        4152 channels."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME              = IFREQ_INTERP
 COLUMN_NUMBER       = 14
 DATA_TYPE          = PC_REAL
 FORMAT            = "F12.5"
 UNIT              = MHz
 START_BYTE         = 98802
 BYTES             = 33216
 DESCRIPTION        = "Array of intermediate frequencies of the 4152-element standard frequency grid. "
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME              = ERR_PLL
 COLUMN_NUMBER       = 15
 DATA_TYPE          = LSB_UNSIGNED_INTEGER
 FORMAT            = "I1"
 START_BYTE         = 132018
 BYTES             = 2
 DESCRIPTION        = "Set to 1 when a phase-lock-loop error was detected during data collection.  Otherwise set
                        to 0."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME              = ERR_LIMITEDCAL
 COLUMN_NUMBER       = 16
 DATA_TYPE          = LSB_UNSIGNED_INTEGER
 FORMAT            = "I1"
 START_BYTE         = 132020
 BYTES             = 2
```

```
 DESCRIPTION        = "Set to 1 when limited calibration data are available.  Otherwise set to 0.  (See Users
                        Manual Section 9.5.)"
END_OBJECT    = COLUMN
```

B.4. GEOMETRY FOR SPECTROMETER LEVEL 3 DATA GENERATED BY MIRO PIPELINE VERSIONS 1.0 AND 1.1 (SEE SECTION 4.3.1)

Filename: GEOM_LEVEL_3_FORMAT.FMT

Rosetta/miro geoemtry for cts calibrated data structure

This structure label gives the data structure for the geometry information associated with calibrated data from the MIRO Chirp Transform Spectrometer (CTS) generated by Version 1.0 and 1.1 of the MIRO Pipeline processing software. Note that these versions of the geometry tables are not very useful because they assumed a tri-axial ellipsoid for the nucleus instead of a more accurate shape model, and because not all desired geometric parameters were calculated. For this reason, not all Version 1 data sets contain geometry data. Version 2 data sets (which all include geometry information) should be used when available.

```
OBJECT       = COLUMN
  NAME             = TIME
  COLUMN_NUMBER    = 1
  DATA_TYPE        = PC_REAL
  FORMAT           = "F16.5"
  UNIT             = SECOND
  START_BYTE       = 1
  BYTES            = 8
  DESCRIPTION      = "Unix time: the number of seconds that have elapsed
                      since 00:00:00 UTC, Thursday, 1-Jan-1970 (see EAICD
                      Section 3.2.2)."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
  NAME             = TGT_RA
  COLUMN_NUMBER    = 2
  DATA_TYPE        = PC_REAL
  FORMAT           = "F7.3"
  UNIT             = DEGREE
  START_BYTE       = 9
  BYTES            = 4
  DESCRIPTION      = "RA of the target center as seen from Rosetta in J2000
                      frame, in degrees."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
  NAME             = TGT_DEC
  COLUMN_NUMBER    = 3
  DATA_TYPE        = PC_REAL
  FORMAT           = "F7.4"
  UNIT             = DEGREE
  START_BYTE       = 13
  BYTES            = 4
  DESCRIPTION      = "Dec of the target center as seen from Rosetta in J2000
                      frame, in degrees."
END_OBJECT   = COLUMN
```

```
OBJECT        = COLUMN
  NAME              = Z_RA
  COLUMN_NUMBER     = 4
  DATA_TYPE         = PC_REAL
  FORMAT            = "F7.3"
  UNIT              = DEGREE
  START_BYTE        = 17
  BYTES             = 4
  DESCRIPTION       = "RA of Rosetta +Z axis in J2000 frame, in degrees."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
  NAME              = Z_DEC
  COLUMN_NUMBER     = 5
  DATA_TYPE         = PC_REAL
  FORMAT            = "F7.4"
  UNIT              = DEGREE
  START_BYTE        = 21
  BYTES             = 4
  DESCRIPTION       = "Dec of Rosetta +Z axis in J2000 frame, in degrees."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
  NAME              = SUN_RA
  COLUMN_NUMBER     = 6
  DATA_TYPE         = PC_REAL
  FORMAT            = "F7.3"
  UNIT              = DEGREE
  START_BYTE        = 25
  BYTES             = 4
  DESCRIPTION       = "RA of the Sun as seen from Rosetta in J2000 frame, in
                       degrees."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
  NAME              = SUN_DEC
  COLUMN_NUMBER     = 7
  DATA_TYPE         = PC_REAL
  FORMAT            = "F7.4"
  UNIT              = DEGREE
  START_BYTE        = 29
  BYTES             = 4
  DESCRIPTION       = "Dec of the Sun as seen from Rosetta in J2000 frame, in
                       degrees."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
  NAME              = DIST
  COLUMN_NUMBER     = 8
  DATA_TYPE         = PC_REAL
  FORMAT            = "F7.4"
  UNIT              = KILOMETER
  START_BYTE        = 33
  BYTES             = 4
  DESCRIPTION       = "Distance from Rosetta to center of target body, in km."
END_OBJECT    = COLUMN
```

```
OBJECT        = COLUMN
  NAME              = PHASE_ANG
  COLUMN_NUMBER     = 9
  DATA_TYPE         = PC_REAL
  FORMAT            = "F7.4"
  UNIT              = DEGREE
  START_BYTE        = 37
  BYTES             = 4
  DESCRIPTION       = "Solar phase angle at the target (Sun-Targt-Rosetta), in
                       degrees."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
  NAME              = POL_ANG
  COLUMN_NUMBER     = 10
  DATA_TYPE         = PC_REAL
  FORMAT            = "F7.4"
  UNIT              = DEGREE
  START_BYTE        = 41
  BYTES             = 4
  DESCRIPTION       = "Angle from the Rosetta Y-axis to the projection of the
                       body spin axis in the Rosetta X,Y plane, in degrees."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
  NAME              = BS_X_ANG
  COLUMN_NUMBER     = 11
  DATA_TYPE         = PC_REAL
  FORMAT            = "F8.6"
  UNIT              = DEGREE
  START_BYTE        = 45
  BYTES             = 4
  DESCRIPTION       = "MIRO boresight vector offset from the Rosetta-target
                       center vector in MIRO frame X axis, in degrees."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
  NAME              = BS_Y_ANG
  COLUMN_NUMBER     = 12
  DATA_TYPE         = PC_REAL
  FORMAT            = "F8.6"
  UNIT              = DEGREE
  START_BYTE        = 49
  BYTES             = 4
  DESCRIPTION       = "MIRO boresight vector offset from the Rosetta-target
                       center vector in MIRO frame Y axis, in degrees."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
  NAME              = BS_Z_ANG
  COLUMN_NUMBER     = 13
  DATA_TYPE         = PC_REAL
  FORMAT            = "F8.6"
  UNIT              = DEGREE
  START_BYTE        = 53
  BYTES             = 4
```

```
  DESCRIPTION      = "MIRO boresight vector offset from the Rosetta-target
                      center vector, in degrees."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
  NAME             = RH
  COLUMN_NUMBER    = 14
  DATA_TYPE        = PC_REAL
  FORMAT           = "F7.5"
  UNIT             = AU
  START_BYTE       = 57
  BYTES            = 4
  DESCRIPTION      = "Heliocentric distance of the target body, in AU."
END_OBJECT   = COLUMN
```

B.5. GEOMETRY FOR SPECTROMETER LEVEL 3 DATA, LEVEL3/4 DATA AND LEVEL 4 DATA GENERATED BY MIRO PIPELINE VERSION 2.0 (SEE SECTION 4.3.1)

Filename: GEOM_LEVEL_3_FORMAT.FMT.

Rosetta/miro geoemtry for cts calibrated data structure

This structure label gives the data structure for the geometry information associated with calibrated data from the MIRO Chirp Transform Spectrometer (CTS) generated by Version 2.0 of the MIRO Pipeline processing software.

```
OBJECT       = COLUMN
 NAME             = TIME
 COLUMN_NUMBER       = 1
 DATA_TYPE          = PC_REAL
 FORMAT            = "F16.5"
 UNIT              = SECOND
 START_BYTE         = 1
 BYTES             = 8
 DESCRIPTION        = "Time  for which geometry parameters are calculated.  Units are elapsed UTC seconds after
                       1-Jan-1970 (see EAICD Section 3.2.2).  "
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME             = GMT
 COLUMN_NUMBER       = 2
 DATA_TYPE          = TIME
 FORMAT            = "A13"
 START_BYTE         = 9
 BYTES             = 13
 DESCRIPTION        = "UTC time for which geometry parameters are calculated.  Format is
                       YYYYDDDHHMMSS where YYYY is the year DDD is the day of year HH is the hour
                       MM is the minute and SS is the second.  Refer to TIME field for fractional seconds."
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME             = SW_VERSION
 COLUMN_NUMBER       = 3
```

```
 DATA_TYPE          = PC_REAL
 FORMAT             = "F6.1"
 START_BYTE         = 22
 BYTES              = 8
 DESCRIPTION        = "Identifier for MIRO software used to generate this record."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME               = BS_X_ANG
 COLUMN_NUMBER      = 4
 DATA_TYPE          = PC_REAL
 FORMAT             = "F6.2"
 UNIT               = DEG
 START_BYTE         = 30
 BYTES              = 8
 DESCRIPTION        = "Angle between MIRO boresight and comet center projected on the MIRO x-axis (-360 to
                       +360 deg with positive angles measured  counterclockwise from the x-axis towards the y-
                       axis)."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME               = BS_Y_ANG
 COLUMN_NUMBER      = 5
 DATA_TYPE          = PC_REAL
 FORMAT             = "F6.2"
 UNIT               = DEG
 START_BYTE         = 38
 BYTES              = 8
 DESCRIPTION        = "Angle between MIRO boresight and comet center projected on the MIRO y-axis (-360 to
                       +360 deg with positive angles measured  counterclockwise from the y-axis towards the
                       negative x-axis)."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME               = BS_Z_ANG
 COLUMN_NUMBER      = 6
 DATA_TYPE          = PC_REAL
 FORMAT             = "F6.2"
 UNIT               = DEG
 START_BYTE         = 46
 BYTES              = 8
 DESCRIPTION        = "Angle between MIRO boresight and the spacecraft to comet-center line (0 to 90 degrees)."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME               = DIST
 COLUMN_NUMBER      = 7
 DATA_TYPE          = PC_REAL
 FORMAT             = "F6.2"
 UNIT               = KM
 START_BYTE         = 54
 BYTES              = 8
 DESCRIPTION        = "Distance between the spacecraft and comet center."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
```

```
 NAME              = EMI_ANG
 COLUMN_NUMBER       = 8
 DATA_TYPE          = PC_REAL
 FORMAT            = "F6.2"
 UNIT             = DEG
 START_BYTE         = 62
 BYTES             = 8
 DESCRIPTION         = "Emission angle (0 to 90 deg): Angle between surface normal and MIRO boresight.  Set to
                       -999.9 when found_intersection=0."
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = FOUND_INTERSECTION
 COLUMN_NUMBER       = 9
 DATA_TYPE          = LSB_UNSIGNED_INTEGER
 FORMAT            = "I1"
 START_BYTE         = 70
 BYTES             = 2
 DESCRIPTION         = "Set to 1 when MIRO boresight intercepts shape model.  Otherwise set to 0."
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = LOCAL_SOLHA
 COLUMN_NUMBER       = 10
 DATA_TYPE          = PC_REAL
 FORMAT            = "F6.2"
 UNIT             = HOURS
 START_BYTE         = 72
 BYTES             = 8
 DESCRIPTION         = "Angle between the plane containing the comet rotation axis and the Sun and the plane
                       containing the rotation axis and the boresight location on the surface.  (Equivalent to
                       solar hour angle on a spherical surface.  See also scene_eff_solha.)  0 is midnight and 12
                       is Noon.  Set to -999.9 if found_intersection=0."
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = PHASE_ANG
 COLUMN_NUMBER       = 11
 DATA_TYPE          = PC_REAL
 FORMAT            = "F6.2"
 UNIT             = DEG
 START_BYTE         = 80
 BYTES             = 8
 DESCRIPTION         = "Angle between Sun and spacecraft as measured at the comet center (-180 to 180 degrees;
                       negative values represent local solar times between  midnight and Noon)."
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = PLATE_ID
 COLUMN_NUMBER       = 12
 DATA_TYPE          = LSB_INTEGER
 FORMAT            = "I1"
 START_BYTE         = 88
 BYTES             = 4
 DESCRIPTION         = "Identifier for the shape model plate at the MIRO boresight.  Set to -1 when
                       found_intersection=0."
```

```
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = POL_ANG
 COLUMN_NUMBER       = 13
 DATA_TYPE          = PC_REAL
 FORMAT            = "F6.2"
 UNIT              = DEG
 START_BYTE         = 92
 BYTES             = 8
 DESCRIPTION        = "Pole angle: Angle from the Rosetta y-axis to the projection of the comet spin axis on the
                      Rosetta xy-plane (-180 to 180 degrees positive counterclockwise from the y-axis towards
                      the negative x-axis)."
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = RH
 COLUMN_NUMBER       = 14
 DATA_TYPE          = PC_REAL
 FORMAT            = "F6.2"
 UNIT              = AU
 START_BYTE         = 100
 BYTES             = 8
 DESCRIPTION        = "Distance between the comet and the Sun."
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = SC_ANG
 COLUMN_NUMBER       = 15
 DATA_TYPE          = PC_REAL
 FORMAT            = "F6.2"
 UNIT              = DEG
 START_BYTE         = 108
 BYTES             = 8
 DESCRIPTION        = "Angle between the Rosetta y-axis and the J2000 z-axis measured counterclockwise in the
                      Rosetta xy-plane (-180 to 180 degrees). "
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = SCENE_EFF_LAT
 COLUMN_NUMBER       = 16
 DATA_TYPE          = PC_REAL
 FORMAT            = "F6.2"
 UNIT              = DEG
 START_BYTE         = 116
 BYTES             = 8
 DESCRIPTION        = "Effective latitude (-90 to 90 deg): Over the course of one comet day"
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = SCENE_EFF_LON
 COLUMN_NUMBER       = 17
 DATA_TYPE          = PC_REAL
 FORMAT            = "F6.2"
 UNIT              = DEG
 START_BYTE         = 124
```

```
 BYTES            = 8
 DESCRIPTION      = "Effective east longitude (-180 to 180 deg):  The angle between the prime meridian and the
                     surface normal projected on the equatorial plane.   Set to -999.9 when
                     found_intersection=0."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME             = SCENE_EFF_SOLHA
 COLUMN_NUMBER      = 18
 DATA_TYPE        = PC_REAL
 FORMAT           = "F6.2"
 UNIT           = HOURS
 START_BYTE       = 132
 BYTES            = 8
 DESCRIPTION      = "Effective solar hour angle (0 to 24 hours):  The angle between the plane containing the
                     Sun and the comet rotation axis and the plane parallel to the surface normal that contains
                     the rotation axis.  0 is Midnight, 12 is Noon.  Set to -999.9 when found_intersection=0."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME             = SCENE_LAT
 COLUMN_NUMBER      = 19
 DATA_TYPE        = PC_REAL
 FORMAT           = "F6.2"
 UNIT           = DEG
 START_BYTE       = 140
 BYTES            = 8
 DESCRIPTION      = "Comet-centric latitude (-90 to 90 deg) of the boresight on the surface.  Set to -999.9 when
                     found_intersection=0."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME             = SCENE_LON
 COLUMN_NUMBER      = 20
 DATA_TYPE        = PC_REAL
 FORMAT           = "F6.2"
 UNIT           = DEG
 START_BYTE       = 148
 BYTES            = 8
 DESCRIPTION      = "Comet-centric eastward longitude of the boresight on the surface (-180 to 180 deg).  Set to
                     -999.9 when found_intersection=0."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME             = SCENE_R
 COLUMN_NUMBER      = 21
 DATA_TYPE        = PC_REAL
 FORMAT           = "F6.2"
 UNIT           = KM
 START_BYTE       = 156
 BYTES            = 8
 DESCRIPTION      = "Distance between the comet center and the boreisght intersection with the surface.  Set to -
                     999.9 when found_intersection=0."
END_OBJECT   = COLUMN

OBJECT       = COLUMN
```

```
 NAME              = SCENE_SOL_INC_ANGLE
 COLUMN_NUMBER       = 22
 DATA_TYPE          = PC_REAL
 FORMAT            = "F6.2"
 UNIT             = DEG
 START_BYTE         = 164
 BYTES            = 8
 DESCRIPTION        = "Angle between the surface normal at the boresight location and the Sun (0 to 180
                       deg).  Set to -999.9 when found_intersection=0."
END_OBJECT   = COLUMN

OBJECT      = COLUMN
 NAME              = SHAPE_VERSION
 COLUMN_NUMBER       = 23
 DATA_TYPE          = LSB_INTEGER
 FORMAT            = "I11"
 START_BYTE         = 172
 BYTES            = 4
 DESCRIPTION        = "Identifier for shape model used. 1=shap5-v0.3; 2=shap5-v1.2; 3=Osiris_shap7_1.6;
                       4=OSIRIS_v_1.1."
END_OBJECT   = COLUMN

OBJECT      = COLUMN
 NAME              = SPICE_KERNEL_VERSION
 COLUMN_NUMBER       = 24
 DATA_TYPE          = PC_REAL
 FORMAT            = "F6.2"
 START_BYTE         = 176
 BYTES            = 8
 DESCRIPTION        = "Identifier for SPICE kernels used.  See interface document for details. "
END_OBJECT   = COLUMN

OBJECT      = COLUMN
 NAME              = SSC_LAT
 COLUMN_NUMBER       = 25
 DATA_TYPE          = PC_REAL
 FORMAT            = "F6.2"
 UNIT             = DEG
 START_BYTE         = 184
 BYTES            = 8
 DESCRIPTION        = "Comet-centric latitude of the sub-spacecraft point on the nucleus (-90 to 90 deg)."
END_OBJECT   = COLUMN

OBJECT      = COLUMN
 NAME              = SSC_LON
 COLUMN_NUMBER       = 26
 DATA_TYPE          = PC_REAL
 FORMAT            = "F6.2"
 UNIT             = DEG
 START_BYTE         = 192
 BYTES            = 8
 DESCRIPTION        = "Comet-centric east longitude of the sub-spacecraft point on the nucleus (-180 to 180
                       deg)."
END_OBJECT   = COLUMN

OBJECT      = COLUMN
```

```
 NAME            = SSOL_LAT
 COLUMN_NUMBER   = 27
 DATA_TYPE       = PC_REAL
 FORMAT          = "F6.2"
 UNIT            = DEG
 START_BYTE      = 200
 BYTES           = 8
 DESCRIPTION     = "Comet-centric latitude of the sub-solar point on the nucleus (-90 to 90 deg)."
END_OBJECT  = COLUMN

OBJECT      = COLUMN
 NAME            = SSOL_LON
 COLUMN_NUMBER   = 28
 DATA_TYPE       = PC_REAL
 FORMAT          = "F6.2"
 UNIT            = DEG
 START_BYTE      = 208
 BYTES           = 8
 DESCRIPTION     = "Comet-centric east longitude of the sub-solar point on the nucleus (-180 to 180 deg)."
END_OBJECT  = COLUMN

OBJECT      = COLUMN
 NAME            = SUN_DEC
 COLUMN_NUMBER   = 29
 DATA_TYPE       = PC_REAL
 FORMAT          = "F6.2"
 UNIT            = DEG
 START_BYTE      = 216
 BYTES           = 8
 DESCRIPTION     = "Position of the Sun in J2000 declination (-90 to 90 deg)."
END_OBJECT  = COLUMN

OBJECT      = COLUMN
 NAME            = SUN_RA
 COLUMN_NUMBER   = 30
 DATA_TYPE       = PC_REAL
 FORMAT          = "F6.2"
 UNIT            = DEG
 START_BYTE      = 224
 BYTES           = 8
 DESCRIPTION     = "Position of the Sun in J2000 Right Ascension (-180 to 180 deg)."
END_OBJECT  = COLUMN

OBJECT      = COLUMN
 NAME            = TGT_DEC
 COLUMN_NUMBER   = 31
 DATA_TYPE       = PC_REAL
 FORMAT          = "F6.2"
 UNIT            = DEG
 START_BYTE      = 232
 BYTES           = 8
 DESCRIPTION     = "Position of the comet in J2000 declination (-90 to 90 deg)."
END_OBJECT  = COLUMN

OBJECT      = COLUMN
 NAME            = TGT_RA
```

```
 COLUMN_NUMBER       = 32
 DATA_TYPE           = PC_REAL
 FORMAT              = "F6.2"
 UNIT                = DEG
 START_BYTE          = 240
 BYTES               = 8
 DESCRIPTION         = "Position of the comet in J2000 Right Ascension (0 to 360 deg)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
 NAME                = VLOS
 COLUMN_NUMBER       = 33
 DATA_TYPE           = PC_REAL
 FORMAT              = "F6.2"
 UNIT                = "KM/S"
 START_BYTE          = 248
 BYTES               = 8
 DESCRIPTION         = "Velocity of spacecraft relative to comet center projected on line-of-sight vector."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
 NAME                = VRAD
 COLUMN_NUMBER       = 34
 DATA_TYPE           = PC_REAL
 FORMAT              = "F6.2"
 UNIT                = "KM/S"
 START_BYTE          = 256
 BYTES               = 8
 DESCRIPTION         = "Velocity of spacecraft relative to comet center."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
 NAME                = Z_DEC
 COLUMN_NUMBER       = 35
 DATA_TYPE           = PC_REAL
 FORMAT              = "F6.2"
 UNIT                = DEG
 START_BYTE          = 264
 BYTES               = 8
 DESCRIPTION         = "Declination of the spacecraft z-axis in J2000 coordinates (-90 to 90 deg)."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
 NAME                = Z_RA
 COLUMN_NUMBER       = 36
 DATA_TYPE           = PC_REAL
 FORMAT              = "F6.2"
 UNIT                = DEG
 START_BYTE          = 272
 BYTES               = 8
 DESCRIPTION         = "Right Ascension (0 to 360 deg) of the spacecraft z-axis in J2000 coordinates."
END_OBJECT    = COLUMN
```

B.6. CONTINUUM LEVEL 2 DATA GENERATED BY MIRO PIPELINE VERSIONS 1.0 AND 1.1 (SEE SECTION 4.3.2)

Filename: CONT_LEVEL_2_FORMAT.FMT

Rosetta/MIRO continuum files raw data structure

This structure label gives the data structure for the data decommutated from the telemetry for the uncalibrated (raw) data from the MIRO Millimeter and Submillimeter Continuum Radiometers.

```
OBJECT                = COLUMN
  NAME                      = TIME
  COLUMN_NUMBER             = 1
  DATA_TYPE                 = IEEE_REAL
  FORMAT                    = F16.5
  START_BYTE                = 1
  BYTES                     = 8
  DESCRIPTION               = "Time of start of acquisition of the data in elapsed UTC seconds after 1-
                            Jan-1970 (see EAICD Section 3.2.2)."
END_OBJECT            = COLUMN

OBJECT                = COLUMN
  NAME                      = TIME1
  COLUMN_NUMBER             = 2
  DATA_TYPE                 = IEEE_REAL
  FORMAT                    = F16.5
  START_BYTE                = 9
  BYTES                     = 8
  DESCRIPTION               = "Time of acquisition of the 100th element of the raw data array, if
                            summation=1, or of the 50th element if summation=2 or greater; this is zero
                            if summation=0."
END_OBJECT            = COLUMN

OBJECT                = COLUMN
  NAME                      = TIME2
  COLUMN_NUMBER             = 3
  DATA_TYPE                 = IEEE_REAL
  FORMAT                    = F16.5
  START_BYTE                = 17
  BYTES                     = 8
  DESCRIPTION               = "Time of acquisition of the 100th element of the raw data array, if
                            summation=2 or greater; otherwise zero."
END_OBJECT            = COLUMN

OBJECT                = COLUMN
  NAME                      = TIME3
  COLUMN_NUMBER             = 4
  DATA_TYPE                 = IEEE_REAL
  FORMAT                    = F16.5
  START_BYTE                = 25
  BYTES                     = 8
  DESCRIPTION               = "Time of acquisition of the 150th element of the raw data array, if
                            summation=2 or greater; otherwise zero."
END_OBJECT            = COLUMN

OBJECT                = COLUMN
```

```
   NAME                     = MIRPOS
   COLUMN_NUMBER            = 5
   DATA_TYPE                = MSB_UNSIGNED_INTEGER
   FORMAT                   = I1
   START_BYTE               = 33
   BYTES                    = 1
   DESCRIPTION              = "Mirror position: 1: sky, 2: warm target, 3: cold target"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
   NAME                     = POWERMODE
   COLUMN_NUMBER            = 6
   DATA_TYPE                = MSB_UNSIGNED_INTEGER
   FORMAT                   = I1
   START_BYTE               = 34
   BYTES                    = 1
   DESCRIPTION              = "Values 1-6 as described in MIRO User Manual 6.1.2.1""
END_OBJECT          = COLUMN

OBJECT              = COLUMN
   NAME                     = SUMMATION
   COLUMN_NUMBER            = 7
   DATA_TYPE                = MSB_UNSIGNED_INTEGER
   FORMAT                   = I1
   START_BYTE               = 35
   BYTES                    = 1
   DESCRIPTION              = "Values 0-4 as described in MIRO User Manual 6.1.2.1""
END_OBJECT          = COLUMN

OBJECT              = COLUMN
   NAME                     = ND
   COLUMN_NUMBER            = 8
   DATA_TYPE                = MSB_UNSIGNED_INTEGER
   FORMAT                   = I3
   START_BYTE               = 36
   BYTES                    = 1
   DESCRIPTION              = "Number of elements in raw data array; typically 200."
END_OBJECT          = COLUMN

OBJECT              = COLUMN
   NAME                     = MMSUBTRACTION
   COLUMN_NUMBER            = 9
   DATA_TYPE                = UNSIGNED_INTEGER
   FORMAT                   = I5
   START_BYTE               = 37
   BYTES                    = 2
   DESCRIPTION              = "Offset in millimeter continuum data, as described in MIRO User Manual
                              7.1.5."
END_OBJECT          = COLUMN

OBJECT              = COLUMN
   NAME                     = SMMSUBTRACTION
   COLUMN_NUMBER            = 10
   DATA_TYPE                = UNSIGNED_INTEGER
   FORMAT                   = I5
   START_BYTE               = 39
```

```
  BYTES                       = 2
  DESCRIPTION                 = "Offset in submillimeter continuum data, as described in MIRO User
                              Manual 7.1.4."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                        = CALMODE
  COLUMN_NUMBER               = 11
  DATA_TYPE                   = UNSIGNED_INTEGER
  FORMAT                      = I1
  START_BYTE                  = 41
  BYTES                       = 2
  DESCRIPTION                 = "0: Calibration in progress, 1: No calibration in progress"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                        = SP
  COLUMN_NUMBER               = 12
  DATA_TYPE                   = UNSIGNED_INTEGER
  FORMAT                      = I1
  START_BYTE                  = 43
  BYTES                       = 2
  DESCRIPTION                 = "Spare, not used"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                        = D
  COLUMN_NUMBER               = 13
  DATA_TYPE                   = MSB_INTEGER
  FORMAT                      = 200I6
  START_BYTE                  = 45
  BYTES                       = 400
  ITEMS                       = 200
  ITEM_BYTES                  = 2
  DESCRIPTION                 = "Uncalibrated brightness temperature as signed integer"
END_OBJECT              = COLUMN
```

The following is an example of the first record of a Level-2 Continuum file, with just the first 4 of the 200 data fields shown, in both hex and formatted representations:

```
Listing of rows     1 to     1 for file RO-E-MIRO-2-EAR1-EARTH1-
V1.0/DATA/CONTINUUM/MIRO_2_MM_20050630809.DAT

 COL.#:          1                 2                 3                 4          5   6   7   8    9
 10   11   12   13
 ITEMS:  41D08A0D4F339485 41D08A0D508AF41F 0000000000000000 0000000000000000 02  01  00  C8  0000
0000 0000 0000 1CA9 1CAB 1CAB 1CAA

COL.#:          1                 2                 3                 4             5    6    7    8
9  10  11  12   13
 ITEMS:   1.109931325E+09  1.109931330E+09  0.000000000E+00  0.000000000E+00   2    1    0  200
 0    0    0    0   7337   7339   7339   7338
```

B.7. CONTINUUM LEVEL 3 DATA GENERATED BY MIRO PIPELINE VERSIONS 1.0 AND 1.1 (SEE SECTION 4.3.2)

Filename: CONT_LEVEL_3_FORMAT.FMT

Rosetta/MIRO continuum files raw data structure

This structure label gives the data structure for the calibrated data from the MIRO Millimeter and Submillimeter Continuum Radiometers.

```
OBJECT                  = COLUMN
   NAME                       = TIME
   COLUMN_NUMBER              = 1
   DATA_TYPE                  = IEEE_REAL
   FORMAT                     = F16.5
   START_BYTE                 = 1
   BYTES                      = 8
   DESCRIPTION                = "Time of start of acquisition of the data in elapsed UTC seconds after 1-
                                Jan-1970 (see EAICD Section 3.2.2)."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
   NAME                       = TIME1
   COLUMN_NUMBER              = 2
   DATA_TYPE                  = IEEE_REAL
   FORMAT                     = F16.5
   START_BYTE                 = 9
   BYTES                      = 8
   DESCRIPTION                = "Time of acquisition of the 100th element of the raw data array, if
                                summation=1, or of the 50th element if summation=2 or greater; this is zero
                                if summation=0."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
   NAME                       = TIME2
   COLUMN_NUMBER              = 3
   DATA_TYPE                  = IEEE_REAL
   FORMAT                     = F16.5
   START_BYTE                 = 17
   BYTES                      = 8
   DESCRIPTION                = "Time of acquisition of the 100th element of the raw data array, if
                                summation=2 or greater; otherwise zero."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
   NAME                       = TIME3
   COLUMN_NUMBER              = 4
   DATA_TYPE                  = IEEE_REAL
   FORMAT                     = F16.5
   START_BYTE                 = 25
   BYTES                      = 8
   DESCRIPTION                = "Time of acquisition of the 150th element of the raw data array, if
                                summation=2 or greater; otherwise zero."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
   NAME                       = UTC
   COLUMN_NUMBER              = 5
   DATA_TYPE                  = TIME
   FORMAT                     = A19
   START_BYTE                 = 33
```

```
  BYTES                         = 19
  DESCRIPTION                   = "Absolute time of start of acquisition of the data in the UTC system."
END_OBJECT = COLUMN

OBJECT              = COLUMN
  NAME                          = MIRPOS
  COLUMN_NUMBER                 = 6
  DATA_TYPE                     = MSB_UNSIGNED_INTEGER
  FORMAT                        = I1
  START_BYTE                    = 52
  BYTES                         = 1
  DESCRIPTION                   = "Mirror position: 1: sky, 2: warm target, 3: cold target"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                          = POWERMODE
  COLUMN_NUMBER                 = 7
  DATA_TYPE                     = MSB_UNSIGNED_INTEGER
  FORMAT                        = I1
  START_BYTE                    = 53
  BYTES                         = 1
  DESCRIPTION                   = "Values 1-6 as described in MIRO User Manual 6.1.2.1""
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                          = SUMMATION
  COLUMN_NUMBER                 = 8
  DATA_TYPE                     = MSB_UNSIGNED_INTEGER
  FORMAT                        = I1
  START_BYTE                    = 54
  BYTES                         = 1
  DESCRIPTION                   = "Values 0-4 as described in MIRO User Manual 6.1.2.1""
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                          = ND
  COLUMN_NUMBER                 = 9
  DATA_TYPE                     = MSB_UNSIGNED_INTEGER
  FORMAT                        = I3
  START_BYTE                    = 55
  BYTES                         = 1
  DESCRIPTION                   = "Number of elements in raw data array; typically 200."
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                          = MMSUBTRACTION
  COLUMN_NUMBER                 = 10
  DATA_TYPE                     = UNSIGNED_INTEGER
  FORMAT                        = I5
  START_BYTE                    = 56
  BYTES                         = 2
  DESCRIPTION                   = "Offset in millimeter continuum data, as described in MIRO User Manual
                                  7.1.5."
END_OBJECT          = COLUMN

OBJECT              = COLUMN
```

```
   NAME                              = SMMSUBTRACTION
   COLUMN_NUMBER                     = 11
   DATA_TYPE                         = UNSIGNED_INTEGER
   FORMAT                            = I1
   START_BYTE                        = 58
   BYTES                             = 2
   DESCRIPTION                       = "Offset in submillimeter continuum data, as described in MIRO User
                                       Manual 7.1.4."
END_OBJECT             = COLUMN

OBJECT                 = COLUMN
   NAME                              = CALMODE
   COLUMN_NUMBER                     = 12
   DATA_TYPE                         = UNSIGNED_INTEGER
   FORMAT                            = I1
   START_BYTE                        = 60
   BYTES                             = 2
   DESCRIPTION                       = "0: Calibration in progress, 1: No calibration in progress"
END_OBJECT = COLUMN

OBJECT                 = COLUMN
   NAME                              = SP
   COLUMN_NUMBER                     = 13
   DATA_TYPE                         = UNSIGNED_INTEGER
   FORMAT                            = I1
   START_BYTE                        = 62
   BYTES                             = 2
   DESCRIPTION                       = "Spare, not used"
END_OBJECT             = COLUMN

OBJECT                 = COLUMN
   NAME                              = D
   COLUMN_NUMBER                     = 14
   DATA_TYPE                         = IEEE_REAL
   FORMAT                            = 200F6.0
   UNIT                              = KELVIN
   START_BYTE                        = 64
   BYTES                             = 800
   ITEMS                             = 200
   ITEM_BYTES                        = 4
   DESCRIPTION                       = "Antenna temperatures"
END_OBJECT             = COLUMN
```

The following is an example of the first record of a Level-3 Continuum file, with just the first 4 of the 200 data fields shown, in both hex and formatted representations:

```
Listing of rows     1 to     1 for file RO-E-MIRO-3-EAR1-EARTH1-
V1.0/DATA/CONTINUUM/MIRO_3_MM_20050631017.DAT

 COL.#:          1                2                3                4                5
  6  7  8  9  10   11   12   13     14
 ITEMS:  41D08A0D6A110EAA 41D08A0D6B6223E2 0000000000000000 0000000000000000 2005-03-
04T10:17:12 01 01 00 C8 0000 0000 0001 0000 412CBA5D 4135BD7F 4135BD7F 413BBF95

 COL.#:          1                2                3                4                5
   6   7   8   9  10  11  12  13      14
 ITEMS:   1.109931432E+09  1.109931438E+09  0.000000000E+00  0.000000000E+00 2005-03-
04T10:17:12   1   1   0 200   0   0   1   0  1.080E+01  1.136E+01  1.136E+01  1.173E+01
```

B.8. CONTINUUM LEVEL 3 DATA AND LEVEL 4 DATA GENERATED BY MIRO PIPELINE VERSION 2.0 (SEE SECTION 4.3.2)

Filename: CONT_LEVEL_3_FORMAT_2.FMT or CONT_LEVEL_4_FORMAT.FMT

Rosetta/MIRO calibrated continuum files data structure generated by MIRO Pipeline software Version 2.0.

This structure label gives the data structure for the calibrated data from the MIRO Millimeter and Submillimeter Continuum Radiometers, generated by MIRO Pipeline software version 2.0.

```
OBJECT       = COLUMN
 NAME             = TIME
 COLUMN_NUMBER       = 1
 DATA_TYPE         = PC_REAL
 FORMAT           = "F16.5"
 UNIT           = SECOND
 START_BYTE        = 1
 BYTES           = 8
 DESCRIPTION        = "Time of start of acquisition of the first data point in the continuum record.  (Typically
                        there are 200 samples in each record.)  Units are elapsed UTC seconds after 1-Jan-1970
                        (see EAICD Section 3.2.2).  "
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME             = RECEIVER_ID
 COLUMN_NUMBER       = 2
 DATA_TYPE         = LSB_UNSIGNED_INTEGER
 FORMAT           = "I1"
 START_BYTE        = 9
 BYTES           = 2
 DESCRIPTION        = "Indicates whether the data are from the mm (0) or submm (1) receiver.  "
END_OBJECT   = COLUMN

OBJECT       = COLUMN
 NAME             = GMT
 COLUMN_NUMBER       = 3
 DATA_TYPE         = TIME
 FORMAT           = "A13"
 START_BYTE        = 11
 BYTES           = 13
 DESCRIPTION        = "Absolute UTC time of start of acquisition of the data.  Format is YYYYDDDHHMMSS
                        where YYYY is the year DDD is the day of year HH is the hour MM is the minute and
                        SS is the second.  Refer to TIME field for fractional seconds."
```

```
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = DAYNO
 COLUMN_NUMBER       = 4
 DATA_TYPE          = PC_REAL
 FORMAT            = "F7.4"
 UNIT              = DAY
 START_BYTE         = 24
 BYTES             = 8
 DESCRIPTION        = "Day of year"
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = TIME1
 COLUMN_NUMBER       = 5
 DATA_TYPE          = PC_REAL
 FORMAT            = "F16.5"
 UNIT              = SECOND
 START_BYTE         = 32
 BYTES             = 8
 DESCRIPTION        = "For Summation=0 TIME1 is the time of start of acquisition of the 101st data point in the
                      continuum record.  For Summation=1 TIME1 is the time of start of acquisition of the
                      51st sample.  For all other values of Summation TIME1 is zero."
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = TIME2
 COLUMN_NUMBER       = 6
 DATA_TYPE          = PC_REAL
 FORMAT            = "F16.5"
 UNIT              = SECOND
 START_BYTE         = 40
 BYTES             = 8
 DESCRIPTION        = "For Summation=1 TIME2 is the time of start of acquisition of the 101st data point in the
                      continuum record.  For all other values of Summation TIME2 is zero. "
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = TIME3
 COLUMN_NUMBER       = 7
 DATA_TYPE          = PC_REAL
 FORMAT            = "F16.5"
 UNIT              = SECOND
 START_BYTE         = 48
 BYTES             = 8
 DESCRIPTION        = "For Summation=1 TIME3 is the time of start of acquisition of the 151st data point in the
                      continuum record.  For all other values of Summation TIME3 is zero. "
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = MIRPOS
 COLUMN_NUMBER       = 8
 DATA_TYPE          = LSB_UNSIGNED_INTEGER
 FORMAT            = "I1"
 START_BYTE         = 56
```

```
 BYTES            = 2
 DESCRIPTION      = "Mirror position: 1=sky 2=warm target 3=cold target"
END_OBJECT   = COLUMN

OBJECT      = COLUMN
 NAME             = CAL
 COLUMN_NUMBER    = 9
 DATA_TYPE        = LSB_UNSIGNED_INTEGER
 FORMAT           = "I1"
 START_BYTE       = 58
 BYTES            = 2
 DESCRIPTION      = "Calibration status: 0=calibration in progress 1=no calibration in progress (note the non-
                    standard use of 0/1)."
END_OBJECT   = COLUMN

OBJECT      = COLUMN
 NAME             = POWER
 COLUMN_NUMBER    = 10
 DATA_TYPE        = LSB_UNSIGNED_INTEGER
 FORMAT           = "I1"
 START_BYTE       = 60
 BYTES            = 2
 DESCRIPTION      = "Power mode: values 1-6 as described in MIRO User Manual 6.1.2.1.2"
END_OBJECT   = COLUMN

OBJECT      = COLUMN
 NAME             = SUMMATION
 COLUMN_NUMBER    = 11
 DATA_TYPE        = LSB_UNSIGNED_INTEGER
 FORMAT           = "I1"
 START_BYTE       = 62
 BYTES            = 2
 DESCRIPTION      = "Summation mode: values 0-4 as described in MIRO User Manual 6.1.2.1.2"
END_OBJECT   = COLUMN

OBJECT      = COLUMN
 NAME             = ND
 COLUMN_NUMBER    = 12
 DATA_TYPE        = LSB_UNSIGNED_INTEGER
 FORMAT           = "I3"
 START_BYTE       = 64
 BYTES            = 2
 DESCRIPTION      = "Number of elements in data array of TA; typically it is 200."
END_OBJECT   = COLUMN

OBJECT      = COLUMN
 NAME             = TA
 COLUMN_NUMBER    = 13
 DATA_TYPE        = PC_REAL
 FORMAT           = "F6.2"
 UNIT             = KELVIN
 START_BYTE       = 66
 BYTES            = 1600
 DESCRIPTION      = "Array of ND antenna temperatures (see MIRO User Manual Section 9.2)."
END_OBJECT   = COLUMN
```

```
OBJECT       = COLUMN
 NAME              = MIN
 COLUMN_NUMBER       = 14
 DATA_TYPE          = PC_REAL
 FORMAT            = "F6.2"
 UNIT             = KELVIN
 START_BYTE         = 1666
 BYTES             = 8
 DESCRIPTION        = "Mimimum value of TA array"
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = MAX
 COLUMN_NUMBER       = 15
 DATA_TYPE          = PC_REAL
 FORMAT            = "F6.2"
 UNIT             = KELVIN
 START_BYTE         = 1674
 BYTES             = 8
 DESCRIPTION        = "Maximum value of TA array"
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = AVG
 COLUMN_NUMBER       = 16
 DATA_TYPE          = PC_REAL
 FORMAT            = "F6.2"
 UNIT             = KELVIN
 START_BYTE         = 1682
 BYTES             = 8
 DESCRIPTION        = "Average value of TA array"
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = STD
 COLUMN_NUMBER       = 17
 DATA_TYPE          = PC_REAL
 FORMAT            = "F6.2"
 UNIT             = KELVIN
 START_BYTE         = 1690
 BYTES             = 8
 DESCRIPTION        = "Standard deviation of TA array"
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = SW_VERSION
 COLUMN_NUMBER       = 18
 DATA_TYPE          = PC_REAL
 FORMAT            = "F6.2"
 START_BYTE         = 1698
 BYTES             = 8
 DESCRIPTION        = "Identifier for MIRO software used to generate this record."
END_OBJECT    = COLUMN

OBJECT       = COLUMN
 NAME              = ERR_CALFIT
```

```
 COLUMN_NUMBER      = 19
 DATA_TYPE          = LSB_UNSIGNED_INTEGER
 FORMAT             = "I1"
 START_BYTE         = 1706
 BYTES              = 2
 DESCRIPTION        = "Set to 1 when there are too few valid calibration records present for the polynomial fit to
                       the gain (requires at least 3) or the intercept (requires at least 2) within 8 hours of
                       TIME.  Otherwise set to 0."
END_OBJECT    = COLUMN

OBJECT        = COLUMN
 NAME               = ERR_MISSINGCAL
 COLUMN_NUMBER      = 20
 DATA_TYPE          = LSB_UNSIGNED_INTEGER
 FORMAT             = "I1"
 START_BYTE         = 1708
 BYTES              = 2
 DESCRIPTION        = "Set to 1 if there are not valid calibration records both before and after TIME which are
                       both within 35 minutes of TIME.  Otherwise set to 0."
END_OBJECT    = COLUMN
```

B.9. GEOMETRY FOR CONTINUUM LEVEL 3 DATA GENERATED BY MIRO PIPELINE VERSION 1.0 AND 1.X (SEE SECTION 4.3.2)

Rosetta/MIRO continuum geometry data file structure generated by MIRO Pipeline software Versions 1.0 and 1.1. Note that these versions of the geometry tables are not very useful because they assumed a tri-axial ellipsoid for the nucleus instead of a more accurate shape model, and because not all desired geometric parameters were calculated. For this reason, not all Version 1 data sets contain geometry data. Version 2 data sets (which all include geometry information) should be used when available.

File structure is identical to the Version 1.0 spectrometer geometry data file (see Appendix B.4).

B.10. GEOMETRY FOR CONTINUUM LEVEL 3 DATA AND LEVEL 4 DATA GENERATED BY MIRO PIPELINE VERSION 2.0 (SEE SECTION 4.3.2)

Filename: Applicable to GEOM_LEVEL_3_FORMAT.FMT.

Rosetta/MIRO continuum geometry data file structure generated by MIRO Pipeline software Version 2.0.

This structure label gives the data structure for the geometry data for the MIRO Millimeter and Submillimeter Continuum Radiometers, generated by MIRO Pipeline software version 2.0.

File structure is identical to the Version 2.0 spectrometer geometry data file (see Appendix B.5).

B.11. HOUSEKEEPING DATA (SEE SECTION 4.3.3)

Filename: ENG_LEVEL_2_FORMAT.FMT

Rosetta/MIRO engineering raw data structure

This structure label gives the data structure for the data decommutated from the telemetry for the engineering (housekeeping) data from the MIRO instrument.

```
OBJECT                  = COLUMN
   NAME                          = TIME
   COLUMN_NUMBER                 = 1
   DATA_TYPE                     = IEEE_REAL
   FORMAT                        = F16.5
   START_BYTE                    = 1
   BYTES                         = 8
   DESCRIPTION                   = "Time of acquisition of the data packet in elapsed UTC seconds after 1-
                                 Jan-1970 (see EAICD Section 3.2.2)."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
   NAME                          = SPECT_T1
   COLUMN_NUMBER                 = 2
   DATA_TYPE                     = IEEE_REAL
   FORMAT                        = F7.3
   START_BYTE                    = 9
   BYTES                         = 4
   DESCRIPTION                   = "CTS Temperature sensor #1 Branch A (deg C)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
   NAME                          = SPECT_T2
   COLUMN_NUMBER                 = 3
   DATA_TYPE                     = IEEE_REAL
   FORMAT                        = F7.3
   START_BYTE                    = 13
   BYTES                         = 4
   DESCRIPTION                   = "CTS Temperature sensor #2 Branch A (deg C)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
   NAME                          = SPECT_T3
   COLUMN_NUMBER                 = 4
   DATA_TYPE                     = IEEE_REAL
   FORMAT                        = F7.3
   START_BYTE                    = 17
   BYTES                         = 4
   DESCRIPTION                   = "CTS Temperature sensor #1 Branch B (deg C)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
   NAME                          = SPECT_T4
   COLUMN_NUMBER                 = 5
   DATA_TYPE                     = IEEE_REAL
   FORMAT                        = F7.3
   START_BYTE                    = 21
   BYTES                         = 4
   DESCRIPTION                   = "CTS Temperature sensor #2 Branch B (deg C)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
   NAME                          = SPECT_T5
```

```
   COLUMN_NUMBER              = 6
   DATA_TYPE                  = IEEE_REAL
   FORMAT                     = F7.3
   START_BYTE                 = 25
   BYTES                      = 4
   DESCRIPTION                = "CTS Temperature sensor #1 analog tray (deg C)"
END_OBJECT            = COLUMN

OBJECT                = COLUMN
   NAME                       = SPECT_T6
   COLUMN_NUMBER              = 7
   DATA_TYPE                  = IEEE_REAL
   FORMAT                     = F7.3
   START_BYTE                 = 29
   BYTES                      = 4
   DESCRIPTION                = "CTS Temperature sensor #2 analog tray (deg C)"
END_OBJECT            = COLUMN

OBJECT                = COLUMN
   NAME                       = EU_TEMP
   COLUMN_NUMBER              = 8
   DATA_TYPE                  = IEEE_REAL
   FORMAT                     = F7.3
   START_BYTE                 = 33
   BYTES                      = 4
   DESCRIPTION                = "Electronics Unit (EU) temperature (deg C)"
END_OBJECT            = COLUMN

OBJECT                = COLUMN
   NAME                       = ECAL_TEMP
   COLUMN_NUMBER              = 9
   DATA_TYPE                  = IEEE_REAL
   FORMAT                     = F5.0
   START_BYTE                 = 37
   BYTES                      = 4
   DESCRIPTION                = "Reference temperature (634 Ohms) (Digital Units)"
END_OBJECT            = COLUMN

OBJECT                = COLUMN
   NAME                       = POS_5V_EU
   COLUMN_NUMBER              = 10
   DATA_TYPE                  = IEEE_REAL
   FORMAT                     = F5.3
   START_BYTE                 = 41
   BYTES                      = 4
   DESCRIPTION                = "EU +5V voltage monitor (V)"
END_OBJECT            = COLUMN

OBJECT                = COLUMN
   NAME                       = POS_12V_EU
   COLUMN_NUMBER              = 11
   DATA_TYPE                  = IEEE_REAL
   FORMAT                     = F6.3
   START_BYTE                 = 45
   BYTES                      = 4
   DESCRIPTION                = "EU +12V voltage monitor (V)"
```

```
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                          = NEG_12V_EU
  COLUMN_NUMBER                 = 12
  DATA_TYPE                     = IEEE_REAL
  FORMAT                        = F7.3
  START_BYTE                    = 49
  BYTES                         = 4
  DESCRIPTION                   = "EU -12V voltage monitor (V)"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                          = 3V_EU
  COLUMN_NUMBER                 = 13
  DATA_TYPE                     = IEEE_REAL
  FORMAT                        = F05.3
  START_BYTE                    = 53
  BYTES                         = 4
  DESCRIPTION                   = "EU +3.3V voltage monitor (V)"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                          = POS_24V_EU
  COLUMN_NUMBER                 = 14
  DATA_TYPE                     = IEEE_REAL
  FORMAT                        = F6.3
  START_BYTE                    = 57
  BYTES                         = 4
  DESCRIPTION                   = "EU +24V voltage monitor (V)"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                          = POS_5V_ANA_EU
  COLUMN_NUMBER                 = 15
  DATA_TYPE                     = IEEE_REAL
  FORMAT                        = F5.3
  START_BYTE                    = 61
  BYTES                         = 4
  DESCRIPTION                   = "EU +5V analog voltage monitor (V)"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                          = POS_5V_CURR_EU
  COLUMN_NUMBER                 = 16
  DATA_TYPE                     = IEEE_REAL
  FORMAT                        = E11.3
  START_BYTE                    = 65
  BYTES                         = 4
  DESCRIPTION                   = "EU +5V current monitor (A)"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                          = POS_12V_CURR_EU
  COLUMN_NUMBER                 = 17
  DATA_TYPE                     = IEEE_REAL
```

```
   FORMAT                  = E11.3
   START_BYTE              = 69
   BYTES                   = 4
   DESCRIPTION             = "EU +12V current monitor (A)"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
   NAME                    = NEG_12V_CURR_EU
   COLUMN_NUMBER           = 18
   DATA_TYPE               = IEEE_REAL
   FORMAT                  = E11.3
   START_BYTE              = 73
   BYTES                   = 4
   DESCRIPTION             = "EU -12V current monitor (A)"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
   NAME                        = POS_24V_ANA_CURR_EU
   FORMAT                  = E11.3
   COLUMN_NUMBER           = 19
   DATA_TYPE               = IEEE_REAL
   START_BYTE              = 77
   BYTES                   = 4
   DESCRIPTION             = "EU +24V current monitor (A)"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
   NAME                    = 3V_CURR_EU
   COLUMN_NUMBER           = 20
   DATA_TYPE               = IEEE_REAL
   FORMAT                  = E11.3
   START_BYTE              = 81
   BYTES                   = 4
   DESCRIPTION              = "EU +3V current monitor (A)"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
   NAME                    = POS_5V_ANA_CURR_EU
   COLUMN_NUMBER           = 21
   DATA_TYPE               = IEEE_REAL
   FORMAT                  = E11.3
   START_BYTE              = 85
   BYTES                   = 4
   DESCRIPTION             = "EU +5V analog current monitor (A)"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
   NAME                    = TLM_Heating
   COLUMN_NUMBER           = 22
   DATA_TYPE               = IEEE_REAL
   FORMAT                  = E11.3
   START_BYTE              = 89
   BYTES                   = 4
   DESCRIPTION             = "this item has been removed, see MIRO User Manual 7.1.2.5.
END_OBJECT           = COLUMN
```

```
OBJECT              = COLUMN
  NAME                        = TLM_RF
  COLUMN_NUMBER = 23
  DATA_TYPE                   = IEEE_REAL
  FORMAT                      = E11.3
  START_BYTE                  = 93
  BYTES                       = 4
  DESCRIPTION                 = "this item has been removed, see MIRO User Manual 7.1.2.5.
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                        = CTS_V_ANA_1
  COLUMN_NUMBER               = 24
  DATA_TYPE                   = IEEE_REAL
  FORMAT                      = F5.3
  START_BYTE                  = 97
  BYTES                       = 4
  DESCRIPTION                 = "CTS PG1 Voltage (V)"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                        = CTS_V_ANA_2
  FORMAT                      = F5.3
  COLUMN_NUMBER               = 25
  DATA_TYPE                   = IEEE_REAL
  START_BYTE                  = 101
  BYTES                       = 4
  DESCRIPTION                 = "CTS PG1 Voltage (V)"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                        = COLD_LOAD1_TEMP
  COLUMN_NUMBER               = 26
  DATA_TYPE                   = IEEE_REAL
  FORMAT                      = F6.1
  START_BYTE                  = 105
  BYTES                       = 4
  DESCRIPTION                 = "Cold load temperature #1 (deg C)"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                        = COLD_LOAD2_TEMP
  COLUMN_NUMBER               = 27
  DATA_TYPE                   = IEEE_REAL
  FORMAT                      = F6.1
  START_BYTE                  = 109
  BYTES                       = 4
  DESCRIPTION                 = "Cold load temperature #2 (deg C)"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
  NAME                        = WARM_LOAD1_TEMP
  COLUMN_NUMBER               = 28
  DATA_TYPE                   = IEEE_REAL
  FORMAT                      = F5.1
  START_BYTE                  = 113
```

```
   BYTES                          = 4
   DESCRIPTION                    = "Warm load temperature #1 (deg C)"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
   NAME                           = OB_TEMP
   COLUMN_NUMBER                  = 29
   DATA_TYPE                      = IEEE_REAL
   FORMAT                         = F5.1
   START_BYTE                     = 117
   BYTES                          = 4
   DESCRIPTION                    = "Optical Bench temperature (deg C)"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
   NAME                           = TELESCOPE1_TEMP
   COLUMN_NUMBER                  = 30
   DATA_TYPE                      = IEEE_REAL
   FORMAT                         = F6.1
   START_BYTE                     = 121
   BYTES                          = 4
   DESCRIPTION                    = "Telescope #1 temperature (deg C)"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
   NAME                           = TELESCOPE2_TEMP
   COLUMN_NUMBER                  = 31
   DATA_TYPE                      = IEEE_REAL
   FORMAT                         = F6.1
   START_BYTE                     = 125
   BYTES                          = 4
   DESCRIPTION                    = "Telescope #2 temperature (deg C)"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
   NAME                           = PLL_TEMP
   COLUMN_NUMBER                  = 32
   DATA_TYPE                      = IEEE_REAL
   FORMAT                         = F5.1
   START_BYTE                     = 129
   BYTES                          = 4
   DESCRIPTION                    = "Phase lock loop temerature (deg C)"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
   NAME                           = IFP_DET_TEMP
   COLUMN_NUMBER                  = 33
   DATA_TYPE                      = IEEE_REAL
   FORMAT                         = F5.1
   START_BYTE                     = 133
   BYTES                          = 4
   DESCRIPTION                    = "smm IF processor detector temperature (deg C)"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
   NAME                               = IFP_AMP_TEMP
```

```
   FORMAT                        = F5.1
   COLUMN_NUMBER                 = 34
   DATA_TYPE                     = IEEE_REAL
   START_BYTE                    = 137
   BYTES                         = 4
   DESCRIPTION                   = "smm IF processor amplifier temperature (deg C)"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
   NAME                          = SMM_LO_GUNN
   COLUMN_NUMBER                 = 35
   DATA_TYPE                     = IEEE_REAL
   FORMAT                        = F5.1
   START_BYTE                    = 141
   BYTES                         = 4
   DESCRIPTION                   = "smm LO Gunn temperature (deg C)"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
   NAME                          = MM_LO_GUNN
   COLUMN_NUMBER                 = 36
   DATA_TYPE                     = IEEE_REAL
   FORMAT                        = F5.1
   START_BYTE                    = 145
   BYTES                         = 4
   DESCRIPTION                   = "mm LO Gunn temperature (deg C)"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
   NAME                          = MOTOR_TEMP
   COLUMN_NUMBER                 = 37
   DATA_TYPE                     = IEEE_REAL
   FORMAT                        = F5.1
   START_BYTE                    = 149
   BYTES                         = 4
   DESCRIPTION                   = "Mirror motor temperature (deg C)"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
   NAME                          = SEN_EL
   COLUMN_NUMBER                 = 38
   DATA_TYPE                     = IEEE_REAL
   FORMAT                        = F5.1
   START_BYTE                    = 153
   BYTES                         = 4
   DESCRIPTION                   = "Sensor Electronics Unit (SBEU) temperature (deg C)"
END_OBJECT          = COLUMN

OBJECT              = COLUMN
   NAME                          = WARM_LOAD2_TEMP
   COLUMN_NUMBER                 = 39
   DATA_TYPE                     = IEEE_REAL
   FORMAT                        = F5.1
   START_BYTE                    = 157
   BYTES                         = 4
   DESCRIPTION                   = "Warm load temperature #2 (deg C)"
```

```
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                            = CAL_TEMP_LOW
  COLUMN_NUMBER                   = 40
  DATA_TYPE                       = IEEE_REAL
  FORMAT                          = F3.0
  START_BYTE                      = 161
  BYTES                           = 4
  DESCRIPTION                     = "Reference temperature 191 Ohms (digital units)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                            = CAL_TEMP_HIGH
  COLUMN_NUMBER                   = 41
  DATA_TYPE                       = IEEE_REAL
  FORMAT                          = F4.0
  START_BYTE                      = 165
  BYTES                           = 4
  DESCRIPTION                     = "Reference temperature 681 Ohms (digital units)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                            = POS_5V_SBEU
  COLUMN_NUMBER                   = 42
  DATA_TYPE                       = IEEE_REAL
  FORMAT                          = F5.3
  START_BYTE                      = 169
  BYTES                           = 4
  DESCRIPTION                     = "SBEU +5V voltage monitor (V)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                            = POS_12V_1_SBEU
  COLUMN_NUMBER                   = 43
  DATA_TYPE                       = IEEE_REAL
  FORMAT                          = F6.3
  START_BYTE                      = 173
  BYTES                           = 4
  DESCRIPTION                     = "SBEU +12V voltage monitor #1 (V)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                            = POS_12V_2_SBEU
  COLUMN_NUMBER                   = 44
  DATA_TYPE                       = IEEE_REAL
  FORMAT                          = F6.3
  START_BYTE                      = 177
  BYTES                           = 4
  DESCRIPTION                     = "SBEU +12V voltage monitor #2 (V)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                            = NEG_12V_SBEU
  COLUMN_NUMBER                   = 45
  DATA_TYPE                       = IEEE_REAL
```

```
    FORMAT                          = E11.3
    START_BYTE                      = 181
    BYTES                           = 4
    DESCRIPTION                     = "SBEU -12V voltage monitor (V)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                            = POS_5V_CURR_SBEU
    COLUMN_NUMBER                   = 46
    DATA_TYPE                           = IEEE_REAL
    FORMAT                          = E11.3
    START_BYTE                      = 185
    BYTES                           = 4
    DESCRIPTION                     = "SBEU +5V current monitor (A)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                            = POS_12V_CURR_1_SBEU
    COLUMN_NUMBER                   = 47
    DATA_TYPE                       = IEEE_REAL
    FORMAT                          = E11.3
    START_BYTE                      = 189
    BYTES                           = 4
    DESCRIPTION                     = "SBEU +12V current monitor #1 (A)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                            = POS_12V_CURR_2_SBEU
    COLUMN_NUMBER                   = 48
    DATA_TYPE                       = IEEE_REAL
    FORMAT                          = E11.3
    START_BYTE                      = 193
    BYTES                           = 4
    DESCRIPTION                     = "SBEU +12V current monitor #2 (A)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                            = NEG_12V_CURR_SBEU
    COLUMN_NUMBER                   = 49
    DATA_TYPE                       = IEEE_REAL
    FORMAT                          = E11.3
    START_BYTE                      = 197
    BYTES                           = 4
    DESCRIPTION                     = "SBEU -12V current monitor (A)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                            = MM_GUNN_CURR
    COLUMN_NUMBER                   = 50
    DATA_TYPE                       = IEEE_REAL
    FORMAT                          = F6.2
    START_BYTE                      = 201
    BYTES                           = 4
    DESCRIPTION                     = "mm LO Gunn current (mA)"
END_OBJECT              = COLUMN
```

```
OBJECT                  = COLUMN
  NAME                        = SMM_Mult_CURR
  COLUMN_NUMBER               = 51
  DATA_TYPE                   = IEEE_REAL
  FORMAT                      = E11.3
  START_BYTE                  = 205
  BYTES                       = 4
  DESCRIPTION                 = "smm multiplier current (mA)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                        = SMM_PLL_ERR
  COLUMN_NUMBER               = 52
  DATA_TYPE                   = IEEE_REAL
  FORMAT                      = F5.3
  START_BYTE                  = 209
  BYTES                       = 4
  DESCRIPTION                 = "static phase error for smm PLL (V)"
END_OBJECT              = COLUMN

OBJECT = COLUMN
  NAME                        = FS1_ERR
  COLUMN_NUMBER               = 53
  DATA_TYPE                   = IEEE_REAL
  FORMAT                      = F5.3
  START_BYTE                  = 213
  BYTES                       = 4
  DESCRIPTION                 = "Phase error for frequency synthesizer #1 (V)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                        = FS2_ERR
  COLUMN_NUMBER               = 54
  DATA_TYPE                   = IEEE_REAL
  FORMAT                      = F5.3
  START_BYTE                  = 217
  BYTES                       = 4
  DESCRIPTION                 = "Phase error for frequency synthesizer #2 (V)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                        = FS3_ERR
  COLUMN_NUMBER               = 55
  DATA_TYPE                   = IEEE_REAL
  FORMAT                      = F5.3
  START_BYTE                  = 221
  BYTES                       = 4
  DESCRIPTION                 = "Phase error for frequency synthesizer #3 (V)"
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
  NAME                        = SMM_PLL_GUNN_CURR
  COLUMN_NUMBER               = 56
  DATA_TYPE                   = IEEE_REAL
  FORMAT                      = F6.2
  START_BYTE                  = 225
```

```
   BYTES                         = 4
   DESCRIPTION                   = "smm Gunn oscillator current (via PLL) (mA)"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
   NAME                          = SMM_PLL_IF_PWR
   COLUMN_NUMBER                 = 57
   DATA_TYPE                     = IEEE_REAL
   FORMAT                        = E11.3
   START_BYTE                    = 229
   BYTES                         = 4
   DESCRIPTION                   = "smm PLL IF power monitor (V)"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
   NAME                          = SMM_GDO_VOLTAGE
   COLUMN_NUMBER                 = 58
   DATA_TYPE                     = IEEE_REAL
   FORMAT                        = E11.3
   START_BYTE                    = 233
   BYTES                         = 4
   DESCRIPTION                   = "smm GDO bias voltage (V)"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
   NAME                          = SPAREF
   COLUMN_NUMBER                 = 59
   DATA_TYPE                     = IEEE_REAL
   FORMAT                        = E11.3
   START_BYTE                    = 237
   BYTES                         = 4
   DESCRIPTION                   = "spare"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
   NAME                          = MIRPOS
   COLUMN_NUMBER                 = 60
   DATA_TYPE                     = MSB_UNSIGNED_INTEGER
   FORMAT                        = I1
   START_BYTE                    = 241
   BYTES                         = 1
   DESCRIPTION                   = "Mirror position: 1: sky, 2: warm load, 3: cold load"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
   NAME                          = POWERMODE
   COLUMN_NUMBER                 = 61
   DATA_TYPE                     = MSB_UNSIGNED_INTEGER
   FORMAT                        = I1
   START_BYTE                    = 242
   BYTES                         = 1
   DESCRIPTION                   = "Values 1-6 as described in MIRO User Manual 6.1.2.1.5"
END_OBJECT           = COLUMN

OBJECT               = COLUMN
   NAME                          = SUCR0
```

```
   COLUMN_NUMBER              = 62
   DATA_TYPE                  = CHARACTER
   FORMAT                     = A2
   START_BYTE                 = 243
   BYTES                      = 2
   DESCRIPTION                = "Low order bits 0-15 of Sensor Unit Control Register"

OBJECT              = BIT_COLUMN
   NAME                       = HSKMUX
   START_BIT                  = 1
   BITS                       = 5
   BIT_DATA_TYPE              = MSB_UNSIGNED_INTEGER
   FORMAT                     = Z5
   DESCRIPTION                = "Selects housekeeping channel"
END_OBJECT          = BIT_COLUMN

OBJECT              = BIT_COLUMN
   NAME                       = NON5VSMM
   START_BIT                  = 6
   BITS                       = 1
   BIT_DATA_TYPE              = MSB_UNSIGNED_INTEGER
   FORMAT                     = Z1
   DESCRIPTION                = "Commands +5V, +/-12V on after -5V is commanded using smm cont
                                mode"
END_OBJECT          = BIT_COLUMN

OBJECT              = BIT_COLUMN
   NAME                       = IFPCTL0
   START_BIT                  = 7
   BITS                       = 1
   BIT_DATA_TYPE              = MSB_UNSIGNED_INTEGER
   FORMAT                     = Z1
   DESCRIPTION                = "Bit 0 of 4 bit ifp power control setting"
END_OBJECT          = BIT_COLUMN

OBJECT              = BIT_COLUMN
   NAME                       = IFPCTL1
   START_BIT                  = 8
   BITS                       = 1
   BIT_DATA_TYPE              = MSB_UNSIGNED_INTEGER
   FORMAT                     = Z1
   DESCRIPTION                = "Bit 1 of 4 bit ifp power control setting"
END_OBJECT          = BIT_COLUMN

OBJECT              = BIT_COLUMN
   NAME                       = MMLNAON
   START_BIT                  = 9
   BITS                       = 1
   BIT_DATA_TYPE              = MSB_UNSIGNED_INTEGER
   FORMAT                     = Z1
   DESCRIPTION                = "Powers on mm LNA bias 0 = on, 1 = off"
END_OBJECT          = BIT_COLUMN

OBJECT              = BIT_COLUMN
   NAME                       = SMMLNAON
   START_BIT                  = 10
```

```
   BITS                          = 1
   BIT_DATA_TYPE                 = MSB_UNSIGNED_INTEGER
   FORMAT                        = Z1
   DESCRIPTION                   = "Powers on smm LNA bias 0 = on, 1 = off"
END_OBJECT             = BIT_COLUMN

OBJECT                 = BIT_COLUMN
   NAME                          = NON5VMM
   START_BIT                     = 11
   BITS                          = 1
   BIT_DATA_TYPE                 = MSB_UNSIGNED_INTEGER
   FORMAT                        = Z1
   DESCRIPTION                   = "Commands +5V, +/-12V on after -5V is commanded using mm cont
                                   mode"
END_OBJECT             = BIT_COLUMN

OBJECT                 = BIT_COLUMN
   NAME                          = NON5VSPC
   START_BIT                     = 12
   BITS                          = 1
   BIT_DATA_TYPE                 = MSB_UNSIGNED_INTEGER
   FORMAT                        = Z1
   DESCRIPTION                   = "Commands +5V, +/-12V on after -5V is commanded using cts mode"
END_OBJECT             = BIT_COLUMN

OBJECT                 = BIT_COLUMN
   NAME                          = PLLRESET
   START_BIT                     = 13
   BITS                          = 1
   BIT_DATA_TYPE                 = MSB_UNSIGNED_INTEGER
   FORMAT                        = Z1
   DESCRIPTION                   = "Phase-lock reset (0 locks, 1 unlocks) CF User Manual V7.1-7"
END_OBJECT             = BIT_COLUMN

OBJECT                 = BIT_COLUMN
   NAME                          = IFPCTL2
   START_BIT                     = 14
   BITS                          = 1
   BIT_DATA_TYPE                 = MSB_UNSIGNED_INTEGER
   FORMAT                        = Z1
   DESCRIPTION                   = "Bit 2 of 4 bit ifp power control setting"
END_OBJECT             = BIT_COLUMN

OBJECT                 = BIT_COLUMN
   NAME                          = IFPCTL3
   START_BIT                     = 15
   BITS                          = 1
   BIT_DATA_TYPE                 = MSB_UNSIGNED_INTEGER
   FORMAT                        = Z1
   DESCRIPTION                   = "Bit 3 of 4 bit ifp power control setting (MSB)"
END_OBJECT             = BIT_COLUMN

END_OBJECT = COLUMN
OBJECT                 = COLUMN
   NAME                          = SUCR16
   COLUMN_NUMBER                 = 63
```

```
   DATA_TYPE                = CHARACTER
   FORMAT                   = A2
   START_BYTE               = 244
   BYTES                    = 2
   DESCRIPTION              = "High order bits 16-31 of Sensor Unit Control Register"
END_OBJECT           = COLUMN

OBJECT               = BIT_COLUMN
   NAME                     = SMMGUNNOSCV
   START_BIT                = 1
   BITS                     = 4
   BIT_DATA_TYPE            = MSB_UNSIGNED_INTEGER
   FORMAT                   = Z4
   DESCRIPTION              = "Setting for voltage to smm Gunn oscillator"
END_OBJECT           = BIT_COLUMN

OBJECT               = BIT_COLUMN
   NAME                     = MMGUNNOSCV
   START_BIT                = 5
   BITS                     = 4
   BIT_DATA_TYPE            = MSB_UNSIGNED_INTEGER
   FORMAT                   = Z4
   DESCRIPTION              = "Setting for voltage to mm Gunn oscillator"
END_OBJECT           = BIT_COLUMN

OBJECT               = BIT_COLUMN
   NAME                     = NEG5VSMM
   START_BIT                = 9
   BITS                     = 1
   BIT_DATA_TYPE            = MSB_UNSIGNED_INTEGER
   FORMAT                   = Z1
   DESCRIPTION              = "Set -5V for smm continuum mode"
END_OBJECT           = BIT_COLUMN

OBJECT               = BIT_COLUMN
   NAME                     = NEG5VMM
   START_BIT                = 10
   BITS                     = 1
   BIT_DATA_TYPE            = MSB_UNSIGNED_INTEGER
   FORMAT                   = Z1
   DESCRIPTION              = "Set -5V for mm continuum mode"
END_OBJECT           = BIT_COLUMN

OBJECT               = BIT_COLUMN
   NAME                     = NEG5VCTS
   START_BIT                = 11
   BITS                     = 1
   BIT_DATA_TYPE            = MSB_UNSIGNED_INTEGER
   FORMAT                   = Z1
   DESCRIPTION              = "Set -5V for cts mode"
END_OBJECT           = BIT_COLUMN

OBJECT               = BIT_COLUMN
   NAME                     = LDFRQ
   START_BIT                = 12
   BITS                     = 1
```

```
  BIT_DATA_TYPE              = MSB_UNSIGNED_INTEGER
  FORMAT                     = Z1
  DESCRIPTION                = "Set and cleared to load the 3 frequency synthesizer chips""
END_OBJECT           = BIT_COLUMN

OBJECT               = BIT_COLUMN
  NAME                       = MIRROROFF
  START_BIT                  = 13
  BITS                       = 1
  BIT_DATA_TYPE              = MSB_UNSIGNED_INTEGER
  FORMAT                     = Z1
  DESCRIPTION                = "0: Mirror power on, 1: Mirror power off"
END_OBJECT           = BIT_COLUMN

OBJECT               = BIT_COLUMN
  NAME                       = MIRRORBACK
  START_BIT                  = 14
  BITS                       = 1
  BIT_DATA_TYPE              = MSB_UNSIGNED_INTEGER
  FORMAT                     = Z1
  DESCRIPTION                = "1: backward mirror motion, 0: forward mirror motion"
END_OBJECT           = BIT_COLUMN

OBJECT               = BIT_COLUMN
  NAME                       = SMMFRQSW
  START_BIT                  = 15
  BITS                       = 1
  BIT_DATA_TYPE              = MSB_UNSIGNED_INTEGER
  FORMAT                     = Z1
  DESCRIPTION                = "Set LO = 0 or 1 when frequency swtiching is on"
END_OBJECT           = BIT_COLUMN

OBJECT               = BIT_COLUMN
  NAME                       = PINPULLER
  START_BIT                  = 16
  BITS                       = 1
  BIT_DATA_TYPE              = MSB_UNSIGNED_INTEGER
  FORMAT                     = Z1
  DESCRIPTION                = "Set and cleared to activate mirror pin puller"
END_OBJECT           = BIT_COLUMN

END_OBJECT           = COLUMN

OBJECT               = COLUMN
  NAME                       = ADDR100
  COLUMN_NUMBER              = 64
  DATA_TYPE                  = CHARACTER
  FORMAT                     = A2
  START_BYTE                 = 246
  BYTES                      = 2
  DESCRIPTION                = "Bits from address 100"

OBJECT               = BIT_COLUMN
  NAME                       = EMUX
  START_BIT                  = 1
  BITS                       = 5
  BIT_DATA_TYPE              = MSB_UNSIGNED_INTEGER
```

```
   FORMAT                  = Z5
   DESCRIPTION             = "Bits 0-5 set corresponding EMUX, 0-5"
END_OBJECT         = BIT_COLUMN

OBJECT             = BIT_COLUMN
   NAME                    = SND2SU
   START_BIT               = 6
   BITS                    = 1
   BIT_DATA_TYPE           = MSB_UNSIGNED_INTEGER
   FORMAT                  = Z1
   DESCRIPTION             = "Send command register data to Sensor Unit"
END_OBJECT         = BIT_COLUMN

OBJECT             = BIT_COLUMN
   NAME                    = MOTSTEP
   START_BIT               = 7
   BITS                    = 1
   BIT_DATA_TYPE           = MSB_UNSIGNED_INTEGER
   FORMAT                  = Z1
   DESCRIPTION             = "Enable motor stepping"
END_OBJECT         = BIT_COLUMN

OBJECT             = BIT_COLUMN
   NAME                    = LDENABLE
   START_BIT               = 8
   BITS                    = 1
   BIT_DATA_TYPE           = MSB_UNSIGNED_INTEGER
   FORMAT                  = Z1
   DESCRIPTION             = "1: Enable load, 0: Disable load""
END_OBJECT         = BIT_COLUMN

OBJECT             = BIT_COLUMN
   NAME                    = POS12VSPEC
   START_BIT               = 9
   BITS                    = 1
   BIT_DATA_TYPE           = MSB_UNSIGNED_INTEGER
   FORMAT                  = Z1
   DESCRIPTION             = "+12V Spectrometer on, 1: On, 0: Off"
END_OBJECT         = BIT_COLUMN

OBJECT             = BIT_COLUMN
   NAME                    = POS5VSPEC
   START_BIT               = 10
   BITS                    = 1
   BIT_DATA_TYPE           = MSB_UNSIGNED_INTEGER
   FORMAT                  = Z1
   DESCRIPTION             = "+5V Spectrometer on, 1: On, 0: Off"
END_OBJECT         = BIT_COLUMN

OBJECT             = BIT_COLUMN
   NAME                    = POS5VANA
   START_BIT               = 11
   BITS                    = 1
   BIT_DATA_TYPE           = MSB_UNSIGNED_INTEGER
   FORMAT                  = Z1
   DESCRIPTION             = "+5V Analog spectrometer on, 1: On, 0: Off"
```

```
END_OBJECT          = BIT_COLUMN

OBJECT              = BIT_COLUMN
  NAME                        = POS3VSPEC
  START_BIT                   = 12
  BITS                        = 1
  BIT_DATA_TYPE               = MSB_UNSIGNED_INTEGER
  FORMAT                      = Z1
  DESCRIPTION                 = "+3V Spectrometer on, 1: On, 0: Off"
END_OBJECT          = BIT_COLUMN

OBJECT              = BIT_COLUMN
  NAME                        = NEG12VSPEC
  START_BIT                   = 13
  BITS                        = 1
  BIT_DATA_TYPE               = MSB_UNSIGNED_INTEGER
  FORMAT                      = Z1
  DESCRIPTION                 = "-12V Spectrometer on, 1: On, 0: Off"
END_OBJECT          = BIT_COLUMN

OBJECT              = BIT_COLUMN
  NAME                        = USO24V
  START_BIT                   = 14
  BITS                        = 1
  BIT_DATA_TYPE               = MSB_UNSIGNED_INTEGER
  FORMAT                      = Z1
  DESCRIPTION                 = "+24V USO on, 1: On, 0: Off"
END_OBJECT          = BIT_COLUMN


OBJECT              = BIT_COLUMN
  NAME                        = CALHTRON
  START_BIT                   = 15
  BITS                        = 1
  BIT_DATA_TYPE               = MSB_UNSIGNED_INTEGER
  FORMAT                      = Z1
  DESCRIPTION                 = "Calibration Heater On, 0: Off, 1: On"
END_OBJECT          = BIT_COLUMN

OBJECT              = BIT_COLUMN
  NAME                        = CTSTRISTORE
  START_BIT                   = 16
  BITS                        = 1
  BIT_DATA_TYPE               = MSB_UNSIGNED_INTEGER
  FORMAT                      = Z1
  DESCRIPTION                 = "CTS Tri-state, 1: disable, 0: enable"
END_OBJECT          = BIT_COLUMN

END_OBJECT          = COLUMN
```

The following is an example of the first record of an Engineering file, with just the first 4 of the 58 engineering data fields shown, in both hex and formatted representations:

```
Listing of rows     1 to     2 for file RO-CAL-MIRO-2-GRND-THERMALVAC-
V1.0/DATA/ENGINEERING/MIRO_2_HSK_20011410000.DAT

 COL.#:          1            2        3        4        5    60 61  62   63   64
 ITEMS:  41CD8476E0294984 C19DCEA5 41C03E77 41BF872B 41C042C4 01 06 0000 1004 0000
 ITEMS:  41CD8476E5C2F683 41C00553 41C08312 41BFCC30 41C042C4 01 06 001F 1004 0000

Listing of rows     1 to     2 for file RO-CAL-MIRO-2-GRND-THERMALVAC-
V1.0/DATA/ENGINEERING/MIRO_2_HSK_20011410000.DAT

 COL.#:          1              2         3         4         5     60  61    62    63    64
 ITEMS:   9.904408963E+08 -1.973E+01 2.403E+01 2.394E+01 2.403E+01   1   6     0  4100     0
```

Appendix C,
Available Software to Read PDS Files

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C. AVAILABLE SOFTWARE TO READ PDS FILES

The MIRO data files can be read by PDS-supported software such as NASAVIEW. The PDS also provides an IDL routine, called READPDS, for reading archived data It can be found on-line at:

https://pds-smallbodies.astro.umd.edu/tools/tools_readPDS.shtml

The MIRO team has provided, in the DOCUMENT directory, a python program named MIRO_READ_DATA. It can read all MIRO data formats for comet data as of January 2018, and can serve as an example for understanding the data structure of MIRO products and for developing data processing software. Limitations of MIRO_READ_DATA to be aware of are:

- MIRO_READ_DATA does not read archived data for mission phases prior to encountering the comet (i.e. prior to PRL).
- The last three fields in MIRO Level 2, Version 1.0 Engineering data are “bit column” fields. This means each is a sequence of 1 to 16 bits, each bit being an independent data field, but the bits are stored as a 2-byte integer. MIRO_READ_DATA does not separate out the separate bit column values, and reports each bit column field as a single integer.
- As described in Appendix B, MIRO products use several different formats. MIRO_READ_DATA uses the name of the input file to identify the correct format to use, so the naming conventions used in the PSA/PDS archive must be maintained when using MIRO_READ_DATA.

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