Austrian Academy of Sciences
Space Research Institute
Department of Experimental Space Research

ROSETTA-MIDAS

To Planetary Science Archive Interface Control Document

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ÖAW
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16 November 2017	4.2.1 Updated data products table 4.2.6 Astronomical vs. MIDAS targets 4.3.7 Added pixel scale attributes to label	October 2017 Science Archive Review update

ITEMS

Section	Description

Table Of Contents

1 Introduction

1.1 Purpose and Scope

The purpose of this EAICD (Experimenter to (Science) Archive Interface Control Document) is twofold. At first, it provides users of the MIDAS instrument with a detailed description of the product and a description and the methods by which it is generated, including data sources and destinations. Secondly, it is the official interface between the MIDAS instrument team and the archiving authority.

1.2 Archiving Authorities

The Planetary Data System Standard is used as an 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

1.2.1 ESA's Planetary Science Archive (PSA)

ESA implements an online science archive, the PSA,

- 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 MIDAS instrument on ROSETTA from the S/C until insertion into the PSA for ESA. 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. Software that may be used to access the product is explained further on.

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 staff of the archiving authority (Planetary Science Archive, ESA, RSSD, design team) and any potential user of the MIDAS data.

1.5 Applicable Documents

[1] Planetary Data System Data Preparation Workbook
February 17, 1995, Version 3.1, JPL D-7669, Part1

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

[3] ROSETTA Archive Generation, Validation and Transfer Plan
October 6, 2005, Issue 2.2, RO-EST-PL-5011

[4] ROSETTA Experiment Interface Document – Part A
February *1, 2004, Issue 2, Rev. 3, RO-EST-RS-3001/EIDA*

[5] ROSETTA - MIDAS Experiment Interface Document – Part B
February 15, 2001, Issue 2d, Rev. 0, RO-EST-RS-3010/EIDB

[6] ROSETTA - Data Delivery Interface Document (DDID)
October 23, 2003, Issue B6, RO-ESC-IF-5003

[7] MIDAS User Manual
February 23, 2004, Issue 2, Rev. 1, MID-IWF-UM-0047

[8] ROSETTA Time Handling
February 28, 2006, Issue 1, Rev. 1, RO-EST-TN-3165

[9] MIDAS Co-ordinate Systems
October 28, 2008, Issue 1.0, MID-IWF-TD-0029

1.6 Relationships to Other Interfaces

N/A

1.7 Acronyms and Abbreviations

AFM	Atomic Force Microscope
DAQ	Data Acquisition
DDID	Data Delivery Interface Document
DDS	Data Disposition System
EAICD	Experimenter to (Science) Archive Interface Control Document
EGSE	Electrical Ground Support Equipment
FM	Flight Model
FS	Flight Spare Model

IDL	Interactive Data Language
IWF/OAW	Space Research Institute of the Austrian Academy of Sciences
JPL	Jet Propulsion Laboratory
LVDT	Linear Variable Differential Transformer
MIDAS	Micro-Imaging Dust Analysis System
N/A	Not applicable
NAIF	The Navigation and Ancillary Information Facility, JPL/NASA
NASA	National Aeronautics and Space Administration
OBT	S/C On-board Time (Spacecraft Elapsed Time according to [4])
PDS	Planetary Data System
PSA	Planetary Science Archive
QM	Qualification Model
SCET	Spacecraft Event Time (according to [6])
SPM	Scanning Probe Microscope
STM	Scanning Tunneling Microscopy
TB/TV	Thermal Balance/Thermal Vacuum

1.8 Contact Names and Addresses

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2 Overview of Instrument Design, Data Handling Process and Product Generation

2.1 Scientific Objectives

The experiment MIDAS (Micro-Imaging Dust Analysis System) is dedicated to the micro textural and statistical analysis of cometary dust particles. The instrument is based on the technique of atomic force microscopy. Under the conditions prevailing at the Rosetta Orbiter this technique permits textural and other analysis of dust particles to be performed down to a spatial resolution of 4 nm.

During the rendezvous with the comet MIDAS will provide the following information:

- images of single particles with a spatial resolution of 4 nm,
- statistical evaluation of the particles according to size, volume, and shape,
- size distribution of particles ranging from about 4 nm to a few µm,
- shape, volume and topographic structure of individual particles,
- temporal variation of particle fluxes,
- spatial variation of particle fluxes, and
- measurements on local elastic properties if further studies show that they do not affect the tip lifetime

During the cruise phase to the comet MIDAS may provide:

- characterization of the dust environment in the vicinity of the asteroids for which a fly-by is performed
- imaging of impact craters caused by fast interplanetary dust particles, and
- statistical analysis of craters on the exposed surface in terms of particle size and volume

MIDAS will deliver global images, i.e. complete images of the entire scan field, and images of individual dust particles. The latter are contained in the former, since selected particles are identified from the global image. These particles are then re-scanned with a much higher resolution. The measurements by the MIDAS instrument will address many of the questions related to cometary dust. In particular, the MIDAS instrument can measure and address the following qualities of the collected dust grains:

- 3D images of single particles
- Images of the textural complexity of particle aggregates
- Identification of crystalline material if idiomorphic or hypidiomorphic shapes are developed
- Identification of sub-features on clean surfaces which provides insight into the growth conditions (e.g. twinning defects) and/or storage environment (e.g. dissolution marks)
- Statistical evaluation of the particles according to size, volume and shape

- Variation of particle fluxes between individual exposures of the collector unit on time scales of hours
- Four out of the sixteen sensors are capable of detecting a magnetic gradient between sensor and sample and allow the identification of ferromagnetic minerals or the visualisation of the internal magnetic structure of a grain.

2.2 AFM Operating Modes

Contact mode

The working point is set close to the repulsive force regime where the tip actually touches the surface. Typically, a force of the order 10^{-7}–10^{-6} N is exerted on the sample. Owing to the strongly increasing repulsive force at decreasing distances, the tip cannot penetrate deeply into the surface and the soft cantilever bends. However, the pressure exerted by the tip is high and soft samples, particularly, can be scratched or damaged.

Dynamic mode

The cantilever is excited at its natural mechanical resonance frequency (~100 kHz) at close distance to the sample. The amplitude of the cantilever vibration is of the order 100 nm. Depending on the operational setting, the tip may or may not touch the sample during each oscillation. At small tip-sample separation of the order 5–10 nm, the interaction of the electron orbits results in a weak attractive force, and the resonance frequency of the cantilever changes owing to a virtual increase in its spring constant. The quantity thereby measured is not the force directly, but its gradient. As in the contact mode, vertical resolution in the nm range can be achieved. The force applied by the tip to the sample is of the order 10^{-8} N. This relatively small force and the absence of lateral forces makes damage to the tip less likely, and the lifetime of the tip increases considerably. The lateral resolution obtained in dynamic mode is comparable to that of the contact mode. However, dynamic mode images often represent not only the topography, but also to some extent the elastic properties of the sample under investigation. The mechanical resonance frequency of the cantilever has to be determined before any measurement in dynamic mode.

Magnetic force microscopy

This derivative of atomic force microscopy (Martin and Wickramasinghe, 1987) records a magnetostatic force between sample and a magnetised tip. Four of the MIDAS tips have been coated with a thin layer of cobalt. The deflections of their cantilevers then result from a combination of mechanical and magnetic forces, which can be separated by measurements at two different tip-sample distances. These tips map the magnetic structures of the particles in addition to the topographies.

2.3 Operating Principle

MIDAS is designed to analyse micro dust particles collected in the cometary environment, irrespective of their electrical conductivity and shape, by means of atomic force microscopy. The size of the particles which can be analysed ranges from about 4 nm to a few µm. The dust collector system includes a shutter mechanism which controls the particle flux onto a wheel covered with special coating to provide maximum adhesion for the particles. Sixty-one separate targets at the wheel are available for subsequent exposure to the ambient dust flux. The MIDAS microscope consists of five functional parts: a one shot cover and a funnel to protect the aperture on the ground and during launch, the shutter to define the exposure time to the dust flux, the robotics system for manipulation of the dust particles, the scanner head, and the supporting electronics.

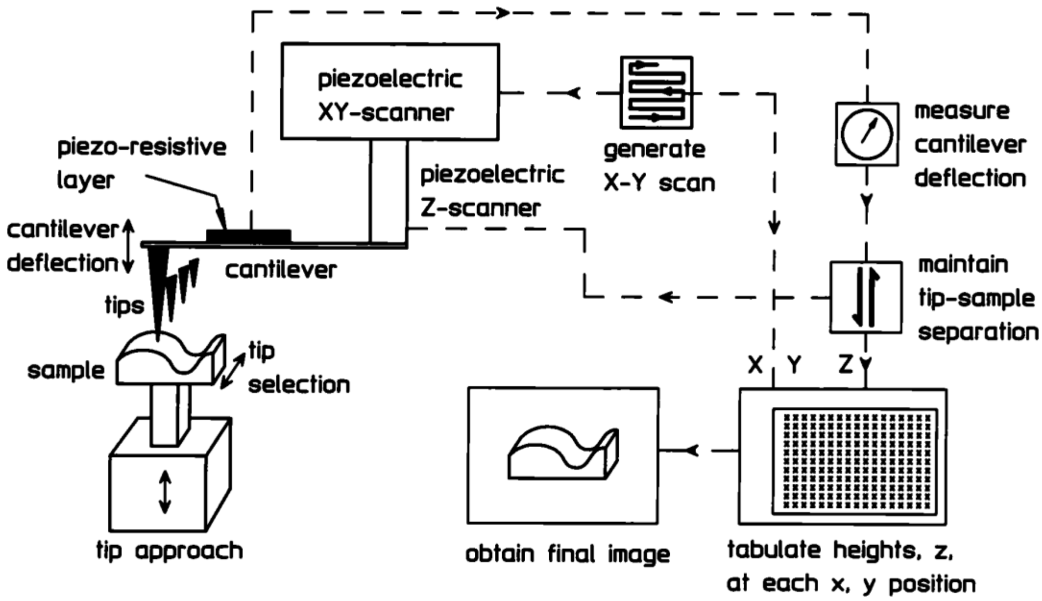


Fig. 2.1 – MIDAS Working Principle

At the heart of the atomic force microscope (AFM) is a very small tip which maps the surface of the particle. An AFM is capable, in principle, of imaging details down to atomic resolution. In the simplest case, the tip remains in permanent contact with the surface and follows its height variations with a control mechanism which keeps a constant force on the tip (contact mode). In a technically more complex mode, the tip scans the surface while its supporting cantilever vibrates at one of its natural resonance frequencies. Depending on the amplitude of the oscillation in dynamic mode, (a) the tip does not come closer to the surface than a few tenths of a nanometre (non-contact mode) or (b) the tip hits the surface during its sinusoidal oscillation (tapping mode). In all modes it is essential either to keep the force constant or to measure it accurately in order to derive an image of the surface.

The tip must move over the surface in a reproducible manner, which can be relatively easily achieved by piezo electric scanners in three independent directions. The combination of the tip, supporting cantilever, and piezo-electric actuators is called scanner head. Due to lifetime requirements, several tips will be employed (16 in total).

2.4 Data Handling Process

The data products will be prepared and delivered by IWF/OAW in collaboration with partners from ESTEC. A list of contact persons, phone numbers and email addresses is given in section 1.8.

All data products are planned to be level 1b and/or level 2 data (PSA processing label) throughout the whole mission lifetime. Higher level data products will be included in the final archive volume distribution.

It is foreseen to use most of the already developed EGSE software modules for data processing. This software will be adapted to generate the data products from the raw data archive (locally stored laboratory data as well as DDS data after launch).

2.5 Overview of Data Products

The table below shows the data products which are intended to be archived. A detailed description of the different data types follows.

Data Type	Type Mnemonic	PDS Data Type
Housekeeping Data (Standard, Extended)	HK1, HK2	TABLE
Frequency Scan Data	FSC	SERIES
Single Point Approach Data (Control Data)	SPA	TABLE
Single Point Sampling Data (High Resolution Data)	SPS	SERIES
Line Scan Data	LIN	TABLE
Image Scan Data	IMG	IMAGE
Feature Vector Data (Regions Of Interest)	ROI	TABLE
Event Data	EVN	TABLE
Cantilever Utilisation History	CAH	TABLE
Target Utilisation History	TGH	TABLE

Table 2.1 – MIDAS Archive Data Products

Housekeeping Data

MIDAS generates two types of housekeeping data:

- The standard housekeeping report contains basic information and reflects the “general condition” of the instrument (e.g. voltage monitors, temperatures).
- The much larger extended housekeeping report includes the status of the instrument sub-systems (e.g. linear stage, approach) and all parameters related to the science operations.

Typical data cadences are 4 seconds for the standard HK report and 8 seconds for the extended HK report for laboratory generated data. The individual data rates can be changed via telecommand and will be much lower during normal flight operations.

Frequency Scan Data

In order to set the operating point (excitation frequency) for a certain cantilever (tip), the resonance frequency has to be determined. This is achieved by performing a frequency sweep in a commanded frequency range. The operating point is set relative to the detected resonance amplitude. A frequency scan produces up to 8 data packets (depending of the commanded frequency range and resolution) of 256 data acquisition points each.

The frequency scan is performed

- every time approaching the surface,
- whenever a new tip is selected, or
- during long-lasting (dynamic) scans when re-adjustment of the frequency is required.

The cantilevers (tips) are numbered from 1 to 16 and are addressable by 2 blocks of 8 cantilevers each (physically the cantilevers are structured into four cantilever arrays):

Tip #	Description	Cantilever selection	
		Block #	Cantilever #
1-4	Cantilever array #1	1	1-4
5-8	Cantilever array #2	1	5-8
9-12	Cantilever array #3	2	1-4
13-16	Cantilever array #4 (cobalt coated)	2	5-8

Tip, cantilever block and cantilever number are also present in the extended housekeeping data product. Please note that the cantilever number ranges from 0 to 7 in this data product.

Single Point Approach Data

The MIDAS instrument software is capable of monitoring selected data acquisition process parameters (cantilever AC, DC and phase signal; Z set value) simultaneously in a single scan position. This feature can be enabled or disabled when performing a line scan and is not available for the full image scan. The associated data packet contains the last 256 processed parameter values before the measurement reading is recorded. During a line scan, 32 uniformly distributed positions are monitored. The parameter MAIN_SCAN_CNT indicates the pixel number within the line where the approach vector has been recorded.

Single Point Sampling Data

The data acquisition monitoring structure is also used for a more complex instrument mode. This “high resolution” scanning mode allows the sampling of the above-mentioned parameters with a frequency of up to 700 samples per second. The scanner head remains in the same X/Y position when taking the data samples (STEP_SIZE parameter is 0). Thus the Single Point Sampling data product corresponds to a single point located on the target surface.

By getting into contact with the surface (static or DC mode), the cantilever DC signal can be used to measure micro-vibrations with a maximum frequency of 350 Hz. This mode is frequently used during the pointing and interference scenario.

In order to detect possible micro-vibrations, a Fast Fourier Transform (FFT) has to be applied to the DC sample vector. Analysis of the resulting frequency spectrum will give an indication (spectral lines with higher amplitude) on micro-vibrations.

Line Scan Data

Additionally to the full image scan, MIDAS is able to scan single lines in either X or Y direction. The line scan values have two different meanings depending on the commanded scanning mode:

- In dynamic or contact mode the Z piezo set values at the surface are stored in the line scan.
- In magnetic mode the differences of the cantilever AC signals at the surface and at a given distance from the surface are recorded.

The size of a line scan is a multiple of 32, ranging from 32 to a maximum of 512 DAQ points.

Image Scan Data

The image scan is the key operation of the instrument MIDAS. The on-board image memory of 1 MB can hold a maximum of 8 standard images (256x256 pixel / 1 DAQ channel = 128 kB). The image dimensions are multiples of 32 pixels, ranging from 32 to a maximum of 512 DAQ points.

During a single image scan up to 8 data channels can be measured in parallel. At the present time 14 data channels are available (the value in curly braces gives the calibration curve number as defined in the calibration table MIDCALIB.TAB defined in chapter 3.4.2.2):

- `[ZS]` Z piezo set value (this is the default channel for all scanning modes) {40}
- `[AC]` Cantilever AC signal at surface (required for magnetic mode) {3}
- `[PH]` Cantilever Phase signal {13}
- `[DC]` Cantilever DC signal {3}
- `[XH,YH,ZH]` X, Y, Z piezo high voltage monitor {8}
- `[M1,M2,M3]` Cantilever AC signal at (magnetic) retract position 1,2,3 {3}
- `[YP,ZP]` Y, Z piezo position (measured) {3}
- `[YE,ZE]` Y, Z piezo offset error (control loop deviation set value / measured value) {3}
- `[S1,S2]` Data point acquisition status information

If more than one data channel is selected for a scan, the software generates a separate image for every channel.

Feature Vector Data

Another facet of the instrument software is the calculation of so-called “feature vectors” for an already acquired image. These vectors are providing statistical information (10 parameters in total) of features found in the image, for example area or volume. The features are selected dependent on a number of commandable criteria. By weighting the selection criteria, it is possible to determine a feature which suits best the given requirements. The coordinates of the determined feature can then be used to automatically zoom-in into the underlying image.

A maximum of 1024 feature vectors can be stored for a single image. The vectors are packed into statistical data packets containing 64 vectors each.

Event Data

Every task (e.g. mechanical sub-system movement, scan, image processing) running on the instrument has associated a number of events providing information about the status of the task (e.g. started, finished and aborted). In order to keep track of the task execution, the events will also be part of the MIDAS data archive.

A list of events is given in the MIDAS User Manual in section 2.3.3.1 “TM data packet overview”.

Cantilever Utilisation History Data

The MIDAS scanner head holds 16 different cantilevers (tips) mainly for redundancy purposes, and four of these tips are coated with magnetic material and may be used for magnetic mode scans. For the interpretation of the AFM images it is necessary to know the history of the tip which has been used for the image acquisition. A list of operating times and associated scanning parameters (e.g. scanning mode, gain levels and excitation level) will be stored for each cantilever.

The cantilever history files are cumulative, containing the data from the start of the mission up to and including the mission phase represented in a dataset.

Target Utilisation History Data

For each of the 64 scanning targets (including the three calibration targets) a list of events concerning the target will be maintained and stored in the archive. Dedicated information like the dust flux during exposure recorded by GIADA or the scanning tip number will be stored in this table.

The targets are numbered from 1 to 64 and each target is subdivided into 16 addressable segments (or scan bands). This results in a total number of 1024 addressable target segments. The segments are numbered from 0 to 1023, with segment 0 referring to the centre of target 1:

Target #	Description	Addressed by segment #		
		Min	Centre	Max
1	Dust collector target	1017	0	7
2	TGZ02 – Z calibration (106 nm height)	9	16	23
3	TGX01 – used for X/Y calibration	25	32	39
4	TGT01 – X/Y calibration and tip imaging	41	48	55
5	Dust collector target	57	64	71
…				
64	Dust collector target	1001	1008	1015

The target history files are cumulative, containing the data from the start of the mission up to and including the mission phase represented in a dataset.

2.5.1 Pre-Flight Data Products

MIDAS will provide laboratory data from the TB/TV acceptance tests of the FM. Since the generation of the feature vectors was not implemented in the instrument S/W at that time, it is also intended to create a data set from dedicated FS or QM tests.

2.5.2 Sub-System Tests

A series of micro-vibration tests were performed on the QM.

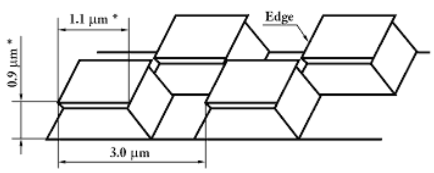
2.5.3 Instrument Calibrations

X/Y/Z Calibration

The X-, Y- and Z-sensors of the MIDAS instrument are calibrated by means of three reference grids which are mounted on the target wheel. These reference grids are scanned on a more or less regular basis in order to re-calibrate the scanner head:

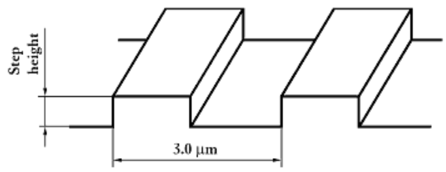
- TGX01 – used for X/Y calibration

  The silicon calibration grating of the TGX series is a chessboard-like array of square pillars with sharp undercut edges formed by (110) crystallographic planes of silicon.



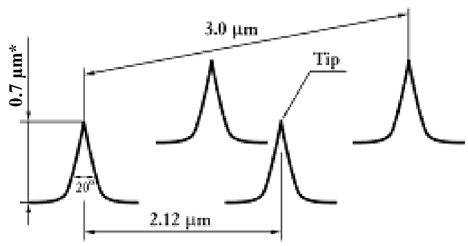
- TGZ02 – Z calibration (106 nm height)

  Calibration gratings of the TGZ series are 1-D arrays of rectangular SiO_2 steps on a Si wafer. The structure is coated by Si_3N_4 to prevent Si from oxidation. The step height value is calibrated over the whole active area.



- TGT01 – X/Y calibration and tip imaging

  The silicon calibration grating of the TGT01 series is an array of sharp tips, characterized by strict symmetry of tip sides, small cone angle (less than 20 degrees) and small curvature radius of the tips (less than 10 nm) over the whole active area.



The dimensions marked (*) show approximate values and are given for information only.

The archive will contain the following calibration data:

- Tip resonance curves as a function of the excitation frequency in [V]
- Tip positions as a function of the linear stage LVDT monitor in [V] and [µm] (see [9])
- Tip images acquired by sampling calibration grating TGT01
- X/Y step calibration (can be derived from sampling calibration grating TGX01)
- Z step calibration (can be derived from sampling calibration grating TGZ02)
- HK parameter conversion from raw to physical values

2.5.4 Other Files written during Calibration

Numerous reference measurements with commercial AFM's (Zeiss, Park) have been performed. The resultant image database is used as reference for the analysis and interpretation of MIDAS generated images.

2.5.5 In-Flight Data Products

A list of data products as well as a detailed description is already provided at the beginning of section 2.5.

The data products are planned to be level 1b and/or level 2 data (PSA processing label) throughout the whole mission lifetime. Higher level data products are likely to be included in the final archive volume distribution.

2.5.6 Software

2.5.6.1 Data Archiving Software

The MIDAS data archiving software is a graphical user interface written in IDL and is used to prepare the MIDAS archive data sets to be delivered to the PSA.

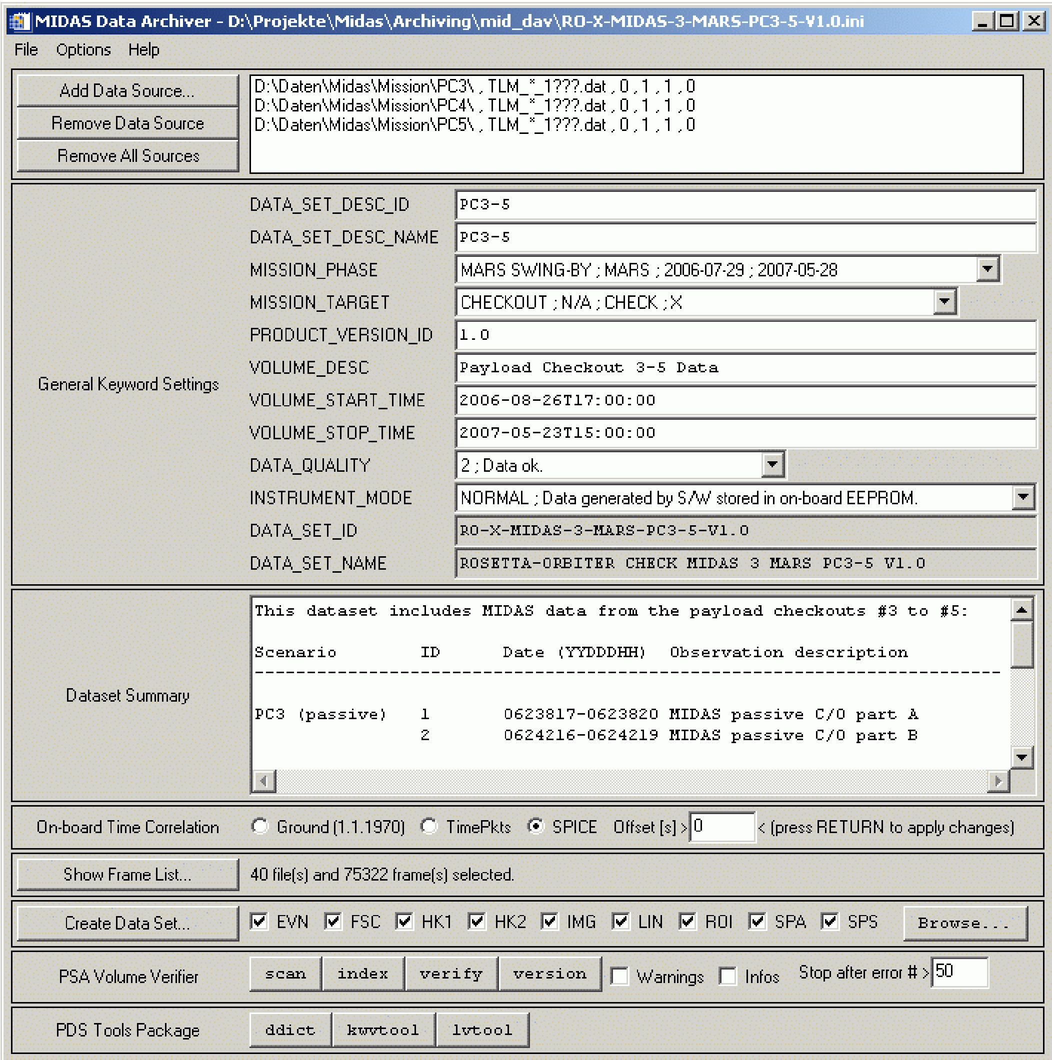


Fig. 2.2 – MIDAS Data Archiving S/W

Key features of the archiving software are:

- Data sets are created directly from the MIDAS raw data archive by means of data set templates which are completed during data processing.
- The S/W is capable of managing so called “data set profiles” in order to ease re-production of entire data sets.

- A number of label verification tools (PVV, NASA PDS tools) are already integrated into the archiving software. This allows the user to validate the data sets immediately after generation.

2.5.6.2 Data Verification Software

This software is used to display and validate the contents of an entire MIDAS archive data set interactively. The software is entirely written in IDL and the source code is included in the data sets. The source files (extension *.PRO) are located in the DOCUMENT directory of a data set. A detailed description of the software is provided in section 5.

2.5.6.3 Third Party Software Packages

NASAView

NASAView (http://pds.nasa.gov/tools/nasa-view.shtml) is a PDS archive product display program that runs on multiple platforms in a GUI environment. The tool can be used to view the MIDAS images located in the DATA/IMG directory.

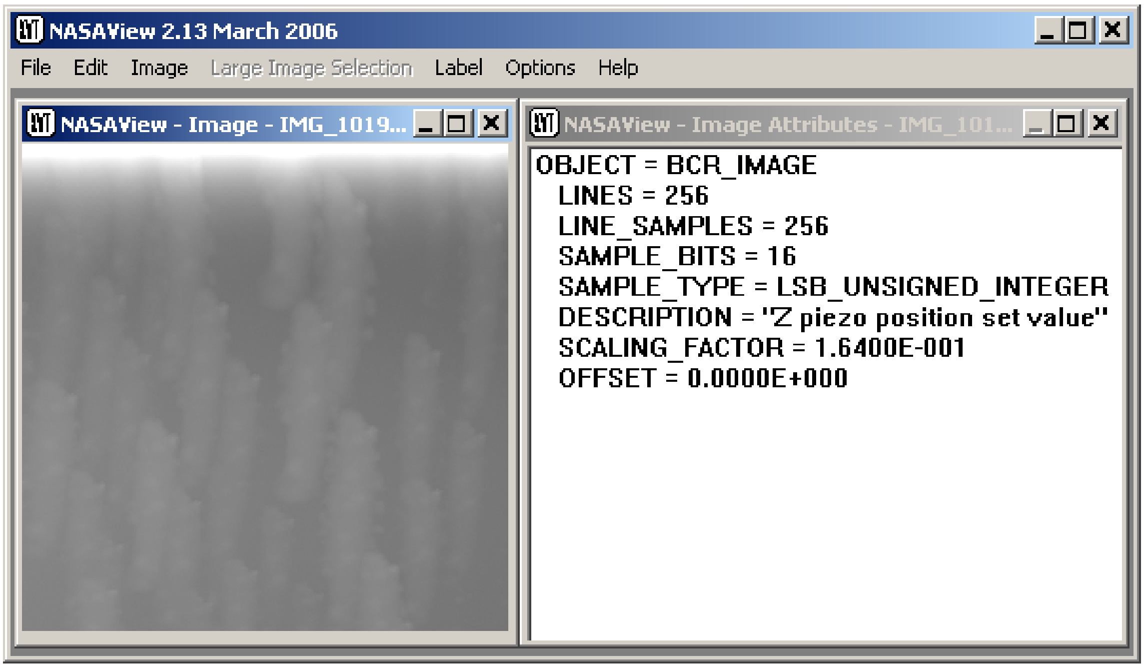


Fig. 2.3 – MIDAS Image taken during LUTETIA Fly-by

PDS Tools Package

The PDS Tools Package (http://pds.nasa.gov/tools/pds-tools-package.shtml) is the complete set of PDS Engineering Node supported tools. This package contains a single installer file which includes the option to install the following tools:

- Keyword Definition (ddict): Lists all keywords and their definitions from the specified file(s).
- Keyword Verifier (kwvtool): Lists all keywords and a distinct set of their values from the specified file(s).

- Label Parser: The Java-based label parser parses an ODL label and generates an XML representation.
- Label Verifier (lvtool): Performs validation of PDS labels.
- Line Analyzer (line): Analyzes each line of a file and reports anomalies.
- Make Index (make_index): Creates an index file (pdsdd.idx) from a data dictionary file (pdsdd.full).
- Perl Validation Toolkit: Validates PDS volumes (includes lvtool and kwvtool).
- Table Checker (table_check): Performs a variety of tests on PDS table objects.
- Table to Label Generator (tab2lab): Generates PDS labels from values in a table.
- Table Verifier (tbtool): Utility for validating, browsing and summarizing data that is organized by rows and columns and is described by a PDS label.

The PDS Tools Package also includes libraries which are utilized by the tools listed above and are available for use in customized applications:

- Label Library (lablib): This library, written in C, can be used to read, process and write PDS labels.
- Label Library Light (lablib3): This library, written in C, can be used to read, process and write PDS labels. Compared to lablib, this library is smaller, faster and has a simpler interface.
- ODLC Library (odlc): This library, written in C, can be used to access data that meet the standards of the PDS.
- Object Access Library (oal): This library, written in C, can be used to access data that meet the standards of the PDS.

2.5.7 Documentation

The following documents will be included in the MIDAS archive DOCUMENT directory:

- MIDAS User Manual
- MIDAS EAICD
- MIDAS Co-ordinate Systems
- MIDAS instrument paper as presented in the Space Science Review (2007)

These documents are converted to ASCII format. Associated drawings are stored as “Portable Network Graphic” (PNG) files.

In addition, PDF versions of the listed documents are available from the same directory.

2.5.8 Derived and other Data Products

N/A

2.5.9 Ancillary Data Usage

N/A

3 Archive Format and Content

3.1 Format and Conventions

3.1.1 Deliveries and Archive Volume Format

The logical archive volumes will contain one data set per volume. Up to now, three basic types of logical archive volumes are planned:

- Selected laboratory data
- Checkout data generated during flight (cruise phase)
- Data acquired in the close comet environment (cometary phase)

3.1.2 Data Set ID Formation

The MIDAS data set identifiers are defined as follows (see archive plan [3]):

- "`RO`-{target ID}-`MIDAS`-{level}-{phase}-{description}-`Vx.y`"

{target ID} = {`C, A, E, M, CAL, X, D, SS, C`}

{level} = processing level = {`3, 5`}

{phase} = mission phase = {`GRND, CVP, CR1,` …}

{description} = free character string containing only `A-Z, 0-9` (e.g. `TV`)

3.1.3 Data Set Name Formation

The MIDAS data set names are defined as follows (see archive plan [3]):

- "`ROSETTA-ORBITER` {target name} `MIDAS` {level} {phase} {description} `Vx.y`"

{target name} = {`67P, STEINS, LUTETIA,` …}

{level} = processing level = {`3, 5`}

{phase} = mission phase = {`GRND, CVP, CR1,` …}

{description} = free character string containing `A-Z, 0-9, -` (e.g. TV-TEST)

3.1.4 Data Directory Naming Convention

For all data sets the data directory is structured as follows:

- `/DATA`[/{data type}]`/file(s)`

{data type} = {`EVN, FSC, HK1, HK2, IMG, LIN, ROI, SPA, SPS`}

Cantilever and target history files (`CAH, TGH`) are stored in the data directory root.

3.1.5 File Naming Convention

The following file naming scheme will be used for all data sets (the “extra” field is optional and depends on the data type):

- {data type}_{start}_{stop}[_{extra}].{ext}

{data type} = {CAH, EVN, FSC, HK1, HK2, IMG, LIN, ROI, SPA, SPS, TGH}

{start} = begin of observation rounded to nearest hour, format = yydddhh

{stop} = end of observation rounded to nearest hour, format = yydddhh

{extra} = more specific information about the file content:

<table>
<tr><th>data type</th><th>extra information</th><th>possible values</th><th>field format</th></tr>
<tr><td>HK1, HK2, EVN</td><td colspan="3">not used</td></tr>
<tr><td rowspan="2">FSC, SPA, SPS, LIN</td><td>sequence counter [nnn]</td><td>001..FFF</td><td rowspan="2">nnn_tt</td></tr>
<tr><td>tip number [tt]</td><td>01..16</td></tr>
<tr><td rowspan="2">IMG</td><td>sequence counter [nnn]</td><td>001..999</td><td rowspan="2">nnn_dd</td></tr>
<tr><td>DAQ channel [dd]</td><td>ZS, AC, PH, DC, M1, M2, M3, XH, YH, ZH, YP, ZP, YE, ZE, S1, S2*)</td></tr>
<tr><td rowspan="2">ROI</td><td>sequence counter [nnn]</td><td>001..999</td><td rowspan="2">nnn_ff</td></tr>
<tr><td>target number [ff]</td><td>01..64</td></tr>
<tr><td>CAH</td><td>tip number [tt]</td><td>01..16</td><td>tt</td></tr>
<tr><td>TGH</td><td>target number [ff]</td><td>01..64</td><td>ff</td></tr>
</table>

*) A description of the DAQ channels is given in section 2.5 (Image Scan Data).

{ext} = depends on the data type (e.g. IMG for images, DAT/TAB for binary/ASCII tables)

3.2 Standards Used in Data Product Generation

3.2.1 PDS Standards

The MIDAS archive is based on the PDS Standard version 3.6 released in August 2003.

3.2.2 Time Standards

All MIDAS timing information of archive data products that are mapped to binary tables (e.g. housekeeping data telemetry packets), is given in the Spacecraft Elapsed Time (referred to as OBT to prevent confusion with the SCET defined in the DDID) format as defined in [4], section 2.7. The format used to represent the OBT is 4 bytes of unit seconds followed by 2 bytes of fractional seconds and is stored in the TM packet data field header. **The OBT is set to zero at 00:00:00 UTC on 1 Jan 2003.** The instrument is synchronised with the S/C OBT on a regular basis (typically every 30 minutes). In order to convert the OBT to UTC the NAIF SPICE software library is used. A more detailed description of the ROSETTA time standards is given in [8].

To represent UTC time values in archive data products represented by ASCII tables (e.g. cantilever history data), the ASCII Time Code A format, defined by the Consultative Committee for Space Data Systems (CCSDS) is used. The ASCII Time Code A is a 24 character string of the format "YYYY-MM-DDThh:mm:ss.dddZ". According to the archive plan the trailing "Z" is omitted and no quotes are used

In ground-based data sets the OBT reference is **00:00:00 UTC on 1 Jan 1970**. Since the S/C clock is not defined for ground based data, there is no relationship between the SPACECRAFT_CLOCK_START/STOP_COUNT keywords (set to "N/A") and the START/STOP_TIME keywords (representing UTC) in the data labels. This has been taken into account by adding the NATIVE_START/STOP_TIME keywords to the data labels. The **native start/stop time** is given in seconds since 00:00:00 UTC on 1 Jan 1970 with leap seconds not taken into account (also referred to as UNIX time).

3.2.3 Reference Systems

<u>MIDAS Coordinate Systems</u>

The following reference systems are applicable to the MIDAS instrument:

- **Unit Reference Frame:** The basic co-ordinate system to be used for MIDAS at instrument level.
- **AFM Reference Frame:** The ARF system is used in the context of scanner operations and is fixed to the frame of the scanner table.
- **Target Reference Frame:** Defines the co-ordinate system on any individual target area (or target) on the collector.

A detailed description of the MIDAS X/Y/Z reference systems can be found in the MIDAS Co-ordinate Systems document [9].

<u>J2000 System</u>

The Earth Mean Equator and Equinox of Julian Date 2451545.0 (referred to as the J2000 system) is the standard inertial reference frame. Some of the geometry keywords given in the data labels are expressed in J2000 coordinates (e.g. SC_SUN_POSITION_VECTOR).

3.2.4 Other Applicable Standards

In order to represent and store the images in the MIDAS archive, the raw data images are converted to BCR. The BCR-STM file format has been developed for easy exchange of SPM files independent of the instruments used (see SPIP Reference Guide at http://www.imagemet.com/WebHelp6/Default.htm).

The header is 2048 bytes long and written in ASCII characters, which can be edited by a text editor. The first line identifies the format and should be:

- **fileformat** = bcrstm

Additional parameters are defined as follows:

- **xpixels** and **ypixels** defines the number of pixels in the image
- **xlength** and **ylength** defines the scanning range in nm

- **xunit, yunit** and **zunit** units for the three axes (if not defined nm will be the default unit)
- **current** defines the tunneling current in nA (optional)
- **bias** defines the bias voltage in V (optional)
- **starttime** defines the starting time of the scanning (DD MM YY hh:mm:ss:hh) (optional)
- **scanspeed** is measured in nm/sec (optional)
- **intelmode** = 1 indicates that the data is written in little-endian 16-bit integers (LSB first; e.g. Intel x86 processors)
- **intelmode** = 0 indicates that the data is written in big-endian 16-bit integers (MSB first; e.g. Motorola 6800 processors)
- **bit2nm** is the scale factor for scaling the integer height data to nm
- **xoffset** and **yoffset** defines physical offset in nm (optional)
- **voidpixels** defines the value of void pixels (should be set equal to 32767; if omitted, the value is assumed to be 0)

Comments can be written by starting the line with the characters '**%**' or '**#**'.

It is possible to integrate new parameters as long the header size does not exceed 2048 bytes.

The body of the BCR file contains **xpixels*ypixels** 16 bit signed integer data values.

3.3 Data Validation

The following tools are used in order to validate the generated MIDAS data sets:

<u>PSA Volume Verifier (PVV)</u>

The PVV is a tool constructed by the PSA team to allow instrument teams from all of ESA's planetary missions to check their datasets before they are delivered to the PSA database for ingestion into the long-term archive. The tool allows a user to verify PDS compliance of a label, and validates all aspects of the data set structure / content prior to delivery to the PSA. The PVV is systematically used by the PSA team to check data sets as part of the ingestion process to the Planetary Science Archive (PSA).

<u>NASA PDS Tools</u>

The PDS Tools Package is the complete set of PDS Engineering Node supported tools. The following tools of the package are used:

- **ddict** - Extracts the data dictionary definition for every keyword used in a specified PDS label file, a specified list of PDS label Files, all of the labels in a directory, or all of the files on an entire volume. DDICT also lists those keywords that are not in the dictionary.
- **kwvtool** - This software creates a list of all keywords and their values found in a PDS label file or in a group of PDS label files.
- **line** - The LINE program analyzes each line in each file and reports on the status of certain PDS standards and the value associated with some of the PDS keywords.
- **lvtool** - This software checks PDS labels for compliance with the labeling standards established by the PDS for data product labels.
- **NASAView** - This program allows the user to display and examine PDS archive data products interactively.

- **table_check** - The table checker program is a tool that checks PDS labels and its corresponding data files. It parses a label, checks for label and data errors (BINARY or ASCII files), and reports and summarizes its findings.
- **tbtool** - The PDS Table Browser is a utility for validating, browsing, and summarizing data that is organized by rows and columns and is described by a PDS label file.

MIDAS Data Set Browser

This software is used to display and validate the contents of an entire MIDAS archive data set interactively. The software is entirely written in IDL and the source code files are included in the DOCUMENT directory of the data sets (see chapter 5).

3.4 Content

The MIDAS archive will contain data from important laboratory measurements, instrument checkout data generated in the interplanetary cruise phase and instrument data acquired in the close comet environment, as well as derived or merged instrument data e.g. the cantilever utilisation history or the target exposure history.

3.4.1 Volume Set / Data Set

The Rosetta archive is an online archive, where the data are delivered electronically. Thus there is no need to bundle several data sets into one volume, and one data set corresponds to one volume. A data set will include the data products as well as the secondary data, software and documentation that completely document and support the use of these data products. In general, the data products from the different instruments are contained in separate data sets, but merged data sets are possible. Data sets may include data products from one or more mission phases. Data products of different data processing levels are contained in separate data sets.

3.4.2 Directories

The top-level structure of the ROOT directory of a typical MIDAS data archive volume (= data set) corresponds to chapter 19 of the PDS Standards Reference [AD2] and is summarised below:

3.4.2.1 Root Directory

.PDSVOLUME: Archive data file catalogue generated by PVV.

AAREADME.TXT: This file describes the volume (= data set) as a whole. It gives an overview of the contents and organisation of the data set, general instructions for its use and contact information.

ERRATA.TXT: This file describes errors and/or anomalies found in this and previous volumes (= data sets). As erroneous data sets should be corrected and delivered again, there is no need for this file.

VOLDESC.CAT: This file contains the VOLUME object, which gives a high-level description of the contents of the volume (= data set).

3.4.2.2 Calibration Directory

This directory contains the calibration files used in the processing of the raw data or needed to use the data products in the volume (= data set).

CALINFO.TXT: Description of the contents of the CALIB directory.

MIDCALIB.LBL: PDS label associated to the standard MIDAS calibration table.

MIDCALIB.TAB: Standard MIDAS calibration table in PDS ASCII format.

The following table shows the standard calibration curves used for MIDAS housekeeping and science data calibration:

Reference #	Calibration Offset	Calibration Factor	Unit	Description
1	0.0	1.0		One to one conversion
2	-10.0	4.884005E-03	V	12 bit DAC set value [-10..10 V]
3	0.0	3.051804E-04	V	16 bit ADC data [-10..10 V]
4	-10.0	3.051804E-04	V	16 bit DAC set value [-10..10 V]
5	-273.0	1.142998E-02	degC	Temperature [-273..101.52 °C]
6	0.0	9.170596E-04	V	+15 voltage monitor [-30..30 V]
7	0.0	9.170596E-04	V	-15 voltage monitor [-30..30 V]
8	100.0	4.272530E-03	V	Piezo HV voltage monitor [-40..240 V]
9	0.0	1.0	um	Linear position set value [0..65535 um]
10	0.0	0.1	um	XY stage positioning [0..6553.5 um]
11	0.0	2.136263E-01	nm	XYZ position monitor [0..14000 nm]
12	21.0	42.0	us	Pulse generator pulse width [21..2752491 us]
13	0.0	5.493248E-03	deg	Cantilever phase signal [-180..180 deg]
14	0.0	1.525902E-03	%	F-scan operating variables [0..100 %]
15	0.0	4.577034E+01	Hz	Frequency high word [0..2999.56 kHz]
16	0.0	6.984E-04	Hz	Frequency step/low word [0..45.77 Hz]
17	0.0	1.0	sec	Time in seconds [0..65535]
22	-0.065904	0.010293	A	MIDAS LCL 6A current
23	-0.071692	0.010242	A	MIDAS LCL 6B current
24	-1.845312	0.288204	W	MIDAS LCL 6A power
25	-2.007376	0.286776	W	MIDAS LCL 6B power
30	0.0	1.0		Bit pattern for image types
31	800.0	-2.71276E-02	um	Approach LVDT position
32	16.398	1.8221	mm	Linear stage LVDT position
33	0.0	3.051804E-04	%	F-scan operating point [-100..100 %]
34	0.0	6.103609E-05		Feature vector weight factor [0..4]
35	0.0	1.525902E-05		Linear regression x/y factor
40	0.0	0.164	nm	Z DAC set value (closed loop)
41	0.0	3.814	nm	X DAC set value (open loop = default)
42	0.0	1.389	nm	X DAC set value (closed loop)
43	0.0	3.814	nm	Y DAC set value (open loop = default)
44	0.0	1.389	nm	Y DAC set value (closed loop)

3.4.2.3 Catalog Directory

This directory contains the catalog object files for the entire volume (= data set):

CATINFO.TXT: Description of the contents of the CATALOG directory.

DATASET.CAT: PDS data set catalog information about the data set currently being submitted.

INST.CAT: PDS instrument catalog information about the MIDAS instrument (likely to be the same in all deliveries, unless updates are needed).

INSTHOST.CAT: PDS instrument host catalog information about the Rosetta spacecraft and the mounting relationship of the instruments within the spacecraft; *provided by ESA*.

MISSION.CAT: PDS mission catalog information about the Rosetta mission; *provided by ESA*.

REFERENCE.CAT: PDS reference catalog information about the every journal article, book or other published reference mentioned in the above catalog objects or their components.

SOFTWARE.CAT: PDS software catalog information about the software submitted in the data set.

TARGET.CAT: PDS target catalog information about the observation target, i.e. comet, asteroid, Earth or Mars; *provided by ESA*.

3.4.2.4 Index Directory

This directory contains the index files summarising all data products in the volume (= data set) by mode, key instrument parameters or mission phase, and organised to facilitate finding the data of interest for a particular scientific question. Information about the observation geometry of the data products are also included here, i.e. spacecraft position and attitude, illumination conditions etc. Information that is not accurately known at the time of delivery and thus will probably be updated later is stored in the index files rather than in the data product labels.

INDXINFO.TXT: Description of the contents of the INDEX directory.

3.4.2.4.1 Dataset Index File, index.lbl and index.tab

INDEX.LBL: Detached label for the index table INDEX.TAB. The INDEX_TABLE specific object is used to identify and describe the columns of the index table.

INDEX.TAB: Index of the data set in tabular format.

3.4.2.4.2 Other Index Files

None

3.4.2.5 Software Directory

This directory will not be provided in the data sets. Nevertheless, the source codes (IDL routines) for data calibration, visualization and analysis will be provided in the DOCUMENT directory.

3.4.2.6 Label Directory

This directory contains PDS labels and includes files (referenced by a pointer in a PDS label) that are not packaged with the data products or in the data directory. For example, the format descriptions (columns) of the standard and extended housekeeping data products are located in this directory.

LABINFO.TXT : Description of the contents of the LABEL directory.

3.4.2.7 Document Directory

This directory provides documentation and supplementary and ancillary information to assist in understanding and using the data products in the volume (= data set). The documentation describes the MIDAS instrument as well as the MIDAS data sets and calibration. The MIDAS EAICD is included. According to the PDS standards the documents are present in ASCII format to ensure long-term readability. Document versions in PDF format are also provided in this directory.

DOCINFO.TXT : Description of the contents of the DOCUMENT directory.

3.4.2.8 Extras Directory

This directory will not be provided in the data sets.

3.4.2.9 Data Directory

This directory contains the actual data such as images or tables. PDS labeled data files or data files with detached PDS label files are arranged in a logical subdirectory structure (see section 3.1.4, *Data Directory Naming Convention*). Format specifications referred to in PDS labels are provided in the LABEL directory.

3.4.2.10 Browse, Geometry and Gazetter Directory

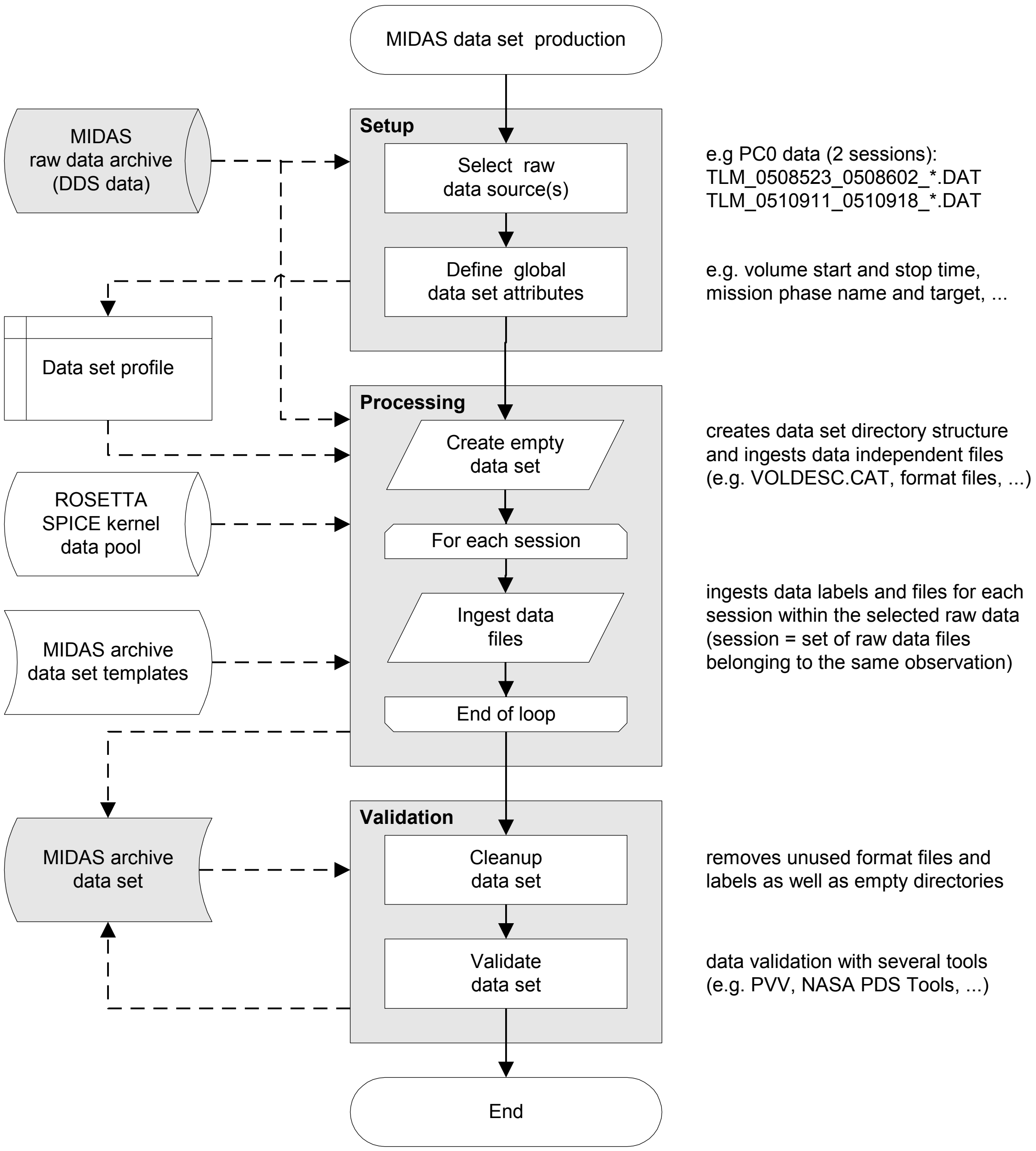
These directories are not provided in the data sets.

4 Detailed Interface Specifications

4.1 Structure and Organization Overview

4.1.1 Data Processing Diagram

The diagram below shows the MIDAS archive data set production principle:



4.1.2 Data Product Preparation

The preparation of the different data products is carried out in two different ways, depending on the data type:

- **Plain TM packet copy:** The archive data files are generated from the plain DDS raw data telemetry packets with the DDS header removed (e.g. housekeeping data files).
- **Derived data products:** At least one additional processing step is required in order to generate the data files (e.g. image data files).

The following table gives an overview of the MIDAS data products and the associated type of data preparation (session = set of raw data files belonging to the same observation and/or time range):

Data Type	Mnemonic	Data Processing	Table Type
Housekeeping Data	HK1, HK2	plain TM copy; one file per session	BINARY
Frequency Scan Data	FSC	plain TM copy; one file per scan	BINARY
Single Point Approach Data	SPA	plain TM copy; one file per approach	BINARY
Single Point Sampling Data	SPS	plain TM copy; one file per scan	BINARY
Line Scan Data	LIN	plain TM copy; one file per line	BINARY
Image Scan Data	IMG	converted to BCR format; one file per image and image data type	BINARY
Feature Vector Data	ROI	plain TM copy; one file per task	BINARY
Event Data	EVN	converted to ASCII; one file per session	ASCII
Cantilever Utilisation History	CAH	extracted from cumulative cantilever history file; one file per data set	ASCII
Target Utilisation History	TGH	extracted from cumulative target history file; one file per data set	ASCII

4.2 Data Sets, Definition and Content

4.2.1 Data Set Production

According to the ROSETTA Archive Plan there is one separate data set per mission phase in the pre-cometary phase. The PDS formatted MIDAS data archives are delivered at the latest 6 months after the end of the single mission phases.

After arriving at the comet, a continuous data flow is anticipated (mission phases approach, Lander delivery and relay, escort, extended mission), and the PDS formatted MIDAS data sets are delivered in 3-month intervals. The last proprietary, validation and archive preparation period of 6 months starts at the end of the Rosetta mission.

The following data sets are provided (as defined in the ROSETTA Mission Calendar):

Mission Phase	Start Date	End Date	Date Set ID
GROUND	2000-01-01	2004-03-01	data set selection ongoing
LAUNCH	2004-03-02	2004-03-04	no data
COMMISSIONING	2004-03-05 2004-09-06	2004-06-06 2004-10-16	RO-CAL-MIDAS-3-CVP-FULL-V2.0
CRUISE 1	2004-06-07	2004-09-05	no data
EARTH SWING-BY 1	2004-10-17	2005-04-04	RO-X-MIDAS-3-EAR1-PC0-V2.0
CRUISE 2	2005-04-05	2006-07-28	RO-X-MIDAS-3-CR2-PC1-2-V2.0
MARS SWING-BY	2006-07-29	2007-05-28	RO-X-MIDAS-3-MARS-PC3-5-V2.0
CRUISE 3	2007-05-29	2007-09-12	no data
EARTH SWING-BY 2	2007-09-13	2008-01-27	RO-X-MIDAS-3-EAR2-PC6-7-V2.0
CRUISE 4-1	2008-01-28	2008-08-03	RO-X-MIDAS-3-CR4A-PC8-V2.0
STEINS FLY-BY	2008-08-04	2008-10-05	no data
CRUISE 4-2	2008-10-06	2009-09-13	RO-X-MIDAS-3-CR4B-PC9-V2.0
EARTH SWING-BY 3	2009-09-14	2009-12-13	RO-X-MIDAS-3-EAR3-PC10-V2.0
CRUISE 5	2009-12-14	2010-05-16	RO-X-MIDAS-3-CR5-PC12-V2.0
LUTETIA FLY-BY	2010-05-17	2010-09-03	RO-A-MIDAS-3-AST2-LUTE-V2.0
RENDEZVOUS MANEUVER 1	2010-09-04	2011-06-07	no data
CRUISE 6	2011-06-08	2014-01-20	no data
PRELANDING	2014-01-21	2014-11-18	RO-D-MIDAS-3-PRL-SAMPLES-V2.0
COMET ESCORT 1	2014-11-19	2015-03-10	RO-C-MIDAS-3-ESC1-SAMPLES-V2.0
COMET ESCORT 2	2015-03-11	2015-06-30	RO-C-MIDAS-3-ESC2-SAMPLES-V2.0
COMET ESCORT 3	2015-07-01	2015-10-20	RO-C-MIDAS-3-ESC3-SAMPLES-V2.0
COMET ESCORT 4	2015-10-21	2016-01-12	RO-C-MIDAS-3-ESC4-SAMPLES-V2.0
ROSETTA EXTENS. 1	2016-01-13	2016-04-05	RO-C-MIDAS-3-EXT1-SAMPLES-V2.0
ROSETTA EXTENS. 2	2016-04-06	2016-06-28	RO-C-MIDAS-3-EXT2-SAMPLES-V2.0
ROSETTA EXTENS. 3	2016-06-29	2016-09-30	RO-C-MIDAS-3-EXT3-SAMPLES-V2.0

4.2.2 Instrument Mode Definition

The MIDAS operational concept is based on tasks, rather than on modes. In order to perform a scientific observation, several tasks are executed one after the other. Therefore it is not very meaningful to describe a full observation (from instrument switch-on to switch-off) with a single mode identifier. Nevertheless, two rudimental instrument “modes” have been identified:

INSTRUMENT_MODE_ID	INSTRUMENT_MODE_DESC
NORMAL	Data generated by S/W stored in on-board EEPROM.
MODIFIED_NORMAL	Data generated by temporarily patched on-board S/W.

4.2.3 Data Quality Definition

The following table lists the data quality identifiers and data quality descriptions used in the MIDAS data labels:

DATA_QUALITY_ID	DATA_QUALITY_DESC
-1	Data quality information is not supplied.
0	Bad data.
1	Use with caution.
2	Data ok.

4.2.4 Geometry Information

The following geometry keywords are used in the MIDAS data labels:

Geometry Keyword	Comment
SC_SUN_POSITION_VECTOR	“N/A” for ground based data sets.
SC_TARGET_POSITION_VECTOR	“N/A” for ground based data sets.
SC_TARGET_VELOCITY_VECTOR	“N/A” for ground based data sets.
SPACECRAFT_ALTITUDE	“N/A” for ground based and pre-comet data sets.
SUB_SPACECRAFT_LATITUDE	“N/A” for ground based and pre-comet data sets.
SUB_SPACECRAFT_LONGITUDE	“N/A” for ground based and pre-comet data sets.

4.2.5 Mission Specific Keywords

The following mission specific keywords (namespace ROSETTA) are used in the MIDAS data labels:

Mission Specific Keyword	**Data Values**	**Description**
MIDAS_LIN_STAGE_POS	-9.00 - +9.00 <V>	Position of the linear stage given by the linear LVDT position sensor. For a description of the relationship between tip number and linear stage position see [9], chapter 4.2.2.
MIDAS_SCANNING_MODE	"DYNAMIC" "CONTACT" "MAGNETIC"	Data acquisition mode.
MIDAS_SCAN_DATA_TYPE	"ZS:Z_SET_VAL" "AC:CANT_AC_MON" "AR:CANT_AC_RET" "PH:CANT_PH_MON" "DC:CANT_DC_MON" "XH:X_HV_MON" "YH:Y_HV_MON" "ZH:Z_HV_MON" "XP:X_POS_MON" "YP:Y_POS_MON" "ZP:Z_POS_MON" "XE:X_ERR_MON" "YE:Y_ERR_MON" "ZE:Z_ERR_MON" "S1:DAQ_STATUS_1" "S2:DAQ_STATUS_2" "M1:CANT_AC_MAG1" "M2:CANT_AC_MAG2" "M3:CANT_AC_MAG3"	Image scans data type. A detailed description of the different data types is given in chapter 2.5, "Image Scan Data".
MIDAS_SCAN_DIRECTION	{M,X,Y} M = MAIN_X, MAIN_Y X = X_LTOH, X_HTOL Y = Y_LTOH, Y_HTOL	Main, X and Y image and line scan direction. LTOH indicates scans from low to high piezo control voltages (default). HTOL denotes the opposite direction.
MIDAS_SCAN_START_XY	(X,Y) X = 0..65535 Y = 0..65535	Start coordinates (origin) of an image, line or single point scan relative to the X/Y stage origin. The coordinates are given in DAC (digital-analogue converter) set values.
MIDAS_SCAN_STOP_XY	(X,Y) X = 0..65535 Y = 0..65535	End coordinates of an image, line, or single point scan relative to the X/Y stage origin. The coordinates are given in DAC set values.

MIDAS_SEGMENT_NUMBER	0..1023	Selected scan segment. The correlation between target number and segment number is described in chapter 2.5, “Target Utilisation History”.
MIDAS_TARGET_NAME	“TGZ02” “TGX01” “TGT01” “SILICON” “SOLGEL”	Name of scan target. TGZ02, TGX01 and TGT01 are used for (re-)calibration of the scanner head (see chapter 2.5.3). Silicon and SOLGEL targets are used for duct collection.
MIDAS_TARGET_NUMBER	1..64	Selected scan target. The correlation between target number and segment number is described in chapter 2.5, “Target Utilisation History”.
MIDAS_TARGET_TYPE	“CALIBRATION” “PLAIN SILICON” “SOLGEL COATED”	Type of scan target. Plain silicon and SOLGEL coated targets are used for dust collection.
MIDAS_TIP_NUMBER	1..16	Selected scan cantilever. For a description of the relationship between tip number and linear stage position see [9], chapter 4.2.2.

4.2.6 Astronomical Targets vs. MIDAS Targets

The term "Target" is used both to refer to the MIDAS dust collection targets (also known as scan targets or facets) and the astronomical target which may be a planet, satellite, ring, region, feature, asteroid or comet.

<u>Astronomical Targets</u> are referenced in the following context:

- Astronomical target attributes in PDS labels (TARGET_NAME, TARGET_TYPE, SC_TARGET_POSITION_VECTOR and SC_TARGET_VELOCITY_VECTOR)
- Catalog files INSTHOST.CAT, MISSION.CAT and TARGET.CAT
- DATA_SET_TARGET object in dataset catalog (DATASET.CAT)

<u>MIDAS Targets</u> are referred to by

- Mission specific keywords in PDS labels (ROSETTA:MIDAS_TARGET_NAME, ROSETTA:MIDAS_TARGET_NUMBER and ROSETTA:MIDAS_TARGET_TYPE)
- Target column of image list provided in DATASET.CAT and targets in INST.CAT
- Event table in MIDAS target history files (/DATA/TGH*.LBL, TGH_STRUCTURE.FMT)

4.3 Data Product Design

4.3.1 Data Product Design – Standard Housekeeping Data

The MIDAS standard housekeeping data files are binary tables containing the plain telemetry packets as retrieved from the DDS. Each data file has associated a detached PDS label with the same name as the data file it describes, but with the extension `.LBL`. The data file columns are defined in a separate format file referred to by the `^STRUCTURE` keyword in the PDS labels:

- Data directory: `/DATA/HK1`
- File naming: `HK1_yydddhh_yydddhh.DAT`
- File structure: `/LABEL/HK1_STRUCTURE.FMT`

Parameters having a physical representation can be calibrated by applying the OFFSET, SCALING_FACTOR and UNIT keywords (defined in the related column object in the format file) to the raw value:

- physical_value = `OFFSET` + raw_value*`SCALING_FACTOR` [`UNIT`]

A typical PDS label for a standard housekeeping data file is given below:

```
PDS_VERSION_ID                  = PDS3
LABEL_REVISION_NOTE             = "<LABEL_REVISION_NOTE>"

RECORD_TYPE                     = FIXED_LENGTH
RECORD_BYTES                    = 56
FILE_RECORDS                    = <FILE_RECORDS>

DATA_SET_ID                     = "<DATA_SET_ID>"
DATA_SET_NAME                   = "<DATA_SET_NAME>"

PRODUCT_ID                      = "<PRODUCT_ID>"
PRODUCT_VERSION_ID              = "<PRODUCT_VERSION_ID>"
PRODUCT_CREATION_TIME           = <PRODUCT_CREATION_TIME>
PRODUCT_TYPE                    = <PRODUCT_TYPE>
PROCESSING_LEVEL_ID             = <PROCESSING_LEVEL_ID>

MISSION_ID                      = ROSETTA
MISSION_NAME                    = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME              = "<MISSION_PHASE_NAME>"

INSTRUMENT_HOST_ID              = <INSTRUMENT_HOST_ID>
INSTRUMENT_HOST_NAME            = "<INSTRUMENT_HOST_NAME>"
INSTRUMENT_ID                   = <INSTRUMENT_ID>
INSTRUMENT_NAME                 = "<INSTRUMENT_NAME>"
INSTRUMENT_TYPE                 = "<INSTRUMENT_TYPE>"
INSTRUMENT_MODE_ID              = <INSTRUMENT_MODE_ID>
INSTRUMENT_MODE_DESC            = "<INSTRUMENT_MODE_DESC>"

TARGET_NAME                     = "<TARGET_NAME>"
TARGET_TYPE                     = "<TARGET_TYPE>"

START_TIME                      = <START_TIME>
STOP_TIME                       = <STOP_TIME>
SPACECRAFT_CLOCK_START_COUNT    = "<START_COUNT>"
SPACECRAFT_CLOCK_STOP_COUNT     = "<STOP_COUNT>"
NATIVE_START_TIME               = <NATIVE_START_TIME>
NATIVE_STOP_TIME                = <NATIVE_STOP_TIME>

PRODUCER_ID                     = "<PRODUCER_ID>"
PRODUCER_FULL_NAME              = "<PRODUCER_FULL_NAME>"
PRODUCER_INSTITUTION_NAME       = "<PRODUCER_INSTITUTION_NAME>"
```

```
DATA_QUALITY_ID                = <DATA_QUALITY_ID>
DATA_QUALITY_DESC              = "<DATA_QUALITY_DESC>"

/* GEOMETRY INFORMATION */

SC_SUN_POSITION_VECTOR         = <SC_SUN_POSITION_VECTOR>
SC_TARGET_POSITION_VECTOR      = <SC_TARGET_POSITION_VECTOR>
SC_TARGET_VELOCITY_VECTOR      = <SC_TARGET_VELOCITY_VECTOR>
SPACECRAFT_ALTITUDE            = <SPACECRAFT_ALTITUDE>
SUB_SPACECRAFT_LATITUDE        = <SUB_SPACECRAFT_LATITUDE>
SUB_SPACECRAFT_LONGITUDE       = <SUB_SPACECRAFT_LONGITUDE>

/* DATA FILE POINTER(S) */

^HK1_TABLE                     = "<FILE_NAME>"

/* DATA OBJECT DEFINITION(S) */

OBJECT                         = HK1_TABLE
    INTERCHANGE_FORMAT         = BINARY
    ROWS                       = <FILE_RECORDS>
    COLUMNS                    = 28
    ROW_BYTES                  = 56
    NAME                       = "MIDAS standard HK"
    ^STRUCTURE                 = "HK1_STRUCTURE.FMT"
END_OBJECT                     = HK1_TABLE

END
```

The standard housekeeping data file structure is defined as follows:

```
    /* HK1 FRAME STRUCTURE */

    OBJECT                     = COLUMN
        NAME                   = "PACKET_ID"
        DESCRIPTION            = "Telemetry packet identifier."
        DATA_TYPE              = MSB_UNSIGNED_INTEGER
        START_BYTE             = 1
        BYTES                  = 2
    END_OBJECT                 = COLUMN

    OBJECT                     = COLUMN
        NAME                   = "PACKET_SEQUENCE_CONTROL"
        DESCRIPTION            = "Telemetry packet sequence counter."
        DATA_TYPE              = MSB_UNSIGNED_INTEGER
        START_BYTE             = 3
        BYTES                  = 2
    END_OBJECT                 = COLUMN

    OBJECT                     = COLUMN
        NAME                   = "PACKET_LENGTH"
        DESCRIPTION            = "Telemetry packet length."
        DATA_TYPE              = MSB_UNSIGNED_INTEGER
        START_BYTE             = 5
        BYTES                  = 2
    END_OBJECT                 = COLUMN

    OBJECT                     = COLUMN
        NAME                   = "PACKET_OBT_SECONDS"
        DESCRIPTION            = "S/C clock count at packet generation."
        DATA_TYPE              = MSB_UNSIGNED_INTEGER
        START_BYTE             = 7
        BYTES                  = 4
    END_OBJECT                 = COLUMN

    OBJECT                     = COLUMN
        NAME                   = "PACKET_OBT_FRACTION"
        DESCRIPTION            = "Fractional part of S/C clock count."
        DATA_TYPE              = MSB_UNSIGNED_INTEGER
        START_BYTE             = 11
```

```
    BYTES                      = 2
END_OBJECT                     = COLUMN

OBJECT                         = COLUMN
    NAME                       = "PACKET_PUS_AND_CRC"
    DESCRIPTION                = "Telemetry packet PUS-Version and CRC flag."
    DATA_TYPE                  = MSB_UNSIGNED_INTEGER
    START_BYTE                 = 13
    BYTES                      = 1
END_OBJECT                     = COLUMN

OBJECT                         = COLUMN
    NAME                       = "PACKET_TYPE"
    DESCRIPTION                = "Telemetry packet type."
    DATA_TYPE                  = MSB_UNSIGNED_INTEGER
    START_BYTE                 = 14
    BYTES                      = 1
END_OBJECT                     = COLUMN

OBJECT                         = COLUMN
    NAME                       = "PACKET_SUBTYPE"
    DESCRIPTION                = "Telemetry packet sub-type."
    DATA_TYPE                  = MSB_UNSIGNED_INTEGER
    START_BYTE                 = 15
    BYTES                      = 1
END_OBJECT                     = COLUMN

OBJECT                         = COLUMN
    NAME                       = "PACKET_PAD_FIELD"
    DESCRIPTION                = "Telemetry packet padding field."
    DATA_TYPE                  = MSB_UNSIGNED_INTEGER
    START_BYTE                 = 16
    BYTES                      = 1
END_OBJECT                     = COLUMN

OBJECT                         = COLUMN
    NAME                       = "STRUCTURE_ID"
    DESCRIPTION                = "Telemetry packet structure identifier."
    DATA_TYPE                  = MSB_UNSIGNED_INTEGER
    START_BYTE                 = 17
    BYTES                      = 2
END_OBJECT                     = COLUMN

OBJECT                         = COLUMN
    NAME                       = "SOFTWARE_VERSION"
    DESCRIPTION                = "On-board software version."
    DATA_TYPE                  = MSB_UNSIGNED_INTEGER
    START_BYTE                 = 19
    BYTES                      = 2
END_OBJECT                     = COLUMN

OBJECT                         = COLUMN
    NAME                       = "INSTRUMENT_MODE"
    DESCRIPTION                = "Instrument mode status word."
    DATA_TYPE                  = MSB_UNSIGNED_INTEGER
    START_BYTE                 = 21
    BYTES                      = 2
END_OBJECT                     = COLUMN

OBJECT                         = COLUMN
    NAME                       = "BASEPLATE_TEMPERATURE"
    DESCRIPTION                = "AFM base plate temperature sensor readout."
    DATA_TYPE                  = MSB_INTEGER
    START_BYTE                 = 23
    BYTES                      = 2
    OFFSET                     = 0.0
    SCALING_FACTOR             = 0.01143
    UNIT                       = KELVIN
END_OBJECT                     = COLUMN

OBJECT                         = COLUMN
    NAME                       = "PREAMPLIFIER_TEMPERATURE"
    DESCRIPTION                = "Cantilever preamplifier temperature readout."
    DATA_TYPE                  = MSB_INTEGER
    START_BYTE                 = 25
```

```
        BYTES                   = 2
        OFFSET                  = 0.0
        SCALING_FACTOR          = 0.01143
        UNIT                    = KELVIN
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "CONVERTER_TEMPERATURE"
        DESCRIPTION             = "Power converter temperature readout."
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 27
        BYTES                   = 2
        OFFSET                  = 0.0
        SCALING_FACTOR          = 0.01143
        UNIT                    = KELVIN
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "CSSC_XREF_TEMPERATURE"
        DESCRIPTION             = "Capacitive sensor X reference temperature."
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 29
        BYTES                   = 2
        OFFSET                  = 0.0
        SCALING_FACTOR          = 0.01143
        UNIT                    = KELVIN
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "CSSC_YREF_TEMPERATURE"
        DESCRIPTION             = "Capacitive sensor Y reference temperature."
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 31
        BYTES                   = 2
        OFFSET                  = 0.0
        SCALING_FACTOR          = 0.01143
        UNIT                    = KELVIN
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "INLET_TEMPERATURE"
        DESCRIPTION             = "Temperature measured at the dust inlet."
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 33
        BYTES                   = 2
        OFFSET                  = 0.0
        SCALING_FACTOR          = 0.01143
        UNIT                    = KELVIN
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "VOLTAGE_MONITOR_P05"
        DESCRIPTION             = "+5V voltage monitor readout."
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 35
        BYTES                   = 2
        OFFSET                  = 0.0
        SCALING_FACTOR          = 0.00030518
        UNIT                    = V
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "VOLTAGE_MONITOR_P15"
        DESCRIPTION             = "+15V voltage monitor readout."
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 37
        BYTES                   = 2
        OFFSET                  = 0.0
        SCALING_FACTOR          = 0.00091706
        UNIT                    = V
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "VOLTAGE_MONITOR_N15"
        DESCRIPTION             = "-15V voltage monitor readout."
```

```
        DATA_TYPE                = MSB_INTEGER
        START_BYTE               = 39
        BYTES                    = 2
        OFFSET                   = 0.0
        SCALING_FACTOR           = 0.00091706
        UNIT                     = V
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "DIGITAL_STATUS_1"
        DESCRIPTION              = "Digital lines status word #1."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 41
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "DIGITAL_STATUS_2"
        DESCRIPTION              = "Digital lines status word #2."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 43
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "DIGITAL_STATUS_3"
        DESCRIPTION              = "Digital lines status word #3."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 45
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "DIGITAL_STATUS_4"
        DESCRIPTION              = "Digital lines status word #4."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 47
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "DIGITAL_STATUS_5"
        DESCRIPTION              = "Digital lines status word #5."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 49
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "ADC_OVERFLOW_FLAGS"
        DESCRIPTION              = "Analog-Digital Converter overflow flags."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 51
        BYTES                    = 4
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "CRC16_CHECKSUM"
        DESCRIPTION              = "Telemetry packet checksum (CRC 16)."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 55
        BYTES                    = 2
    END_OBJECT                   = COLUMN
```

4.3.2 Data Product Design – Extended Housekeeping Data

The MIDAS extended housekeeping data files are binary tables containing the plain telemetry packets as retrieved from the DDS. Each data file has associated a detached PDS label with the same name as the data file it describes, but with the extension .LBL. The data file columns are defined in a separate format file referred to by the ^STRUCTURE keyword in the PDS labels:

- Data directory: /DATA/HK2
- File naming: HK2_yydddhh_yydddhh.DAT
- File structure: /LABEL/HK2_STRUCTURE.FMT

Parameters having a physical representation can be calibrated by applying the OFFSET, SCALING_FACTOR and UNIT keywords (defined in the related column object in the format file) to the raw value:

- physical_value = OFFSET + raw_value*SCALING_FACTOR [UNIT]

A typical PDS label for an extended housekeeping data file is given below:

```
PDS_VERSION_ID                  = PDS3
LABEL_REVISION_NOTE             = "<LABEL_REVISION_NOTE>"

RECORD_TYPE                     = FIXED_LENGTH
RECORD_BYTES                    = 524
FILE_RECORDS                    = <FILE_RECORDS>

DATA_SET_ID                     = "<DATA_SET_ID>"
DATA_SET_NAME                   = "<DATA_SET_NAME>"

PRODUCT_ID                      = "<PRODUCT_ID>"
PRODUCT_VERSION_ID              = "<PRODUCT_VERSION_ID>"
PRODUCT_CREATION_TIME           = <PRODUCT_CREATION_TIME>
PRODUCT_TYPE                    = <PRODUCT_TYPE>
PROCESSING_LEVEL_ID             = <PROCESSING_LEVEL_ID>

MISSION_ID                      = ROSETTA
MISSION_NAME                    = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME              = "<MISSION_PHASE_NAME>"

INSTRUMENT_HOST_ID              = <INSTRUMENT_HOST_ID>
INSTRUMENT_HOST_NAME            = "<INSTRUMENT_HOST_NAME>"
INSTRUMENT_ID                   = <INSTRUMENT_ID>
INSTRUMENT_NAME                 = "<INSTRUMENT_NAME>"
INSTRUMENT_TYPE                 = "<INSTRUMENT_TYPE>"
INSTRUMENT_MODE_ID              = <INSTRUMENT_MODE_ID>
INSTRUMENT_MODE_DESC            = "<INSTRUMENT_MODE_DESC>"

TARGET_NAME                     = "<TARGET_NAME>"
TARGET_TYPE                     = "<TARGET_TYPE>"

START_TIME                      = <START_TIME>
STOP_TIME                       = <STOP_TIME>
SPACECRAFT_CLOCK_START_COUNT    = "<START_COUNT>"
SPACECRAFT_CLOCK_STOP_COUNT     = "<STOP_COUNT>"
NATIVE_START_TIME               = <NATIVE_START_TIME>
NATIVE_STOP_TIME                = <NATIVE_STOP_TIME>

PRODUCER_ID                     = "<PRODUCER_ID>"
PRODUCER_FULL_NAME              = "<PRODUCER_FULL_NAME>"
PRODUCER_INSTITUTION_NAME       = "<PRODUCER_INSTITUTION_NAME>"

DATA_QUALITY_ID                 = <DATA_QUALITY_ID>
DATA_QUALITY_DESC               = "<DATA_QUALITY_DESC>"
```

```
/* GEOMETRY INFORMATION */

SC_SUN_POSITION_VECTOR            = <SC_SUN_POSITION_VECTOR>
SC_TARGET_POSITION_VECTOR         = <SC_TARGET_POSITION_VECTOR>
SC_TARGET_VELOCITY_VECTOR         = <SC_TARGET_VELOCITY_VECTOR>
SPACECRAFT_ALTITUDE               = <SPACECRAFT_ALTITUDE>
SUB_SPACECRAFT_LATITUDE           = <SUB_SPACECRAFT_LATITUDE>
SUB_SPACECRAFT_LONGITUDE          = <SUB_SPACECRAFT_LONGITUDE>

/* DATA FILE POINTER(S) */

^HK2_TABLE                        = "<FILE_NAME>"

/* DATA OBJECT DEFINITION(S) */

OBJECT                            = HK2_TABLE
    INTERCHANGE_FORMAT            = BINARY
    ROWS                          = <FILE_RECORDS>
    COLUMNS                       = 259
    ROW_BYTES                     = 524
    NAME                          = "MIDAS extended HK"
    ^STRUCTURE                    = "HK2_STRUCTURE.FMT"
END_OBJECT                        = HK2_TABLE

END
```

The extended housekeeping data file structure is defined as follows:

```
    /* HK2 FRAME STRUCTURE */

    OBJECT                        = COLUMN
        NAME                      = "PACKET_ID"
        DESCRIPTION               = "Telemetry packet identifier."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 1
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "PACKET_SEQUENCE_CONTROL"
        DESCRIPTION               = "Telemetry packet sequence counter."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 3
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "PACKET_LENGTH"
        DESCRIPTION               = "Telemetry packet length."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 5
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "PACKET_OBT_SECONDS"
        DESCRIPTION               = "S/C clock count at packet generation."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 7
        BYTES                     = 4
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "PACKET_OBT_FRACTION"
        DESCRIPTION               = "Fractional part of S/C clock count."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 11
        BYTES                     = 2
    END_OBJECT                    = COLUMN
```

```
OBJECT                          = COLUMN
    NAME                        = "PACKET_PUS_AND_CRC"
    DESCRIPTION                 = "Telemetry packet PUS-Version and CRC flag."
    DATA_TYPE                   = MSB_UNSIGNED_INTEGER
    START_BYTE                  = 13
    BYTES                       = 1
END_OBJECT                      = COLUMN

OBJECT                          = COLUMN
    NAME                        = "PACKET_TYPE"
    DESCRIPTION                 = "Telemetry packet type."
    DATA_TYPE                   = MSB_UNSIGNED_INTEGER
    START_BYTE                  = 14
    BYTES                       = 1
END_OBJECT                      = COLUMN

OBJECT                          = COLUMN
    NAME                        = "PACKET_SUBTYPE"
    DESCRIPTION                 = "Telemetry packet sub-type."
    DATA_TYPE                   = MSB_UNSIGNED_INTEGER
    START_BYTE                  = 15
    BYTES                       = 1
END_OBJECT                      = COLUMN

OBJECT                          = COLUMN
    NAME                        = "PACKET_PAD_FIELD"
    DESCRIPTION                 = "Telemetry packet padding field."
    DATA_TYPE                   = MSB_UNSIGNED_INTEGER
    START_BYTE                  = 16
    BYTES                       = 1
END_OBJECT                      = COLUMN

OBJECT                          = COLUMN
    NAME                        = "STRUCTURE_ID"
    DESCRIPTION                 = "Telemetry packet structure identifier."
    DATA_TYPE                   = MSB_UNSIGNED_INTEGER
    START_BYTE                  = 17
    BYTES                       = 2
END_OBJECT                      = COLUMN

OBJECT                          = COLUMN
    NAME                        = "SOFTWARE_VERSION"
    DESCRIPTION                 = "On-board software version."
    DATA_TYPE                   = MSB_UNSIGNED_INTEGER
    START_BYTE                  = 19
    BYTES                       = 2
END_OBJECT                      = COLUMN

OBJECT                          = COLUMN
    NAME                        = "U_CAN_RMS"
    DESCRIPTION                 = "Cantilever AC signal readout."
    DATA_TYPE                   = MSB_INTEGER
    START_BYTE                  = 21
    BYTES                       = 2
    OFFSET                      = 1.52590E-004
    SCALING_FACTOR              = 3.05180E-004
    UNIT                        = V
END_OBJECT                      = COLUMN

OBJECT                          = COLUMN
    NAME                        = "U_CAN_AMP_DC"
    DESCRIPTION                 = "Cantilever DC signal readout."
    DATA_TYPE                   = MSB_INTEGER
    START_BYTE                  = 23
    BYTES                       = 2
    OFFSET                      = 1.52590E-004
    SCALING_FACTOR              = 3.05180E-004
    UNIT                        = V
END_OBJECT                      = COLUMN

OBJECT                          = COLUMN
    NAME                        = "U_CAN_PHASE"
    DESCRIPTION                 = "Cantilever phase signal readout."
    DATA_TYPE                   = MSB_INTEGER
    START_BYTE                  = 25
```

```
        BYTES                     = 2
        OFFSET                    = 2.74662E-003
        SCALING_FACTOR            = 5.49325E-003
        UNIT                      = deg
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "APP_POS_MON"
        DESCRIPTION               = "Approach position sensor readout."
        DATA_TYPE                 = MSB_INTEGER
        START_BYTE                = 27
        BYTES                     = 2
        OFFSET                    = 1.52590E-004
        SCALING_FACTOR            = 3.05180E-004
        UNIT                      = V
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "LIN_POS_MON"
        DESCRIPTION               = "Linear stage position sensor readout."
        DATA_TYPE                 = MSB_INTEGER
        START_BYTE                = 29
        BYTES                     = 2
        OFFSET                    = 1.52590E-004
        SCALING_FACTOR            = 3.05180E-004
        UNIT                      = V
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "X_PR_OUT"
        DESCRIPTION               = "X piezo control loop offset error readout."
        DATA_TYPE                 = MSB_INTEGER
        START_BYTE                = 31
        BYTES                     = 2
        OFFSET                    = 1.52590E-004
        SCALING_FACTOR            = 3.05180E-004
        UNIT                      = V
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "Y_PR_OUT"
        DESCRIPTION               = "Y piezo control loop offset error readout."
        DATA_TYPE                 = MSB_INTEGER
        START_BYTE                = 33
        BYTES                     = 2
        OFFSET                    = 1.52590E-004
        SCALING_FACTOR            = 3.05180E-004
        UNIT                      = V
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "Z_PR_OUT"
        DESCRIPTION               = "Z piezo control loop offset error readout."
        DATA_TYPE                 = MSB_INTEGER
        START_BYTE                = 35
        BYTES                     = 2
        OFFSET                    = 1.52590E-004
        SCALING_FACTOR            = 3.05180E-004
        UNIT                      = V
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "XPIEZO_VSENS_OUT"
        DESCRIPTION               = "X piezo high voltage monitor readout."
        DATA_TYPE                 = MSB_INTEGER
        START_BYTE                = 37
        BYTES                     = 2
        OFFSET                    = 1.00002E+002
        SCALING_FACTOR            = 4.27253E-003
        UNIT                      = V
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "YPIEZO_VSENS_OUT"
        DESCRIPTION               = "Y piezo high voltage monitor readout."
```

```
        DATA_TYPE                = MSB_INTEGER
        START_BYTE               = 39
        BYTES                    = 2
        OFFSET                   = 1.00002E+002
        SCALING_FACTOR           = 4.27253E-003
        UNIT                     = V
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "XPIEZO_POS"
        DESCRIPTION              = "X piezo position sensor readout."
        DATA_TYPE                = MSB_INTEGER
        START_BYTE               = 41
        BYTES                    = 2
        OFFSET                   = 1.52590E-004
        SCALING_FACTOR           = 3.05180E-004
        UNIT                     = V
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "YPIEZO_POS"
        DESCRIPTION              = "Y piezo position sensor readout."
        DATA_TYPE                = MSB_INTEGER
        START_BYTE               = 43
        BYTES                    = 2
        OFFSET                   = 1.52590E-004
        SCALING_FACTOR           = 3.05180E-004
        UNIT                     = V
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "ZPIEZO_POS"
        DESCRIPTION              = "Z piezo position sensor readout."
        DATA_TYPE                = MSB_INTEGER
        START_BYTE               = 45
        BYTES                    = 2
        OFFSET                   = 1.52590E-004
        SCALING_FACTOR           = 3.05180E-004
        UNIT                     = V
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "ZPIEZO_VSENS_OUT"
        DESCRIPTION              = "Z piezo high voltage monitor readout."
        DATA_TYPE                = MSB_INTEGER
        START_BYTE               = 47
        BYTES                    = 2
        OFFSET                   = 1.00002E+002
        SCALING_FACTOR           = 4.27253E-003
        UNIT                     = V
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "ABORT_FULLSCAN"
        DESCRIPTION              = "Flag, set if ABORT command was sent during a full
scan."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 49
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "ABORT_FUNCTION"
        DESCRIPTION              = "Flag, set if ABORT command was sent during an active
task."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 51
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "ABORT_LINE"
        DESCRIPTION              = "Flag, set if Z DAC value reached its lower limit (-
10V)."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
```

```
        START_BYTE                = 53
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "ABORT_POINT"
        DESCRIPTION               = "Flag, set if Z DAC value reached its upper limit
(+10V)."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 55
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "AC_GAIN"
        DESCRIPTION               = "Gain level for cantilever AC signal amplifier (0-7)."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 57
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "APPR_BACKW_STARTED"
        DESCRIPTION               = "Flag, set if backward approach task is active."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 59
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "APPR_FINISHED"
        DESCRIPTION               = "Flag, set if segment surface was detected during
forward approach."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 61
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "APPR_FINE_STEP"
        DESCRIPTION               = "Flag, set if fine steps are applied during approach."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 63
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "APPR_ON_MAX_POS"
        DESCRIPTION               = "Flag, set if max. position was reached during an
approach task."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 65
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "APPR_ON_MIN_POS"
        DESCRIPTION               = "Flag, set if min. position was reached during an
approach task."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 67
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "APPR_POSITION"
        DESCRIPTION               = "Approach position sensor readout during an approach
task."
        DATA_TYPE                 = MSB_INTEGER
        START_BYTE                = 69
        BYTES                     = 2
        OFFSET                    = 1.52590E-004
        SCALING_FACTOR            = 3.05180E-004
        UNIT                      = V
    END_OBJECT                    = COLUMN
```

```
    OBJECT                          = COLUMN
        NAME                        = "APPR_POS_SET"
        DESCRIPTION                 = "Approach position set value for next forward approach
step."
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 71
        BYTES                       = 2
        OFFSET                      = 1.52590E-004
        SCALING_FACTOR              = 3.05180E-004
        UNIT                        = V
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "APPR_STARTED"
        DESCRIPTION                 = "Flag, set if forward approach task is active."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 73
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "APPR_POS_ABS"
        DESCRIPTION                 = "Approach position set value for absolute approach
movement."
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 75
        BYTES                       = 2
        OFFSET                      = 1.52590E-004
        SCALING_FACTOR              = 3.05180E-004
        UNIT                        = V
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "APPR_DIR"
        DESCRIPTION                 = "Flag, set if approach direction is towards surface."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 77
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "APPR_ABS_STARTED"
        DESCRIPTION                 = "Flag, set if absolute approach positioning task is
active."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 79
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "APPR_TIMO_CNT"
        DESCRIPTION                 = "Holds remaining seconds until approach timeout
occurs."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 81
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "AVERAGE"
        DESCRIPTION                 = "Average factor for Z strain gauge signal
measurement."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 83
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "CANTILEVER"
        DESCRIPTION                 = "Selected cantilever of current cantilever block (0-
7)."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 85
        BYTES                       = 2
```

```
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "CANT_BLOCK"
        DESCRIPTION               = "Number of selected cantilever block (1 or 2)."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 87
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "CANT_SIGNAL"
        DESCRIPTION               = "Current cantilever signal measured during scan."
        DATA_TYPE                 = MSB_INTEGER
        START_BYTE                = 89
        BYTES                     = 2
        OFFSET                    = 1.52590E-004
        SCALING_FACTOR            = 3.05180E-004
        UNIT                      = V
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "CAL_X_CYCLE_STARTED"
        DESCRIPTION               = "Flag, set if X position sensor calibration task has
started."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 91
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "CAL_X_CYCLE_FINISHED"
        DESCRIPTION               = "Flag, set if X position sensor calibration task has
completed successfully."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 93
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "CAL_Y_CYCLE_STARTED"
        DESCRIPTION               = "Flag, set if Y position sensor calibration task has
started."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 95
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "CAL_Y_CYCLE_FINISHED"
        DESCRIPTION               = "Flag, set if Y position sensor calibration task has
completed successfully."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 97
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "CAP_SENS_EN"
        DESCRIPTION               = "Flag, set if X/Y position sensor control is enabled."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 99
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "CAL_CYCLES"
        DESCRIPTION               = "X/Y position sensor calibration cycle counter."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 101
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "CALIB_TIMO_CNT"
```

```
        DESCRIPTION             = "Holds remaining seconds until X/Y position sensor
calibration timeout occurs."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 103
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "COR_TAB"
        DESCRIPTION             = "Selected correction table (0=norm temp, 1=high temp,
2=low temp)."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 105
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "CO_CMD"
        DESCRIPTION             = "Last checkout (technical) command which has been
executed on-board."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 107
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "CUR_LIN_POS"
        DESCRIPTION             = "Current linear position sensor value measured during
linear stage movement."
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 109
        BYTES                   = 2
        OFFSET                  = 1.52590E-004
        SCALING_FACTOR          = 3.05180E-004
        UNIT                    = V
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "CYCLES"
        DESCRIPTION             = "Holds number of Z increments and decrements during
single point scan."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 111
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "DATA_TYPE"
        DESCRIPTION             = "Image scan data type (0=z-topography, 1=z-error,
...)."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 113
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "DC_GAIN"
        DESCRIPTION             = "Gain level for cantilever DC signal amplifier (0-7)."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 115
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "DC_PULSEWIDTH"
        DESCRIPTION             = "Approach DC motor pulse width set value."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 117
        BYTES                   = 2
        OFFSET                  = 2.10000E+001
        SCALING_FACTOR          = 4.20000E+001
        UNIT                    = usec
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
```

```
        NAME                        = "DECR_APPR_POS"
        DESCRIPTION                 = "Flag, set if approach advances to next position."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 119
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "DSCAN_RAND_AMPL"
        DESCRIPTION                 = "Dummy scan random noise amplitude set value."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 121
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "DELTA_APPR_POS"
        DESCRIPTION                 = "Approach position signal decrement used in coarse
approach steps."
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 123
        BYTES                       = 2
        OFFSET                      = 1.52590E-004
        SCALING_FACTOR              = 3.05180E-004
        UNIT                        = V
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "DELTA_OP_PERC"
        DESCRIPTION                 = "Allowed deviation from cantilever signal operating
point in % of resonance amplitude."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 125
        BYTES                       = 2
        OFFSET                      = 0.00000E+000
        SCALING_FACTOR              = 1.52590E-003
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "DELTA_OP_AMPL"
        DESCRIPTION                 = "Allowed deviation from cantilever signal operating
point (calculated)."
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 127
        BYTES                       = 2
        OFFSET                      = 1.52590E-004
        SCALING_FACTOR              = 3.05180E-004
        UNIT                        = V
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "DUMMY_FULL_SCAN"
        DESCRIPTION                 = "Flag, set if dummy image scan task is active."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 129
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "EXC_LEV"
        DESCRIPTION                 = "Gain level for cantilever excitation (0-7)."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 131
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "DSCAN_SINE_AMPL"
        DESCRIPTION                 = "Dummy scan sine amplitude set value."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 133
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
```

```
        NAME                        = "DSCAN_ZERO_OFFS"
        DESCRIPTION                 = "Dummy scan zero offset set value."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 135
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "DSCAN_GRAD_SINE"
        DESCRIPTION                 = "Dummy scan X/Y gradient and sine period set value."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 137
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "F_SCAN_NO_THRES"
        DESCRIPTION                 = "Flag, set if threshold amplitude has not been found
during frequency scan."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 139
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "F_SCAN_CYCLE"
        DESCRIPTION                 = "Current scan cycle of the automatic frequency scan
task."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 141
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "APPR_STUCK_CNT"
        DESCRIPTION                 = "Number of times the approach stuck event will be
ignored."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 143
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "F_SCAN_STARTED"
        DESCRIPTION                 = "Flag, set if the automatic frequency scan task is
active."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 145
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "F_SCAN_FINISHED"
        DESCRIPTION                 = "Flag, set if the automatic frequency scan task has
completed."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 147
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "F_STEP"
        DESCRIPTION                 = "Nominal frequency scan step increment."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 149
        BYTES                       = 2
        OFFSET                      = 0.00000E+000
        SCALING_FACTOR              = 6.98253E-004
        UNIT                        = Hz
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "F_STEP_HI"
        DESCRIPTION                 = "Frequency scan step increment for threshold
detection."
```

```
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 151
        BYTES                   = 2
        OFFSET                  = 0.00000E+000
        SCALING_FACTOR          = 6.98253E-004
        UNIT                    = Hz
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "FULLSCAN_STARTED"
        DESCRIPTION             = "Flag, set if the image scan task is active."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 153
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "GAIN_STEP"
        DESCRIPTION             = "Gain control increment/decrement for X/Y position
sensor calibration."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 155
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "HK2_PERIOD"
        DESCRIPTION             = "Extended HK report update period in seconds."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 157
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "LAST_TC"
        DESCRIPTION             = "Last received private telecommand (MSB=type,
LSB=subtype)."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 159
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "LIN_MOVE_STARTED"
        DESCRIPTION             = "Flag, set if a linear stage movement task is active."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 161
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "LIN_MOVE_FINISHED"
        DESCRIPTION             = "Flag, set if a linear stage movement task has
completed."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 163
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "TEST_LIN_LVDT"
        DESCRIPTION             = "Flag, set if linear stage position sensor is
evaluated during task."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 165
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "LINE_SCAN_CNT"
        DESCRIPTION             = "Number of scanned image lines so far."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 167
        BYTES                   = 2
    END_OBJECT                  = COLUMN
```

```
    OBJECT                         = COLUMN
        NAME                       = "LINE_NUM_STEPS"
        DESCRIPTION                = "Total number of image lines to be scanned."
        DATA_TYPE                  = MSB_UNSIGNED_INTEGER
        START_BYTE                 = 169
        BYTES                      = 2
    END_OBJECT                     = COLUMN

    OBJECT                         = COLUMN
        NAME                       = "LINESCAN_DONE"
        DESCRIPTION                = "Flag, set if the line scan task has completed."
        DATA_TYPE                  = MSB_UNSIGNED_INTEGER
        START_BYTE                 = 171
        BYTES                      = 2
    END_OBJECT                     = COLUMN

    OBJECT                         = COLUMN
        NAME                       = "LINESCAN_STARTED"
        DESCRIPTION                = "Flag, set if the line scan task is active."
        DATA_TYPE                  = MSB_UNSIGNED_INTEGER
        START_BYTE                 = 173
        BYTES                      = 2
    END_OBJECT                     = COLUMN

    OBJECT                         = COLUMN
        NAME                       = "LINMOVE_TIMO_CNT"
        DESCRIPTION                = "Holds remaining seconds until linear stage timeout
occurs."
        DATA_TYPE                  = MSB_UNSIGNED_INTEGER
        START_BYTE                 = 175
        BYTES                      = 2
    END_OBJECT                     = COLUMN

    OBJECT                         = COLUMN
        NAME                       = "LINMOVE_TIMO"
        DESCRIPTION                = "Linear stage movement timeout set value."
        DATA_TYPE                  = MSB_UNSIGNED_INTEGER
        START_BYTE                 = 177
        BYTES                      = 2
    END_OBJECT                     = COLUMN

    OBJECT                         = COLUMN
        NAME                       = "MAIN_SCAN_CNT"
        DESCRIPTION                = "Number of scanned pixels in main scan direction
(within line) so far."
        DATA_TYPE                  = MSB_UNSIGNED_INTEGER
        START_BYTE                 = 179
        BYTES                      = 2
    END_OBJECT                     = COLUMN

    OBJECT                         = COLUMN
        NAME                       = "MAIN_SCAN_DIR"
        DESCRIPTION                = "Main dummy/image/line scan direction (0=X, 1=Y)."
        DATA_TYPE                  = MSB_UNSIGNED_INTEGER
        START_BYTE                 = 181
        BYTES                      = 2
    END_OBJECT                     = COLUMN

    OBJECT                         = COLUMN
        NAME                       = "MAIN_NUM_STEPS"
        DESCRIPTION                = "Total number of pixels in main scan direction."
        DATA_TYPE                  = MSB_UNSIGNED_INTEGER
        START_BYTE                 = 183
        BYTES                      = 2
    END_OBJECT                     = COLUMN

    OBJECT                         = COLUMN
        NAME                       = "MAGN_RETRACT_DIST"
        DESCRIPTION                = "Z retraction distance for magnetic mode."
        DATA_TYPE                  = MSB_UNSIGNED_INTEGER
        START_BYTE                 = 185
        BYTES                      = 2
    END_OBJECT                     = COLUMN
```

```
    OBJECT                          = COLUMN
        NAME                        = "MSUB_CYCLES"
        DESCRIPTION                 = "Maximum number of scan cycles per single_point()
function call."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 187
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "MAX_CYCLES"
        DESCRIPTION                 = "Maximum number of scan cycles allowed for a single
point."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 189
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "MAX_CAL_CYCLES"
        DESCRIPTION                 = "Maximum number of X/Y position sensor calibration
cycles."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 191
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "LAST_APPR_DIR"
        DESCRIPTION                 = "Approach movement direction during last approach
task."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 193
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "NO_OF_FSCANS"
        DESCRIPTION                 = "Number of frequency sweep cycles for the automatic
frequency scan."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 195
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "OFFS_STEP"
        DESCRIPTION                 = "Offset control increment/decrement for X/Y position
sensor calibration."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 197
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "OP_POINT_PERC"
        DESCRIPTION                 = "Threshold value of cantilever signal in % of
resonance amplitude for data acquisition."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 199
        BYTES                       = 2
        OFFSET                      = 0.00000E+000
        SCALING_FACTOR              = 1.52590E-003
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "OP_POINT_AMPL"
        DESCRIPTION                 = "Threshold value of cantilever signal for data
acquisition (calculated)."
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 201
        BYTES                       = 2
        OFFSET                      = 1.52590E-004
        SCALING_FACTOR              = 3.05180E-004
        UNIT                        = V
```

```
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "OP_UP"
        DESCRIPTION              = "Cantilever signal threshold value upper limit
(calculated)."
        DATA_TYPE                = MSB_INTEGER
        START_BYTE               = 203
        BYTES                    = 2
        OFFSET                   = 1.52590E-004
        SCALING_FACTOR           = 3.05180E-004
        UNIT                     = V
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "OP_LO"
        DESCRIPTION              = "Cantilever signal threshold value lower limit
(calculated)."
        DATA_TYPE                = MSB_INTEGER
        START_BYTE               = 205
        BYTES                    = 2
        OFFSET                   = 1.52590E-004
        SCALING_FACTOR           = 3.05180E-004
        UNIT                     = V
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "PERCENT_OP_AMPL"
        DESCRIPTION              = "% of resonance amplitude at which to set the
operating frequency (+=right, -=left)."
        DATA_TYPE                = MSB_INTEGER
        START_BYTE               = 207
        BYTES                    = 2
        OFFSET                   = 1.52590E-003
        SCALING_FACTOR           = 3.05180E-003
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "PARAMETER"
        DESCRIPTION              = "Parameter part of last executed parameter command."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 209
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "PARAMETER_CMD"
        DESCRIPTION              = "Command code of last executed parameter command."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 211
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "PULSE_DELAY"
        DESCRIPTION              = "Pulse delay mode for linear stage motor (0-3)."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 213
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "PULSEWIDTH"
        DESCRIPTION              = "Piezo motor driver pulse width."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 215
        BYTES                    = 2
        OFFSET                   = 2.10000E+001
        SCALING_FACTOR           = 4.20000E+001
        UNIT                     = usec
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "REF_SEARCH_STARTED"
```

```
        DESCRIPTION             = "Flag, set if wheel reference point search has
started."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 217
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "RELAY_STATUS"
        DESCRIPTION             = "Power relay status flags."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 219
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "RESONANCE_AMPL"
        DESCRIPTION             = "Cantilever signal amplitude at resonance frequency."
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 221
        BYTES                   = 2
        OFFSET                  = 1.52590E-004
        SCALING_FACTOR          = 3.05180E-004
        UNIT                    = V
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "RETRACT_DIST"
        DESCRIPTION             = "Z retraction before advancing to next scan position."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 223
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "SCAN_MODE"
        DESCRIPTION             = "Scanning mode (0=dynamic, 1=contact, 2=magnetic)."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 225
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "SCAN_ERROR_CNT"
        DESCRIPTION             = "Holds the number of pixels where the max. number of
scan cycles was exceeded."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 227
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "SEARCH_ALGOR"
        DESCRIPTION             = "Cantilever resonance frequency search mode."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 229
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "SEND_CO_FR"
        DESCRIPTION             = "Flag, set if checkout frame is sent periodically."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 231
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "DST_SELECT"
        DESCRIPTION             = "Data set selection for cleanup/transfer (bit 15 =
oldest, bit 14 = newest)."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 233
        BYTES                   = 2
    END_OBJECT                  = COLUMN
```

```
    OBJECT                          = COLUMN
        NAME                        = "SEGMENT_PULSES"
        DESCRIPTION                 = "Wheel encoder ticks for segment selection."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 235
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SEGMENT_SEARCH_STARTED"
        DESCRIPTION                 = "Flag, set if segment search task is active."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 237
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SEGMENT_FOUND"
        DESCRIPTION                 = "Flag, set if the wheel segment search has completed
successfully."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 239
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SEGMENT_NO"
        DESCRIPTION                 = "Wheel segment selection set value (0-1023)."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 241
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SET_LIN_POS"
        DESCRIPTION                 = "Linear stage position sensor value for absolute
positioning (calculated)."
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 243
        BYTES                       = 2
        OFFSET                      = 1.52590E-004
        SCALING_FACTOR              = 3.05180E-004
        UNIT                        = V
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SET_LIN_POS_ABS"
        DESCRIPTION                 = "Linear stage position sensor set value for absolute
positioning."
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 245
        BYTES                       = 2
        OFFSET                      = 1.52590E-004
        SCALING_FACTOR              = 3.05180E-004
        UNIT                        = V
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "REGULAR_EXT_CODE"
        DESCRIPTION                 = "Flag, set if the extended program code area is
entered every millisecond."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 247
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SHUT_CLOSE_STARTED"
        DESCRIPTION                 = "Flag, set if the shutter closing task is active."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 249
        BYTES                       = 2
    END_OBJECT                      = COLUMN
```

```
    OBJECT                          = COLUMN
        NAME                        = "SHUT_OPEN_STARTED"
        DESCRIPTION                 = "Flag, set if the shutter opening task is active."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 251
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SHUTTER_TIMO_CNT"
        DESCRIPTION                 = "Holds remaining seconds until a shutter movement
timeout occurs."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 253
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SINGLE_F_SCAN"
        DESCRIPTION                 = "Flag, set if the single frequency scan is active."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 255
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SURF_DETECTED"
        DESCRIPTION                 = "Flag, set if surface was detected during approach."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 257
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "TECH_MODE"
        DESCRIPTION                 = "Flag, set if technical mode commands are enabled."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 259
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "TIMEOUTS"
        DESCRIPTION                 = "Timeout status flags."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 261
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "TIP_NO"
        DESCRIPTION                 = "Cantilever selection set value (0-15)."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 263
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "U_MAX"
        DESCRIPTION                 = "Maximum cantilever signal amplitude detected during
frequency scan so far."
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 265
        BYTES                       = 2
        OFFSET                      = 1.52590E-004
        SCALING_FACTOR              = 3.05180E-004
        UNIT                        = V
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "VREF_ACC"
        DESCRIPTION                 = "X/Y position sensor calibration accuracy."
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 267
        BYTES                       = 2
```

```
        OFFSET                  = 1.52590E-004
        SCALING_FACTOR          = 3.05180E-004
        UNIT                    = V
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "VXREF1"
        DESCRIPTION             = "X position sensor reference voltage 1."
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 269
        BYTES                   = 2
        OFFSET                  = 1.52590E-004
        SCALING_FACTOR          = 3.05180E-004
        UNIT                    = V
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "VXREF2"
        DESCRIPTION             = "X position sensor reference voltage 2."
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 271
        BYTES                   = 2
        OFFSET                  = 1.52590E-004
        SCALING_FACTOR          = 3.05180E-004
        UNIT                    = V
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "VYREF1"
        DESCRIPTION             = "Y position sensor reference voltage 1."
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 273
        BYTES                   = 2
        OFFSET                  = 1.52590E-004
        SCALING_FACTOR          = 3.05180E-004
        UNIT                    = V
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "VYREF2"
        DESCRIPTION             = "Y position sensor reference voltage 2."
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 275
        BYTES                   = 2
        OFFSET                  = 1.52590E-004
        SCALING_FACTOR          = 3.05180E-004
        UNIT                    = V
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "WAIT_CYCLE"
        DESCRIPTION             = "Flag, set if a wait cycle is active."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 277
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "WAITING_TIME"
        DESCRIPTION             = "Holds number of seconds until the wait cycle
completes."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 279
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "WAX_ACTUATOR"
        DESCRIPTION             = "AFM base plate lock mechanism actuator selection
(0=actuator 1, 1= actuator 2)."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 281
        BYTES                   = 2
    END_OBJECT                  = COLUMN
```

```
    OBJECT                          = COLUMN
        NAME                        = "WAXACT_TIMO_CNT"
        DESCRIPTION                 = "Holds number of seconds until a base plate release
task timeout occurs."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 283
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "WAXACT_STATUS"
        DESCRIPTION                 = "AFM base plate lock mechanism actuator heating status
(1=main, 2=red, 4=extended)."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 285
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "WAXACT_EXT_CNT"
        DESCRIPTION                 = "Holds number of seconds until base plate actuator
extended heating cycle completes."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 287
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "WAXACT_TIMO"
        DESCRIPTION                 = "AFM base plate lock mechanism actuator heating
timeout set value."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 289
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "WHEEL_TIMO_CNT"
        DESCRIPTION                 = "Holds number of seconds until a wheel segment
selection timeout occurs."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 291
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "X_ORIGIN"
        DESCRIPTION                 = "X offset of image with respect to the X/Y table
origin."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 293
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "X_NUM_STEPS"
        DESCRIPTION                 = "Number of scan pixels in X direction (n times 32,
n=1-16)."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 295
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "X_SCAN_DIRECTION"
        DESCRIPTION                 = "Flag, indicates X scan direction (0=low to high DAC
voltage, 1= high to low)."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 297
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "X_STEP_SIZE"
        DESCRIPTION                 = "X scan step set value in DAC units."
```

```
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 299
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "XY_ACTUATOR"
        DESCRIPTION              = "X/Y table lock mechanism actuator selection (0= x-
actuator, 1= y-actuator)."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 301
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "XYACT_MAIN_STARTED"
        DESCRIPTION              = "Flag, set if heating cycle of the main X or Y
actuator is active."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 303
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "XYACT_RED_STARTED"
        DESCRIPTION              = "Flag, set if heating cycle of the redundant X or Y
actuator is active."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 305
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "XYACT_TIMO"
        DESCRIPTION              = "X/Y table lock mechanism actuator heating timeout set
value."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 307
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "XYACT_TIMO_CNT"
        DESCRIPTION              = "Holds number of seconds until an X/Y table release
timeout occurs."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 309
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "Y_STEP_SIZE"
        DESCRIPTION              = "Y scan step set value in DAC units."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 311
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "Y_ORIGIN"
        DESCRIPTION              = "Y offset of image with respect to the X/Y table
origin."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 313
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "Y_SCAN_DIRECTION"
        DESCRIPTION              = "Flag, indicates Y scan direction (0=low to high DAC
voltage, 1= high to low)."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 315
        BYTES                    = 2
    END_OBJECT                   = COLUMN
```

```
    OBJECT                        = COLUMN
        NAME                      = "Y_NUM_STEPS"
        DESCRIPTION               = "Number of scan pixels in Y direction (n times 32,
n=1-16)."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 317
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "Z_STEP_SIZE"
        DESCRIPTION               = "Z scan step set value in DAC units."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 319
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "HK2_OVFL_FLAGS"
        DESCRIPTION               = "ADC channel overflow flags."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 321
        BYTES                     = 4
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "DELTA_DC_CONTACT"
        DESCRIPTION               = "Maximum allowed cantilever DC value change during
surface approach."
        DATA_TYPE                 = MSB_INTEGER
        START_BYTE                = 325
        BYTES                     = 2
        OFFSET                    = 1.52590E-004
        SCALING_FACTOR            = 3.05180E-004
        UNIT                      = V
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "CANT_SIGNAL_RETR"
        DESCRIPTION               = "Cantilever signal at retracted position (magnetic
mode)."
        DATA_TYPE                 = MSB_INTEGER
        START_BYTE                = 327
        BYTES                     = 2
        OFFSET                    = 1.52590E-004
        SCALING_FACTOR            = 3.05180E-004
        UNIT                      = V
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "DST_INFO"
        DESCRIPTION               = "Data set control status word (0-7=ID, 8-11=status,
12-15=transfer mode)."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 329
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "LONG_Z"
        DESCRIPTION               = "Last Z piezo position set value during scan."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 331
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "Z_GAIN"
        DESCRIPTION               = "Gain level for Z position sensor (strain gauge)."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 333
        BYTES                     = 2
    END_OBJECT                    = COLUMN
```

```
    OBJECT                          = COLUMN
        NAME                        = "GC_X"
        DESCRIPTION                 = "X/Y position sensor X gain control value."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 335
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "GC_Y"
        DESCRIPTION                 = "X/Y position sensor Y gain control value."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 337
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "OFC_X"
        DESCRIPTION                 = "X/Y position sensor X offset control value."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 339
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "OFC_Y"
        DESCRIPTION                 = "X/Y position sensor Y offset control value."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 341
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SCAN_ALGOR"
        DESCRIPTION                 = "Scan algorithm (1=window detection, 2=p-controller,
else threshold detection)."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 343
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "FIRST_THRES_DET"
        DESCRIPTION                 = "Flag, set for first threshold detection cycle at
current scan location."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 345
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "DUST_FLUX"
        DESCRIPTION                 = "GIADA dust flux monitor value readout."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 347
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "OP_POINT_PCONTROL"
        DESCRIPTION                 = "P-controller (scanning) operating point value
(calculated)."
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 349
        BYTES                       = 2
        OFFSET                      = 1.52590E-004
        SCALING_FACTOR              = 3.05180E-004
        UNIT                        = V
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "OP_POINT_PCONTR_PERC"
        DESCRIPTION                 = "P-controller (scanning) operating point set value in
% of resonance amplitude."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
```

```
        START_BYTE              = 351
        BYTES                   = 2
        OFFSET                  = 0.00000E+000
        SCALING_FACTOR          = 1.52590E-003
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "PCONTR_KC"
        DESCRIPTION             = "P-controller (scanning) gain control set value."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 353
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "PCONTR_ACTIVE"
        DESCRIPTION             = "Flag, indicates that the P-controller is active
during scanning."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 355
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "LAST_EVENT"
        DESCRIPTION             = "Identifier of last generated on-board event."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 357
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "X_DAC_VAL"
        DESCRIPTION             = "Last DAC value applied to the X piezo of the scanner
head."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 359
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "Y_DAC_VAL"
        DESCRIPTION             = "Last DAC value applied to the Y piezo of the scanner
head."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 361
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "Z_DAC_VAL"
        DESCRIPTION             = "Last DAC value applied to the Z piezo of the scanner
head."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 363
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "Z_SETTLE_TIME"
        DESCRIPTION             = "Z piezo settling time in milliseconds before
advancing to next scan position."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 365
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "XY_SETTLE_TIME"
        DESCRIPTION             = "X/Y piezo settling time in milliseconds before
advancing to next scan position."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 367
        BYTES                   = 2
    END_OBJECT                  = COLUMN
```

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    OBJECT                          = COLUMN
        NAME                        = "DUST_FLUX_MIN"
        DESCRIPTION                 = "GIADA dust flux monitor lower limit (exposure time
increases when exceeded)."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 369
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "DUST_FLUX_MAX"
        DESCRIPTION                 = "GIADA dust flux monitor upper limit (exposure time
decreases when exceeded)."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 371
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "F_SCAN_MODE"
        DESCRIPTION                 = "Flag, set if threshold detection after frequency scan
is skipped."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 373
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "F_THRES_HI"
        DESCRIPTION                 = "Cantilever operating point frequency (high word)."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 375
        BYTES                       = 2
        OFFSET                      = 0.00000E+000
        SCALING_FACTOR              = 4.57703E+001
        UNIT                        = Hz
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "F_THRES_LO"
        DESCRIPTION                 = "Cantilever operating point frequency (low word)."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 377
        BYTES                       = 2
        OFFSET                      = 0.00000E+000
        SCALING_FACTOR              = 6.98253E-004
        UNIT                        = Hz
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "F_SYNTH"
        DESCRIPTION                 = "Last output value of frequency synthesizer."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 379
        BYTES                       = 4
        OFFSET                      = 0.00000E+000
        SCALING_FACTOR              = 6.98253E-004
        UNIT                        = Hz
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "HK1_PERIOD"
        DESCRIPTION                 = "Standard HK report update period in seconds."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 383
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "F_HI"
        DESCRIPTION                 = "Last output value of frequency synthesizer (high
word)."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 385
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        BYTES                       = 2
        OFFSET                      = 0.00000E+000
        SCALING_FACTOR              = 4.57703E+001
        UNIT                        = Hz
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "F_LO"
        DESCRIPTION                 = "Last output value of frequency synthesizer (low
word)."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 387
        BYTES                       = 2
        OFFSET                      = 0.00000E+000
        SCALING_FACTOR              = 6.98253E-004
        UNIT                        = Hz
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "FRES_HI"
        DESCRIPTION                 = "Detected cantilever resonance frequency (high word)."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 389
        BYTES                       = 2
        OFFSET                      = 0.00000E+000
        SCALING_FACTOR              = 4.57703E+001
        UNIT                        = Hz
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "FRES_LO"
        DESCRIPTION                 = "Detected cantilever resonance frequency (low word)."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 391
        BYTES                       = 2
        OFFSET                      = 0.00000E+000
        SCALING_FACTOR              = 6.98253E-004
        UNIT                        = Hz
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "READ_ANALOG"
        DESCRIPTION                 = "Flag, set if analog channels readout is performed
periodically"
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 393
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "F_SGL_START"
        DESCRIPTION                 = "Frequency scan start value of current cycle."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 395
        BYTES                       = 4
        OFFSET                      = 0.00000E+000
        SCALING_FACTOR              = 6.98253E-004
        UNIT                        = Hz
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "F_INC"
        DESCRIPTION                 = "Frequency scan increment value between cycles (256
times F_STEP)."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 399
        BYTES                       = 4
        OFFSET                      = 0.00000E+000
        SCALING_FACTOR              = 6.98253E-004
        UNIT                        = Hz
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "DC_AMPL_SET"
        DESCRIPTION                 = "DC threshold value for contact mode scanning."
```

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        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 403
        BYTES                   = 2
        OFFSET                  = 1.52590E-004
        SCALING_FACTOR          = 3.05180E-004
        UNIT                    = V
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "CHECK_DC_SIGNAL"
        DESCRIPTION             = "Flag, set if checking of the cantilever DC signal
during approach is enabled."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 405
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "U_CANT_DC_START"
        DESCRIPTION             = "Cantilever DC signal value at the beginning of the
coarse approach."
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 407
        BYTES                   = 2
        OFFSET                  = 1.52590E-004
        SCALING_FACTOR          = 3.05180E-004
        UNIT                    = V
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "CONTACT"
        DESCRIPTION             = "Flag, set if surface contact has occurred during
coarse approach."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 409
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "AUTO_F_ADJUST"
        DESCRIPTION             = "Flag, set if frequency adjustment is enabled during
image scan."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 411
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "WHEEL_COUNTS"
        DESCRIPTION             = "Remaining wheel encoder counts until segment is
reached."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 413
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "PULSE_APPLIED"
        DESCRIPTION             = "Flag, set if an approach pulse has been applied."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 415
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "LAST_APPR_POSITION"
        DESCRIPTION             = "Last approach position used for checking the approach
movement."
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 417
        BYTES                   = 2
        OFFSET                  = 1.52590E-004
        SCALING_FACTOR          = 3.05180E-004
        UNIT                    = V
    END_OBJECT                  = COLUMN
```

```
    OBJECT                          = COLUMN
        NAME                        = "MOVEMENT_CHECKED"
        DESCRIPTION                 = "Flag, set if the approach movement has been checked."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 419
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "CUR_APPROACH_POS"
        DESCRIPTION                 = "Current approach position used for checking the
approach movement."
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 421
        BYTES                       = 2
        OFFSET                      = 1.52590E-004
        SCALING_FACTOR              = 3.05180E-004
        UNIT                        = V
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "TEST_COUNT"
        DESCRIPTION                 = "Holds number of milliseconds until approach movement
is checked."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 423
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "APPR_TEST_COUNT"
        DESCRIPTION                 = "Approach movement test interval in milliseconds (set
value)."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 425
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "DELTA_OP_AMPL_DC"
        DESCRIPTION                 = "Contact mode operating point deviation (calculated)."
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 427
        BYTES                       = 2
        OFFSET                      = 1.52590E-004
        SCALING_FACTOR              = 3.05180E-004
        UNIT                        = V
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "DELTA_OP_PERC_DC"
        DESCRIPTION                 = "Contact mode operating point deviation in % of
cantilever DC set value."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 429
        BYTES                       = 2
        OFFSET                      = 0.00000E+000
        SCALING_FACTOR              = 1.52590E-003
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "OP_UP_DC"
        DESCRIPTION                 = "Contact mode operating point amplitude upper limit."
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 431
        BYTES                       = 2
        OFFSET                      = 1.52590E-004
        SCALING_FACTOR              = 3.05180E-004
        UNIT                        = V
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "OP_LO_DC"
        DESCRIPTION                 = "Contact mode operating point amplitude lower limit."
```

```
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 433
        BYTES                   = 2
        OFFSET                  = 1.52590E-004
        SCALING_FACTOR          = 3.05180E-004
        UNIT                    = V
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "DELTA_APPR_LVDT"
        DESCRIPTION             = "Minimum approach position change before incrementing
the stuck counter."
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 435
        BYTES                   = 2
        OFFSET                  = 1.52590E-004
        SCALING_FACTOR          = 3.05180E-004
        UNIT                    = V
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "APPR_POS_MAX"
        DESCRIPTION             = "Approach sensor position upper limit (set value)."
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 437
        BYTES                   = 2
        OFFSET                  = 1.52590E-004
        SCALING_FACTOR          = 3.05180E-004
        UNIT                    = V
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "APPR_POS_MIN"
        DESCRIPTION             = "Approach sensor position lower limit (set value)."
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 439
        BYTES                   = 2
        OFFSET                  = 1.52590E-004
        SCALING_FACTOR          = 3.05180E-004
        UNIT                    = V
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "FINE_ADJUSTMENT_STARTED"
        DESCRIPTION             = "Flag, set if the approach fine adjustment has
started."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 441
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "TASK_ACTIVE"
        DESCRIPTION             = "Flag, set if a task is active (e.g. scan)."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 443
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "APPR_NUM_PULSES"
        DESCRIPTION             = "Number of approach pulses to apply before testing the
approach movement."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 445
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "CANT_HIRES_STARTED"
        DESCRIPTION             = "Flag, set if the cantilever high resolution DAQ task
is active."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 447
        BYTES                   = 2
```

```
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "CANT_HIRES_TIME"
        DESCRIPTION               = "Time in milliseconds between two cantilever high
resolution measurements."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 449
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "CANT_HIRES_PKTS"
        DESCRIPTION               = "Total number of cantilever high resolution DAQ data
packets."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 451
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "CANT_HIRES_TIME_CNT"
        DESCRIPTION               = "Time in milliseconds since last cantilever high
resolution measurement."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 453
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "CANT_HIRES_PKTS_CNT"
        DESCRIPTION               = "Number of cantilever high resolution DAQ data packets
generated so far."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 455
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "CAL_STATE"
        DESCRIPTION               = "X/Y position sensor calibration task status word."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 457
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "SW_DATA_PAGE"
        DESCRIPTION               = "Page number for S/W backup/restore."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 459
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "SW_STATUS"
        DESCRIPTION               = "S/W encoding/decoding task status word."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 461
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "SW_PAR_SET_ADDR"
        DESCRIPTION               = "Last S/W parameter address."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 463
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "SW_PAR_SET_VAL"
        DESCRIPTION               = "Last S/W parameter set value."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 465
```

```
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SW_PAR_HK1_ADDR"
        DESCRIPTION                 = "Address of 1st adjustable HK parameter readout."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 467
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SW_PAR_HK2_ADDR"
        DESCRIPTION                 = "Address of 2nd adjustable HK parameter readout."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 469
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SW_PAR_HK3_ADDR"
        DESCRIPTION                 = "Address of 3rd adjustable HK parameter readout."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 471
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SW_PAR_HK4_ADDR"
        DESCRIPTION                 = "Address of 4th adjustable HK parameter readout."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 473
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SW_PAR_HK1_VAL"
        DESCRIPTION                 = "Value of 1st adjustable HK parameter readout."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 475
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SW_PAR_HK2_VAL"
        DESCRIPTION                 = "Value of 2nd adjustable HK parameter readout."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 477
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SW_PAR_HK3_VAL"
        DESCRIPTION                 = "Value of 3rd adjustable HK parameter readout."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 479
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SW_PAR_HK4_VAL"
        DESCRIPTION                 = "Value of 4th adjustable HK parameter readout."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 481
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "FVECT_MODE"
        DESCRIPTION                 = "Feature vector calculation mode."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 483
        BYTES                       = 2
    END_OBJECT                      = COLUMN
```

```
    OBJECT                          = COLUMN
        NAME                        = "FVECT_LPERC"
        DESCRIPTION                 = "Feature detection threshold value in percent of
min/max Z value."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 485
        BYTES                       = 2
        OFFSET                      = 0.00000E+000
        SCALING_FACTOR              = 1.52590E-003
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "FVECT_LEVEL"
        DESCRIPTION                 = "Calculated feature vector threshold value."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 487
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "FVECT_XMARGIN"
        DESCRIPTION                 = "Feature vector X margin (pixel) with respect to
selected image."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 489
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "FVECT_YMARGIN"
        DESCRIPTION                 = "Feature vector Y margin (pixel) with respect to
selected image."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 491
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "FVECT_STATUS"
        DESCRIPTION                 = "Feature vector calculation status word."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 493
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "FVECT_NUMPTS"
        DESCRIPTION                 = "Required number of points related to a feature in
order to be selected."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 495
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "FVECT_AVG_Z"
        DESCRIPTION                 = "Required average height over Z level for a feature in
order to be selected."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 497
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "FVECT_RATIO"
        DESCRIPTION                 = "Required minimum pixels/area ratio for a feature in
order to be selected."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 499
        BYTES                       = 2
        OFFSET                      = 0.00000E+000
        SCALING_FACTOR              = 1.52590E-003
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
```

```
        NAME                        = "FVECT_ZFACTOR"
        DESCRIPTION                 = "Feature vector calculation zoom factor in % of
feature size."
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 501
        BYTES                       = 2
        OFFSET                      = 1.52590E-003
        SCALING_FACTOR              = 3.05180E-003
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "SC_ENABLED"
        DESCRIPTION                 = "Flag, set if science data transfer is enabled?"
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 503
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "POINT_READY"
        DESCRIPTION                 = "Flag, set if cantilever signal is within operating
point range."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 505
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "IMAGE_POINT"
        DESCRIPTION                 = "Z set value or AC signal difference (magnetic mode)
for last DAQ point."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 507
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "LIN_TIP_CENTER"
        DESCRIPTION                 = "Linear LVDT value to center the currently selected
tip within the target."
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 509
        BYTES                       = 2
        OFFSET                      = 1.52590E-004
        SCALING_FACTOR              = 3.05180E-004
        UNIT                        = V
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "F_ADJUST_AMPL"
        DESCRIPTION                 = "Threshold amplitude for automatic f-adjusting during
scans."
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 511
        BYTES                       = 2
        OFFSET                      = 1.52590E-004
        SCALING_FACTOR              = 3.05180E-004
        UNIT                        = V
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "HK2_SPARE_1"
        DESCRIPTION                 = "Extended HK report spare word #1."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 513
        BYTES                       = 2
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = "HK2_SPARE_2"
        DESCRIPTION                 = "Extended HK report spare word #2."
        DATA_TYPE                   = MSB_UNSIGNED_INTEGER
        START_BYTE                  = 515
        BYTES                       = 2
    END_OBJECT                      = COLUMN
```

```
OBJECT                          = COLUMN
    NAME                        = "HK2_SPARE_3"
    DESCRIPTION                 = "Extended HK report spare word #3."
    DATA_TYPE                   = MSB_UNSIGNED_INTEGER
    START_BYTE                  = 517
    BYTES                       = 2
END_OBJECT                      = COLUMN

OBJECT                          = COLUMN
    NAME                        = "HK2_SPARE_4"
    DESCRIPTION                 = "Extended HK report spare word #4."
    DATA_TYPE                   = MSB_UNSIGNED_INTEGER
    START_BYTE                  = 519
    BYTES                       = 2
END_OBJECT                      = COLUMN

OBJECT                          = COLUMN
    NAME                        = "HK2_SPARE_5"
    DESCRIPTION                 = "Extended HK report spare word #5."
    DATA_TYPE                   = MSB_UNSIGNED_INTEGER
    START_BYTE                  = 521
    BYTES                       = 2
END_OBJECT                      = COLUMN

OBJECT                          = COLUMN
    NAME                        = "HK2_FRAME_CS"
    DESCRIPTION                 = "Frame checksum (CRC16), including frame header."
    DATA_TYPE                   = MSB_UNSIGNED_INTEGER
    START_BYTE                  = 523
    BYTES                       = 2
END_OBJECT                      = COLUMN
```

4.3.3 Data Product Design – Frequency Scan Data

The MIDAS frequency scan data files are binary tables containing the plain telemetry packets as retrieved from the DDS. Each data file has associated a detached PDS label with the same name as the data file it describes, but with the extension `.LBL`. The data file columns are defined in a separate format file referred to by the `^STRUCTURE` keyword in the PDS labels:

- Data directory: `/DATA/FSC`
- File naming: `FSC_yydddhh_yydddhh_nnn_tt.DAT`
- File structure: `/LABEL/FSC_PREFIX.FMT`

Parameters having a physical representation can be calibrated by applying the OFFSET, SCALING_FACTOR and UNIT keywords (defined in the related column object in the format file) to the raw value:

- physical_value = `OFFSET` + raw_value*`SCALING_FACTOR` [`UNIT`]

A frequency scan comprises `n` (n=1…8) scan cycles of 256 samples each. This data can be mapped to a frequency series table with `n` rows and `1` column having 256 items. Thus the sampling parameter interval of the table object is 256 times the sampling parameter interval of the associated column object. The frequency range for a given scan is defined by the following keywords of the FREQUENCY_SERIES object:

- Start frequency: `MINIMUM_SAMPLING_PARAMETER`
- Scan cycles: `ROWS` (total number of samples = `256*ROWS`)
- Frequency step: `SAMPLING_PARAMETER_INTERVAL/256`
- Frequency range: `(256*ROWS - 1)*SAMPLING_PARAMETER_INTERVAL/256`

A typical PDS label for a frequency scan data file is given below:

```
PDS_VERSION_ID                  = PDS3
LABEL_REVISION_NOTE             = "<LABEL_REVISION_NOTE>"

RECORD_TYPE                     = FIXED_LENGTH
RECORD_BYTES                    = 576
FILE_RECORDS                    = <FILE_RECORDS>

DATA_SET_ID                     = "<DATA_SET_ID>"
DATA_SET_NAME                   = "<DATA_SET_NAME>"

PRODUCT_ID                      = "<PRODUCT_ID>"
PRODUCT_VERSION_ID              = "<PRODUCT_VERSION_ID>"
PRODUCT_CREATION_TIME           = <PRODUCT_CREATION_TIME>
PRODUCT_TYPE                    = <PRODUCT_TYPE>
PROCESSING_LEVEL_ID             = <PROCESSING_LEVEL_ID>

MISSION_ID                      = ROSETTA
MISSION_NAME                    = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME              = "<MISSION_PHASE_NAME>"

INSTRUMENT_HOST_ID              = <INSTRUMENT_HOST_ID>
INSTRUMENT_HOST_NAME            = "<INSTRUMENT_HOST_NAME>"
INSTRUMENT_ID                   = <INSTRUMENT_ID>
INSTRUMENT_NAME                 = "<INSTRUMENT_NAME>"
INSTRUMENT_TYPE                 = "<INSTRUMENT_TYPE>"
INSTRUMENT_MODE_ID              = <INSTRUMENT_MODE_ID>
INSTRUMENT_MODE_DESC            = "<INSTRUMENT_MODE_DESC>"
```

```
TARGET_NAME                     = "<TARGET_NAME>"
TARGET_TYPE                     = "<TARGET_TYPE>"

START_TIME                      = <START_TIME>
STOP_TIME                       = <STOP_TIME>
SPACECRAFT_CLOCK_START_COUNT    = "<START_COUNT>"
SPACECRAFT_CLOCK_STOP_COUNT     = "<STOP_COUNT>"
NATIVE_START_TIME               = <NATIVE_START_TIME>
NATIVE_STOP_TIME                = <NATIVE_STOP_TIME>

PRODUCER_ID                     = "<PRODUCER_ID>"
PRODUCER_FULL_NAME              = "<PRODUCER_FULL_NAME>"
PRODUCER_INSTITUTION_NAME       = "<PRODUCER_INSTITUTION_NAME>"

DATA_QUALITY_ID                 = <DATA_QUALITY_ID>
DATA_QUALITY_DESC               = "<DATA_QUALITY_DESC>"

/* GEOMETRY INFORMATION */

SC_SUN_POSITION_VECTOR          = <SC_SUN_POSITION_VECTOR>
SC_TARGET_POSITION_VECTOR       = <SC_TARGET_POSITION_VECTOR>
SC_TARGET_VELOCITY_VECTOR       = <SC_TARGET_VELOCITY_VECTOR>
SPACECRAFT_ALTITUDE             = <SPACECRAFT_ALTITUDE>
SUB_SPACECRAFT_LATITUDE         = <SUB_SPACECRAFT_LATITUDE>
SUB_SPACECRAFT_LONGITUDE        = <SUB_SPACECRAFT_LONGITUDE>

/* MISSION SPECIFIC KEYWORDS */

ROSETTA:MIDAS_TIP_NUMBER        = <MIDAS_TIP_NUMBER>

/* DATA FILE POINTER(S) */

^ROW_PREFIX_TABLE               = "<FILE_NAME>"
^FREQUENCY_SERIES               = "<FILE_NAME>"

/* DATA OBJECT DEFINITION(S) */

OBJECT                          = ROW_PREFIX_TABLE
    NAME                        = PKT_HEADER
    INTERCHANGE_FORMAT          = BINARY
    ROWS                        = <FILE_RECORDS>
    COLUMNS                     = 23
    ROW_BYTES                   = 62
    ROW_SUFFIX_BYTES            = 514
    DESCRIPTION                 = "Frequency scan header table"
    ^STRUCTURE                  = "FSC_PREFIX.FMT"
END_OBJECT                      = ROW_PREFIX_TABLE

OBJECT                          = FREQUENCY_SERIES
    NAME                        = FREQUENCY_DATA
    INTERCHANGE_FORMAT          = BINARY
    ROWS                        = <FILE_RECORDS>
    COLUMNS                     = 1
    ROW_BYTES                   = 512
    ROW_PREFIX_BYTES            = 62
    ROW_SUFFIX_BYTES            = 2
    SAMPLING_PARAMETER_NAME     = FREQUENCY
    SAMPLING_PARAMETER_UNIT     = HERTZ
    SAMPLING_PARAMETER_INTERVAL = <FSC_INTERVAL>        /* time between rows */
    MINIMUM_SAMPLING_PARAMETER  = <FSC_MINIMUM>
    DESCRIPTION                 = "<FSC_DESCRIPTION>"

    OBJECT                      = COLUMN
        NAME                    = DATA_SAMPLES
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 1
        BYTES                   = 512
        ITEMS                   = 256
        ITEM_BYTES              = 2
        SAMPLING_PARAMETER_NAME = FREQUENCY
        SAMPLING_PARAMETER_UNIT = HERTZ
        SAMPLING_PARAMETER_INTERVAL = <FSC_SAMPLING>      /* time between samples */

        SCALING_FACTOR          = 3.0518E-04
        OFFSET                  = 0.0
```

```
        DERIVED_MINIMUM           = 0.0
        DERIVED_MAXIMUM           = 10.0
    END_OBJECT                    = COLUMN
END_OBJECT                        = FREQUENCY_SERIES

END
```

The frequency scan row prefix structure is defined as follows:

```
    /* FSC PREFIX STRUCTURE */

    OBJECT                        = COLUMN
        NAME                      = "PACKET_ID"
        DESCRIPTION               = "Telemetry packet identifier."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 1
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "PACKET_SEQUENCE_CONTROL"
        DESCRIPTION               = "Telemetry packet sequence counter."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 3
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "PACKET_LENGTH"
        DESCRIPTION               = "Telemetry packet length."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 5
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "PACKET_OBT_SECONDS"
        DESCRIPTION               = "S/C clock count at packet generation."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 7
        BYTES                     = 4
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "PACKET_OBT_FRACTION"
        DESCRIPTION               = "Fractional part of S/C clock count."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 11
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "PACKET_PUS_AND_CRC"
        DESCRIPTION               = "Telemetry packet PUS-Version and CRC flag."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 13
        BYTES                     = 1
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "PACKET_TYPE"
        DESCRIPTION               = "Telemetry packet type."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 14
        BYTES                     = 1
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "PACKET_SUBTYPE"
        DESCRIPTION               = "Telemetry packet sub-type."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
```

```
        START_BYTE              = 15
        BYTES                   = 1
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "PACKET_PAD_FIELD"
        DESCRIPTION             = "Telemetry packet padding field."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 16
        BYTES                   = 1
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "STRUCTURE_ID"
        DESCRIPTION             = "Telemetry packet structure identifier."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 17
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "SOFTWARE_VERSION"
        DESCRIPTION             = "On-board software version."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 19
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "START_TIME"
        DESCRIPTION             = "S/C clock count at frequency scan start."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 21
        BYTES                   = 4
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "START_FREQUENCY"
        DESCRIPTION             = "Start value of frequency sweep."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 25
        BYTES                   = 4
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "FREQUENCY_STEP"
        DESCRIPTION             = "Increment value of frequency sweep."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 29
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "AC_MAXIMUM"
        DESCRIPTION             = "Detected max. cantilever signal amplitude
                                   (up to the current scan cycle)."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 31
        BYTES                   = 2
        SCALING_FACTOR          = 3.0518E-04
        OFFSET                  = 0.0
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "FREQUENCY_AT_MAX"
        DESCRIPTION             = "Frequency where the maximum signal
                                  amplitude was detected."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 33
        BYTES                   = 4
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "NUM_SCANS"
        DESCRIPTION             = "Total number of frequency scan cycles."
```

```
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 37
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "SCAN_CYCLE"
        DESCRIPTION               = "Current scan cycle number."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 39
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "CANT_TIP_NUM"
        DESCRIPTION               = "Selected cantilever [1-8]."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 41
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "CANT_BLK_NUM"
        DESCRIPTION               = "Selected cantilever block [1-2]."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 43
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "EXCITATION_LEVEL"
        DESCRIPTION               = "Gain level of piezo-electric actuator
                                     used for cantilever excitation [0-7]."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 45
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "AC_GAIN_LEVEL"
        DESCRIPTION               = "Gain level of cantilever AC signal
                                     amplifier [0-7]."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 47
        BYTES                     = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "SPARE"
        DESCRIPTION               = "Currently not used."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 49
        BYTES                     = 14
        ITEMS                     = 7
        ITEM_BYTES                = 2
    END_OBJECT                    = COLUMN
```

4.3.4 Data Product Design – Single Point Approach Data

The MIDAS single point approach data files are binary tables containing the plain telemetry packets as retrieved from the DDS. Each data file has associated a detached PDS label with the same name as the data file it describes, but with the extension `.LBL`. The data file columns are defined in a separate format file referred to by the `^STRUCTURE` keyword in the PDS labels:

- Data directory: `/DATA/SPA`
- File naming: `SPA_yydddhh_yydddhh_nnn_tt.DAT`
- File structure: `/LABEL/SPA_STRUCTURE.FMT`

Parameters having a physical representation can be calibrated by applying the OFFSET, SCALING_FACTOR and UNIT keywords (defined in the related column object in the format file) to the raw value:

- physical_value = `OFFSET` + raw_value*`SCALING_FACTOR` [`UNIT`]

A single point approach scan data record comprises 4 data channels with up to `n` (n=1-256) data samples each. The actual number of data samples (valid for all channels) for a record is given in the `NUM_SAMPLES` column.

A typical PDS label for a single point approach data file is given below:

```
PDS_VERSION_ID                 = PDS3
LABEL_REVISION_NOTE            = "<LABEL_REVISION_NOTE>"

RECORD_TYPE                    = FIXED_LENGTH
RECORD_BYTES                   = 2096
FILE_RECORDS                   = <FILE_RECORDS>

DATA_SET_ID                    = "<DATA_SET_ID>"
DATA_SET_NAME                  = "<DATA_SET_NAME>"

PRODUCT_ID                     = "<PRODUCT_ID>"
PRODUCT_VERSION_ID             = "<PRODUCT_VERSION_ID>"
PRODUCT_CREATION_TIME          = <PRODUCT_CREATION_TIME>
PRODUCT_TYPE                   = <PRODUCT_TYPE>
PROCESSING_LEVEL_ID            = <PROCESSING_LEVEL_ID>

MISSION_ID                     = ROSETTA
MISSION_NAME                   = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME             = "<MISSION_PHASE_NAME>"

INSTRUMENT_HOST_ID             = <INSTRUMENT_HOST_ID>
INSTRUMENT_HOST_NAME           = "<INSTRUMENT_HOST_NAME>"
INSTRUMENT_ID                  = <INSTRUMENT_ID>
INSTRUMENT_NAME                = "<INSTRUMENT_NAME>"
INSTRUMENT_TYPE                = "<INSTRUMENT_TYPE>"
INSTRUMENT_MODE_ID             = <INSTRUMENT_MODE_ID>
INSTRUMENT_MODE_DESC           = "<INSTRUMENT_MODE_DESC>"

TARGET_NAME                    = "<TARGET_NAME>"
TARGET_TYPE                    = "<TARGET_TYPE>"

START_TIME                     = <START_TIME>
STOP_TIME                      = <STOP_TIME>
SPACECRAFT_CLOCK_START_COUNT   = "<START_COUNT>"
SPACECRAFT_CLOCK_STOP_COUNT    = "<STOP_COUNT>"
NATIVE_START_TIME              = <NATIVE_START_TIME>
NATIVE_STOP_TIME               = <NATIVE_STOP_TIME>

PRODUCER_ID                    = "<PRODUCER_ID>"
```

```
PRODUCER_FULL_NAME              = "<PRODUCER_FULL_NAME>"
PRODUCER_INSTITUTION_NAME       = "<PRODUCER_INSTITUTION_NAME>"

DATA_QUALITY_ID                 = <DATA_QUALITY_ID>
DATA_QUALITY_DESC               = "<DATA_QUALITY_DESC>"

/* GEOMETRY INFORMATION */

SC_SUN_POSITION_VECTOR          = <SC_SUN_POSITION_VECTOR>
SC_TARGET_POSITION_VECTOR       = <SC_TARGET_POSITION_VECTOR>
SC_TARGET_VELOCITY_VECTOR       = <SC_TARGET_VELOCITY_VECTOR>
SPACECRAFT_ALTITUDE             = <SPACECRAFT_ALTITUDE>
SUB_SPACECRAFT_LATITUDE         = <SUB_SPACECRAFT_LATITUDE>
SUB_SPACECRAFT_LONGITUDE        = <SUB_SPACECRAFT_LONGITUDE>

/* MISSION SPECIFIC KEYWORDS */

ROSETTA:MIDAS_TIP_NUMBER        = <MIDAS_TIP_NUMBER>
ROSETTA:MIDAS_TARGET_NUMBER     = <MIDAS_TARGET_NUMBER>
ROSETTA:MIDAS_TARGET_TYPE       = <MIDAS_TARGET_TYPE>
ROSETTA:MIDAS_TARGET_NAME       = <MIDAS_TARGET_NAME>

ROSETTA:MIDAS_LIN_STAGE_POS     = <MIDAS_LIN_STAGE_POS>
ROSETTA:MIDAS_SEGMENT_NUMBER    = <MIDAS_SEGMENT_NUMBER>
ROSETTA:MIDAS_SCAN_START_XY     = <MIDAS_SCAN_START_XY>
ROSETTA:MIDAS_SCAN_STOP_XY      = <MIDAS_SCAN_STOP_XY>
ROSETTA:MIDAS_SCAN_DIRECTION    = <MIDAS_SCAN_DIRECTION>

ROSETTA:MIDAS_SCANNING_MODE     = <MIDAS_SCANNING_MODE>

/* DATA FILE POINTER(S) */

^SPA_TABLE                      = "<FILE_NAME>"

/* DATA OBJECT DEFINITION(S) */

OBJECT                          = SPA_TABLE
    INTERCHANGE_FORMAT          = BINARY
    ROWS                        = <FILE_RECORDS>
    COLUMNS                     = 27
    ROW_BYTES                   = 2096
    DESCRIPTION                 = "MIDAS scan control data"
    ^STRUCTURE                  = "SPA_STRUCTURE.FMT"
END_OBJECT                      = SPA_TABLE

END
```

The single point approach record structure is defined as follows:

```
    /* SPA FRAME STRUCTURE */

    OBJECT                      = COLUMN
        NAME                    = "PACKET_ID"
        DESCRIPTION             = "Telemetry packet identifier."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 1
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "PACKET_SEQUENCE_CONTROL"
        DESCRIPTION             = "Telemetry packet sequence counter."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 3
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "PACKET_LENGTH"
        DESCRIPTION             = "Telemetry packet length."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
```

```
        START_BYTE              = 5
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "PACKET_OBT_SECONDS"
        DESCRIPTION             = "S/C clock count at packet generation."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 7
        BYTES                   = 4
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "PACKET_OBT_FRACTION"
        DESCRIPTION             = "Fractional part of S/C clock count."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 11
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "PACKET_PUS_AND_CRC"
        DESCRIPTION             = "Telemetry packet PUS-Version and CRC flag."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 13
        BYTES                   = 1
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "PACKET_TYPE"
        DESCRIPTION             = "Telemetry packet type."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 14
        BYTES                   = 1
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "PACKET_SUBTYPE"
        DESCRIPTION             = "Telemetry packet sub-type."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 15
        BYTES                   = 1
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "PACKET_PAD_FIELD"
        DESCRIPTION             = "Telemetry packet padding field."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 16
        BYTES                   = 1
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "STRUCTURE_ID"
        DESCRIPTION             = "Telemetry packet structure identifier."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 17
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "SOFTWARE_VERSION"
        DESCRIPTION             = "On-board software version."
        DATA_TYPE               = MSB_UNSIGNED_INTEGER
        START_BYTE              = 19
        BYTES                   = 2
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = "LINEAR_POS"
        DESCRIPTION             = "Linear stage position sensor readout."
        DATA_TYPE               = MSB_INTEGER
        START_BYTE              = 21
        BYTES                   = 2
        OFFSET                  = 1.52590E-004
```

```
        SCALING_FACTOR           = 3.05180E-004
        UNIT                     = VOLT
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "WHEEL_POS"
        DESCRIPTION              = "Current wheel position (segment number)."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 23
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "TIP_NUMBER"
        DESCRIPTION              = "Number of selected tip."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 25
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "X_ORIGIN"
        DESCRIPTION              = "Scan origin in X direction (DAC units)."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 27
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "Y_ORIGIN"
        DESCRIPTION              = "Scan origin in Y direction (DAC units)."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 29
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "STEP_SIZE"
        DESCRIPTION              = "Line scan step size (DAC units)."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 31
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "NUM_STEPS"
        DESCRIPTION              = "Number of line scan steps (pixels)."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 33
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "SCAN_MODE"
        DESCRIPTION              = "Scanning mode for image acquisition):
                                    Bit 0-7: 0=DYN[amic], 1=CON[tact], 2=MAG[netic],
                                    Bit   8: line scan direction (0=std.,1=reverse),
                                    Bit  12: main scan direction (0=X,1=Y)"
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 35
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "MAIN_SCAN_CNT"
        DESCRIPTION              = "Current main scan counter."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 37
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "NUM_SAMPLES"
        DESCRIPTION              = "Total number of measurements."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
```

```
        START_BYTE               = 39
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "SPARE"
        DESCRIPTION              = "Currently not used."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 41
        BYTES                    = 6
        ITEMS                    = 3
        ITEM_BYTES               = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = CONTAINER
        NAME                     = FRAME_STRUCTURE
        START_BYTE               = 47
        BYTES                    = 8
        REPETITIONS              = 256
        DESCRIPTION              = "Container for the 256 repeating
            DAQ samples of AC, DC, phase and Z position signal."

        OBJECT                   = COLUMN
            NAME                 = "AC_SAMPLE"
            DESCRIPTION          = "Cantilever AC signal sample."
            DATA_TYPE            = MSB_INTEGER
            START_BYTE           = 1
            BYTES                = 2
            SCALING_FACTOR       = 3.0518E-04
            OFFSET               = 0.0
            UNIT                 = VOLT
            FORMAT               = "F6.2"
            DERIVED_MINIMUM      = 0.0
            DERIVED_MAXIMUM      = 10.0
        END_OBJECT               = COLUMN

        OBJECT                   = COLUMN
            NAME                 = "DC_SAMPLE"
            DESCRIPTION          = "Cantilever DC signal samples."
            DATA_TYPE            = MSB_INTEGER
            START_BYTE           = 3
            BYTES                = 2
            SCALING_FACTOR       = 3.0518E-04
            OFFSET               = 0.0
            UNIT                 = VOLT
            FORMAT               = "F6.2"
            DERIVED_MINIMUM      = -10.0
            DERIVED_MAXIMUM      = +10.0
        END_OBJECT               = COLUMN

        OBJECT                   = COLUMN
            NAME                 = "PHASE_SAMPLE"
            DESCRIPTION          = "Cantilever phase signal samples."
            DATA_TYPE            = MSB_INTEGER
            START_BYTE           = 5
            BYTES                = 2
            SCALING_FACTOR       = 5.4932E-03
            OFFSET               = 0.0
            UNIT                 = DEGREE
            FORMAT               = "F6.1"
            DERIVED_MINIMUM      = -180.0
            DERIVED_MAXIMUM      = +180.0
        END_OBJECT               = COLUMN

        OBJECT                   = COLUMN
            NAME                 = "Z_POS_SAMPLE"
            DESCRIPTION          = "Z piezo position monitor (strain gauge)."
            DATA_TYPE            = MSB_INTEGER
            START_BYTE           = 7
            BYTES                = 2
            SCALING_FACTOR       = 3.0518E-04
            OFFSET               = 0.0
            UNIT                 = VOLT
            FORMAT               = "F6.2"
            DERIVED_MINIMUM      = -10.0
```

```
        DERIVED_MAXIMUM      = +10.0
    END_OBJECT               = COLUMN

END_OBJECT                   = CONTAINER

OBJECT                       = COLUMN
    NAME                     = "CRC16_CHECKSUM"
    DESCRIPTION              = "Telemetry packet checksum (CRC 16)."
    DATA_TYPE                = MSB_UNSIGNED_INTEGER
    START_BYTE               = 2095
    BYTES                    = 2
END_OBJECT                   = COLUMN
```

4.3.5 Data Product Design – Single Point Sampling Data

The MIDAS single point sampling data files are binary tables containing the plain telemetry packets as retrieved from the DDS. Each data file has associated a detached PDS label with the same name as the data file it describes, but with the extension `.LBL`. The data file columns are defined in a separate format file referred to by the `^STRUCTURE` keyword in the PDS labels:

- Data directory: `/DATA/SPS`
- File naming: `SPS_yydddhh_yydddhh_nnn_tt.DAT`
- File structure: `/LABEL/SPS_PREFIX.FMT`

Parameters having a physical representation can be calibrated by applying the OFFSET, SCALING_FACTOR and UNIT keywords (defined in the related column object in the format file) to the raw value:

- physical_value = `OFFSET` + raw_value*`SCALING_FACTOR` [`UNIT`]

A single point sampling scan comprises `n` (n=1-65535) scan cycles with 4 data channels of 256 samples each. This data can be mapped to a time series table consisting of `n` rows and `4` interleaved columns with 256 items. Thus the sampling parameter interval of the table object is 256 times the sampling parameter interval of the associated column object. The time range for a given scan is defined by the following keywords of the TIME_SERIES object:

- Scan cycles: `ROWS` (total number of samples per channel = `256*ROWS`)
- Time step: `SAMPLING_PARAMETER_INTERVAL/256`
- Time range: `(256*ROWS – 1)*SAMPLING_PARAMETER_INTERVAL/256`

A typical PDS label for a single point sampling data file is given below:

```
PDS_VERSION_ID                = PDS3
LABEL_REVISION_NOTE           = "<LABEL_REVISION_NOTE>"

RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 2096
FILE_RECORDS                  = <FILE_RECORDS>

DATA_SET_ID                   = "<DATA_SET_ID>"
DATA_SET_NAME                 = "<DATA_SET_NAME>"

PRODUCT_ID                    = "<PRODUCT_ID>"
PRODUCT_VERSION_ID            = "<PRODUCT_VERSION_ID>"
PRODUCT_CREATION_TIME         = <PRODUCT_CREATION_TIME>
PRODUCT_TYPE                  = <PRODUCT_TYPE>
PROCESSING_LEVEL_ID           = <PROCESSING_LEVEL_ID>

MISSION_ID                    = ROSETTA
MISSION_NAME                  = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME            = "<MISSION_PHASE_NAME>"

INSTRUMENT_HOST_ID            = <INSTRUMENT_HOST_ID>
INSTRUMENT_HOST_NAME          = "<INSTRUMENT_HOST_NAME>"
INSTRUMENT_ID                 = <INSTRUMENT_ID>
INSTRUMENT_NAME               = "<INSTRUMENT_NAME>"
INSTRUMENT_TYPE               = "<INSTRUMENT_TYPE>"
INSTRUMENT_MODE_ID            = <INSTRUMENT_MODE_ID>
INSTRUMENT_MODE_DESC          = "<INSTRUMENT_MODE_DESC>"

TARGET_NAME                   = "<TARGET_NAME>"
TARGET_TYPE                   = "<TARGET_TYPE>"
```

```
START_TIME                          = <START_TIME>
STOP_TIME                           = <STOP_TIME>
SPACECRAFT_CLOCK_START_COUNT        = "<START_COUNT>"
SPACECRAFT_CLOCK_STOP_COUNT         = "<STOP_COUNT>"
NATIVE_START_TIME                   = <NATIVE_START_TIME>
NATIVE_STOP_TIME                    = <NATIVE_STOP_TIME>

PRODUCER_ID                         = "<PRODUCER_ID>"
PRODUCER_FULL_NAME                  = "<PRODUCER_FULL_NAME>"
PRODUCER_INSTITUTION_NAME           = "<PRODUCER_INSTITUTION_NAME>"

DATA_QUALITY_ID                     = <DATA_QUALITY_ID>
DATA_QUALITY_DESC                   = "<DATA_QUALITY_DESC>"

/* GEOMETRY INFORMATION */

SC_SUN_POSITION_VECTOR              = <SC_SUN_POSITION_VECTOR>
SC_TARGET_POSITION_VECTOR           = <SC_TARGET_POSITION_VECTOR>
SC_TARGET_VELOCITY_VECTOR           = <SC_TARGET_VELOCITY_VECTOR>
SPACECRAFT_ALTITUDE                 = <SPACECRAFT_ALTITUDE>
SUB_SPACECRAFT_LATITUDE             = <SUB_SPACECRAFT_LATITUDE>
SUB_SPACECRAFT_LONGITUDE            = <SUB_SPACECRAFT_LONGITUDE>

/* MISSION SPECIFIC KEYWORDS */

ROSETTA:MIDAS_TIP_NUMBER            = <MIDAS_TIP_NUMBER>
ROSETTA:MIDAS_TARGET_NUMBER         = <MIDAS_TARGET_NUMBER>
ROSETTA:MIDAS_TARGET_TYPE           = <MIDAS_TARGET_TYPE>
ROSETTA:MIDAS_TARGET_NAME           = <MIDAS_TARGET_NAME>

ROSETTA:MIDAS_LIN_STAGE_POS         = <MIDAS_LIN_STAGE_POS>
ROSETTA:MIDAS_SEGMENT_NUMBER        = <MIDAS_SEGMENT_NUMBER>
ROSETTA:MIDAS_SCAN_START_XY         = <MIDAS_SCAN_START_XY>
ROSETTA:MIDAS_SCAN_STOP_XY          = <MIDAS_SCAN_STOP_XY>
ROSETTA:MIDAS_SCAN_DIRECTION        = <MIDAS_SCAN_DIRECTION>

ROSETTA:MIDAS_SCANNING_MODE         = <MIDAS_SCANNING_MODE>

/* DATA FILE POINTER(S) */

^ROW_PREFIX_TABLE                   = "<FILE_NAME>"
^TIME_SERIES                        = "<FILE_NAME>"

/* DATA OBJECT DEFINITION(S) */

OBJECT                              = ROW_PREFIX_TABLE
    NAME                            = PKT_HEADER
    INTERCHANGE_FORMAT              = BINARY
    ROWS                            = <FILE_RECORDS>
    COLUMNS                         = 22
    ROW_BYTES                       = 46
    ROW_SUFFIX_BYTES                = 2050
    DESCRIPTION                     = "Control data prefix table"
    ^STRUCTURE                      = "SPS_PREFIX.FMT"
END_OBJECT                          = ROW_PREFIX_TABLE

OBJECT                              = TIME_SERIES
    NAME                            = CONTROL_DATA
    INTERCHANGE_FORMAT              = BINARY
    ROWS                            = <FILE_RECORDS>
    COLUMNS                         = 4
    ROW_PREFIX_BYTES                = 46
    ROW_BYTES                       = 2048
    ROW_SUFFIX_BYTES                = 2
    SAMPLING_PARAMETER_NAME         = TIME
    SAMPLING_PARAMETER_UNIT         = SECONDS
    SAMPLING_PARAMETER_INTERVAL = 3.6900E-1
    DESCRIPTION                     = "MIDAS hi-res sampling data"

    OBJECT                          = COLUMN
        NAME                        = AC_SAMPLES
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 1
        BYTES                       = 2042
```

```
        ITEMS                       = 256
        ITEM_BYTES                  = 2
        ITEM_OFFSET                 = 8
        SAMPLING_PARAMETER_NAME = TIME
        SAMPLING_PARAMETER_UNIT = SECONDS
        SAMPLING_PARAMETER_INTERVAL = 1.4414E-3
        SCALING_FACTOR              = 3.0518E-04
        OFFSET                      = 0.0
        DERIVED_MINIMUM             = 0.0
        DERIVED_MAXIMUM             = 10.0
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = DC_SAMPLES
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 3
        BYTES                       = 2042
        ITEMS                       = 256
        ITEM_BYTES                  = 2
        ITEM_OFFSET                 = 8
        SAMPLING_PARAMETER_NAME = TIME
        SAMPLING_PARAMETER_UNIT = SECONDS
        SAMPLING_PARAMETER_INTERVAL = 1.4414E-3
        SCALING_FACTOR              = 3.0518E-04
        OFFSET                      = 0.0
        DERIVED_MINIMUM             = 0.0
        DERIVED_MAXIMUM             = 10.0
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = PHASE_SAMPLES
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 5
        BYTES                       = 2042
        ITEMS                       = 256
        ITEM_BYTES                  = 2
        ITEM_OFFSET                 = 8
        SAMPLING_PARAMETER_NAME = TIME
        SAMPLING_PARAMETER_UNIT = SECONDS
        SAMPLING_PARAMETER_INTERVAL = 1.4414E-3
        SCALING_FACTOR              = 3.0518E-04
        OFFSET                      = 0.0
        DERIVED_MINIMUM             = 0.0
        DERIVED_MAXIMUM             = 10.0
    END_OBJECT                      = COLUMN

    OBJECT                          = COLUMN
        NAME                        = Z_POS_SAMPLES
        DATA_TYPE                   = MSB_INTEGER
        START_BYTE                  = 7
        BYTES                       = 2042
        ITEMS                       = 256
        ITEM_BYTES                  = 2
        ITEM_OFFSET                 = 8
        SAMPLING_PARAMETER_NAME = TIME
        SAMPLING_PARAMETER_UNIT = SECONDS
        SAMPLING_PARAMETER_INTERVAL = 1.4414E-3
        SCALING_FACTOR              = 3.0518E-04
        OFFSET                      = 0.0
        DERIVED_MINIMUM             = 0.0
        DERIVED_MAXIMUM             = 10.0
    END_OBJECT                      = COLUMN
END_OBJECT                          = TIME_SERIES

END
```

The single point sampling prefix structure is defined as follows:

```
    /* SPS PREFIX STRUCTURE */

    OBJECT                          = COLUMN
```

```
    NAME                    = "PACKET_ID"
    DESCRIPTION             = "Telemetry packet identifier."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 1
    BYTES                   = 2
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = "PACKET_SEQUENCE_CONTROL"
    DESCRIPTION             = "Telemetry packet sequence counter."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 3
    BYTES                   = 2
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = "PACKET_LENGTH"
    DESCRIPTION             = "Telemetry packet length."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 5
    BYTES                   = 2
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = "PACKET_OBT_SECONDS"
    DESCRIPTION             = "S/C clock count at packet generation."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 7
    BYTES                   = 4
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = "PACKET_OBT_FRACTION"
    DESCRIPTION             = "Fractional part of S/C clock count."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 11
    BYTES                   = 2
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = "PACKET_PUS_AND_CRC"
    DESCRIPTION             = "Telemetry packet PUS-Version and CRC flag."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 13
    BYTES                   = 1
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = "PACKET_TYPE"
    DESCRIPTION             = "Telemetry packet type."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 14
    BYTES                   = 1
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = "PACKET_SUBTYPE"
    DESCRIPTION             = "Telemetry packet sub-type."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 15
    BYTES                   = 1
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = "PACKET_PAD_FIELD"
    DESCRIPTION             = "Telemetry packet padding field."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 16
    BYTES                   = 1
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = "STRUCTURE_ID"
    DESCRIPTION             = "Telemetry packet structure identifier."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
```

```
    START_BYTE               = 17
    BYTES                    = 2
END_OBJECT                   = COLUMN

OBJECT                       = COLUMN
    NAME                     = "SOFTWARE_VERSION"
    DESCRIPTION              = "On-board software version."
    DATA_TYPE                = MSB_UNSIGNED_INTEGER
    START_BYTE               = 19
    BYTES                    = 2
END_OBJECT                   = COLUMN

OBJECT                       = COLUMN
    NAME                     = "LINEAR_POS"
    DESCRIPTION              = "Linear stage position sensor readout."
    DATA_TYPE                = MSB_INTEGER
    START_BYTE               = 21
    BYTES                    = 2
    OFFSET                   = 1.52590E-004
    SCALING_FACTOR           = 3.05180E-004
    UNIT                     = VOLT
END_OBJECT                   = COLUMN

OBJECT                       = COLUMN
    NAME                     = "WHEEL_POS"
    DESCRIPTION              = "Current wheel position (segment number)."
    DATA_TYPE                = MSB_UNSIGNED_INTEGER
    START_BYTE               = 23
    BYTES                    = 2
END_OBJECT                   = COLUMN

OBJECT                       = COLUMN
    NAME                     = "TIP_NUMBER"
    DESCRIPTION              = "Number of selected tip."
    DATA_TYPE                = MSB_UNSIGNED_INTEGER
    START_BYTE               = 25
    BYTES                    = 2
END_OBJECT                   = COLUMN

OBJECT                       = COLUMN
    NAME                     = "X_ORIGIN"
    DESCRIPTION              = "Scan origin in X direction (DAC units)."
    DATA_TYPE                = MSB_UNSIGNED_INTEGER
    START_BYTE               = 27
    BYTES                    = 2
END_OBJECT                   = COLUMN

OBJECT                       = COLUMN
    NAME                     = "Y_ORIGIN"
    DESCRIPTION              = "Scan origin in Y direction (DAC units)."
    DATA_TYPE                = MSB_UNSIGNED_INTEGER
    START_BYTE               = 29
    BYTES                    = 2
END_OBJECT                   = COLUMN

OBJECT                       = COLUMN
    NAME                     = "STEP_SIZE"
    DESCRIPTION              = "Line scan step size (DAC units)."
    DATA_TYPE                = MSB_UNSIGNED_INTEGER
    START_BYTE               = 31
    BYTES                    = 2
END_OBJECT                   = COLUMN

OBJECT                       = COLUMN
    NAME                     = "NUM_STEPS"
    DESCRIPTION              = "Number of line scan steps (pixels)."
    DATA_TYPE                = MSB_UNSIGNED_INTEGER
    START_BYTE               = 33
    BYTES                    = 2
END_OBJECT                   = COLUMN

OBJECT                       = COLUMN
    NAME                     = "SCAN_MODE"
    DESCRIPTION              = "Scanning mode for image acquisition):
                                Bit 0-7: 0=DYN[amic], 1=CON[tact], 2=MAG[netic],
```

```
                                  Bit   8: line scan direction (0=std.,1=reverse),
                                  Bit  12: main scan direction (0=X,1=Y)"
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 35
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "MAIN_SCAN_CNT"
        DESCRIPTION              = "Current main scan counter."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 37
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "NUM_SAMPLES"
        DESCRIPTION              = "Total number of measurements."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 39
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "SPARE"
        DESCRIPTION              = "Currently not used."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 41
        BYTES                    = 6
        ITEMS                    = 3
        ITEM_BYTES               = 2
    END_OBJECT                   = COLUMN
```

4.3.6 Data Product Design – Line Scan Data

The MIDAS line scan data files are binary tables containing the plain telemetry packets as retrieved from the DDS. Each data file has associated a detached PDS label with the same name as the data file it describes, but with the extension `.LBL`. The data file columns are defined in a separate format file referred to by the `^STRUCTURE` keyword in the PDS labels:

- Data directory: `/DATA/LIN`
- File naming: `LIN_yydddhh_yydddhh_nnn_tt.DAT`
- File structure: `/LABEL/LIN_STRUCTURE.FMT`

Parameters having a physical representation can be calibrated by applying the OFFSET, SCALING_FACTOR and UNIT keywords (defined in the related column object in the format file) to the raw value:

- physical_value = `OFFSET` + raw_value*`SCALING_FACTOR` [`UNIT`]

A line scan can have `n` (n=32, 64, .., 512) data points depending on the commanded number of pixels in the main scan direction. The line scan records have a fixed size, capable of holding the maximum number of 512 line scan data points. The actual number of data points for a given record can be determined from the `NUM_STEPS` column.

<u>Note:</u> *The column TIP_NUMBER is always 0 for telemetry data generated prior to payload checkout #4 (corrected via S/W upload). Nevertheless, the proper value can be obtained from the mission specific keyword MIDAS_TIP_NUMBER which is included in the PDS label.*

A typical PDS label for a line scan data file is given below:

```
PDS_VERSION_ID                = PDS3
LABEL_REVISION_NOTE           = "<LABEL_REVISION_NOTE>"

RECORD_TYPE                   = FIXED_LENGTH
RECORD_BYTES                  = 1072
FILE_RECORDS                  = <FILE_RECORDS>

DATA_SET_ID                   = "<DATA_SET_ID>"
DATA_SET_NAME                 = "<DATA_SET_NAME>"

PRODUCT_ID                    = "<PRODUCT_ID>"
PRODUCT_VERSION_ID            = "<PRODUCT_VERSION_ID>"
PRODUCT_CREATION_TIME         = <PRODUCT_CREATION_TIME>
PRODUCT_TYPE                  = <PRODUCT_TYPE>
PROCESSING_LEVEL_ID           = <PROCESSING_LEVEL_ID>

MISSION_ID                    = ROSETTA
MISSION_NAME                  = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME            = "<MISSION_PHASE_NAME>"

INSTRUMENT_HOST_ID            = <INSTRUMENT_HOST_ID>
INSTRUMENT_HOST_NAME          = "<INSTRUMENT_HOST_NAME>"
INSTRUMENT_ID                 = <INSTRUMENT_ID>
INSTRUMENT_NAME               = "<INSTRUMENT_NAME>"
INSTRUMENT_TYPE               = "<INSTRUMENT_TYPE>"
INSTRUMENT_MODE_ID            = <INSTRUMENT_MODE_ID>
INSTRUMENT_MODE_DESC          = "<INSTRUMENT_MODE_DESC>"

TARGET_NAME                   = "<TARGET_NAME>"
TARGET_TYPE                   = "<TARGET_TYPE>"

START_TIME                    = <START_TIME>
STOP_TIME                     = <STOP_TIME>
```

```
SPACECRAFT_CLOCK_START_COUNT     = "<START_COUNT>"
SPACECRAFT_CLOCK_STOP_COUNT      = "<STOP_COUNT>"
NATIVE_START_TIME                = <NATIVE_START_TIME>
NATIVE_STOP_TIME                 = <NATIVE_STOP_TIME>

PRODUCER_ID                      = "<PRODUCER_ID>"
PRODUCER_FULL_NAME               = "<PRODUCER_FULL_NAME>"
PRODUCER_INSTITUTION_NAME        = "<PRODUCER_INSTITUTION_NAME>"

DATA_QUALITY_ID                  = <DATA_QUALITY_ID>
DATA_QUALITY_DESC                = "<DATA_QUALITY_DESC>"

/* GEOMETRY INFORMATION */

SC_SUN_POSITION_VECTOR           = <SC_SUN_POSITION_VECTOR>
SC_TARGET_POSITION_VECTOR        = <SC_TARGET_POSITION_VECTOR>
SC_TARGET_VELOCITY_VECTOR        = <SC_TARGET_VELOCITY_VECTOR>
SPACECRAFT_ALTITUDE              = <SPACECRAFT_ALTITUDE>
SUB_SPACECRAFT_LATITUDE          = <SUB_SPACECRAFT_LATITUDE>
SUB_SPACECRAFT_LONGITUDE         = <SUB_SPACECRAFT_LONGITUDE>

/* MISSION SPECIFIC KEYWORDS */

ROSETTA:MIDAS_TIP_NUMBER         = <MIDAS_TIP_NUMBER>
ROSETTA:MIDAS_TARGET_NUMBER      = <MIDAS_TARGET_NUMBER>
ROSETTA:MIDAS_TARGET_TYPE        = <MIDAS_TARGET_TYPE>
ROSETTA:MIDAS_TARGET_NAME        = <MIDAS_TARGET_NAME>

ROSETTA:MIDAS_LIN_STAGE_POS      = <MIDAS_LIN_STAGE_POS>
ROSETTA:MIDAS_SEGMENT_NUMBER     = <MIDAS_SEGMENT_NUMBER>
ROSETTA:MIDAS_SCAN_START_XY      = <MIDAS_SCAN_START_XY>
ROSETTA:MIDAS_SCAN_STOP_XY       = <MIDAS_SCAN_STOP_XY>
ROSETTA:MIDAS_SCAN_DIRECTION     = <MIDAS_SCAN_DIRECTION>

ROSETTA:MIDAS_SCANNING_MODE      = <MIDAS_SCANNING_MODE>

/* DATA FILE POINTER(S) */

^LINE_SCAN_TABLE                 = "<FILE_NAME>"

/* DATA OBJECT DEFINITION(S) */

OBJECT                           = LINE_SCAN_TABLE
    INTERCHANGE_FORMAT           = BINARY
    ROWS                         = <FILE_RECORDS>
    COLUMNS                      = 23
    ROW_BYTES                    = 1072
    DESCRIPTION                  = "MIDAS line scan data"
    ^STRUCTURE                   = "LIN_STRUCTURE.FMT"
END_OBJECT                       = LINE_SCAN_TABLE

END
```

The line scan data structure is defined as follows:

```
    /* LINE SCAN FRAME STRUCTURE */

    OBJECT                       = COLUMN
        NAME                     = "PACKET_ID"
        DESCRIPTION              = "Telemetry packet identifier."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 1
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "PACKET_SEQUENCE_CONTROL"
        DESCRIPTION              = "Telemetry packet sequence counter."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 3
        BYTES                    = 2
```

```
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = "PACKET_LENGTH"
    DESCRIPTION             = "Telemetry packet length."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 5
    BYTES                   = 2
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = "PACKET_OBT_SECONDS"
    DESCRIPTION             = "S/C clock count at packet generation."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 7
    BYTES                   = 4
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = "PACKET_OBT_FRACTION"
    DESCRIPTION             = "Fractional part of S/C clock count."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 11
    BYTES                   = 2
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = "PACKET_PUS_AND_CRC"
    DESCRIPTION             = "Telemetry packet PUS-Version and CRC flag."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 13
    BYTES                   = 1
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = "PACKET_TYPE"
    DESCRIPTION             = "Telemetry packet type."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 14
    BYTES                   = 1
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = "PACKET_SUBTYPE"
    DESCRIPTION             = "Telemetry packet sub-type."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 15
    BYTES                   = 1
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = "PACKET_PAD_FIELD"
    DESCRIPTION             = "Telemetry packet padding field."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 16
    BYTES                   = 1
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = "STRUCTURE_ID"
    DESCRIPTION             = "Telemetry packet structure identifier."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 17
    BYTES                   = 2
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
    NAME                    = "SOFTWARE_VERSION"
    DESCRIPTION             = "On-board software version."
    DATA_TYPE               = MSB_UNSIGNED_INTEGER
    START_BYTE              = 19
    BYTES                   = 2
END_OBJECT                  = COLUMN

OBJECT                      = COLUMN
```

```
    NAME                      = "LINEAR_POS"
    DESCRIPTION               = "Linear stage position sensor readout."
    DATA_TYPE                 = MSB_INTEGER
    START_BYTE                = 21
    BYTES                     = 2
    OFFSET                    = 1.52590E-004
    SCALING_FACTOR            = 3.05180E-004
    UNIT                      = VOLT
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = "WHEEL_POS"
    DESCRIPTION               = "Current wheel position (segment number)."
    DATA_TYPE                 = MSB_INTEGER
    START_BYTE                = 23
    BYTES                     = 2
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = "TIP_NUMBER"
    DESCRIPTION               = "Number of selected tip."
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 25
    BYTES                     = 2
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = "X_ORIGIN"
    DESCRIPTION               = "Scan origin in X direction (DAC units)."
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 27
    BYTES                     = 2
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = "Y_ORIGIN"
    DESCRIPTION               = "Scan origin in Y direction (DAC units)."
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 29
    BYTES                     = 2
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = "STEP_SIZE"
    DESCRIPTION               = "Line scan step size (DAC units)."
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 31
    BYTES                     = 2
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = "NUM_STEPS"
    DESCRIPTION               = "Number of line scan steps (pixels)."
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 33
    BYTES                     = 2
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = "SCAN_MODE"
    DESCRIPTION               = "Scanning mode for image acquisition):
                                 Bit 0-7: 0=DYN[amic], 1=CON[tact], 2=MAG[netic],
                                 Bit   8: line scan direction (0=std.,1=reverse),
                                 Bit  12: main scan direction (0=X,1=Y)"
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 35
    BYTES                     = 2
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = "LINE_SCAN_CNT"
    DESCRIPTION               = "Current line scan counter."
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 37
    BYTES                     = 2
```

```
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "SPARE"
        DESCRIPTION               = "Currently not used."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 39
        BYTES                     = 8
        ITEMS                     = 4
        ITEM_BYTES                = 2
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "Z_SET_VALUE"
        DESCRIPTION               = "Line scan data vector (Z piezo DAC set value)."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 47
        BYTES                     = 1024
        ITEMS                     = 512
        ITEM_BYTES                = 2
        SCALING_FACTOR            = 1.6400E-001
        OFFSET                    = 0.0000E+000
        UNIT                      = "nm"
    END_OBJECT                    = COLUMN

    OBJECT                        = COLUMN
        NAME                      = "CRC16_CHECKSUM"
        DESCRIPTION               = "Telemetry packet checksum (CRC 16)."
        DATA_TYPE                 = MSB_UNSIGNED_INTEGER
        START_BYTE                = 1071
        BYTES                     = 2
    END_OBJECT                    = COLUMN
```

4.3.7 Data Product Design – Image Scan Data

The MIDAS image data files are stored in BCR format which is described in chapter 3.2.4. Each data file has associated a detached PDS label with the same name as the data file it describes, but with the extension `.LBL`:

- Data directory: `/DATA/IMG`
- File naming: `IMG_yydddhh_yydddhh_nnn_dd.IMG`

A typical PDS label for an image data file is given below:

```
PDS_VERSION_ID                  = PDS3
LABEL_REVISION_NOTE             = "<LABEL_REVISION_NOTE>"

RECORD_TYPE                     = FIXED_LENGTH
RECORD_BYTES                    = 2048
FILE_RECORDS                    = <FILE_RECORDS>

DATA_SET_ID                     = "<DATA_SET_ID>"
DATA_SET_NAME                   = "<DATA_SET_NAME>"

PRODUCT_ID                      = "<PRODUCT_ID>"
PRODUCT_VERSION_ID              = "<PRODUCT_VERSION_ID>"
PRODUCT_CREATION_TIME           = <PRODUCT_CREATION_TIME>
PRODUCT_TYPE                    = <PRODUCT_TYPE>
PROCESSING_LEVEL_ID             = <PROCESSING_LEVEL_ID>

MISSION_ID                      = ROSETTA
MISSION_NAME                    = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME              = "<MISSION_PHASE_NAME>"

INSTRUMENT_HOST_ID              = <INSTRUMENT_HOST_ID>
INSTRUMENT_HOST_NAME            = "<INSTRUMENT_HOST_NAME>"
INSTRUMENT_ID                   = <INSTRUMENT_ID>
INSTRUMENT_NAME                 = "<INSTRUMENT_NAME>"
INSTRUMENT_TYPE                 = "<INSTRUMENT_TYPE>"
INSTRUMENT_MODE_ID              = <INSTRUMENT_MODE_ID>
INSTRUMENT_MODE_DESC            = "<INSTRUMENT_MODE_DESC>"

TARGET_NAME                     = "<TARGET_NAME>"
TARGET_TYPE                     = "<TARGET_TYPE>"

START_TIME                      = <START_TIME>
STOP_TIME                       = <STOP_TIME>
SPACECRAFT_CLOCK_START_COUNT    = "<START_COUNT>"
SPACECRAFT_CLOCK_STOP_COUNT     = "<STOP_COUNT>"
NATIVE_START_TIME               = <NATIVE_START_TIME>
NATIVE_STOP_TIME                = <NATIVE_STOP_TIME>

PRODUCER_ID                     = "<PRODUCER_ID>"
PRODUCER_FULL_NAME              = "<PRODUCER_FULL_NAME>"
PRODUCER_INSTITUTION_NAME       = "<PRODUCER_INSTITUTION_NAME>"

DATA_QUALITY_ID                 = <DATA_QUALITY_ID>
DATA_QUALITY_DESC               = "<DATA_QUALITY_DESC>"

/* GEOMETRY INFORMATION */

SC_SUN_POSITION_VECTOR          = <SC_SUN_POSITION_VECTOR>
SC_TARGET_POSITION_VECTOR       = <SC_TARGET_POSITION_VECTOR>
SC_TARGET_VELOCITY_VECTOR       = <SC_TARGET_VELOCITY_VECTOR>
SPACECRAFT_ALTITUDE             = <SPACECRAFT_ALTITUDE>
SUB_SPACECRAFT_LATITUDE         = <SUB_SPACECRAFT_LATITUDE>
SUB_SPACECRAFT_LONGITUDE        = <SUB_SPACECRAFT_LONGITUDE>
```

```
/* PIXEL SCALING (HORIZONTAL=X, VERTICAL=Y) */

HORIZONTAL_PIXEL_SCALE           = <HORIZONTAL_PIXEL_SCALE>
VERTICAL_PIXEL_SCALE             = <VERTICAL_PIXEL_SCALE>

/* MISSION SPECIFIC KEYWORDS */

ROSETTA:MIDAS_TIP_NUMBER         = <MIDAS_TIP_NUMBER>
ROSETTA:MIDAS_TARGET_NUMBER      = <MIDAS_TARGET_NUMBER>
ROSETTA:MIDAS_TARGET_TYPE        = <MIDAS_TARGET_TYPE>
ROSETTA:MIDAS_TARGET_NAME        = <MIDAS_TARGET_NAME>

ROSETTA:MIDAS_LIN_STAGE_POS      = <MIDAS_LIN_STAGE_POS>
ROSETTA:MIDAS_SEGMENT_NUMBER     = <MIDAS_SEGMENT_NUMBER>
ROSETTA:MIDAS_SCAN_START_XY      = <MIDAS_SCAN_START_XY>
ROSETTA:MIDAS_SCAN_STOP_XY       = <MIDAS_SCAN_STOP_XY>
ROSETTA:MIDAS_SCAN_DIRECTION     = <MIDAS_SCAN_DIRECTION>

ROSETTA:MIDAS_SCANNING_MODE      = <MIDAS_SCANNING_MODE>
ROSETTA:MIDAS_SCAN_DATA_TYPE     = <MIDAS_SCAN_DATA_TYPE>

/* DATA FILE POINTER(S) */

^BCR_HEADER                      = "<FILE_NAME>"
^BCR_IMAGE                       = ("<FILE_NAME>",2)

OBJECT                           = BCR_HEADER
    BYTES                        = 2048
    HEADER_TYPE                  = TEXT
    INTERCHANGE_FORMAT           = BINARY
    RECORDS                      = 1
    DESCRIPTION                  = "
    BCR-STM format as used by the Image Metrology SPIP application.
    Parameter definitions are given in file /DOCUMENT/MID_EIDC.pdf"
END_OBJECT                       = BCR_HEADER

OBJECT                           = BCR_IMAGE
    LINES                        = <LINES>
    LINE_SAMPLES                 = <LINE_SAMPLES>
    SAMPLE_BITS                  = 16
    SAMPLE_TYPE                  = LSB_UNSIGNED_INTEGER
    DESCRIPTION                  = "<DESCRIPTION>"
    SCALING_FACTOR               = <SCALING_FACTOR>
    OFFSET                       = <OFFSET>
END_OBJECT                       = BCR_IMAGE

END
```

4.3.8 Data Product Design – Feature Vector Data

The MIDAS feature vector data files are binary tables containing the plain telemetry packets as retrieved from the DDS. Each data file has associated a detached PDS label with the same name as the data file it describes, but with the extension `.LBL`. The data file columns are defined in a separate format file referred to by the `^STRUCTURE` keyword in the PDS labels:

- Data directory: `/DATA/ROI`
- File naming: `ROI_yydddhh_yydddhh_nnn_ff.DAT`
- File structure: `/LABEL/ROI_STRUCTURE.FMT`

Parameters having a physical representation can be calibrated by applying the OFFSET, SCALING_FACTOR and UNIT keywords (defined in the related column object in the format file) to the raw value:

- physical_value = `OFFSET` + raw_value*`SCALING_FACTOR` [`UNIT`]

A feature vector record comprises 64 feature vector frames having identical vector parameters. The actual number of feature vectors for a record is given in the `NUM_VECTORS` column. The repeating structure of the 64 feature vectors is defined by means of the PDS CONTAINER object.

A typical PDS label for a feature vector data file is given below:

```
PDS_VERSION_ID                  = PDS3
LABEL_REVISION_NOTE             = "<LABEL_REVISION_NOTE>"

RECORD_TYPE                     = FIXED_LENGTH
RECORD_BYTES                    = 2096
FILE_RECORDS                    = <FILE_RECORDS>

DATA_SET_ID                     = "<DATA_SET_ID>"
DATA_SET_NAME                   = "<DATA_SET_NAME>"

PRODUCT_ID                      = "<PRODUCT_ID>"
PRODUCT_VERSION_ID              = "<PRODUCT_VERSION_ID>"
PRODUCT_CREATION_TIME           = <PRODUCT_CREATION_TIME>
PRODUCT_TYPE                    = <PRODUCT_TYPE>
PROCESSING_LEVEL_ID             = <PROCESSING_LEVEL_ID>

MISSION_ID                      = ROSETTA
MISSION_NAME                    = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME              = "<MISSION_PHASE_NAME>"

INSTRUMENT_HOST_ID              = <INSTRUMENT_HOST_ID>
INSTRUMENT_HOST_NAME            = "<INSTRUMENT_HOST_NAME>"
INSTRUMENT_ID                   = <INSTRUMENT_ID>
INSTRUMENT_NAME                 = "<INSTRUMENT_NAME>"
INSTRUMENT_TYPE                 = "<INSTRUMENT_TYPE>"
INSTRUMENT_MODE_ID              = <INSTRUMENT_MODE_ID>
INSTRUMENT_MODE_DESC            = "<INSTRUMENT_MODE_DESC>"

TARGET_NAME                     = "<TARGET_NAME>"
TARGET_TYPE                     = "<TARGET_TYPE>"

START_TIME                      = <START_TIME>
STOP_TIME                       = <STOP_TIME>
SPACECRAFT_CLOCK_START_COUNT    = "<START_COUNT>"
SPACECRAFT_CLOCK_STOP_COUNT     = "<STOP_COUNT>"
NATIVE_START_TIME               = <NATIVE_START_TIME>
NATIVE_STOP_TIME                = <NATIVE_STOP_TIME>
```

```
PRODUCER_ID                      = "<PRODUCER_ID>"
PRODUCER_FULL_NAME               = "<PRODUCER_FULL_NAME>"
PRODUCER_INSTITUTION_NAME        = "<PRODUCER_INSTITUTION_NAME>"

DATA_QUALITY_ID                  = <DATA_QUALITY_ID>
DATA_QUALITY_DESC                = "<DATA_QUALITY_DESC>"

/* GEOMETRY INFORMATION */

SC_SUN_POSITION_VECTOR           = <SC_SUN_POSITION_VECTOR>
SC_TARGET_POSITION_VECTOR        = <SC_TARGET_POSITION_VECTOR>
SC_TARGET_VELOCITY_VECTOR        = <SC_TARGET_VELOCITY_VECTOR>
SPACECRAFT_ALTITUDE              = <SPACECRAFT_ALTITUDE>
SUB_SPACECRAFT_LATITUDE          = <SUB_SPACECRAFT_LATITUDE>
SUB_SPACECRAFT_LONGITUDE         = <SUB_SPACECRAFT_LONGITUDE>

/* DATA FILE POINTER(S) */

^ROI_TABLE                       = "<FILE_NAME>"

/* DATA OBJECT DEFINITION(S) */

OBJECT                           = ROI_TABLE
    INTERCHANGE_FORMAT           = BINARY
    ROWS                         = <FILE_RECORDS>
    COLUMNS                      = 35
    ROW_BYTES                    = 2096
    DESCRIPTION                  = "MIDAS feature vector data"
    ^STRUCTURE                   = "ROI_STRUCTURE.FMT"
END_OBJECT                       = ROI_TABLE

END
```

The feature vector structure is defined as follows:

```
    /* MIDAS FEATURE VECTOR FRAME STRUCTURE */

    OBJECT                       = COLUMN
        NAME                     = "PACKET_ID"
        DESCRIPTION              = "Telemetry packet identifier."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 1
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "PACKET_SEQUENCE_CONTROL"
        DESCRIPTION              = "Telemetry packet sequence counter."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 3
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "PACKET_LENGTH"
        DESCRIPTION              = "Telemetry packet length."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 5
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "PACKET_OBT_SECONDS"
        DESCRIPTION              = "S/C clock count at packet generation."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 7
        BYTES                    = 4
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "PACKET_OBT_FRACTION"
        DESCRIPTION              = "Fractional part of S/C clock count."
```

```
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 11
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "PACKET_PUS_AND_CRC"
        DESCRIPTION              = "Telemetry packet PUS-Version and CRC flag."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 13
        BYTES                    = 1
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "PACKET_TYPE"
        DESCRIPTION              = "Telemetry packet type."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 14
        BYTES                    = 1
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "PACKET_SUBTYPE"
        DESCRIPTION              = "Telemetry packet sub-type."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 15
        BYTES                    = 1
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "PACKET_PAD_FIELD"
        DESCRIPTION              = "Telemetry packet padding field."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 16
        BYTES                    = 1
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "STRUCTURE_ID"
        DESCRIPTION              = "Telemetry packet structure identifier."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 17
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "SOFTWARE_VERSION"
        DESCRIPTION              = "On-board software version."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 19
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "DATASET_ID"
        DESCRIPTION              = "Identifier of analysed data set."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 21
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "TOT_VECTORS"
        DESCRIPTION              = "Total number of detected features."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 23
        BYTES                    = 2
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = "VECTOR_IDX"
        DESCRIPTION              = "Index of first feature vector (x2)."
        DATA_TYPE                = MSB_UNSIGNED_INTEGER
        START_BYTE               = 25
        BYTES                    = 2
```

```
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = "NUM_VECTORS"
    DESCRIPTION               = "Number of feature vectors in packet."
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 27
    BYTES                     = 2
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = "MIN_Z_VALUE"
    DESCRIPTION               = "Minimum Z value of image."
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 29
    BYTES                     = 2
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = "MAX_Z_VALUE"
    DESCRIPTION               = "Maximum Z value of image."
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 31
    BYTES                     = 2
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = "SELECTED_IDX"
    DESCRIPTION               = "Index of favoured feature vector."
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 33
    BYTES                     = 2
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = "SELECTED_WEIGHT"
    DESCRIPTION               = "Weighting of favoured feature vector."
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 35
    BYTES                     = 2
    SCALING_FACTOR            = 6.1036E-5
    OFFSET                    = 0.0
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = "LIN_REG_OFFS"
    DESCRIPTION               = "Linear regression offset value."
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 37
    BYTES                     = 2
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = "LIN_REG_XFACT"
    DESCRIPTION               = "Linear regression X factor (x65535)."
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 39
    BYTES                     = 4
END_OBJECT                    = COLUMN

OBJECT                        = COLUMN
    NAME                      = "LIN_REG_YFACT"
    DESCRIPTION               = "Linear regression Y factor (x65535)."
    DATA_TYPE                 = MSB_UNSIGNED_INTEGER
    START_BYTE                = 43
    BYTES                     = 4
END_OBJECT                    = COLUMN

OBJECT                        = CONTAINER
    NAME                      = "VECTOR_STRUCTURE"
    START_BYTE                = 47
    BYTES                     = 32
    REPETITIONS               = 64
    DESCRIPTION               = "Represents the format of the 64
                                 repeating feature vector attributes."
```

```
OBJECT                  = COLUMN
    NAME                = "NUM_POINTS"
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 1
    BYTES               = 2
    DESCRIPTION         = "Number of feature vector data points."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = "X_IDX_MAX"
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 3
    BYTES               = 1
    DESCRIPTION         = "Maximum X position index."
END_OBJECT              = COLUMN


OBJECT                  = COLUMN
    NAME                = X_IDX_MIN
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 4
    BYTES               = 1
    DESCRIPTION         = "Minimum X position index."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = Y_IDX_MAX
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 5
    BYTES               = 1
    DESCRIPTION         = "Maximum y position index."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = Y_IDX_MIN
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 6
    BYTES               = 1
    DESCRIPTION         = "Minimum Y position index."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = Z_MAX_LVL
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 7
    BYTES               = 2
    DESCRIPTION         = "Maximum Z value over threshold level."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = X_IDX_SUM
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 9
    BYTES               = 4
    DESCRIPTION         = "Sum of X position indices."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = Y_IDX_SUM
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 13
    BYTES               = 4
    DESCRIPTION         = "Sum of Y position indices."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
    NAME                = Z_IDX_SUM
    DATA_TYPE           = MSB_UNSIGNED_INTEGER
    START_BYTE          = 17
    BYTES               = 4
    DESCRIPTION         = "Sum of Z position indices."
END_OBJECT              = COLUMN

OBJECT                  = COLUMN
```

```
            NAME                   = XX_IDX_SUM
            DATA_TYPE              = MSB_UNSIGNED_INTEGER
            START_BYTE             = 21
            BYTES                  = 4
            DESCRIPTION            = "Sum of X*X position indices."
        END_OBJECT                 = COLUMN

        OBJECT                     = COLUMN
            NAME                   = YY_IDX_SUM
            DATA_TYPE              = MSB_UNSIGNED_INTEGER
            START_BYTE             = 25
            BYTES                  = 4
            DESCRIPTION            = "Sum of Y*Y position indices."
        END_OBJECT                 = COLUMN

        OBJECT                     = COLUMN
            NAME                   = XY_IDX_SUM
            DATA_TYPE              = MSB_UNSIGNED_INTEGER
            START_BYTE             = 29
            BYTES                  = 4
            DESCRIPTION            = "Sum of X*Y position indices."
        END_OBJECT                 = COLUMN
    END_OBJECT                     = CONTAINER

    OBJECT                         = COLUMN
        NAME                       = CRC16_CHECKSUM
        DATA_TYPE                  = MSB_UNSIGNED_INTEGER
        START_BYTE                 = 2095
        BYTES                      = 2
        DESCRIPTION                = "Telemetry packet checksum (CRC 16)."
    END_OBJECT                     = COLUMN
```

4.3.9 Data Product Design – Event Data

The MIDAS event data files are ASCII tables containing the list of events within a given time period. Each data file has associated a detached PDS label with the same name as the data file it describes, but with the extension `.LBL`. The data file columns are defined in a separate format file referred to by the `^STRUCTURE` keyword in the PDS labels:

- Data directory: `/DATA/EVN`
- File naming: `EVN_yydddhh_yydddhh.TAB`
- File structure: `/LABEL/EVN_STRUCTURE.FMT`

A typical PDS label for an event data file is given below:

```
PDS_VERSION_ID                  = PDS3
LABEL_REVISION_NOTE             = "<LABEL_REVISION_NOTE>"

RECORD_TYPE                     = FIXED_LENGTH
RECORD_BYTES                    = 80
FILE_RECORDS                    = <FILE_RECORDS>

DATA_SET_ID                     = "<DATA_SET_ID>"
DATA_SET_NAME                   = "<DATA_SET_NAME>"

PRODUCT_ID                      = "<PRODUCT_ID>"
PRODUCT_VERSION_ID              = "<PRODUCT_VERSION_ID>"
PRODUCT_CREATION_TIME           = <PRODUCT_CREATION_TIME>
PRODUCT_TYPE                    = <PRODUCT_TYPE>
PROCESSING_LEVEL_ID             = <PROCESSING_LEVEL_ID>

MISSION_ID                      = ROSETTA
MISSION_NAME                    = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME              = "<MISSION_PHASE_NAME>"

INSTRUMENT_HOST_ID              = <INSTRUMENT_HOST_ID>
INSTRUMENT_HOST_NAME            = "<INSTRUMENT_HOST_NAME>"
INSTRUMENT_ID                   = <INSTRUMENT_ID>
INSTRUMENT_NAME                 = "<INSTRUMENT_NAME>"
INSTRUMENT_TYPE                 = "<INSTRUMENT_TYPE>"
INSTRUMENT_MODE_ID              = <INSTRUMENT_MODE_ID>
INSTRUMENT_MODE_DESC            = "<INSTRUMENT_MODE_DESC>"

TARGET_NAME                     = "<TARGET_NAME>"
TARGET_TYPE                     = "<TARGET_TYPE>"

START_TIME                      = <START_TIME>
STOP_TIME                       = <STOP_TIME>
SPACECRAFT_CLOCK_START_COUNT    = "<START_COUNT>"
SPACECRAFT_CLOCK_STOP_COUNT     = "<STOP_COUNT>"
NATIVE_START_TIME               = <NATIVE_START_TIME>
NATIVE_STOP_TIME                = <NATIVE_STOP_TIME>

PRODUCER_ID                     = "<PRODUCER_ID>"
PRODUCER_FULL_NAME              = "<PRODUCER_FULL_NAME>"
PRODUCER_INSTITUTION_NAME       = "<PRODUCER_INSTITUTION_NAME>"

DATA_QUALITY_ID                 = <DATA_QUALITY_ID>
DATA_QUALITY_DESC               = "<DATA_QUALITY_DESC>"

/* GEOMETRY INFORMATION */

SC_SUN_POSITION_VECTOR          = <SC_SUN_POSITION_VECTOR>
SC_TARGET_POSITION_VECTOR       = <SC_TARGET_POSITION_VECTOR>
SC_TARGET_VELOCITY_VECTOR       = <SC_TARGET_VELOCITY_VECTOR>
SPACECRAFT_ALTITUDE             = <SPACECRAFT_ALTITUDE>
```

```
SUB_SPACECRAFT_LATITUDE          = <SUB_SPACECRAFT_LATITUDE>
SUB_SPACECRAFT_LONGITUDE         = <SUB_SPACECRAFT_LONGITUDE>

/* DATA FILE POINTER(S) */

^EVENT_TABLE                       = "<FILE_NAME>"

/* DATA OBJECT DEFINITION(S) */

OBJECT                           = EVENT_TABLE
    INTERCHANGE_FORMAT           = ASCII
    ROWS                         = <FILE_RECORDS>
    COLUMNS                      = 5
    ROW_BYTES                    = 80
    DESCRIPTION                  = "MIDAS event data"
    ^STRUCTURE                   = "EVN_STRUCTURE.FMT"
END_OBJECT                       = EVENT_TABLE

END
```

The event data file structure is defined as follows:

```
    /* EVENT DATA STRUCTURE */

    OBJECT                       = COLUMN
        NAME                     = EVENT_OBT
        DATA_TYPE                = ASCII_REAL
        START_BYTE               = 1
        BYTES                    = 14
        UNIT                     = SECOND
        DESCRIPTION              = "S/C clock count at event generation."
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = EVENT_UTC
        DATA_TYPE                = DATE
        START_BYTE               = 16
        BYTES                    = 23
        DESCRIPTION              = "Event generation time in UTC format."
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = EVENT_CNT
        DATA_TYPE                = ASCII_INTEGER
        START_BYTE               = 40
        BYTES                    = 5
        DESCRIPTION              = "On-board event counter."
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = EVENT_SID
        DATA_TYPE                = ASCII_INTEGER
        START_BYTE               = 46
        BYTES                    = 5
        DESCRIPTION              = "Event identifier."
    END_OBJECT                   = COLUMN

    OBJECT                       = COLUMN
        NAME                     = EVENT_NAME
        DATA_TYPE                = CHARACTER
        START_BYTE               = 53
        BYTES                    = 25
        DESCRIPTION              = "Event description."
    END_OBJECT                   = COLUMN
```

4.3.10 Data Product Design – Cantilever Utilisation History Data

The MIDAS cantilever history data files are ASCII tables containing the list of events for a certain cantilever within a given time period. Each data file has associated a detached PDS label with the same name as the data file it describes, but with the extension `.LBL`. The data file columns are defined in a separate format file referred to by the `^STRUCTURE` keyword in the PDS labels:

- Data directory: `/DATA`
- File naming: `CAH_yydddhh_yydddhh_tt.TAB`
- File structure: `/LABEL/CAH_STRUCTURE.FMT`

A typical PDS label for a cantilever history data file is given below:

```
PDS_VERSION_ID                  = PDS3
LABEL_REVISION_NOTE             = "<LABEL_REVISION_NOTE>"

RECORD_TYPE                     = FIXED_LENGTH
RECORD_BYTES                    = 119
FILE_RECORDS                    = <FILE_RECORDS>

DATA_SET_ID                     = "<DATA_SET_ID>"
DATA_SET_NAME                   = "<DATA_SET_NAME>"

PRODUCT_ID                      = "<PRODUCT_ID>"
PRODUCT_VERSION_ID              = "<PRODUCT_VERSION_ID>"
PRODUCT_CREATION_TIME           = <PRODUCT_CREATION_TIME>
PRODUCT_TYPE                    = <PRODUCT_TYPE>
PROCESSING_LEVEL_ID             = <PROCESSING_LEVEL_ID>

MISSION_ID                      = ROSETTA
MISSION_NAME                    = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME              = "<MISSION_PHASE_NAME>"

INSTRUMENT_HOST_ID              = <INSTRUMENT_HOST_ID>
INSTRUMENT_HOST_NAME            = "<INSTRUMENT_HOST_NAME>"
INSTRUMENT_ID                   = <INSTRUMENT_ID>
INSTRUMENT_NAME                 = "<INSTRUMENT_NAME>"
INSTRUMENT_TYPE                 = "<INSTRUMENT_TYPE>"
INSTRUMENT_MODE_ID              = <INSTRUMENT_MODE_ID>
INSTRUMENT_MODE_DESC            = "<INSTRUMENT_MODE_DESC>"

TARGET_NAME                     = "<TARGET_NAME>"
TARGET_TYPE                     = "<TARGET_TYPE>"

START_TIME                      = <START_TIME>
STOP_TIME                       = <STOP_TIME>
SPACECRAFT_CLOCK_START_COUNT    = "<START_COUNT>"
SPACECRAFT_CLOCK_STOP_COUNT     = "<STOP_COUNT>"
NATIVE_START_TIME               = <NATIVE_START_TIME>
NATIVE_STOP_TIME                = <NATIVE_STOP_TIME>

PRODUCER_ID                     = "<PRODUCER_ID>"
PRODUCER_FULL_NAME              = "<PRODUCER_FULL_NAME>"
PRODUCER_INSTITUTION_NAME       = "<PRODUCER_INSTITUTION_NAME>"

DATA_QUALITY_ID                 = <DATA_QUALITY_ID>
DATA_QUALITY_DESC               = "<DATA_QUALITY_DESC>"

/* DATA FILE POINTER(S) */

^EVENT_TABLE                    = "<FILE_NAME>"

/* DATA OBJECT DEFINITION(S) */
```

```
OBJECT                          = EVENT_TABLE
    NAME                        = CANTILEVER_HISTORY
    INTERCHANGE_FORMAT          = ASCII
    ROWS                        = <FILE_RECORDS>
    COLUMNS                     = 11
    ROW_BYTES                   = 119
    DESCRIPTION                 = "MIDAS cantilever history data"
    ^STRUCTURE                  = "CAH_STRUCTURE.FMT"
END_OBJECT                      = EVENT_TABLE

END
```

The cantilever history data structure is defined as follows:

```
    /* CANTILEVER HISTORY DATA STRUCTURE */

    OBJECT                      = COLUMN
        NAME                    = START_OBT
        DATA_TYPE               = ASCII_REAL
        START_BYTE              = 1
        BYTES                   = 15
        UNIT                    = SECOND
        DESCRIPTION             = "S/C clock count at event start."
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = START_UTC
        DATA_TYPE               = DATE
        START_BYTE              = 17
        BYTES                   = 23
        DESCRIPTION             = "Event start time in UTC format."
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = STOP_OBT
        DATA_TYPE               = ASCII_REAL
        START_BYTE              = 41
        BYTES                   = 15
        UNIT                    = SECOND
        DESCRIPTION             = "S/C clock count at event stop."
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = STOP_UTC
        DATA_TYPE               = DATE
        START_BYTE              = 57
        BYTES                   = 23
        DESCRIPTION             = "Event stop time in UTC format."
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = EVENT
        DATA_TYPE               = CHARACTER
        START_BYTE              = 82
        BYTES                   = 8
        DESCRIPTION             = "Textual description of the event."
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = AC_GAIN
        DATA_TYPE               = ASCII_INTEGER
        START_BYTE              = 93
        BYTES                   = 1
        DESCRIPTION             = "Gain level of cantilever AC signal
                                   amplifier [0-7]."
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = DC_GAIN
        DATA_TYPE               = ASCII_INTEGER
        START_BYTE              = 95
```

```
        BYTES                      = 1
        DESCRIPTION                = "Gain level of cantilever DC signal
                                      amplifier [0-7]."
    END_OBJECT                     = COLUMN

    OBJECT                         = COLUMN
        NAME                       = EXC_LVL
        DATA_TYPE                  = ASCII_INTEGER
        START_BYTE                 = 97
        BYTES                      = 1
        DESCRIPTION                = "Gain level of piezo-electric actuator
                                      used for cantilever excitation [0-7]."
    END_OBJECT                     = COLUMN

    OBJECT                         = COLUMN
        NAME                       = U_MAX
        DATA_TYPE                  = ASCII_REAL
        UNIT                       = VOLT
        START_BYTE                 = 99
        BYTES                      = 5
        DESCRIPTION                = "Max. cantilever signal amplitude
                                      detected during frequency scan."
    END_OBJECT                     = COLUMN

    OBJECT                         = COLUMN
        NAME                       = F_MAX
        DATA_TYPE                  = ASCII_REAL
        UNIT                       = HERTZ
        START_BYTE                 = 105
        BYTES                      = 8
        DESCRIPTION                = "Frequency where the maximum
                                      signal amplitude was detected."
    END_OBJECT                     = COLUMN

    OBJECT                         = COLUMN
        NAME                       = SCAN_MODE
        DATA_TYPE                  = CHARACTER
        START_BYTE                 = 115
        BYTES                      = 3
        DESCRIPTION                = "Scanning mode for image acquisition e.g.
                                      DYN[amic], CON[tact] or MAG[netic]."
    END_OBJECT                     = COLUMN
```

4.3.11 Data Product Design – Target Utilisation History Data

The MIDAS target history data files are ASCII tables containing the list of events for a certain target within a given time period. Each data file has associated a detached PDS label with the same name as the data file it describes, but with the extension `.LBL`. The data file columns are defined in a separate format file referred to by the `^STRUCTURE` keyword in the PDS labels:

- Data directory: `/DATA`
- File naming: `TGH_yydddhh_yydddhh_tt.TAB`
- File structure: `/LABEL/TGH_STRUCTURE.FMT`

A typical PDS label for a target history data file is given below:

```
PDS_VERSION_ID                 = PDS3
LABEL_REVISION_NOTE            = "<LABEL_REVISION_NOTE>"

RECORD_TYPE                    = FIXED_LENGTH
RECORD_BYTES                   = 95
FILE_RECORDS                   = <FILE_RECORDS>

DATA_SET_ID                    = "<DATA_SET_ID>"
DATA_SET_NAME                  = "<DATA_SET_NAME>"

PRODUCT_ID                     = "<PRODUCT_ID>"
PRODUCT_VERSION_ID             = "<PRODUCT_VERSION_ID>"
PRODUCT_CREATION_TIME          = <PRODUCT_CREATION_TIME>
PRODUCT_TYPE                   = <PRODUCT_TYPE>
PROCESSING_LEVEL_ID            = <PROCESSING_LEVEL_ID>

MISSION_ID                     = ROSETTA
MISSION_NAME                   = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME             = "<MISSION_PHASE_NAME>"

INSTRUMENT_HOST_ID             = <INSTRUMENT_HOST_ID>
INSTRUMENT_HOST_NAME           = "<INSTRUMENT_HOST_NAME>"
INSTRUMENT_ID                  = <INSTRUMENT_ID>
INSTRUMENT_NAME                = "<INSTRUMENT_NAME>"
INSTRUMENT_TYPE                = "<INSTRUMENT_TYPE>"
INSTRUMENT_MODE_ID             = <INSTRUMENT_MODE_ID>
INSTRUMENT_MODE_DESC           = "<INSTRUMENT_MODE_DESC>"

TARGET_NAME                    = "<TARGET_NAME>"
TARGET_TYPE                    = "<TARGET_TYPE>"

START_TIME                     = <START_TIME>
STOP_TIME                      = <STOP_TIME>
SPACECRAFT_CLOCK_START_COUNT   = "<START_COUNT>"
SPACECRAFT_CLOCK_STOP_COUNT    = "<STOP_COUNT>"
NATIVE_START_TIME              = <NATIVE_START_TIME>
NATIVE_STOP_TIME               = <NATIVE_STOP_TIME>

PRODUCER_ID                    = "<PRODUCER_ID>"
PRODUCER_FULL_NAME             = "<PRODUCER_FULL_NAME>"
PRODUCER_INSTITUTION_NAME      = "<PRODUCER_INSTITUTION_NAME>"

DATA_QUALITY_ID                = <DATA_QUALITY_ID>
DATA_QUALITY_DESC              = "<DATA_QUALITY_DESC>"

/* DATA FILE POINTER(S) */

^EVENT_TABLE                   = "<FILE_NAME>"

/* DATA OBJECT DEFINITION(S) */
```

```
OBJECT                          = EVENT_TABLE
    NAME                        = TARGET_HISTORY
    INTERCHANGE_FORMAT          = ASCII
    ROWS                        = <FILE_RECORDS>
    COLUMNS                     = 6
    ROW_BYTES                   = 95
    DESCRIPTION                 = "MIDAS target history data"
    ^STRUCTURE                  = "TGH_STRUCTURE.FMT"
END_OBJECT                      = EVENT_TABLE

END
```

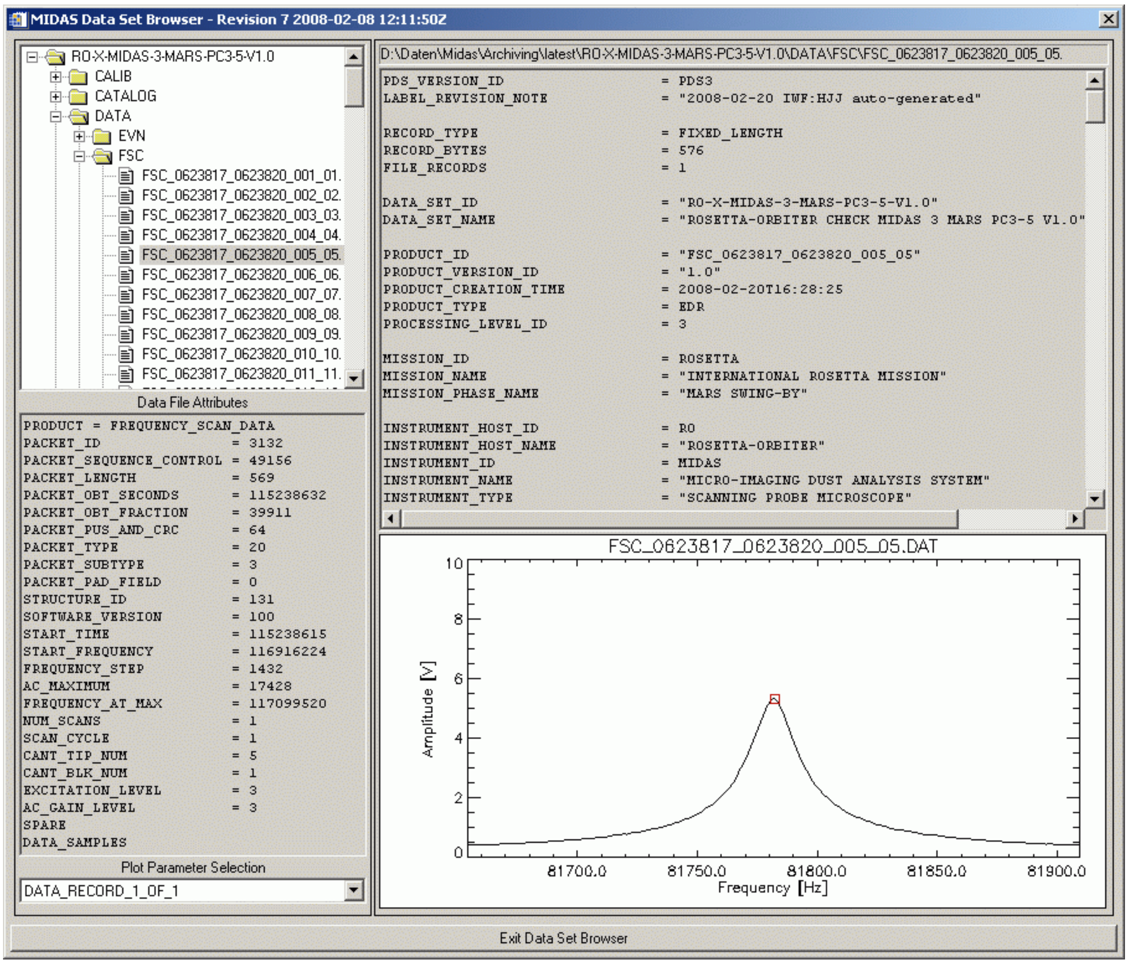
The target history data structure is defined as follows:

```
    /* TARGET HISTORY DATA STRUCTURE */

    OBJECT                      = COLUMN
        NAME                    = START_OBT
        DATA_TYPE               = ASCII_REAL
        START_BYTE              = 1
        BYTES                   = 15
        UNIT                    = SECOND
        DESCRIPTION             = "S/C clock count at event start."
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = START_UTC
        DATA_TYPE               = DATE
        START_BYTE              = 17
        BYTES                   = 23
        DESCRIPTION             = "Event start time in UTC format."
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = STOP_OBT
        DATA_TYPE               = ASCII_REAL
        START_BYTE              = 41
        BYTES                   = 15
        UNIT                    = SECOND
        DESCRIPTION             = "S/C clock count at event stop."
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = STOP_UTC
        DATA_TYPE               = DATE
        START_BYTE              = 57
        BYTES                   = 23
        DESCRIPTION             = "Event stop time in UTC format."
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = EVENT
        DATA_TYPE               = CHARACTER
        START_BYTE              = 82
        BYTES                   = 8
        DESCRIPTION             = "Textual description of the event."
    END_OBJECT                  = COLUMN

    OBJECT                      = COLUMN
        NAME                    = FLUX_OR_TIP
        DATA_TYPE               = ASCII_INTEGER
        START_BYTE              = 92
        BYTES                   = 2
        DESCRIPTION             = "Maximum dust flux or tip number."
    END_OBJECT                  = COLUMN
```

5 Appendix: Available Software to read PDS files

The MIDAS archive data sets can be displayed and validated with the MIDAS Data Set Browser software. The contents of a MIDAS archive data set can be browsed by means of a tree-like structure, displaying the data set directory hierarchy (nodes) an the associated data files (leafs). The software is entirely written in IDL and the source code is included in the data sets.

Figure 5.1 shows a frequency scan from the RO-X-MIDAS-3-MARS-PC3-5 data set:



The browser window is structured into two panels holding the following components (from top to bottom):

Left Panel:
- Data set hierarchy window – used for navigation
- Data file attribute window – shows data file attributes (e.g. row prefix values)
- Plot parameter selection window – plot parameter selection

Right Panel:
- Data file path windows – displays the full path of the selected PDS file
- Text window – displays text files or PDS data file labels
- Graphic/Table window – used for data plotting or tabular data display

5.1 Program Description

5.1.1 *Program Installation*

Before starting the program, the source files need to be copied to a directory on a machine having IDL (6.4 or higher) installed. The source files (extension *.PRO) are located in the DOCUMENT directory of a data set. In order to make IDL aware of the new modules, the directory holding the source files should be added to the IDL path preferences (File->Preferences->Path).

5.1.2 Starting the Program

After starting up IDL, the MIDAS Data Set Browser can be started with the following command:

IDL> mid_browse [,_data_set_root]

The parameter *data_set_root* is optional. It can be used to define the root directory of the MIDAS data set (usually the directory holding the AAREADME.TXT and VOLDESC.CAT files) at start-up. If this parameter is not present, the S/W displays a file selection dialog from where the root directory can be selected.

5.1.3 Navigating the Data Set

The upper left window shows a tree-like structure displaying the data set hierarchy (directories and files).

Directories can be expanded/collapsed by clicking on the ‘+’/’-‘ symbol in front of the directory icon. Double-clicking on the directory icon or the directory name toggles between expanded and collapsed mode.

The up and down arrow keys can be used to navigate sequentially through the directories and files.

Data set files are usually displayed with the file extension included. Nevertheless, in order to reduce the amount of displayed files, the file extension is stripped of from files located in the DATA directory and all subjacent directories. This results in a common filename (without extension) for the data files and the respective PDS labels.

5.1.4 Data Display

Information from a data set file can be retrieved by selecting the file in the data set hierarchy window (entry is highlighted).

<u>Text files:</u>

Data set files having the extension .CAT, .FMT, .LBL, .TAB and .TXT are displayed in the upper right text display window. No data validation is applied to these files.

<u>Adobe PDF files:</u>

When selecting a Portable Data Format file, the file is displayed in the application associated to the .PDF file extension on the system (if any).

PNG Images:

Images stored in PNG format are displayed in the graphic panel located in the lower right corner of the main window.

Files in the DATA directory:

Files located in and underneath the DATA directory are treated differently than the data set files already mentioned.

PDS labels are validated and ^STRUCTURE statements are expanded. The resulting PDS labels are displayed in the text window. Comments are removed from the PDS labels.

The associated data files are loaded and the information is displayed in several windows, depending on the data product type:

- EVN, CAH and TGH Data: The table contents are displayed in the table data panel located in the lower left corner of the main window.
- FSC Data: The resonance curve of one scan cycle of the frequency sweep is displayed in the graphic panel. The red square indicates the resonance peak which has been found by the on-board S/W within the current scan cycle. General frequency scan cycle attributes (row prefix) are displayed in the data file attribute panel. If more than one frequency sweep record is stored in the selected data file, the plot parameter drop-list can be used to navigate through the records.
- HK1, HK2 Data: Housekeeping data parameters are plotted in the graphic panel. The parameters can be selected from the plot parameter drop-list. Due to the rather poor performance of the 3rd party S/W for reading and validating the PDS labels, loading of the extended housekeeping data (HK2) might take some time.
- IMG Data: Images are displayed in the graphic panel.
- LIN Data: Line scans are displayed in the graphic panel. General line scan attributes (row prefix) are displayed in the data file attribute panel. If more than one line scan record is stored in the selected data file, the plot parameter drop-list can be used to navigate through the records.
- SPA, SPS Data: Single point scans are displayed in the graphic panel. General single point scan attributes (row prefix) are displayed in the data file attribute panel. If more than one single point scan record is stored in the selected data file, the plot parameter drop-list can be used to navigate through the records.

5.2 Program Source Files

5.2.1 MIDAS Data Set Browser

The MIDAS Data Set Browser comprises the following IDL source modules:

- error_msg – utility for printing error messages
- escape.pro – utility for handling escape sequences in strings
- ini_file.pro – utility for saving and restoring program settings
- mid_browse.pro – the MIDAS Data Set Browser main program
- release.pro – MIDAS Data Set Browser software revision
- tostr.pro – extended string conversion (e.g. date values)

5.2.2 *Small Bodies Node (SBN) PDS Library*

The READPDS library was created at the Small Bodies Node (SBN) of the Planetary Data System (PDS) to read PDS image and data files. The release provided in the archive is version 4.9 dating from 2016-03-02.

The library consists of the following modules:

- addeobj.pro – insert END_OBJECT keyword if not present and pad lines to 80 bytes
- apply_bitmask.pro – applies bitmask on integer arrays or scalars
- arr_struct.pro – populates an IDL structure for array object to be read
- arrcol_struct.pro – construct an IDL structure for a given array or collection
- arrcolascpds.pro – read a PDS ASCII array or collection object into an IDL structure
- arrcolpds.pro – read a PDS binary array or collection object into an IDL structure
- btabvect2.pro – convert NxM dimensional column vector into IDL data type
- clean.pro – remove all unprintable characters from a string
- cleanarr.pro – remove all unprintable characters from a string array
- coll_struct.pro – populates an IDL structure for collection object to be read
- elem_struct.pro – populates an IDL structure for element object to be read
- get_index.pro – retrieves viable END_OBJECT index position in a PDS label
- headpds.pro – read a PDS label into an array variable
- histogram.pro – read and display PDs histogram objects
- imagepds.pro – read an image array into an array variable
- objpds.pro – obtain viable data objects from a PDS label
- pdspar.pro – obtain the value of a parameter in a PDS header
- pointpds.pro - retrieves pointer information for PDS object from label
- qubepds.pro – read a 3D image qube object into a 3D IDL array
- readhistory.pro – read a history object into a string array variable
- readpds.pro – reads a PDS file into IDL data and label variables
- readspreadsheet.pro – read a PDS spreadsheet object into an IDL structure
- remove_chars.pro – remove all specified characters from a string
- str2num.pro – returns numeric value of a string
- tascpds.pro – read a PDS ASCII table into an IDL structure
- tbinpds.pro – read a PDS binary table file into an IDL structure
- timepds.pro – extract time from PDS label or ASCII table

6 Appendix: Example of Directory Listing of Data Set X

```
[TOP-LEVEL-DIRECTORY]
|
|-- .PDSVOLUME.XML        Archive data file catalog generated by PVV.
|-- AAREADME.TXT         Overview description of the data set contents.
|-- VOLDESC.CAT          Description of the contents of this volume.
|
|--[CALIB]               Directory containing PDS calibration objects.
|  |
|  |-- CALINFO.TXT       Description of files in the CALIB directory.
|  |-- MIDCALIB.LBL      PDS label describing the MIDAS calibration table.
|  +-- MIDCALIB.TAB      Standard MIDAS calibration table in ASCII format.
|
|--[CATALOG]             Directory containing PDS catalog objects.
|  |
|  |-- CATINFO.TXT       Description of files in the CATALOG directory.
|  |-- DATASET.CAT       Description of the MIDAS data set.
|  |-- INST.CAT          Description of the MIDAS instrument.
|  |-- INSTHOST.CAT      Description of the ROSETTA spacecraft.
|  |-- MISSION.CAT       Description of the ROSETTA mission.
|  |-- REFERENCE.CAT     List of publications mentioned in catalog files.
|  |-- SOFTWARE.CAT      Description of provided S/W to read the data set.
|  +-- TARGET.CAT        Description of the ROSETTA mission targets.
|
|--[DATA]                Directory containing the MIDAS data files.
|  |
|  |--[EVN]              Directory containing MIDAS event data.
|  |  |
|  |  |-- *.LBL          Detached label files describing the data.
|  |  +-- *.TAB          MIDAS event data files in ASCII format.
|  |
|  |--[FSC]              Directory containing MIDAS frequency scan data.
|  |  |
|  |  |-- *.LBL          Detached label files describing the data.
|  |  +-- *.TAB          MIDAS frequency scan data files in binary format.
|  |
|  |--[HK1]              Directory containing MIDAS standard HK data.
|  |  |
|  |  |-- *.LBL          Detached label files describing the data.
|  |  +-- *.TAB          MIDAS standard HK data files in binary format.
|  |
|  |--[HK2]              Directory containing MIDAS extended HK data.
|  |  |
|  |  |-- *.LBL          Detached label files describing the data.
|  |  +-- *.TAB          MIDAS extended HK data files in binary format.
|  |
|  |--[IMG]              Directory containing MIDAS image data.
|  |  |
|  |  |-- *.LBL          Detached label files describing the data.
|  |  +-- *.BCR          MIDAS image data files in STM-BCR format.
|  |
|  |--[LIN]              Directory containing MIDAS line scan data.
|  |  |
|  |  |-- *.LBL          Detached label files describing the data.
|  |  +-- *.TAB          MIDAS line scan data files in binary format.
|  |
|  |--[ROI]              Directory containing MIDAS feature vector data.
|  |  |
|  |  |-- *.LBL          Detached label files describing the data.
|  |  +-- *.TAB          MIDAS feature vector data files in binary format.
|  |
|  |--[SPA]              Directory containing MIDAS DAQ approach data.
|  |  |
|  |  |-- *.LBL          Detached label files describing the data.
|  |  +-- *.TAB          MIDAS DAQ approach data files in binary format.
|  |
|  |--[SPS]              Directory containing MIDAS DAQ sampling data.
|  |  |
|  |  |-- *.LBL          Detached label files describing the data.
|  |  +-- *.TAB          MIDAS DAQ sampling data files in binary format.
```

```
|   |
|   |-- CAH*.TAB          MIDAS cantilever history files in ASCII format.
|   |-- TGH*.TAB          MIDAS target history files in ASCII format.
|   +-- *.LBL             Detached label files describing the data.
|
|--[DOCUMENT]             Directory containing volume related documents.
|   |
|   |--[CODE]             Directory containing data browser S/W modules.
|   |   |
|   |   |-- MID_BROWSE.LBL PDS label describing the software modules.
|   |   |-- MID_BROWSE.PRO MIDAS data browser main program (IDL).
|   |   +-- *.PRO          MIDAS data browser S/W source modules (IDL).
|   |
|   |-- DOCINFO.TXT       Description of files in the DOCUMENT directory.
|   |-- MID_*.LBL         PDS labels for documents.
|   |-- MID_EICD.TXT      MIDAS to PSA interface document in ASCII format.
|   |-- MID_EICD.PDF      MIDAS to PSA interface document in PDF format.
|   |-- MID_EICD_*.PNG    MIDAS to PSA I/F document images in PDS format.
|   |-- MID_SSRV.TXT      MIDAS instrument paper in ASCII format.
|   |-- MID_SSRV.PDF      MIDAS instrument paper in Adobe PDF format.
|   |-- MID_SSRV_*.PNG    MIDAS instrument paper images in PNG format.
|   |-- MID_USER.TXT      MIDAS user manual in ASCII format.
|   |-- MID_USER.PDF      MIDAS user manual in Adobe PDF format.
|   +-- MID_USER_*.PNG    MIDAS user manual images in PNG format.
|
+--[INDEX]                Directory containing index files.
    |
    |-- INDXINFO.TXT      Description of files in the INDEX directory.
    |-- INDEX.TAB         Index table of MIDAS data in this data set.
    +-- INDEX.LBL         PDS label for INDEX.TAB file.
```