ROSETTA-NAVCAM

to

Planetary Science Archive
Interface Control Document

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Table 1: Distribution List.

Recipient	Organisation	Contact
Rosetta SGS	ESA/ESAC	

Table 2: Document Change Log.

Date of Update	Update to Document	New Version	Name
2010 Oct 20	Creation of document	V 1.0	Colin Archibald
2012 Jun 26	Corrections	V 2.0	Maud Barthelemy
2013 Jan 08	Corrections; added Sections 3.1, 4.2.1, 4.2.2, 4.2.3	V 3.0	Bernhard Geiger
2013 Aug 30	Corrections in Sections 3.2, 4.1.2	V 3.1	Bernhard Geiger
2015 Feb 06	Major revision - description of comet phase datasets - authorship changed	V 4.0	Bernhard Geiger

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List of Acronyms

A/D Analogue-to-Digital

AIU Avionics Interface Unit

AOCS Attitude and Orbit Control System

APID Application Process Identifier

CAM-BAF Camera Baffle

CAM-EU Camera Electronic Unit

CAM-OH Camera Optical Head

CCD Charge Coupled Device

CODMAC Committee On Data Management, Archiving, and Computation

DDS Data Distribution System

DMS Data Management System

DNA Defocused imaging with No Attenuation

EAICD Experiment to Archive Interface Control Document

ESA European Space Agency

ESAC European Space Astronomy Centre

ESOC European Space Operations Centre

EU Electronic Unit

FA Focused imaging with Attenuation

FITS Flexible Image Transport System

FNA Focused imaging with No Attenuation

FOV Field of View

ftp file transfer protocol

HK Housekeeping

JPEG Joint Photographic Experts Group

NASA National Aeronautics and Space Administration

NavCam Navigation Camera

OBT On-Board Time

OH Optical Head

PDS Planetary Data System

PSA Planetary Science Archive

PSA-DH Planetary Science Archive Data Handler

RMOC Rosetta Mission Operations Centre

RO Rosetta Orbiter

S/C Spacecraft

SCIOPS Science Operations Department

SGS Science Ground Segment

SSMM Solid State Mass Memory

TC Telecommand

TM Telemetry

UTC Coordinated Universal Time

WCS World Coordinate System (FITS)

1 Introduction

1.1 Purpose and Scope

This Experiment to Archive Interface Control Document (EAICD) has two main purposes. Firstly, it gives users of the Navigation Camera (NavCam) instrument data a detailed description of the product and how it was generated, including data sources and destinations. Secondly, it acts as an interface between the NavCam data producers and the data archiving authority. One point of note is that there are two identical NavCams installed on the Rosetta spacecraft, however, for the purposes of this document the singular is generally referred to when discussing the NavCams.

1.2 Archiving Authorities

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

- the National Aeronautics and Space Administration (NASA) for U.S. Planetary Missions, implemented by PDS;

- the European Space Agency (ESA) for European Planetary Missions, implemented by the Science Operations Department (SCIOPS) of ESA.

ESA implements an on-line science archive, the Planetary Science Archive (PSA), for several reasons:

- to support and ease data ingestion;

- to offer additional services to the scientific user community and science operations teams, such as, e.g.:

  1. search queries that allow searches across instruments, missions and scientific disciplines;

  2. several data delivery options, such as:
     - direct download of data products, linked files and data sets;
     - file transfer protocol (ftp) download of data products, linked files and data sets.

The PSA aims for on-line 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 NavCam instrument on Rosetta from the Spacecraft (S/C) until the insertion into the PSA by ESA. It includes information on how data were processed, formatted, labelled and uniquely identified; along with discussing the general naming

schemes for NavCam data volumes, data sets, data and label files. The standards used to generate such products are explained and the design of the data set structure and data products are also given within this document.

1.4 Intended Readership

The staff of the archiving authority (PSA, PDS), members of the Rosetta Science Ground Segment and the instrument team community as well as any potential user of the NavCam data.

1.5 Applicable Documents

- AD1: Rosetta Archive Generation, Validation and Transfer Plan, January 10, 2006, RO-EST-PL-5011

- AD2: Rosetta Archive Conventions, Issue 7, Rev. 6, March 21, 2014, RO-EST-TN-3372

1.6 Reference Documents

- RD1: Rosetta Navigation Camera User's Manual, January 2002, RO-GAL-MA-2008

- RD2: Rosetta Navigation Camera Design Description, January 2002, RO-GAL-RP-2007

- RD3: Navigation Camera TM/TC and Software ICD, November 2001, RO-MMT-IF-2007

- RD4: Rosetta SPICE Frame Kernel, ROS_V24.TF

- RD5: Rosetta Data Delivery Interface Document, Appendix H, November 2013, RO-ESC-IF-5003

1.7 Contact Names and Addresses

Table 3: List of contacts for the NavCam instrument archive.

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2 Overview of Instrument Design

In order to fully satisfy the requirements and objectives regarding navigation and attitude control, Galileo Avionica developed a mission-specific Navigation Camera for Rosetta by building on the heritage of existing models. Table 4 provides an overview of some of the physical and operational parameters of the NavCam.

Table 4: Overview of NavCam properties.

Parameter	Value	Comment
Mass CAM-OH	6.050 kg	Camera Optical Head
Mass CAM-EU	2.700 kg	Camera Electronic Unit
Mass CAM-BAF	1.408 kg	Camera Baffle
Total Mass	10.158 kg	
Total Power	16.8 W	
Field of View	5° × 5°	
Sensor Type	CCD	CCD47-20 by e2v
Number of Pixels	1024 × 1024	
Focal Length	152.5 mm	
Pixel Size	13 μm	
Pixel Angular Size	17 arcsec	
Aperture	70 mm	Non-Attenuated Modes
	30 mm	Attenuated Mode
F/Number	f/2.2	Non-Attenuated Modes
	f/5.1	Attenuated Mode
Limit Magnitude	$M_v = 11$	Exposure time 5 s, SNR ≥ 5
Saturation Magnitude	$M_v = 1.6$	Whole spectral range,
	$M_v = 0.8$	G2 Class; exposure time = 10ms
Integration Time	10 ms	Minimum,
	30 s	Maximum
Bias error (1 σ)	0.2 pixels	$M_v = 11$, exposure time = 5 s, Defocused mode
NEA (1 σ)	0.1 pixels	$M_v = 11$, exposure time = 5 s, Defocused mode
Commanded Window Size	20 × 20	Minimum pixel array
	1024 × 1024	Maximum pixel array
CCD Operative Temp. Range	-50°C	Minimum
	+50°C	Maximum
CCD Performance Temp. Range	-25°C	Minimum
	0°C	Maximum

2.1 Architecture and Configurations

The Rosetta NavCam consists of a Camera Optical Head (CAM-OH), a Camera Electronic Unit (CAM-EU) and a Camera Baffle (CAM-BAF). Information given in this section is mainly

extracted from the User's Manual [RD1] and the Design Description Document [RD2]. In general the Rosetta NavCam camera has three major functions:

1. Track point-like targets (in Point Target Tracking Mode).

2. Track one extended object, during asteroid fly-by and comet approach phases (in Asteroid Tracking Mode).

3. Acquire navigation images of asteroids and the comet nucleus (Imaging mode, also performed in Asteroid Tracking Mode).

2.1.1 Camera Optical Head

The Camera Optical Head for the Rosetta NavCam contains the optical system, the CCD detector and the electronics required to operate the CCD. It also supports the dust cover and attenuation mechanism in front of the optics. Figure 1 depicts three possible configurations of the optical system with exchangeable first element.

- DNA mode. Defocused not attenuated. The first element is a plano-parallel window. The aperture is 70mm. This mode is used for determining the position of point sources with improved centroiding. During the comet escort phase this mode is also used by default as a dust cover when the camera is not operated.
ROSETTA:CAM_COVER_POSITION = DEFOC_NATT

- FA mode. Focused attenuated. The first lens is a quasi-plano parallel window, i.e. a lens with a very low converging power, in order to focus the image on the CCD. One face has an atenuation coating in order to decrease the transmission. The aperture is 30mm. This mode is used for imaging and navigation close to the extended comet nucleus.
ROSETTA:CAM_COVER_POSITION = FOC_ATT

- FNA mode. Focused not attenuated. The first lens is a quasi-plano parallel window with an aperture of 70mm. The image is focused on the CCD and there is no attenuation coating.
ROSETTA:CAM_COVER_POSITION = FOC_NATT.

For each acquired image the mission specific keyword ROSETTA:CAM_COVER_POSITION records the applicable cover position in the meta-information of the data product files (see Table 13). The effects of the reduced aperture and the attenuation coating combined result in a reduction of the transmission by a factor of $\sim$580 for the attenuated mode. For the defocused mode the point spread function is broader. For a point source located in the centre of a pixel approximately 50-55% of the signal are counted in the respective pixel, whereas this fraction ranges between 65 and 70% for the focused modes.
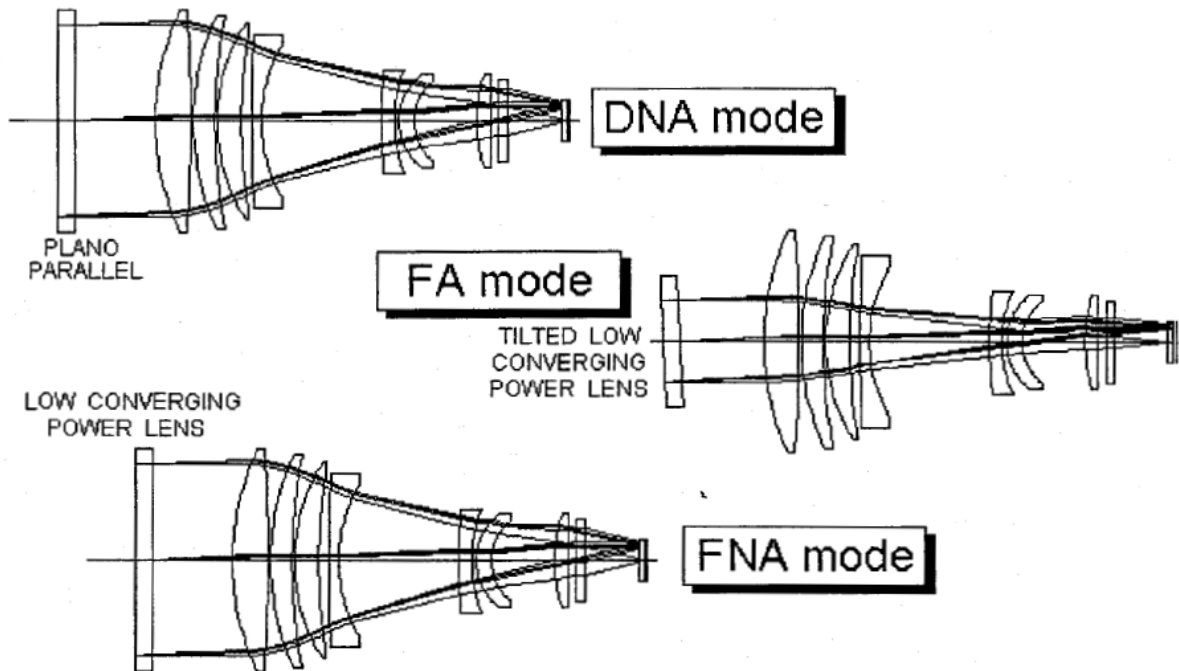
Figure 1: Optical system of the NavCam with exchangeable first element. The lenses are made of radiation resistant glasses with high transmission in the visible wavelength range (LAK9 G15 and SF6 G05 produced by Schott). [RD2]

The CCD detector is a front-illuminated frame transfer device with a broad spectral sensitivity in the visible range. Two different values of the gain can be selected when commanding the camera.

1. High Gain. Increases the grey signal level resolution when faint targets are imaged. In this case the A/D Converter saturates (at 12 bits) before saturation of the CCD is reached.
   ROSETTA:CAM_GAIN = HIGH

2. Low Gain. The A/D Converter saturates at the same time as the CCD and so the full dynamic range can be used.
   ROSETTA:CAM_GAIN = LOW

The chosen gain value is documented in the mission specific keyword ROSETTA:CAM_GAIN in the product files (see Table 13).

2.1.2   Camera Electronic Unit

The Camera Electronic Unit contains the digital electronics and interfaces for data transfer with the Avionics Interface Unit (AIU) and the Solid State Mass Memory (SSMM). Another major function of this module is to provide the programmable constant-current driver for both the

heater in the optical head and the stepper motor that actuates the attenuation cover mechanism of the NavCam.

2.1.3 Camera Baffle

The Camera Baffle provides protection against stray light produced by the Sun and reflected from planetary bodies and the satellite. This level of protection allows the tracking of faint objects. The baffle is mechanically supported by the S/C structure so as to avoid mechanical stress of the optical head. This is done owing to the required high pointing stability of the camera boresight in order to achieve the desired accuracy.

2.2 Operating Modes

The following series of operating modes are available in order to exploit the capabilities of the NavCam:

- Off Mode.

- Initialisation Mode.

- Stand-by Mode.

- Imaging Mode. In this mode the instrument operates as a standard camera in order to acquire images of star-fields or extended objects in the field of view such as the comet nucleus during the escort phase.
  INSTRUMENT_MODE_ID = "IMAGING"

- Point Target Tracking Mode. In this mode the NavCam can track simultaneously up to five point-like objects in the field of view.

- Asteroid (Extended Object) Tracking Mode. In this mode the NavCam can detect and track an extended object in the field of view. Optionally information on the position of this object can be fed into the autonomous attitude control system of the spacecraft. (This was done during the asteroid fly-bys.) In the Asteroid Tracking Mode images can also be acquired and downlinked in the same way as in the Imaging Mode.
  INSTRUMENT_MODE_ID = "ASTEROID TRACKING"

- Self Test Mode.

Image data can be generated and downlinked to ground in the Imaging and Asteroid (Extended Object) Tracking modes. In the archived data sets, the used mode is indicated by the INSTRUMENT_MODE_ID keyword of the label files as indicated above (see also Table 12).

3   Data Handling Process and Product Generation

The NavCam data are primarily used by the Flight Dynamics Team of the Rosetta Mission Operations Centre (RMOC) located at ESOC in Darmstadt, Germany. The images acquired with this camera are essential for determining the spacecraft position with respect to the comet nucleus and hence for safely navigating Rosetta. In addition, the images are also processed from the raw telemetry data at the Rosetta Science Ground Segment (SGS) based at ESAC near Madrid, Spain. The data are made available to the Rosetta instrument team community shortly after acquisition in order to support analysis and interpretation of their scientific data. Later, datasets of the product files are prepared for public release via the Planetary Science Archive (PSA).

3.1   Telemetry Data

For generating the product files the following telemetry data are processed:

- Science Data Report: TM APID 460 (CAM1) and 476 (CAM2), Type 20, Subtype 13. This set of telemetry data contains images as well as a number of meta data parameters. The latter are included in the label files of the generated data products.

- Housekeeping and Health-Check Report: TM APID 452 (CAM1) and 468 (CAM2), Type 3, Subtype 25. From the set of available housekeeping parameters only the CCD temperature and the optics temperature are extracted and included in the label files of the generated data products.

3.2   Data Product Levels

Table 5: Data Processing Levels.

PSA	CODMAC	Description
1a	1	Raw telemetry packet data that have been separated by instrument. This is the level which is distributed by the DDS (ESOC).
1b	2	Level 1a data that have been sorted by instrument data types and instrument modes. Data are in scientifically useful form, e.g. as images. These data are still uncalibrated.
2	3	Level 1b data with calibration and corrections applied to yield data in scientific units.
3	5	Higher level data products developed for specific scientific investigations.

Table 5 summarises the definition of data product levels according to both PSA and CODMAC (Committee On Data Management, Archiving, and Computation).

3.2.1 Uncalibrated Data

Uncalibrated data, i.e. products at CODMAC level 2, were released for the entire cruise phase including images from the Earth and Mars swing-bys as well as distant (unresolved) navigation images of the visited asteroids 2878 Steins and 21 Lutetia. Presently the images acquired after hibernation exit during the comet approach and escort phases are successively being archived and made available. The uncalibrated data products consist of image files with extensive meta-information. For each image pixel the original unaltered digital number values are given as read out from the CCD.

3.2.2 Geometrically Calibrated Data

Accurate geometric information is required for the operational objective of the NavCam and the respective image characteristics are therefore well established (see Section 4.2.4). However, it is not appropriate to generate geometrically calibrated data products by re-sampling the images. The correction shall better be taken into account for each specific application by directly using the existing data products.

3.2.3 Radiometrically Calibrated Data

Radiometrically calibrated data, i.e. products at CODMAC level 3, are currently not yet available but are foreseen to be provided. This requires removing artefacts caused by the optical system and the CCD detector from the raw images and converting the digital number counts into physical radiance units. It is currently not planned by the Rosetta SGS to generate higher level data products such as map projections on a shape model for the comet nucleus images.

4 Archive Conventions and Meta-Information

This chapter describes general rules and conventions for producing the datasets and also gives an overview of important meta-information included in the product files.

4.1 Format and Conventions

The directory tree must be compatible, in terms of directory organisation and naming and file organisation, with the PDS standards and such that:

- each logical archive volume shall contain <u>one</u> NavCam PDS data set;

- data sets will contain data from both NavCams;

- one data set shall be created for each separate mission phase;

- a different data set shall be created for each processing level;

- the top level directory of each logical archive volume shall match that of the NavCam data set ID; and,

- the volume set name shall be as that of the data set.

4.1.1 Data Set ID Formation

The data set ID formation shall be done according to the following rule:

DATA_SET_ID = <INST_HOST>-<TARGET_ID>-<INST>-<CODMAC_LEVEL>-
<MISSION_PHASE_ABBREVIATION>-<VERSION>

Each of the components are described, briefly, in Table 6, with a list of options for TARGET_ID and MISSION_PHASE being given in Tables 7 and 8 respectively. Examples include:

- RO-X-NAVCAM-2-PRL-COM-V1.0

- RO-C-NAVCAM-2-PRL-MTP004-V1.0

In some instances there are several TARGET_ID terms in the DATA_SET_ID naming formation. These terms are combined and included in a list, separated by hyphens, between the <INST_HOST> and <INST> terms in the data set name. Examples from the cruise phase include:

- RO-A-CAL-NAVCAM-2-AST2-V1.0

- RO-E-X-NAVCAM-2-CR1-V1.0

Table 6: Description of Components of the DATA_SET_ID.

Component	Examples	Description
INST_HOST	RO	Rosetta Orbiter
TARGET_ID	A, C, E, M	Asteroid, Comet, Earth, Mars
INST	NAVCAM	Navigation Camera
CODMAC_LEVEL	2, 3, 5	See Table 5
MISSION_PHASE_ ABBREVIATION	AST1, EAR3, CR4B, MARS	Asteroid 1 Flyby, Earth Swingby 3, Cruise 4-B, Mars Swingby, see Table 8
VERSION	Vx.y e.g. V1.0, V1.1, V2.0	x and y are numerical values indicating the version level and revision number

Table 7: List of TARGET_ID values for Rosetta.

Abbreviation	TARGET_TYPE	TARGET_NAME
A	ASTEROID	21 LUTETIA 2867 STEINS
C	COMET	C/LINEAR (2002 T7) 9P/TEMPEL 1 (1867 G1) 67P/CHURYUMOV-GERASIMENKO 1 (1969R1)
E	PLANET	EARTH
J	PLANET	JUPITER
M	PLANET	MARS
	SATELLITE	MOON
	STAR	ZETA CAS
CAL	CALIBRATION	CALIBRATION
X	N/A	CHECKOUT

Table 8: List of MISSION_PHASE_NAME and ABBREVIATION values.

Phase Name	Abbreviation	Start Time
GROUND	GRND	2000-01-01 00:00:00
LAUNCH	LEOP	2004-03-03 00:00:00
COMMISSIONING 1	CVP1	2004-03-05 00:00:00
CRUISE 1	CR1	2004-06-07 00:00:00
COMMISSIONING 2	CVP2	2004-09-06 00:00:00
EARTH SWING-BY 1	EAR1	2004-10-17 00:00:00
CRUISE 2	CR2	2005-04-05 00:00:00
MARS SWING-BY	MARS	2006-07-29 00:00:00
CRUISE 3	CR3	2007-05-29 00:00:00
EARTH SWING-BY 2	EAR2	2007-09-13 00:00:00
CRUISE 4-1	CR4A	2008-01-28 00:00:00
STEINS FLY-BY	AST1	2008-08-04 00:00:00
CRUISE 4-2	CR4B	2008-10-06 00:00:00
EARTH SWING-BY 3	EAR3	2009-09-14 00:00:00
CRUISE 5	CR5	2009-12-14 00:00:00
LUTETIA FLY-BY	AST2	2010-05-17 00:00:00
RENDEZVOUS MANOEUVRE 1	RVM1	2010-09-04 00:00:00
CRUISE 6	CR6	2011-07-14 00:00:00
PRELANDING COMMISSIONING	PRL-COM	2014-01-20 10:00:00
PRELANDING MTP003	PRL-MTP003	2014-05-07 12:48:00
PRELANDING MTP004	PRL-MTP004	2014-06-04 10:50:00
PRELANDING MTP005	PRL-MTP005	2014-07-02 08:35:00
PRELANDING MTP006	PRL-MTP006	2014-08-01 10:00:00
PRELANDING MTP007	PRL-MTP007	2014-09-02 10:00:00
PRELANDING MTP008	PRL-MTP008	2014-09-23 10:00:00
PRELANDING MTP009	PRL-MTP009	2014-10-24 10:00:00
COMET ESCORT 1 MTP010	ESC1-MTP010	2014-11-21 23:25:00
COMET ESCORT 1 MTP011	ESC1-MTP011	2014-12-19 23:25:00
COMET ESCORT 1 MTP012	ESC1-MTP012	2015-01-13 23:25:00
COMET ESCORT 1 MTP013	ESC1-MTP013	2015-02-10 23:25:00
COMET ESCORT 2 MTP014	ESC2-MTP014	2015-03-10 23:25:00
COMET ESCORT 2 MTP015	ESC2-MTP015	2015-04-08 11:25:00
COMET ESCORT 2 MTP016	ESC2-MTP016	2015-05-05 23:25:00
COMET ESCORT 2 MTP017	ESC2-MTP017	2015-06-02 23:25:00

4.1.2 File Naming Convention

Each image data product is generated in the form of a binary file (*.IMG) and a FITS-format file (*.FIT) with associated label files (*.LBL) of the same name that point to the image file. The label files contain meta-information about the camera operating parameters and geometric conditions. For every image a browse version file (*.JPG) with reduced resolution and an associated label file are created. The file naming convention for these files is as follows:

<MISSION>_<CAM#>_<YYYYMMDDThhmmss><F>.<EXT>

Table 9 summarises the definitions of each part:

Table 9: File naming parameters.

Variable	Possible Values	Description
MISSION	ROS	The Rosetta mission.
CAM#	CAM1, CAM2	Denotes which NavCam produced the data.
EXT	IMG, FIT, JPG, LBL	Denotes the file type in question.
F	F, or absent	Is present for the FIT format file and its label file.

The parameter <YYYYMMDDThhmmss> is the Coordinated Universal Time (UTC) without the fractional seconds (see Section 4.1.4) and provides the date and time at which the image was acquired on-board the spacecraft.

4.1.3 PDS Standards

Each complete volume produced will be compliant with both the PDS and PSA standards. In general each individual file is created using PDS Version 3 standards. The PDS format uses the ISO 9660 level 2 standard for the file names. Hence, no complete file name shall be longer than 31 characters and the "27.3" structure shall be obeyed, that is, a maximum of 27 characters before the "." for the file name and 3 characters after for the extension type.

4.1.4 Time Standards

Two time standards are used in the meta-information of the NavCam data product files:

- Coordinated Universal Time (UTC) is expressed in the format
  <YYYYMMDDThhmmss.fff>
  where YYYYMMDD provides the calendar date (year, month and day), T is a fixed separator and hhmmss.fff indicates the time in hours, minutes, seconds and fractions of a second. UTC is used in the following keywords for time stamping the data products:

  – PRODUCT_CREATION_TIME

– IMAGE_TIME

– START_TIME

– STOP_TIME

Here START_TIME = IMAGE_TIME - 0.5 ×EXPOSURE_DURATION and
STOP_TIME = IMAGE_TIME + 0.5×EXPOSURE_TIME.

- Spacecraft Clock Time is given in the format
  1/<time counter high value>.<time counter low value>
  where the high counter roughly corresponds to the number of seconds since initialisation,
  and the low value counts ticks of duration 1/65536 second. (Example: 1/123772074.26377).
  The following keywords contain spacecraft clock time:

  – SPACECRAFT_CLOCK_START_COUNT

  – SPACECRAFT_CLOCK_STOP_COUNT

4.2 Reference Frames and Geometry

4.2.1 Camera Reference Frames

For data processing and analysis purposes the NavCam reference frames are defined as follows:

- The +Z axis points along the camera boresight (optical axis).

- The +X axis is parallel to the apparent image columns. It is nominally co-aligned with
  the S/C +X axis.

- The +Y axis completes the right hand frame. It is nominally parallel to the apparent
  image lines and co-aligned with the S/C +Y axis.

- The origin of the frame is located at the camera focal point.

The actual alignment of the boresights with respect to the spacecraft reference frame as determined by in-flight calibration is given in the Rosetta SPICE frame-kernel [RD4].

4.2.2 Image Orientation

The images in the data product files are oriented such that the CCD columns (and therefore the X axis) appear in vertical direction and the lines (and therefore the Y axis) in horizontal direction. The binary files start with the first byte of the first line read out from the CCD. This first line corresponds to the bottom of the image in the orientation mentioned above. Accordingly, the relevant keywords in the image description section of the product label files are specified as SAMPLE_DISPLAY_DIRECTION = "RIGHT" and LINE_DISPLAY_DIRECTION = "UP".

The orientation of the X and Y axes is such that line and column number counts increase with increasing coordinate value. However, the optics of the instrument introduces an inversion of the image. This means that the signs of both coordinate values need to be reversed when transforming the position of an object in space into image coordinates. Or in other words, the image needs to be rotated by 180 degrees in order to match the orientation of the imaged scene.

4.2.3 Window Size and Position

The camera software allows the user to specify sub-frames in order to reduce the data volume for downlink. In the product label files the size of the images is indicated by the standard keywords LINES and LINE_SAMPLES of the image description section. The specific keywords ROSETTA:CAM_WINDOW_POS_ALONG_ROW
and
ROSETTA:CAM_WINDOW_POS_ALONG_COL,
respectively, indicate the central column and row numbers of the commanded sub-images (see Table13). For full images with 1024×1024 pixels the value of both of these keywords is set to 511, which corresponds to the centre of the CCD.

4.2.4 Geometric Calibration

The optical system of the camera is designed in such a way that geometric distortion over the whole field of view is small (~1% at the edge). Nevertheless for the purposes of precise navigation and astrometric registration these effects need to be taken into account. A procedure for computing the accurate view direction as a function of image pixel is described in Appendix H of the Data Delivery Interface Document [RD5]. It will also be included here in a later issue of this EAICD.

4.2.5 Geometric Information in Label Files

The label files include the following geometric variables:

- SC_SUN_POSITION_VECTOR
  The vector from the spacecraft to the Sun in equatorial J2000 inertial frame.

- SC_TARGET_POSITION_VECTOR
  The vector from the spacecraft to the centre of the comet nucleus in equatorial J2000 inertial frame.

- SC_TARGET_VELOCITY_VECTOR
  The spacecraft to comet nucleus velocity vector in in equatorial J2000 inertial frame.

- TARGET_CENTER_DISTANCE
  The distance between the spacecraft and the comet nucleus centre. (Note that also for checkout and stellar calibration images the comet nucleus distance is given here.)

- SUB_SPACECRAFT_LATITUDE and SUB_SPACECRAFT_LONGITUDE
  The latitude and longitude of the sub-spacecraft point derived from the Flight Dynamics body-fixed reference frame implicitly specified by the information provided in the comet attitude file CATT [RD5].

- RIGHT_ASCENSION and DECLINATION
  Right Ascension and Declination of the camera boresight direction in equatorial J2000 inertial frame.

- CELESTIAL_NORTH_CLOCK_ANGLE
  The direction of celestial north at the center of the image - measured from the 'upward' direction, clockwise to the direction toward celestial north.

- SOLAR_ELONGATION
  The angle between the line of sight of observation and the direction of the Sun.

All geometric values are calculated for the time t = IMAGE_TIME (and not START_TIME).

4.3 Data Quality

The keyword DATA_QUALITY_ID indicates whether the lines of an image were completely acquired (value 0) or the image is incomplete and lines are missing (value 1). The number of missing lines is given in the Rosetta mission specific keyword ROSETTA:CAM_MISSING_LINES (see Table 13).

The keyword ROSETTA:CAM_DATA_VALID with the possible values OK or NOT_OK reports the result of a periodic instrument health check which is included in the science telemetry data. This error flag is set, for example, if the instrument CCD temperature is not within the performance range of [-25°C,0°C]. This is the case for a large fraction of the images taken during the comet escort phase. However, the lower temperatures measured are still within the operating range and do not affect the image quality.

4.4 Observation Type

The keyword OBSERVATION_TYPE was used in the label files in order to provide information about the purpose of the images acquired. The following values are

- NAVIGATION IMAGE
  The image was commanded for navigation purposes by the Flight Dynamics team.

- CONTEXT IMAGE
  The image was requested by the instrument team community via the Science Ground Segment in order to provide context information for other scientific measurements.

- CALIBRATION

  The image was acquired for calibration purposes.

- CHECKOUT

  The image was acquired as an instrument checkout or test.

5 Dataset Content

This section contains information common to all data sets produced for the Rosetta NavCam.

5.1 Volume Set

The following conditions shall remain true for the NavCam data sets at all times:

- Each logical archive volume shall contain one NavCam data set.

- Necessary documentation for the logical archive volumes shall be provided by the Planetary Science Archive Data Handlers (PSA-DHs). Any other non-data file necessary for the logical archive volume will be provided by the PSA-DHs.

- It shall be possible to modify and implement the structure of the directory tree with new sub-directories, whenever needed. The creation and management of the directories shall be performed by the PSA-DHs.

The keywords mandatory for the VOLUME object of the Rosetta mission are presented in Table 10:

Table 10: Mandatory keywords and standard values for the VOLUME object.

Keyword	Required	Max. Length	Standard Value(s)
DATA_SET_ID	yes	40	see Section 4.1.1
DESCRIPTION	yes	N/A	"N/A"
MEDIUM_TYPE	yes	30	"ELECTRONIC"
PUBLICATION_DATE	yes	10	YYYY-MM-DD
VOLUME_FORMAT	yes	20	"ANSI"
VOLUME_ID	yes	12	"N/A"
VOLUME_NAME	yes	60	"N/A"
VOLUME_SERIES_NAME	yes	60	"N/A"
VOLUME_SET_NAME	yes	60	"N/A"
VOLUME_SET_ID	yes	40	"N/A"
VOLUME_VERSION_ID	yes	12	"N/A"
VOLUMES	yes	N/A	"UNK"

5.2 Data Set Naming

The data set naming for the Rosetta NavCam follows the following formation rule:

DATA_SET_NAME = <INSTRUMENT_HOST_NAME> <TARGET>(<OPTIONAL>)
<INST> <CODMAC_LEVEL> <MISSION_PHASE_ABBREVIATION> <VERSION>

where each of these parameters is defined in Table 11:

Table 11: Data set naming parameters.

Parameter	Value(s)
INSTRUMENT_HOST_NAME	ROSETTA-ORBITER
TARGET	see Table 7
INST	NAVCAM
CODMAC_LEVEL	see Table 5
MISSION_PHASE_ABBREVIATION	see Table 8
VERSION	e.g. V1.0, V2.4 etc.

Examples include:

- "ROSETTA-ORBITER CHECK NAVCAM 2 PRELANDING COMMISSIONING V1.0"

- "ROSETTA-ORBITER 67P NAVCAM 2 PRELANDING MTP004 V1.0"

5.3 Directories

Root Directory

The top-level structure of the ROOT directory of a data archive volume corresponds to chapter 19 of the PDS Standards Reference (summarised here):

- **AAREADME.TXT**: This file describes the complete volume. It provides an overview of what can be found in the volume including the organisational attributes and general instructions for use along with contact information.

- **ERRATA.TXT**: This file describes known errors or deficiencies in this archive volume set.

- **VOLDESC.CAT**: This file contains the VOLUME object, which gives a high-level description of the volume contents.

Sub-directories (except the DATA directory) include a file, **xxxxINFO.TXT**, that briefly describes the contents of that directory. In case that an important instrument characteristic cannot be described with an existing PDS keyword, the information will be supplied in a separate parameter file.

BROWSE Directory

This directory contains one or two sub-directories (CAM1 and/or CAM2) with a set of thumbnail images in *.JPG format (one corresponding to each *.IMG file in the DATA directory) and an associated *.LBL for each one. Other files that are included here are:

- **BROWINFO.TXT**: This file describes the contents of the directory.

- ***.LBL**: Detached label files for the browse products.

- ***.JPG**: Browse product images of reduced size in JPEG format. These thumbnail images were created from the raw binary data using the convert tool of the ImageMagick package (v6.8.9-6) and standard parameter settings (-contrast-stretch 2%x1%). The grey scale conversion from the raw data was not tuned to specific image contents and therefore in some cases the resulting image can be dominated by detector noise.

CATALOG Directory

This directory contains the catalogue object files for the complete volume. Files include:

- **CATINFO.TXT**: A description of the contents of the CATALOG directory.

- **MISSION.CAT**: Contains PDS mission catalogue information about the Rosetta Mission (provided by ESA).

- **INSTHOST.CAT**: Contains PDS instrument host catalogue information about the Rosetta S/C and the mounting relationship of the instruments within the S/C (provided by ESA).

- **NAVCAM_INST.CAT**: Contains PDS instrument catalogue information about the instrument (likely to be the same in all deliveries, unless updates are needed).

- **DATASET.CAT**: Contains PDS data set catalogue information about the data set currently being submitted.

- **REF.CAT**: PDS reference catalogue information about every journal article, book or other published reference mentioned in the above catalogue objects or their components.

- **SOFTWARE.CAT**: PDS software catalogue information about the software submitted in the data set.

- **TARGET.CAT**: Contains PDS target catalogue information about the observation targets, i.e. comet, asteroid, Earth or Mars (provided by ESA).

- **NAVCAM_PERS.CAT**: Contains PDS personnel catalogue information about the instrument team responsible for generating the data products.

It should be noted here that the last two files are optional and may not be found in the volume.

DATA Directory

This directory contains one or two sub-directories (CAM1 and/or CAM2) with the data products in the form of binary files (*.IMG) and FITS-format (*.FIT) files, each with a corresponding detached *.LBL (label) file.

DOCUMENT Directory

Included here is a copy of all the documentation relative to the data production and the volume as a whole, specific files are:

- **DOCINFO.TXT**: A description of the contents of the document directory.

- **RO-SGS-IF-0001.PDF**: The Experiment to Archive Interface Control Document (EAICD) (this document) for the NavCam instrument.

- **RO-SGS-IF-0001.TXT**: The ASCII version of the above file.

- **RO-SGS-IF-0001.LBL**: The label of the above files.

INDEX Directory

Contains index files which summarise all of the data products in the volume by mode, key instrument parameters or mission phase. Particular files include:

- **INDXINFO.TXT**: A description of the contents of the directory.

- **INDEX.LBL**: The detached label file for the file INDEX.TAB. The INDEX_TABLE specific object should be used to identify and describe the columns of the index table.

- **INDEX.TAB**: Includes the index of the volume in a tabular format.

- **BROWSE_INDEX.LBL**: The detached label for BROWSE_INDEX.TAB.

- **BROWSE_INDEX.TAB**: This file includes an index of the browse products in tabular format.

6 Product File Content

According to the PDS formatting standard, each data product must be accompanied by a descriptive *.LBL to describe the content. For the NavCam these label files shall be in the detached form and will appear as separate files (see Section 4.1.2). The image data are provided in binary as well as in a FITS format version. There are separate label files for each of them.

6.1 Content of *.LBL Files

The following shall remain true for all label files in all volumes for the Rosetta NavCam:

- The format follows PDS standards for formatting and character usage.

- The labels shall use only valid keywords that appear in both the PDS and PSA dictionaries.

- The character set used shall be that of ASCII 7 bit; specifically characters within and including the code range 001 to 127.

- The characters <CR> and <LF> shall be used and shall be present at the end of each line of every label file.

- Each label file shall not exceed a maximum 80-character limit; including the <CR> <LF> characters.

- Every line that is less than the permitted 80 character maximum shall be padded out to be of a length equal to 80.

Table 12 provides the list of keywords used in label files within the NavCam volumes. Table 13 contains Rosetta mission specific dictionary entries.

Table 12: Keywords used in the label files.

Keyword	Max. Length	Value(s)
PDS_VERSION_ID	6	PDS3
FILE_NAME	N/A	filename
RECORD_TYPE	20	FIXED_LENGTH
RECORD_BYTES	N/A	bytes per image line (for binary)
FILE_RECORDS	N/A	number of image lines (for binary)
INTERCHANGE FORMAT	6	BINARY or FITS
DATA_SET_ID	40	see Section 4.1.1
DATA_SET_NAME	60	see Section 5.2
PRODUCT_ID	40	filename without extension
PRODUCT_CREATION_TIME	24	YYYY-MM-DDThh:mm:ss.fff
PRODUCT_TYPE	30	EDR
PROCESSING_LEVEL_ID	N/A	"2"
IMAGE_TIME	24	YYYY-MM-DDThh:mm:ss.fff
START_TIME	24	YYYY-MM-DDThh:mm:ss.fff
STOP_TIME	24	YYYY-MM-DDThh:mm:ss.fff
SPACECRAFT_CLOCK_START _COUNT	30	see Section 4.1.4
SPACECRAFT_CLOCK_STOP _COUNT	30	see Section 4.1.4
MISSION_ID	N/A	ROSETTA
MISSION_NAME	60	"INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME	30	see Table 8
INSTRUMENT_HOST_ID	6	RO
INSTRUMENT_HOST_NAME	60	"ROSETTA-ORBITER"
TARGET_NAME	120	see Table 7
TARGET_TYPE	20	see Table 7
OBSERVATION_TYPE	30	see Section 4.4
PRODUCER_ID	20	"ESA-ESAC"
PRODUCER_FULL_NAME	60	"BERNHARD GEIGER"
PRODUCER_INSTITUTION _NAME	60	"EUROPEAN SPACE AGENCY-ESAC"
INSTRUMENT_ID	12	NAVCAM

INSTRUMENT_NAME	60	"NAVIGATION CAMERA"
INSTRUMENT_TYPE	30	"CCD CAMERA"
CHANNEL_ID	4	"CAM1" or "CAM2"
EXPOSURE_DURATION	N/A	sss.fff <s>
DATA_QUALITY_ID	3	0 or 1
DATA_QUALITY_DESC	N/A	"0: Image Complete, 1: Lines Missing."
INSTRUMENT_MODE_ID	20	"IMAGING" or "ASTEROID TRACKING"
INSTRUMENT_MODE_DESC	N/A	"Instrument OPERATING MODE (from TM data)"
INSTRUMENT_TEMPERATURE	N/A	CCD and optics temperature retrieved from HK TM
INSTRUMENT_TEMPERATURE _POINT	60	("CCD_T1", "OPTICS_T7")
COORDINATE_SYSTEM_ID	30	J2000
SC_SUN_POSITION_VECTOR	N/A	vector from spacecraft to Sun in J2000 coordinates
SC_TARGET_POSITION_VECTOR	N/A	vector from spacecraft to comet in J2000 coordinates
SC_TARGET_VELOCITY_VECTOR	N/A	relative comet to spacecraft velocity vector in J2000
TARGET_CENTER_DISTANCE	N/A	distance between spacecraft and comet
SUB_SPACECRAFT_LATITUDE	N/A	latitude of the sub-spacecraft point on the surface)
SUB_SPACECRAFT_LONGITUDE	N/A	longitude of the sub-spacecraft point on the surface)
RIGHT_ASCENSION	N/A	right ascension of boresight direction (J2000)
DECLINATION	N/A	declination of boresight direction (J2000)
CELESTIAL_NORTH_CLOCK_ANGLE	N/A	direction of celestial North on the image
SOLAR_ELONGATION	N/A	angle between boresight and Sun directions

| NOTE | N/A | list of SPICE kernels and description of coordinate systems used |

Table 13: Rosetta mission specific dictionary entries.

Keyword	Value(s)
ROSETTA:CAM_ABSOLUTE_FRAME_NUMBER	frame number since instrument start-up
ROSETTA:CAM_MODE_FRAME_NUMBER	frame number in current mode
ROSETTA:CAM_COVER_POSITION	FOC_NATT, FOC_ATT , or DEFOC_NATT, see p.5
ROSETTA:CAM_GAIN	LOW or HIGH, see p.6
ROSETTA:CAM_DATA_VALID	OK or NOT_OK, see p.16
ROSETTA:CAM_WINDOW_POS_ALONG_ROW	see p.15
ROSETTA:CAM_WINDOW_POS_ALONG_COL	see p.15
ROSETTA:CAM_MISSING_LINES	number of missing image lines, see p.16
ROSETTA:PIPELINE_VERSION_ID	version identifier of the data processing pipeline

The following is an example for the label file of one of the binary image files in a dataset:

```
PDS_VERSION_ID                 = PDS3


/***      FILE CHARACTERISTICS                                      ***/
FILE_NAME                      = "ROS_CAM1_20140702T081702.LBL"
RECORD_TYPE                    = FIXED_LENGTH
RECORD_BYTES                   = 2048
FILE_RECORDS                   = 1024
INTERCHANGE_FORMAT             = BINARY


/***      POINTERS TO DATA OBJECTS                                  ***/
^IMAGE                         = ("ROS_CAM1_20140702T081702.IMG",1)


/***      IDENTIFICATION DATA ELEMENTS                              ***/
DATA_SET_ID                    = "RO-C-NAVCAM-2-PRL-MTP004-V1.0"
DATA_SET_NAME                  = "ROSETTA-ORBITER 67P NAVCAM 2 PRELANDING MTP004 V1.0"
PRODUCT_ID                     = "ROS_CAM1_20140702T081702"
PRODUCT_CREATION_TIME          = 2015-02-05T14:32:14
PRODUCT_TYPE                   = EDR
PROCESSING_LEVEL_ID            = "2"
IMAGE_TIME                     = 2014-07-02T08:17:02.925
START_TIME                     = 2014-07-02T08:17:01.925
STOP_TIME                      = 2014-07-02T08:17:03.925
SPACECRAFT_CLOCK_START_COUNT   = "1/362909754.43201"
SPACECRAFT_CLOCK_STOP_COUNT    = "1/362909756.43201"
MISSION_ID                     = "ROSETTA"
MISSION_NAME                   = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME             = "PRELANDING MTP004"
INSTRUMENT_HOST_ID             = RO
INSTRUMENT_HOST_NAME           = "ROSETTA-ORBITER"
TARGET_NAME                    = "67P/CHURYUMOV-GERASIMENKO 1 (1969 R1)"
TARGET_TYPE                    = "COMET"
OBSERVATION_TYPE               = "NAVIGATION IMAGE"
PRODUCER_ID                    = "ESA-ESAC"
PRODUCER_FULL_NAME             = "BERNHARD GEIGER"
PRODUCER_INSTITUTION_NAME      = "EUROPEAN SPACE AGENCY-ESAC"


/***      INSTRUMENT RELATED PARAMETERS                             ***/
INSTRUMENT_ID                  = NAVCAM
INSTRUMENT_NAME                = "NAVIGATION CAMERA"
INSTRUMENT_TYPE                = "CCD CAMERA"
CHANNEL_ID                     = "CAM1"
EXPOSURE_DURATION              =  2.00 <s>
DATA_QUALITY_ID                = "0"
```

```
DATA_QUALITY_DESC             = "0: Image Complete, 1: Lines Missing."
INSTRUMENT_MODE_ID            = "IMAGING"
INSTRUMENT_MODE_DESC          = "Instrument OPERATING MODE (from TM data)"
INSTRUMENT_TEMPERATURE        = (  -23.30 <degC>,   -1.34 <degC> )
INSTRUMENT_TEMPERATURE_POINT  = (      "CCD_T1",    "OPTICS_T7" )


/***     ROSETTA MISSION SPECIFIC DATA DICTIONARY ENTRIES           ***/
ROSETTA:CAM_ABSOLUTE_FRAME_NUMBER  = 4728908
ROSETTA:CAM_MODE_FRAME_NUMBER      = 2206
ROSETTA:CAM_COVER_POSITION         = DEFOC_NATT
ROSETTA:CAM_GAIN                   = LOW
ROSETTA:CAM_DATA_VALID             = OK
ROSETTA:CAM_WINDOW_POS_ALONG_ROW   = 511
ROSETTA:CAM_WINDOW_POS_ALONG_COL   = 511
ROSETTA:CAM_MISSING_LINES          = 0
ROSETTA:PIPELINE_VERSION_ID        = "1.0.0"


/***     SPACECRAFT POSITION AND POINTING (J2000)                   ***/
COORDINATE_SYSTEM_ID          = J2000
SC_SUN_POSITION_VECTOR        = (  -161302945.509 <km>,
                                    472986487.909 <km>,
                                    268380802.673 <km>  )
SC_TARGET_POSITION_VECTOR     = (       -6905.906 <km>,
                                       -43607.351 <km>,
                                       -18458.304 <km>  )
SC_TARGET_VELOCITY_VECTOR     = (          33.437 <m/s>,
                                           92.847 <m/s>,
                                           28.347 <m/s> )
TARGET_CENTER_DISTANCE        =    47853.961 <km>
SUB_SPACECRAFT_LATITUDE       =    47.986283 <deg>
SUB_SPACECRAFT_LONGITUDE      =   -57.954603 <deg>
RIGHT_ASCENSION               =   261.091995 <deg>
DECLINATION                   =   -22.716025 <deg>
CELESTIAL_NORTH_CLOCK_ANGLE   =   107.902343 <deg>
SOLAR_ELONGATION              =   154.419027 <deg>
NOTE                          = "SPICE KERNELS USED:
                                 NAIF0011.TLS
                                 ROS_150126_STEP.TSC
                                 ROS_V24.TF
                                 RORB_DV_078_01_____00134.BSP
                                 RATT_DV_078_01_01____00134.BC
                                 CORB_DV_078_01_____00134.BSP
                                 CATT_DV_078_01_____00134.BC
                                 ROS_CHURYUMOV_V01.TF
                                 DE405.BSP
```

The values of the keywords SC_SUN_POSITION_VECTOR, SC_TARGET_POSITION_VECTOR,
SC_TARGET_VELOCITY_VECTOR, CELESTIAL_NORTH_CLOCK_ANGLE, RIGHT_ASCENSION, and
DECLINATION are related to the equatorial J2000 inertial frame.
The values of SUB_SPACECRAFT_LATITUDE and SUB_SPACECRAFT_LONGITUDE refer to
the Flight Dynamics body-fixed reference frame implicitly specified by the
information provided in the comet attitude file CATT.
All values are computed for the time t = IMAGE_TIME. Distances are given in
<km>, velocities in <m/s>, and angles in <deg>."

```
/***      IMAGE DESCRIPTION                                        ***/
OBJECT                      = IMAGE
   DERIVED_MAXIMUM          = 4095
   DERIVED_MINIMUM          = 177
   LINES                    = 1024
   LINE_SAMPLES             = 1024
   SAMPLE_TYPE              = LSB_UNSIGNED_INTEGER
   SAMPLE_BITS              = 16
   SOURCE_SAMPLE_BITS       = 12
   SAMPLE_DISPLAY_DIRECTION = "RIGHT"
   LINE_DISPLAY_DIRECTION   = "UP"
END_OBJECT                  = IMAGE


END
```

6.2 Content of *.FIT File Header

The labels for the FITS-format file versions contain identical meta-information and only minor changes owing to the differences of the image file format. The *.FIT image files also contain meta-data in their header so that the files can be used independently of the PDS dataset structure. Astrometric registration information is included in the form of WCS keywords. However, the geometric distortion (see Section 4.2.4) towards the edge of the field of view is not modelled here. Table 14 shows the correspondence between PDS and FITS keywords used in the label file and the header, respectively.

Table 14: Correspondence between PDS and FITS keywords.

PDS Keyword	FITS Keyword
DATA_SET_ID	DATASET
PRODUCT_ID	OBS_ID
PRODUCT_CREATION_TIME	DATE
PROCESSING_LEVEL_ID	CODMAC
IMAGE_TIME	IMG-TIME
START_TIME	DATE-OBS
STOP_TIME	TIME-END
SPACECRAFT_CLOCK_START_COUNT	SCLKSTAR
SPACECRAFT_CLOCK_STOP_COUNT	SCLKSTOP
MISSION_PHASE_NAME	MISSPHAS
INSTRUMENT_HOST_NAME	part of INSTRUME
TARGET_NAME	OBJECT
OBSERVATION_TYPE	OBS-TYPE
PRODUCER_FULL_NAME	AUTHOR
PRODUCER_INSTITUTION_NAME	ORIGIN
INSTRUMENT_NAME	part of INSTRUME
CHANNEL_ID	part of INSTRUME
EXPOSURE_DURATION	EXPTIME
INSTRUMENT_MODE_ID	OBS_MODE
INSTRUMENT_TEMPERATURE	CCDTEMP, OPTTEMP
ROSETTA:CAM_ABSOLUTE_FRAME_NUMBER	ABSFRAME
ROSETTA:CAM_MODE_FRAME_NUMBER	MODFRAME
ROSETTA:CAM_COVER_POSITION	FILTER
ROSETTA:CAM_GAIN	GAIN
ROSETTA:CAM_DATA_VALID	DATA_VAL

ROSETTA:CAM_WINDOW_POS_ALONG_ROW	used in CRPIX1
ROSETTA:CAM_WINDOW_POS_ALONG_COL	used in CRPIX2
ROSETTA:CAM_MISSING_LINES	LINEMISS
ROSETTA:PIPELINE_VERSION_ID	CONFIGUR
COORDINATE_SYSTEM_ID	EQUINOX
SC_SUN_POSITION_VECTOR	SC-SUN_X,SC-SUN_Y,SC-SUN_Z
SC_TARGET_POSITION_VECTOR	SC-COM_X,SC-COM_Y,SC-COM_Z
SC_TARGET_VELOCITY_VECTOR	SC-COMVX,SC-COMVY,SC-COMVZ
TARGET_CENTER_DISTANCE	TARGDIST
SUB_SPACECRAFT_LATITUDE	SSP_LAT
SUB_SPACECRAFT_LONGITUDE	SSP_LON
RIGHT_ASCENSION	CRVAL1
DECLINATION	CRVAL2
CELESTIAL_NORTH_CLOCK_ANGLE	implicit in CDx_y
SOLAR_ELONGATION	SUNANGLE
NOTE	SP_KERNx
DERIVED_MAXIMUM	DATAMAX
DERIVED_MINIMUM	DATAMIN
LINES	NAXIS2
LINE_SAMPLES	NAXIS1
SAMPLE_BITS	BITPIX
SOURCE_SAMPLE_BITS	determines SATURATE

7 Product File Content - Cruise Phase

The datasets created and archived for the Rosetta cruise phase did not contain FITS-versions of the product files. In addition, the label files only contained a reduced set of keywords. For reference Tables 15 and 16 are maintained which summarise the available information as applicable in earlier versions of this document.

Table 15: Keywords used in the label files (Cruise Phase).

Keyword	Max. Length	Value(s)
PDS_VERSION_ID	6	PDS3
FILE_NAME	N/A	filename
RECORD_TYPE	20	FIXED_LENGTH
RECORD_BYTES	N/A	bytes per image line
FILE_RECORDS	N/A	number of image lines
INTERCHANGE FORMAT	6	BINARY
DATA_SET_ID	40	see Section 4.1.1
DATA_SET_NAME	60	see Section 5.2
PRODUCT_ID	40	filename without extension
PRODUCT_CREATION_TIME	24	YYYY-MM-DDThh:mm:ss.fff
PRODUCT_TYPE	30	EDR
PROCESSING_LEVEL_ID	N/A	"2"
IMAGE_TIME	24	YYYY-MM-DDThh:mm:ss.fff
START_TIME	24	YYYY-MM-DDThh:mm:ss.fff
STOP_TIME	24	YYYY-MM-DDThh:mm:ss.fff
SPACECRAFT_CLOCK_START _COUNT	30	see Section 4.1.4
SPACECRAFT_CLOCK_STOP _COUNT	30	see Section 4.1.4
MISSION_ID	N/A	ROSETTA
MISSION_NAME	60	"INTERNATIONAL ROSETTA MISSION"
INSTRUMENT_HOST_NAME	60	"ROSETTA-ORBITER"
INSTRUMENT_HOST_ID	6	RO
TARGET_NAME	120	see Table 7
TARGET_TYPE	20	see Table 7
TARGET_DESC	N/A	text description of target

MISSION_PHASE_NAME	30	see Table 8
PRODUCER_INSTITUTION _NAME	60	"EUROPEAN SPACE AGENCY-ESAC"
PRODUCER_ID	20	"ESA-ESAC"
PRODUCER_FULL_NAME	60	"BERNHARD GEIGER"
NOTE	N/A	list of SPICE kernels used
INSTRUMENT_ID	12	NAVCAM
INSTRUMENT_NAME	60	"NAVIGATION CAMERA"
INSTRUMENT_TYPE	30	"CCD CAMERA"
CHANNEL_ID	4	"CAM1" or "CAM2"
EXPOSURE_DURATION	N/A	sss.fff <s>
DATA_QUALITY_ID	3	0 or 1
DATA_QUALITY_DESC	N/A	"0: Image Complete, 1: Lines Missing."
INSTRUMENT_MODE_ID	20	"IMAGING" or "ASTEROID TRACKING"
INSTRUMENT_MODE_DESC	N/A	"Value of OPERATING MODE param. in TM data"
INSTRUMENT_TEMPERATURE	N/A	CCD and optics temperature retrieved from HK TM
INSTRUMENT_TEMPERATURE _POINT	60	("CCD_T1", "OPTICS_T7")
SUN_POSITION_VECTOR	N/A	spacecraft position in ECLIPJ2000 coordinates
RIGHT_ASCENSION	N/A	right ascension of boresight direction (J2000)
DECLINATION	N/A	declination of boresight direction (J2000)

Table 16: Rosetta mission specific dictionary entries (Cruise Phase).

Keyword	Value(s)
ROSETTA:CAM_ABSOLUTE_FRAME_NUMBER	frame number since instrument start-up
ROSETTA:CAM_MODE_FRAME_NUMBER	frame number in current mode
ROSETTA:CAM_COVER_POSITION	FOC_NATT, FOC_ATT , or DEFOC_NATT, see p.5
ROSETTA:CAM_GAIN	LOW or HIGH, see p.6
ROSETTA:CAM_DATA_VALID	OK or NOT_OK, see p.16
ROSETTA:CAM_WINDOW_POS_ALONG_ROW	see p.15
ROSETTA:CAM_WINDOW_POS_ALONG_COL	see p.15
ROSETTA:CAM_MISSING_LINES	number of missing image lines, see p.16

The following is an example for the label file of one of the images in a cruise phase dataset:

```
PDS_VERSION_ID                   = PDS3


/***      FILE CHARACTERISTICS                                        ***/
FILE_NAME                        = "ROS_CAM1_20040926T073116.LBL"
RECORD_TYPE                      = FIXED_LENGTH
RECORD_BYTES                     = 2048
FILE_RECORDS                     = 1024
INTERCHANGE_FORMAT               = BINARY


/***      POINTERS TO DATA OBJECTS                                    ***/
^IMAGE                           = ("ROS_CAM1_20040926T073116.IMG",1)


/***      IDENTIFICATION DATA ELEMENTS                                ***/
DATA_SET_ID                      = "RO-CAL-NAVCAM-2-CVP2-V1.0"
DATA_SET_NAME                    = "ROSETTA-ORBITER-CAL-NAVCAM-2-CVP2-V1.0"
PRODUCT_ID                       = "ROS_CAM1_20040926T073116"
PRODUCT_CREATION_TIME            = 2013-05-20T12:40:46
PRODUCT_TYPE                     = EDR
PROCESSING_LEVEL_ID              = "2"
IMAGE_TIME                       = 2004-09-26T07:31:16.423
START_TIME                       = 2004-09-26T07:31:16.418
STOP_TIME                        = 2004-09-26T07:31:16.427
SPACECRAFT_CLOCK_START_COUNT     = "1/54804659.34474"
SPACECRAFT_CLOCK_STOP_COUNT      = "1/54804659.35129"
MISSION_ID                       = "ROSETTA"
MISSION_NAME                     = "INTERNATIONAL ROSETTA MISSION"
INSTRUMENT_HOST_NAME             = "ROSETTA-ORBITER"
INSTRUMENT_HOST_ID               = RO
TARGET_NAME                      = "CALIBRATION"
TARGET_TYPE                      = "CALIBRATION"
TARGET_DESC                      = "ALPHA GRU"
MISSION_PHASE_NAME               = "COMMISSIONING 2"
PRODUCER_INSTITUTION_NAME        = "EUROPEAN SPACE AGENCY-ESAC"
PRODUCER_ID                      = "ESA-ESAC"
PRODUCER_FULL_NAME               = "BERNHARD GEIGER"
NOTE                             = "SPICE KERNELS USED:
                                   NAIF0009.TLS
                                   ROS_100903_STEP.TSC
                                   ORHR_____00109.BSP
                                   ROS_V16.TF
                                   ATNR_P040302093352_00109.BC"


/***      INSTRUMENT RELATED PARAMETERS                               ***/
```

```
INSTRUMENT_ID                  = NAVCAM
INSTRUMENT_NAME                = "NAVIGATION CAMERA"
INSTRUMENT_TYPE                = "CCD CAMERA"
CHANNEL_ID                     = "CAM1"
EXPOSURE_DURATION              =  0.01 <s>
DATA_QUALITY_ID                = "0"
DATA_QUALITY_DESC              = "0: Image Complete, 1: Lines Missing."
INSTRUMENT_MODE_ID             = IMAGING
INSTRUMENT_MODE_DESC           = "Value of OPERATING MODE param. in TM data"
INSTRUMENT_TEMPERATURE         = (  -12.57 <degC>,    8.66 <degC> )
INSTRUMENT_TEMPERATURE_POINT   = (      "CCD_T1",    "OPTICS_T7" )


/***     ROSETTA MISSION SPECIFIC DATA DICTIONARY ENTRIES          ***/
ROSETTA:CAM_ABSOLUTE_FRAME_NUMBER   = 9420
ROSETTA:CAM_MODE_FRAME_NUMBER       = 8935
ROSETTA:CAM_COVER_POSITION          = FOC_NATT
ROSETTA:CAM_GAIN                    = LOW
ROSETTA:CAM_DATA_VALID              = OK
ROSETTA:CAM_WINDOW_POS_ALONG_ROW    = 511
ROSETTA:CAM_WINDOW_POS_ALONG_COL    = 511
ROSETTA:CAM_MISSING_LINES           = 0


/***    SPACECRAFT POSITION (ECLIPJ2000) AND INSTRUMENT POINTING (J2000)   ***/
SC_SUN_POSITION_VECTOR         = (   138352393.70 <km>,
                                      80450030.08 <km>,
                                       -833729.07 <km>  )
RIGHT_ASCENSION                =  22.117464 <h>
DECLINATION                    = -46.593084 <deg>


/***      IMAGE DESCRIPTION                                              ***/
OBJECT                         = IMAGE
  DERIVED_MAXIMUM              = 968
  DERIVED_MINIMUM              = 174
  LINES                       = 1024
  LINE_SAMPLES                = 1024
  SAMPLE_TYPE                 = LSB_UNSIGNED_INTEGER
  SAMPLE_BITS                 = 16
  SOURCE_SAMPLE_BITS          = 12
  SAMPLE_DISPLAY_DIRECTION     = "RIGHT"
  LINE_DISPLAY_DIRECTION       = "UP"
END_OBJECT                     = IMAGE


END
```