



**ROSETTA RPC-LAP  
to Planetary Science Archive  
Interface Control Document**

RO-IRFU-LAP-EAICD

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## Document History

Version	Date	Sections Changed	Notes
1.0	2003-08-19	New document	Initial draft
1.1	2005-08-04	All sections updated.	PDS Software and archive has matured
1.2	2005-11-24	Most sections updated.	Corrections in response to PSA team.
1.3	2006-01-27		Never issued.
1.4	2006-01-31	Minor corrections.	Corrections in response to PSA team.
1.5	2006-10-31	Numerous updates related to PDS review, mostly RID corrections.	PDS archive review.
1.6	2012-07-03	Almost all.	Complete update and revision of all text, taking RIDs from the Lutetia review into account. Geometry info added.
1.7	2012-10-10	Minor corrections.	Corrections in response to comments on previous version. Non-correspondence of file names in EDITED and CALIBRATED described. More details on bias values and their calibration.
1.8	2012-01-30	2.2, 2.3, 2.5, 3.1.4	Editorial and typo correction in response to comments by PSA. All tables renumbered. Improved description of file names in Section 3.1.4.
1.9	2013-08-13		Editorial changes in response to PSA review.
1.9.1	2015-02-23	1.9, 2.5, 4.3.1.5, 4.3.2.2-5	Updated contact names, addresses, a calibration detail (cubic fit), and renamed keywords, other minor edits.

1.9.2	2015-07-07	2.3, Table 2.3-1	Corrected the macro table graphics. Emphasized that the macro table is an example.
1.9.3	2015-09-01	2.4, 2.7, 4.1.4, 4.2.3, 5.3.2.1.5, Tables 3-1, 3-2	New specifications for geometry files.
1.10	2016-08-31	Most sections modified, in particular Sections 2 and 3 (new).	Changes in response to PSA & PDS review. Updates for new CALIBRATED data set format. Updated specification of geometry files, extended descriptions of in-flight data products and HK, added RPCLAP_CALIB_MEAS_EXCEPT.
1.10.1	2016-10-12	Section 3.5, 4.1.4, Table 8	Changes in response to PSA & PDS review. Added missing information on RPCLAP_CALIB_MEAS_EXCEPT. Product ID text as proper table. Mission-specific keywords cleaned up.
1.10.2	2016-12-14	Section 2.5, 3.1, 3.2.1	Described two additional offset calibrations and a related caveat. Moved tables within Section 3.1 to end of section.
1.10.3	2017-03-02	Section 2.5, 3.1	Calibration typo fixed (offsets between ADC16 and ADC20 data). Fixed broken internal references.

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# 1 Introduction

## 1.1 Purpose and Scope

This document provides users of PSA/PDS data products from the Langmuir Probe instrument of the Rosetta Plasma Consortium (RPC-LAP) with a description of the data products and how they were generated. It is also the official interface between the LAP team and the archiving authority.

## 1.2 Archiving Authorities

### 1.2.1 Planetary Data System (PDS)

The Planetary Data System Standard is used as archiving standard by

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

### 1.2.2 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 LAP instrument on the Rosetta mission from the s/c until the insertion into the PSA for ESA. It includes information on how data were processed, formatted, labeled and uniquely identified. The document discusses general naming schemes for data volumes, data sets, data and label files as well as fundamental features of the instrument. Standards used to generate the product are explained. The design of the data set structure and the data product is given, with some examples.

#### **1.4 Intended Readership**

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

#### **1.5 Applicable Documents**

- AD1 Planetary Data System Standards Reference, February 27, 2009, Version 3.8, JPL D-7669, Part 2
- AD2 ROSETTA Archive Generation, Validation and Transfer Plan, September 01, 2005, RO-EST-PL-5011
- AD3 RO-RPC-UM, Rosetta Plasma Consortium: User's Manual
- AD4 RO-IGEP-TR-0016, RPC Archiving Guidelines

## 1.6 Reference Documents

- RD1 RPC-LAP: The Rosetta Langmuir probe instrument. A. I. Eriksson, R. Boström, R. Gill, L. Åhlén, S.-E. Jansson, J.-E. Wahlsund, M. André, A. Mälkki, J. A. Holtet, B. Lybekk, A. Pedersen, L. G. Blomberg and the LAP team. *Space Science Reviews*, 128, 729-744, 2007. DOI:10.1007/s11214-006-9003-3.
- RD2 RPC-LAP: The Langmuir probe instrument of the Rosetta plasma consortium. A. I. Eriksson, R. Gill, J.-E. Wahlund, M. André, A. Mälkki, B. Lybekk, A. Pedersen, J. A. Holtet, L. G. Blomberg and N. J. T. Edberg. In *Rosetta: ESA's Mission to the Origin of the Solar System*, editors R. Schulz, C. Alexander, H. Bönhardt and K.-H. Glassmeier. Springer, 2009.
- RD3 RPC: The Rosetta Plasma Consortium. C. Carr, E. Cupido, C. G. Y. Lee, A. Balogh, T. Beek, J. L. Burch, C. N. Dunford, A. I. Eriksson, R. Gill, K. H. Glassmeier, R. Goldstein, D. Lagoutte, R. Lundin, K. Lundin, B. Lybekk, J. L. Michau, G. Musmann, H. Nilsson, C. Pollock, I. Richter and J. G. Trotignon. *Space Science Reviews*, 128, 629-647, 2007. DOI: 10.1007/s11214-006-9136-4.
- RD4 RPC: The Rosetta Plasma Consortium. C. Carr, E. Cupido, C.G.Y. Lee, A. Balogh, T. Beek, J. L. Burch, C. N. Dunford, A. I. Eriksson, R. Gill, K.-H. Glassmeier, R. Goldstein, D. Lagoutte, R. Lundin, K. Lundin, B. Lybekk, J. L. Michau, G. Musmann, H. Nilsson, C. Pollock, I. Richter and J. G. Trotignon. In *Rosetta: ESA's Mission to the Origin of the Solar System*, editors R. Schulz, C. Alexander, H. Bönhardt and K.-H. Glassmeier. Springer, 2009.
- RD5 RPC-MIP: The Mutual Impedance Probe of the Rosetta Plasma Consortium. J.-G. Trotignon, J.-L. Michau, D. Lagoutte, M. Chabassière, G. Chalumeau, F. Colin, P. M. E. Décréau, J. Geiswiler, P. Gille, R. Grard, T. Hachemi, M. Hamelin, A. Eriksson, H. Laakso, J.P. Lebreton, C. Mazelle, O. Randriamboarison, W. Schmidt, A. Smit, U. Telljohann and P. Zamora. *Space Science Reviews*, 128, 713-728, 2007. DOI: 10.1007/s11214-006-9005-1.
- RD6 N.J.T. Edberg, A.I. Eriksson, U. Auster, S. Barabash, A. Böswetter, C.M. Carr, S.W.H. Cowley, E. Cupido, M. Fränz, K.-H. Glassmeier, R. Goldstein, M. Lester, R. Lundin, R. Modolo, H. Nilsson, I. Richter, M. Samara, J.G. Trotignon, 'Simultaneous measurements of the Martian plasma environment by Rosetta and Mars Express', *Planet. Space Sci.*, 57, 1085-1096, 2008. doi:10.1016/j.pss.2008.10.016



## 1.7 Relationships to Other Interfaces

This document is the top level document for LAP PDS-compliant PSA archiving.

## 1.8 Acronyms and Abbreviations

ADC	Analog to Digital Converter
ADC16	The 16-bit ADC. One on each probe.
ADC20	The 20-bit ADC. One on each probe.
AQP	Acquisition Period
bps	Bits per second
BM	Burst rate TM mode
DDS	Data Disposition System
DVAL	Data Validation Tool (software)
E	Current bias (E-field measurement) mode of a LAP probe
ESA	European Space Agency
ESOC	European Space Operations Centre
GSE	Ground Support Equipment
HGA	High-Gain Antenna
ICA	Ion Composition Analyzer (other RPC instrument)
HK	Housekeeping
IC	Imperial College, London
IES	Ion and Electron Sensor (other RPC instrument)
IRFU	Swedish Institute of Space Physics, Uppsala (Institutet för rymdfysik, Uppsala)
LAP	Langmuir Probe instrument
LDL	Long Debye Length (mode of the MIP instrument)
LM	Low rate TM mode
MAG	Fluxgate magnetometer (other RPC instrument)
MIP	Mutual Impedance Probe (other RPC instrument)
N	Voltage bias (deNsity measurement), mode of a LAP probe
NM	Normal rate TM mode
P1	LAP probe 1
P2	LAP probe 2

PDS	Planetary Data System
PIU	Plasma Interface Unit (RPC central unit)
PSA	Planetary Science Archive
PVV	PSA Volume Verifier
RPC	Rosetta Plasma Consortium
s/c	Spacecraft
SDL	Short Debye Length (normal mode of MIP instrument)
SSP	Surface Science Package (the Philae lander)
TM	Telemetry
Vps	Probe-to-spacecraft voltage

## 1.9 Contact Names and Addresses

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

### 2.1 RPC and LAP

RPC, the Rosetta Plasma Consortium, is a set of instruments on the Rosetta orbiter for investigation of plasma properties and electromagnetic fields. RPC is described in RD3 and RD4. The Langmuir probe instrument is one of these instruments, and is therefore referred to as RPC-LAP or, as we will do in the rest of this document, just LAP.

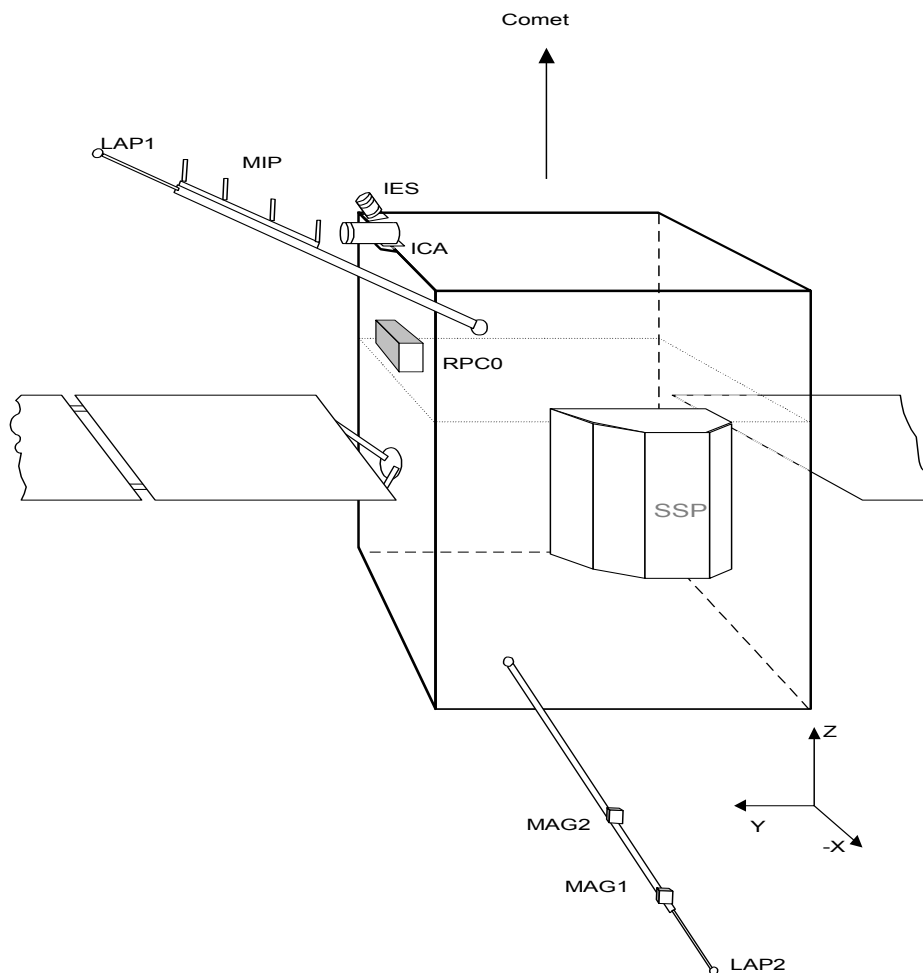
### 2.2 The LAP instrument

This section gives a very brief introduction to the LAP instrument, and is recommended reading for any user of any LAP data product. For more complete information, we refer to the two published instrument descriptions, RD1 and RD2.

LAP uses two spherical sensors of 2.5 cm radius, mounted on 15 cm “stubs,” which, in turn, are attached to the ends of the spacecraft booms by a “foot” (see picture on document cover page). Probe 1 is mounted on the “upper” spacecraft boom, also carrying the RPC-MIP antenna (RD5). This boom, which is 2.24 m in length from hinge to probe, is protruding from the spacecraft at an angle of 45° to the nominal comet direction (the z axis in Figure 1; see also Table 1). By pointing to the comet, probe 1 will get access to a plasma flow from the comet as undisturbed as possible by any spacecraft sheath or wakes, without interfering with the field of view of other instruments. Probe 2 is mounted on the “lower” boom, 1.62 m in length, which also carries the RPC-MAG sensors. The distance between the probes is 5.00 m, and the probe separation in the nominal comet direction (z axis) is 4.55 m.

	x (m)	y (m)	z (m)
Probe 1	-1.19	2.43	3.88
Hinge 1	-1.19	0.85	2.30
Probe 2	-2.48	0.78	-0.65
Hinge 2	-1.19	0.65	0.30

**Table 1. Positions in the spacecraft coordinate system, indicated in Figure 1, for the LAP probes and for the hinges at the boom roots. [After AD3]**



**Figure 1.** The mounting of the LAP sensors, LAP1 and LAP2, and other RPC units on the Rosetta spacecraft. RPC-0 is the common electronics box, also housing the LAP electronics boards. The direction of the s/c coordinate axes are indicated: the origin of the s/c coordinate system is at the center of the  $-Z$  surface (bottom surface in this sketch). SSP is the Philae lander, not part of RPC. [From RD3]

For the two LAP probes, we will here use the designations P1 and P2, though other schemes can be found in the literature and documentation: LAP1 and LAP2 (as in Figure 1), RPC-3.1 and RPC-3.2, probe 1 and probe 1, S1 and S2, and so forth.

The probes can be independently operated in any of two *bias modes*:

- A *bias voltage* can be applied to the probe, in which case the basic measured quantity is the current flowing from the probe to the plasma. In general, we denote this current  $I_p$ , with  $I_1$  and  $I_2$  referring to the specific currents from the two probes. This bias

mode is denoted N (for deNsity mode) or (in the EDITED archive data file names) D.

- A *bias current* (including zero, corresponding to floating probes) can be applied to the probe. In this case, the basic quantity measured is the voltage of the probe with respect to the spacecraft, denoted  $V_{ps}$  in general, with V1 and V2 denoting the specific signal from each probe. This bias mode is denoted E (for Electric field mode).

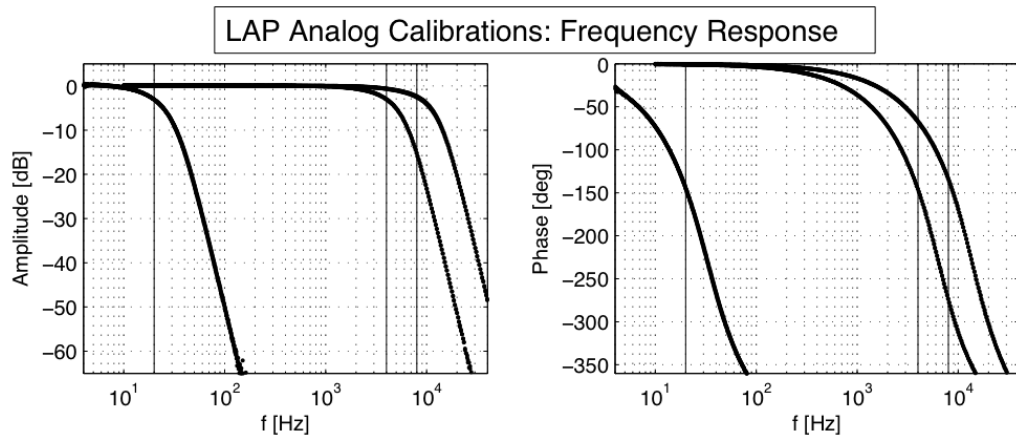
Probe P2 may also be used by the RPC-MIP instrument for use in its LDL (Long Debye-Length) mode [RD5]. In this case, LAP can only take data from P1. To indicate how the probes are operated, it is convenient to group the P1 and P2 bias modes together. For example, "NE" then indicates that P1 is in voltage bias mode (N) and P2 in current bias mode (E), while "E-" indicates that P1 is in current bias mode (E) and P2 is not used by LAP because it is being handed over to MIP for LDL operations.

In general, voltage bias is most useful in dense plasmas for determining the prime LAP science parameters of plasma density, electron temperature, plasma flow speed, and the density fluctuation spectrum, while the bias current is applied to get measurements of spacecraft potential and electric (wave) fields. In tenuous plasmas, the density is better obtained from the spacecraft potential. The limit between "dense" and "tenuous" is not absolute but set by the currents flowing to an object at zero potential with respect to the surrounding plasma: "dense" means that the random thermal electron current dominates, "tenuous" that the photoemission current dominates. Hence, the dense-tenuous density limit depends on the photoemission current, which is proportional to the solar UV flux. The limit density therefore follows a  $1/r^2$  relation with distance from the sun, and also varies with temporal solar UV intensity variations. In general, the limit varies between at a few hundred  $\text{cm}^{-3}$  at Earth orbit to a few tens  $\text{cm}^{-3}$  in the outer part of the Rosetta operational range of solar distances.

The bias applied on a probe can either be set to a constant value or, in the case of bias voltage, "swept", i.e. varied in steps over some range of voltage. LAP also has the possibility to apply a square-wave voltage of up to a few kHz to either probe and observe the resulting signal on the other probe.

Each probe has its own electronics, and can thus be operated independently of the other probe, regarding biasing as well as sampling. To each probe is attached two analog-to-digital converters (ADCs): one 20-bit ADC (ADC20), operating at 57.8 samples/s and denoted L or LF (for low frequency sampling), and one 16-bit ADC (ADC16), operating at 18750 samples/s and denoted H or HF (for high frequency sampling). Data are low-pass filtered by one of three different filters before sampling, cutting (3 dB damping point) at 20 Hz for L sampling and at either 4 kHz or 8 kHz for H sampling. The filter characteristics are shown

in Figure 2, and are also available in the files containing the string FRQ in the CALIB directory, see Section 4.4.3.2.



**Figure 2. The frequency response of the LAP instrument, showing the roll-off of the three anti-aliasing filters, as obtained during laboratory tests of the flight hardware. Data for P1 and P2 are plotted on top of each other: the probes are identical to the limit of this plot resolution.**

A variety of different measurements can be produced by this arrangement, producing different data types. The basic data types are listed below: however, it should be noted that the LAP flight s/w is very flexible, and functions can be defined for construction of other data types not listed here.

- *Fix-bias time series.* With the probes at constant bias (current or voltage), the time series, at some (almost) constant sampling frequency, from both or any of the probes, or derived time series like their sum or their average, can be transmitted.
- *Bias sweeps.* The bias voltage can be varied during a brief interval, known as a sweep. While the samples acquired still constitutes a time series, the basic assumption is that the plasma does not vary during the short sweep, and the sweep is treated as a set of instantaneous and simultaneous samples acquired at different bias. A sweep consists of at least one sequence of monotonously increasing or decreasing bias voltages, possibly followed by another sequence of monotonously decreasing or increasing (i.e. opposite direction) of bias voltages.

Data can be transmitted to the PIU and further to the spacecraft systems at three different data rates or telemetry modes:

- *Low TM mode (LM):* 1.6 bps. Not used for regular science operations.
- *Normal TM mode (NM):* 62.5 bps. Most common mode for science operations.

- *Burst TM mode (BM)*: 2253 bps. Used for shorter intervals when RPC TM allocation so allows.

## 2.3 LAP Operational Modes - Macros

This section describes the LAP operational mode concept. A general knowledge of these is necessary for at least users of LAP EDITED and CALIBRATED data sets, and could be of interest also to users of future DERIVED data sets.

As described above, and in more detail in RD1 and RD2, the LAP probes can be used in different bias and sampling modes. Such settings are combined in instrument macros, which are command sequences stored in the LAP flash memory (RD1, RD2).

The basic time unit for LAP operations is the spacecraft data acquisition period (AQP) of 32 s. A macro specifies the LAP operations over an integer number of AQPs, with indefinite repetition. When the instrument is commanded to run a certain macro, it thus repeats the sequence of operations specified in the macro until commanded to stop or to change macro. A macro can therefore be said to define an operational mode of LAP.

A macro can contain any LAP command. In practice, macro instructions include the following:

- Bias settings for each probe
- Sweep setup
- Number of samples to acquire from each of the ADCs (beginning at the start of the AQP)
- Onboard data reduction: digital filtering, downsampling, and subtraction or addition of two signals.
- Possible idle wait for a number of AQPs (to keep telemetry within bounds)
- Telemetry mode (LM, NM or BM)

Each macro is identified by a macro ID, which is stored in the data so that the instrument setup is always well known. A macro ID is fundamentally a sequence of three hexadecimal digits, e.g. 0x506, although digits outside the range 0-9 have rarely been used.

The document DOCUMENTS/RO-IRFU-LAPMAC-*yymmdd*.PDF contains a human-friendly summary of the types of measurements made by the various science macros used in the current mission phase. As new macros can be uploaded, the macros actually in use may be different for

each phase of the mission. Table 2 shows an example of such a summary.

We define, for practical reasons, we define the term “macro block” as the uninterrupted period of time when a given macro runs. In addition and for practical reasons, we also always break macro blocks at midnight, i.e. if the same macro runs continuously over midnight (once), it will still count as two separate macro blocks. A macro block is therefore a natural period of time for analyzing science data products.

### 2.3.1 *Example macro explained*

To understand the macro table, Table 2, we take as an example macro 0x506, which can be run at Normal telemetry rate. From the table, we can see that when this macro is running, both LAP probes are in bias voltage mode (NN), with a constant bias of +10 V when not sweeping. We can also see that the data sampled by the instrument in this mode are:

- Both probe currents I1 and I2 are available continuously at a time resolution of about 2.2 s (0.45 samples/s). These signals are conveniently denoted as I1L and I2L, the L signifying that the low frequency ADCs (ADC16) are used. Had the probes been in current bias mode, the signals had been voltages denoted V1L and V2L. This continuous sampling is not exactly continuous: the sampling is always reset at the beginning of each AQP, and there may also be one or a few samples missing at the end of an AQP. Despite this, it covers almost all the entire AQP, and is available in every AQP, and hence is at least quasi-continuous. These data are produced by the two 20-bit ADCs at 57.8 samples/s, and are then downsampled by a factor of 128. This downsampling is always by some power of two, so for a macro where the table says continuous data at 0.9 samples/s, the exact number is  $57.8/64$  samples/s.
- Every 5<sup>th</sup> AQP (every 160 s = 5 \* 32 s/AQP), 96 samples are taken simultaneously on both probes at full time resolution by the two ADC16 (18.750 kHz). These signals are denoted I1H and I2H, with H signifying high frequency, and referred to as HF snapshots. In macros where the probes are in current bias mode, the HF signals are voltage samples denoted by V1H and V2H. In this particular macro, they cover 5.12 ms ( $96/18750$  s), and can thus be used to study wave activity between 0.2 and 8 kHz (where the low pass filter sets in, see Figure 2). In some macros (e.g. 0x700), digitally computed differences between the probes rather than individual signals are stored.
- Both probes bias voltages are swept between -12 and +12 V every 5<sup>th</sup> AQP (every 160 s, not the same AQPs as in which the HF snapshots are taken), in steps of 0.5 V. Sweeps are only available in bias voltage mode.



In the LAP EDITED data sets, one file is saved for each record. This means that for this macro, there is for every AQP two data files containing I1L and I2L. For every 5<sup>th</sup> AQP, there are two additional data files containing I1H and I2H. Also every 5<sup>th</sup> AQP, there are also two files containing I1S and I2S data. The number of files produced per AQP can thus differ. In CALIBRATED data sets, data are combined to longer time series which are more convenient to work with.

## LAP Macro Table

Date: 120828

Macro ID	0x104	0x212	0x503	0x504	0x505	0x506	0x600	0x604	0x700	0x701	0x702	0x703	0x704	0x705	0x706	0x803	0x804	0x857	
Notes	Calibration	Use 0x506			Use 0x506		Use 0x506		Use 0x503	Use 0x503	Use 0x503			Use 0x504			Use 0x807		
Purpose	Calibration	Swp, HF	Vs, HF	Vs, HF	N, HF, swp	N, HF, swps	Swp, HF	N, HF, swps	Vs, HF	Vs, HF	Vs, HF	LDL, Vs, HF	LDL, Vs, HF	Vs, HF	Vs, HF	LDL, N, HF	LDL, N, HF	N, HF, amp	
TM rate	NM	NM	NM	BM	NM	NM	NM	BM	NM	NM	NM	NM	BM	NM	BM	NM	BM	BM	
Bias mode	NN	NN	EE	EE	NN	NN	NN	NN	EE	EE	EE	E-	E-	EE	EE	N-	N-	N-	
Fix bias P1	0 V	0 V	-8 pA	-8 pA	+10 V	+10 V	+20 V	+20 V	-17 pA	-17 pA	+1 pA	-30 nA	-30 nA	-29 nA	+10 V	+10 V	+10 V	+10 V	
Fix bias P2	0 V	0 V	+3 pA	+3 pA	+10 V	+10 V	+20 V	+20 V	-17 pA	+1 pA	-17 pA	MIP	MIP	+3 pA	-3 pA	MIP	MIP	MIP	
Continuous data (ADC20)			V1, V2	V1, V2	11, 12	11, 12		11, 12	V1, V2	V1, V2	V1, V2	V1	V1	V1, V2	V1, V2	11	11	11	
Sampled data			0.9	57.8	0.45	0.45		28.9	0.9	0.9	0.9	1.8	57.8	0.9	57.8	57.8	57.8	57.8	
fsamp [Hz]																			
Wave snapshots (ADC16)																			
Sampled data		11, 12	V1	V1, V2	11, 12	11, 12	11, 12	11, 12	V1-V2	V1-V2	V1-V2	V1	V1	V1-V2	V1-V2	11	11	11	
fsamp [Hz]		18750	18750	18750	18750	18750	18750	18750	18750	18750	18750	18750	18750	18750	18750	18750	18750	18750	
Samples		256	272	432	96	96	256	1840	160	160	160	160	2419	272	2624	160	2416	4080	
Cadency [AOPs]		8	5	1	5	5	8	3	3	3	3	3	1	5	3	3	1	2	
Cadency [s]		256	160	32	160	160	256	96	96	96	96	96	32	160	96	96	32	64	
Sweeps (ADC16)																			
Probes	Open	P1, P2			P1, P2	P1, P2	P1, P2	P1, P2											P1
Cadency [AOPs]	8	8			5	5	8	3											2
Cadency [s]	256	256			160	160	256	96											64
Range [V]	[-30, +30]	[-30, +15]			[-18, +18]	[-12, +12]	[-30, +20]	[-30, +20]											[-30, +30]
Step [V]	0.25	1			0.75	0.5	0.25?	0.25											0.25
First upload			PC8	PC8	PC12	PC12	PC12	PC12	PC4	PC4	PC4	PC8	PC8	PC6	PC6	PC10	PC10	PC12	

Field colour indicates use:  
 Green: preferred non-LDL science macros  
 Orange: preferred LDL science macros  
 Yellow: maintenance, diagnostics, etc  
 Grey: superseded science macros

Text colour indicates telemetry mode:  
 Black: Normal Mode  
 Blue: Burst Mode

**Table 2. Example LAP science macros.** LAP science macros uploaded June 2010. Text color indicates normal mode (NM, black) or burst mode (BM, blue) data rate. Background color indicates operational status: Pale green and orange are useful science macros without or with LDL, yellow calibration macros, and grey older science macros. The file DOCUMENTS/RO-IRFU-LAPMAC-yymmdd.PDF contains the table relevant for the current mission phase.

## 2.4 LAP Archive Data

This section describes the general structure of the LAP archive. It should be of interest to any user of this archive.

In conformance to PDS standards, LAP data are archived at three levels: EDITED, CALIBRATED and DERIVED. For LAP, these correspond to decommutated uncalibrated raw data in TM units (EDITED), data corrected for instrumental offsets and converted to engineering units (V and A; CALIBRATED), and final physical output parameters in physical units (V, cm<sup>-3</sup>, eV etc.; DERIVED), respectively.

In more detail:

- EDITED data:
  - Edited science data – the science data stream converted to human and PDS readable format, but still in telemetry units and with no calibrations or corrections applied. One science packet of data from the s/c is converted to one or more files of data in the edited data set, each packet containing the data from one specific measurement. Data files from onboard calibrations are included. The edited science data files are supplied mainly for long term archiving and reference purposes, and are not intended or suitable for regular scientific use.
  - HK data – the HK data stream converted to human and PDS readable format, one file for each LAP HK packet. These data are supplied for long term archiving and reference purposes only, and are not intended or suitable for regular scientific use. The edited HK data files are archived together with the edited science data files.
  - Geometry data – one file per day containing position and attitude information at 32 s intervals throughout the day. The geometry files are archived with the edited science data files.
- CALIBRATED data:
  - Calibrated science data -- the science data stream converted to engineering units (volt and ampere), calibrated and corrected for known offsets and errors. Every type of data is separately collected into a longer time series spanning a macro block (a continuous run of a given macro but still splitting at midnight). Data from pure calibration macros (in particular macro 0x104) are not included since they cannot be used to calibrate themselves. The CALIBRATED data as such are of high quality, but there is no attempt for correction of e.g. attitude-dependent spacecraft-plasma interaction

- effects (wakes, photoemission, etc.), and scientific interpretation of the data requires great caution.
- Sweep descriptions – Information on step biases and time between steps valid for all sweeps on a given probe within a given macro block.
  - Block files – One table per day listing the macro blocks: macro number and their respective time coverages.
  - Geometry data files – one file per day containing position and attitude information at 32 s intervals throughout the day. The geometry files are archived with the calibrated science data files.
- DERIVED data – science data converted to the basic measurement units of volts and amperes, and further to Vps, plasma density, temperature, flow speed, electric field, or any other parameters that can be derived. One file for each derived parameter results from each uninterrupted period of operation of a certain macro, though files are split as to not cross day boundaries. **No DERIVED data sets are yet available.**

## 2.5 Calibration process

This section is included for reference and should only be of relevant for users interested in how to derive CALIBRATED data from EDITED data.

The measured EDITED data (current or voltage) are based on the direct output of the analog-to-digital converters (ADCs), and spans the range -32,768 to 32,769=32,767+2 (16-bit ADC), -32,768 to 32,767 (20-bit ADC data truncated to 16 bits) and -524,288 to 524,287 (20-bit ADC data), with 0 representing zero volt measured by the ADC. The 16-bit ADCs have a small fault around zero volt in the analogue-to-digital conversion and therefore we add two TM units to non-negative edited data set values to compensate for this. Hence the odd upper limit.

Saturation, i.e. the analogue input to the ADCs being outside of the permitted range, is represented by the minimum digital value, both in the case of positive and negative saturation.

The probe current, both in the form of the bias current in E mode or the measured current in N mode, is by standard convention taken to be positive when flowing from the probe to the plasma. However, to follow the actual settings of the digital-to-analog converters, the bias current values have the opposite sign in the EDITED archive, so that -128 corresponds to a nominal bias current of +44 nA (with conventional sign choice) in the CALIBRATED archive, and +127 to -44 nA. Bias voltages

range from -128 to 127 in EDITED, with the same sign as in CALIBRATED. Exact calibration factors are found in the calibration files (see below).

The data in the CALIBRATED data sets have been calibrated using the contents of the CALIB directory and files mentioned below are contained in that directory (see Section 4.4.3.2).

- **Bias voltages and bias currents** are not routinely measured onboard. Their digital values are synthetically generated from knowledge of the commanded bias, after which they are converted to physical units (volts and amperes) using the calibration tables contained in the files RPCLAP030101\_CALIB\_VBIAS.TAB and RPCLAP030101\_CALIB\_IBIAS.TAB, determined on ground. While there is no routine measurement of the biases onboard, it is possible to measure the current resulting from a given voltage bias applied over a 5.1 MOhm resistor (e.g. via macro 0x105) for occasional verification of the instrument integrity and consistency.
- **Measured voltages (i.e. E-field mode)** are converted to volts from TM units by application of the calibration factors ROSETTA:LAP\_VOLTAGE\_CAL\_16B (for data from the ADC16) and ROSETTA:LAP\_VOLTAGE\_CAL\_20B (for data from the ADC20) based on pre-flight ground tests. These are available in the RPCLAPyyymmdd\_CALIB\_MEAS.LBL files. 20-bit ADC data which have been truncated to 16 bits onboard the spacecraft (this is indicated in the label file; see keyword ROSETTA:LAP\_P1P2\_ADC20\_STATUS, Section 5.3.1.5) are additionally divided by another factor 16 to compensate for this (which means that the effective calibration factors for truncated 20-bit ADC data become very similar to the calibration factors for the 16-bit ADCs).
- **Measured currents (i.e. density mode)** are converted to amperes from TM units in a two-stage process:
  - These measurements are sensitive to inevitable bias-dependent offsets due to small leakage currents in the instrument. The offsets are determined regularly by running macro 0x104 (Table 2; using ADC16 with 4 kHz filters), in which the probes are physically disconnected from the electronics by opening a relay. The then measured bias-dependent voltages originate from the instrument electronics themselves. The offsets (in TM units) are fitted to a third-degree polynomial function and are stored in the RPCLAPyyymmdd\_CALIB\_MEAS.TAB files, which values are then subtracted from the data. A cubic fit is used rather than tabulated values, to reduce the possible influence of noise during offset determination. The following algorithm is used to determine which RPCLAPyyymmdd\_CALIB\_MEAS product to use for a given data sample: (1) Take the beginning of the AQP to which the sample belongs. Then (2) determine when is the middle of that UTC day (noon, 12:00). Finally, (3) determine which calibration took place

closest to that point in time, and use that. This ensures that a change of calibration always occurs at approximately midnight, never within an AQP (e.g. within a sweep), and never in the middle of a CALIBRATED or DERIVED data product.

- After offset removal, we apply the relevant calibration factor of ROSETTA:LAP\_CURRENT\_CAL\_16B\_G1, ROSETTA:LAP\_CURRENT\_CAL\_20B\_G1, ROSETTA:LAP\_CURRENT\_CAL\_16B\_G0\_05, or ROSETTA:LAP\_CURRENT\_CAL\_20B\_G0\_05, all measured on ground and stored in the RPCLAPyymmdd\_CALIB\_MEAS.LBL files. The ADC (16 or 20-bit) and gain (1 or 0.05) determines which factor is used. The comment on calibration factor change due to truncation of data stated above for voltage data (bias mode E) applies here as well. Analogous to measured voltages, measured 20-bit ADC current data which are truncated from 20 to 16 bits are additionally divided by another factor 16 to compensate.

In addition to the above, there are known offsets between different types of data, which applies to both measured voltages and measured currents:

- **Offsets between ADC16 data and ADC20 data** (i.e. for both density mode and E-field mode). To compensate for this, we add the following values to all ADC20 data:

Probe 1: -77.9601

Probe 2: -84.8991

Probe 1-Probe 2: (diff. measurements):  $-77.9601 + 84.8991 = 6.9390$

The above values are expressed in ADC16 TM units and one should thus multiply with the relevant ADC16 (not ADC20) calibration factors to convert to physical units (Ampere, Volt), including for ADC20 data. The values were obtained in a one-time in-flight calibration on 2015-05-28.

- **Offsets between 4 kHz and 8 kHz filter data** (i.e. only ADC16 data, both density mode and E-field mode). There are offsets between 4 kHz filter data and 8 kHz filter data, but what we believe to be the correct calibration has only been partially implemented due to software issues, and what is the correct calibration might not be fully understood yet.

- **The incomplete calibration used in the data sets:** We add the following values to our final 8 kHz-filtered measured **currents**:

Probe 1: 0.427 nA

Probe 2: 7.736 nA

Probe 1-Probe 2 (difference measurements): 0 nA

Nothing is currently added to 8 kHz-filtered measured **voltages**.

- **The presumed correct calibration which is not yet used:** At this point in time we believe that the correct calibration should add the following to all 8 kHz-filter data (both measured currents and measured voltages):

Probe 1: 1.4

Probe 2: 25.35

Probe 1-Probe 2 (diff. measurements):  $1.4 - 25.35 = -23.95$

The above values are expressed in ADC16 TM units and one should thus multiply with the relevant ADC16 calibration factors to produce the values in physical units (Ampere, Volt).

The consequence of this incomplete calibration is that we believe the following of our ADC16 8 kHz-filtered data: (1) measured **currents** in high-gain are correctly calibrated, (2) measured **currents** in low-gain are calibrated using an offset that is one 20<sup>th</sup> of the correct value, and (3) measured **voltages** are not calibrated using any offset, even if they should. Note that the majority of ADC16 data is density mode (measured current) in high-gain and is thus not affected. This will be fixed in later versions of the data sets.

The CALIB directory also includes files with the instrument frequency response measured on ground (transfer functions; See Section 4.4.3.2). These are not used at present, but are included for reference as vital instrument information.

## 2.6 Data Quality Flag

The EDITED and CALIBRATED data sets just present the output of the instrument, and are as such of high quality. There is therefore no attempt to assign a detailed quality assessment of these data. The LBL files contain a placeholder quality indicator DATA\_QUALITY\_ID always set to 1. Further use of this flag is expected only for the DERIVED data set.

## 3 Overview of Data Products

This section describes the organization of the LAP data products. The descriptions of science data products (Section 3.1), caveats (Section 3.2), documentation (Section 3.7) should be of interest to any user of the archived LAP data. **The regular user should only be interested in the CALIBRATED-level data sets**, and eventually in the

DERIVED-level data sets. Note that there is as of yet no DERIVED-level data set.

The regular user should also be aware of the **important caveats relating science data which can be found in Section 3.2.**

### 3.1 Science Data Products

To understand and classify the types of LAP science data available one must consider that every LAP science data product is based on data acquired using a certain combination of instrument options (settings). For a single data product, many of these options can be set independently of each other, but not necessarily in all combinations, and not all combinations are useful.

The list below summarizes the most important options which can be combined to produce different types of science data products. Each item lists mutually exclusive options, where exactly one option under every item is always used for a single data product. "Data" here refers to any one edited or calibrated science data product. Multiple such data products can cover the same time interval.

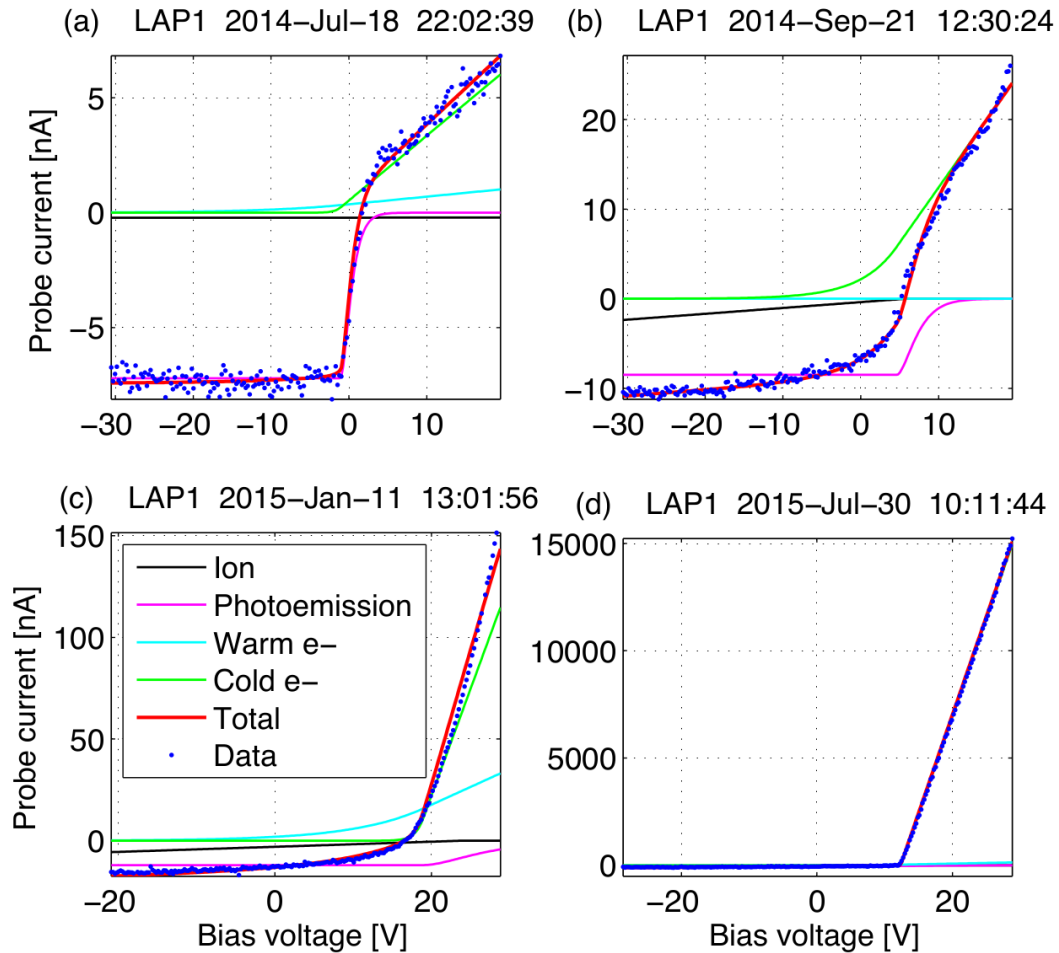
- Data is always acquired from either
  - P1,
  - P2, or
  - "P3" = The (onboard) calculated value of P1 minus P2 (difference measurement).
- Data is always acquired in either
  - density mode (bias voltage; measures current), or
  - E field mode (bias current; measures voltage)
- Data is always acquired in either of two bias modes:
  - sweep bias (with measurements via ADC16), i.e. bias rapidly sweeping over voltages (never currents) within a short period of time. This is only applicable to density mode.
  - fix bias, which is always acquired in any of the two forms below:
    - LF, i.e. low frequency samplings (and using ADC20 for measurements) which for the most of the time are quasi-continuous, or
    - HF, i.e. short high-frequency snapshots (and using ADC16 for measurements)



For technical reasons, it may however also be important to know that

- Data is always acquired through either of the two different ADCs connected to each probe listed below:
  - ADC20 (20-bit), with a physical low-pass filter with a cutoff at 20 Hz.
  - ADC16 (16-bit), with a physical low-pass filter with a cutoff at either of the two options below:
    - 4 kHz, or
    - 8 kHz

All of these settings can be determined from the flags in the data product ID as well as the file name (except the ADC16 4 kHz/8 kHz filter setting in CALIBRATED), see Section 4.1.4. (Note: LF/HF can be determined indirectly from the EDITED filenames via ADC+fix bias.) The remaining, and more technical and obscure settings, can be determined from mission-specific PDS keywords found in the data product label files, see Section 5.3.1.5.



**Figure 3. Examples of LAP probe sweep characteristics from various mission phases, fitted to orbital-motion-limited (OML) current models.** Distances in AU are heliocentric, in km are cometocentric. Data are blue dots, fitted currents given by colors as in the box in panel (c). Panels: (a) Solar wind prior to arrival at comet (3.7 AU, 7,000 km). (b) Warm electrons at early activity (3.33 AU, 35 km). (c) Cold electrons mix in as activity increases (2.57 AU, 28 km). (d) Dense cold plasma near perihelion (1.25 AU, 180 km).

The exact science data products which are actually available within a macro block depends on the LAP macro (see Section 2.3). The macro which produced a particular data product can be derived from the value of the PDS keyword `INSTRUMENT_MODE_ID` in the data product label files, see Section 5.3.1.5. This however only necessary for EDITED, since CALIBRATED data products contain the macro ID in the filename. The file `DOCUMENTS/RO-IRFU-LAPMAC-yymmdd.PDF` contains a human reader-friendly table over what the science macros relevant for the current mission phase do.

In the EDITED archives, each file includes data covering up to 32 seconds of time (one AQP). Therefore, a large number of files may need to be opened for studies of longer time intervals of EDITED data.

For EDITED and CALIBRATED data, the LAP data sets contain the data products in Table 3 and Table 4, all of them stored in table (.TAB) files and described in label (.LBL) files. Note that probe, data type etc. is specified in the data file names and product IDs and that they are explained further in Section 4.1.4.

<b>EDITED Science Data Products</b>			
<b>Data type</b>	<b>Columns</b>		<b>Product ID</b>
	<b>Number of columns</b>	<b>Column data</b>	
(1) Time series (fix bias; LF/HF), or (2) sweep	1	UTC time	RPCLAPYYMMDD_AAAa_bcd1fgS (probe 1)
	1	OBT time	
	1	Current; bias or measured	RPCLAPYYMMDD_AAAa_bcd2fgS (probe 2)
	1	Voltage; bias or measured	
Difference measurements, E-field	1	UTC time	RPCLAPYYMMDD_AAAa_bEd3fgS
	1	OBT time	
	2	Current bias, P1 and P2	
	1	Measured voltage difference, P1 minus P2	
Difference measurements, Density mode	1	UTC time	RPCLAPYYMMDD_AAAa_bDd3fgS
	1	OBT time	
	1	Measured current difference, P1 minus P2	
	2	Voltage bias, P1 and P2	

**Table 3.** LAP data products in the EDITED data sets. The complete file naming and product ID convention as well as the meaning of italicized letter can be found in Section 4.1.4.

<b>CALIBRATED Science Data Products</b>			
<b>Data type</b>	<b>Columns</b>		<b>Product ID</b>
	<b>Number of columns</b>	<b>Column data</b>	
Time series (fix bias; LF/HF)	1	UTC time	LAP_YYMMDD_hhmmss_iii_jek ("e" = probe = 1 or 2)
	1	OBT time	
	1	Current; bias or measured	
	1	Voltage; bias or measured	
	1	Quality	
Time series, difference measurements, E-field (fix bias, HF)	1	UTC time	LAP_YYMMDD_hhmmss_iii_V3H
	1	OBT time	
	2	Current bias, P1 and P2	
	1	Measured voltage difference, P1 minus P2	
	1	Quality	
Time series, difference measurements, Density mode (fix bias, HF)	1	UTC time	LAP_YYMMDD_hhmmss_iii_I3H
	1	OBT time	
	1	Measured current difference, P1 minus P2	
	2	Voltage bias, P1 and P2	
	1	Quality	
Sweep data	1	Start UTC time	LAP_YYMMDD_hhmmss_iii_leS ("e" = probe = 1 or 2)
	1	Stop UTC time	
	1	Start OBT time	
	1	Stop OBT time	
	1	Quality	
	N (varies)	Measured currents for every step of a sweep	

Sweep descriptions (step biases and time between steps)	1	Step time (seconds since beginning of sweep)	LAP_YYMMDD_hhmmss_iii_BeS ( <i>"e"</i> = probe = 1 or 2)
	1	Step bias	
Block list	1	UTC start time	LAP_YYMMDD_000000_BLK LIST. <i>ext</i>
	1	UTC stop time	
	1	Macro ID	

**Table 4.** LAP data products in CALIBRATED data sets. The complete file naming and product ID convention as well as the meaning of italicized letters can be found in Section 4.1.4. Combinations I3L (difference measurement, density mode, LF) and V3L (difference measurement, E-field mode, LF) are conceivable but have never been used and are therefore not represented.

Sweep descriptions (calibrated) are needed to understand the biases and times of measurement for sweeps. They are given once per probe and macro block since they are identical for all sweeps for a given macro. Block lists contain the macros that have been run during a given day and when. Calibrated science data products (but not block lists) cover an entire macro block.

### 3.1.1 Data Quality Flag

The CALIBRATED data set has a quality factor ranging from 000 (best quality) to 999 (worst), based on assessment of the rotation of the spacecraft during measurement, possible perturbation effects from other instruments (LDL), low sample size, etc. Each detrimental quality effect is an integer additive component to the total quality factor of each data point. The quality factor flag is constructed so that each value can only be reached by a unique combination of factors detrimental to the quality of the data. The full list can be seen below:

<b>Quality factor event description</b>	<b>Additive effect</b>
Known bug (not used) during measurement	+200
Langmuir probe sweep during measurement	+100
LDL disturbance (MIP in LDL mode)	+40
Bias change near measurement	+20
SAA rotation of more than 0.01° during sweep	+10
Low sample size / zero padding	+2

Poor model fit in analysis (DERIVED)	+1
--------------------------------------	----

## 3.2 Caveats When Interpreting Science Data

This section lists technical details which are important for regular LAP data users to be aware of:

### 3.2.1 General

- After hibernation, LAP probe 2 (P2) showed strong signs of contamination. Clear signs of this include that the current to P2 is always lower than to P1 at similar bias voltage, and sweeps in both directions (available from macro 0x204) showing hysteresis effects. To avoid problems, **only use probe 2 current measurements obtained at fixed negative bias potential**, as available in e.g. macros 0x525, 0x624, and 0x805. **The PI discourages any other use of P2 data in this archive except for diagnostics.**
- Saturated data means that the pre-ADC signal is outside the range of the ADC. It can thus not be properly represented digitally and should not be used. **Saturation on either the positive or negative side is represented as the maximum *negative* value** in the data (i.e. -32,768 in EDITED 16-bit or truncated 20-bit data; -524,288 for non-truncated 20-bit data; or e.g. -40 V in CALIBRATED E mode data). See Section 2.5.
- **8 kHz-filtered (i.e. ADC16) data that is measured voltage, or low-gain measured current, is calibrated using incorrect calibration offsets** (too small or none). Note that the majority of 8 kHz-filtered data is density mode (measured current) in high-gain and hence is correctly calibrated. See Section 2.5.
- **Fix bias values included in the files are not measured but reconstructed from the instrument command log**, calibrations, and the known characteristics of the instrument modes (macros). When the fix bias value on any of the probes is changed by telecommand, the bias step will be seen in the data files at the time of telecommand execution. **The bias setting actually takes effect 2-3 seconds later**, as can be seen in data. In addition, in certain plasmas the time constant for charging a probe when in current bias mode (E mode) can be so long that there is a further delay before the bias has settled. Users should thus take care when interpreting data close to a bias setting. This only applies to measurements at fixed bias; the bias voltage in sweeps has correct timing. See also Section 2.5.

- **There is obvious interference from the MIP instrument when using its LDL mode** (e.g. when running macros 0x801 or 0x807). This affects mainly the data sampled at kHz frequencies at fixed bias and in sweeps. Outliers are removed from sweep data to compensate for this. For the fix bias snapshots at 18.75 kHz sampling frequency, this mostly affects the first samples in a record, but can in longer records sometimes be seen also further into the record. In sweeps from e.g. macro 0x807, MIP interference can be detected as spikes where one or two samples deviate from their neighbors. Some MIP interference may occur also outside of LDL operations, as might of course interference from other sources. LDL mode (on/off) is determined by the macro running and is therefore the same during every run of any particular macro. Therefore the LDL mode can be detected through the macro number and the macro table in the DOCUMENT directory. The column MIPLAP (not LDLMODE) in HK (Table 6) can also be used to detect the LDL mode. Each step in a calibrated sweep only contains one average of multiple measured currents made on that sweep step (bias voltage). Outliers are removed before the average is made, and only if all measurements on a sweep step are outliers will the average for that step be removed.
- The **transfer functions are currently not used for calibration**, but are provided for reference.

### 3.2.2 *Fix-bias measurements*

- For probe-to-spacecraft potential (Vps) time series: this is a commonly used proxy for the plasma density in tenuous plasmas. However, because the perturbations from the solar panels, the wake formed behind the s/c and solar panels in the solar wind, and the photoelectron cloud around the spacecraft are all sensitive to the probe location, **Vps can be used as a density proxy only during intervals of constant pointing**. See the paper by Edberg et al (RD6) for an example of how Vps may be used as a plasma density proxy. Perturbations from wake and photoemission have been studied by Sjogren (report available at [http://www.space.irfu.se/exjobb/2009\\_alex\\_sjogren/](http://www.space.irfu.se/exjobb/2009_alex_sjogren/)).

### 3.2.3 *Sweep measurements*

- **Probe bias sweeps are sensitive to the spacecraft pointing** for the same reasons that fix-bias time measurements are. However, for all sweeps obtained prior to the comet phase, except some acquired in Earth's plasmasphere, the ion contribution to the data is so low that the photoemission saturation current can be obtained at all angles for which the probe is sunlit. Note however that the probe may be partially shadowed by its supporting rod (the stub), and that



surface inhomogeneities may cause the photoemission to vary also with the pointing.

- For all sweeps obtained before coming close to the nucleus in September 2014, and for some parts also later on, the dominating contributions to the probe current are probe photoemission (at negative bias voltage) and collection of photoelectrons emitted by the spacecraft and solar panels (at positive bias voltage). Hence, probe sweep data can be interpreted in terms of local plasma parameters only in the Earth's plasmasphere. The main reasons for occasionally running such sweeps in other environments, e.g. the solar wind and the Earth's magnetosphere, are to gather data for investigation of spacecraft-plasma-probe interactions and to monitor probe photoemission.

### 3.3 Geometry Data Products

The geometry data are all produced by using the SPICE toolkit with kernels for Rosetta provided and updated by ESA. These data include the most important parameters for understanding the LAP measurements and are provided once every 32 seconds (once per AQP). The position is provided in target-centered solar orbital coordinates (TSO), which for the specific cases of 67P, Mars and Earth are known as cometocentric solar orbital (CSO), Mars centric orbital (MSO) and geocentric solar ecliptic (GSE) coordinates, respectively. In these coordinates:

- X points towards the sun.
- Z is along the normal (the angular momentum vector) of the target (67P, Mars, Earth) orbit around the sun.
- Y completes the right hand triad (X,Y,Z).

The latitude and longitude are given in target-centered geographic coordinates, rotating with the target. For Rosetta at 67P, this is the Cheops system.

The solar zenith angle (SZA), commonly also known as the s/c phase angle, is the angle sun-target-Rosetta (0 deg. at the subsolar point, 90 deg. at the terminator).

The solar aspect and elevation angles are provided for describing the positions of the LAP probes w.r.t. the solar direction, and thereby regulates their illumination which is important to know since this controls the probes' emission of photoelectrons. To intuitively and visually understand these angles, consider the spacecraft coordinate system in Figure 1. The solar panels are nominally held perpendicular to the direction of the sun, meaning it stays in the s/c XZ plane. The

illumination of the probes thus depends on one angle alone, which we can take to be the angle from the s/c Z axis to the solar direction, counted as increasing from zero when the sun moves from +Z towards +X in the s/c frame. This we define to be the solar aspect angle, SAA. It is complemented by the solar elevation angle, SEA, which nominally is zero but attains positive (negative) values if the sun moves out of the s/c XZ plane toward the s/c +Y (-Y) axis. For the nominal case of SEA = 0, the probe illumination is given by SAA as:

- 179 deg. < SAA < 18 deg. Both probes sunlit
- 18 deg. < SAA < 82 deg. P1 sunlit; P2 in shadow behind s/c body
- 82 deg. < SAA < 107 deg. P1 sunlit; P2 possibly in shadow behind the high-gain antenna (HGA) depending on how the HGA is turned.
- 107 deg. < SAA < 131 deg. Both probes sunlit
- 131 deg. < SAA < 181 deg. P1 in shadow behind solar array; P2 sunlit

The target aspect and elevation angles (TAA and TEA) are similar except for referring to the target body instead of the sun. They are useful mainly at the comet in the case of TEA = 0 (i.e. the nucleus in the s/c XZ plane), as similar TAA intervals as for SAA above will indicate if the probes are exposed to or in the wake of a nominal radial outward plasma flow from the nucleus (corresponding to the sunlit and shadowed cases for SAA). This information is very much more approximate than the rather exact solar illumination and should be used only as a rough indication, because of the often non-radial plasma flow as well as by the fact that there is no guarantee the solar array normal will be along the flow direction -- in fact, it is mostly perpendicular to that direction.

<b>Column</b>	<b>Name</b>	<b>Description</b>
1	TIME.UTC	UTC time
2	OB.T.TIME	OB.T.time
3	X.TSO	Target-centric solar orbital coordinates [km]
4	Y.TSO	
5	Z.TSO	
6	LATITUDE	Spacecraft latitude in target coordinates [deg.]
7	LONGITUDE	Spacecraft longitude in target coordinates [deg.]
8	SZA	Solar zenith angle (SZA), a.k.a. phase angle [deg.]
9	SAA	Solar aspect angle (SAA) [deg.]
10	TAA	Target aspect angle (TAA) [deg.]
11	SEA	Solar elevation angle (SEA) [deg.]
12	TEA	Target elevation angle (TEA) [deg.]

**Table 5.** LAP geometry file content.

### 3.4 Housekeeping Data Products

The HK parameters, only present in the EDITED archive, should not be of interest to normal science users since they do not provide any information not already present in the description of the macro. They are listed and described above for completeness. They are used for monitoring instrument operation and have no scientific interest on their own.

<b>Column</b>	<b>Name</b>	<b>Description and values</b>
1	UTC_TIME	Generation time of HK packet (UT).
2	OBT_TIME	Generation time of HK packet (s/c clock counter)
3	PMAC	Currently programming macro (nonzero only during upload of instrument macros)
4	EMAC	Currently executing macro (indicates number within bank of last started macro)
5	WATCHD	Watchdog status (usually ENABLED, DISABLED only when uploading new macros)
6	PROMEN	PROM and flash memory status (usually DISABLED, ENABLED only at boot time and when uploading new macros)
7	OSC	Using oscillator (using oscillator 0 or 1)
8	LDLMODE	LDL mode and phase (this refers to an old LDL implementation not used in main mission, therefore always NONE)
9	TEMP	Temperature sensor status (usually DISABLED, ENABLED only when booting up)
10	CDRIV2	Range P2 bias (+-32 or +-1.3 V; usually +-32)
11	CDRIV1	Range P1 bias (+-32 or +-1.3 V; usually +-32)
12	E2D216	ADC 16 P2 mode (E-FIELD or DENSITY)
13	E1D116	ADC 16 P1 mode (E-FIELD or DENSITY)
14	E2D120	ADC 20 P2 mode (E-FIELD or DENSITY)
15	E1D120	ADC 20 P1 mode (E-FIELD or DENSITY)
16	CNTRE2	P2 feedback (E-FIELD or DENSITY)
17	CNTRE1	P1 feedback (E-FIELD or DENSITY)
18	MIPLAP	Instrument using probe 2 (LAP or MIP)
19	BTSTRP	Internal bootstrap status (usually ENABLED, rarely DISABLED)
20	F2122	P2 connected to: RX=analog input (usual), TX=transmitter (very rare)
21	F22ED	P2 bias mode (DENSITY or E-FIELD)
22	F22EDDEDC	P2 density range or E-field strategy (for DENSITY, G1.0 or G.05 gives high or the rarely used low gain; for E-FIELD, BIAS or FLOAT specifies if a bias current is applied or the probe is floating)
23	F1121	P1 connected to: RX=analog input (usual), TX=transmitter (very rare)
24	F11ED	P1 bias mode (DENSITY or E-FIELD)

<b>Column</b>	<b>Name</b>	<b>Description and values</b>
25	F11EDDEDC	P1 density range or E-field strategy (for DENSITY, G1.0 or G.05 gives high or the rarely used low gain; for E-FIELD, BIAS or FLOAT specifies if a bias current is applied or the probe is floating)
26	CALIBRATIONA	Flash checksum at reboot, then most significant byte of macro identifier.
27	CALIBRATIONB	Flash checksum at reboot, then least significant byte of macro identifier.
28	TMP12	Uncalibrated temperature, valid if TEMP is ENABLED and P2 in E-FIELD.
29	SWVERSION	Software version (15 in main mission).

**Table 6.** LAP HK parameters.

### 3.5 Instrument Calibration Data Products

Ground calibration data as well as in-flight calibrations are used and included in the archive. The following calibration products are included in the CALIB directory of the LAP archives:

<b><i>In flight</i></b>	<b><i>Product ID</i></b>
Measured current offset as a function of set bias voltage.	RPCLAPYYMMDD_CALIB_MEAS
Manually selected exceptions to the default rule for selecting RPCLAPYYMMDD_CALIB_MEAS.	RPCLAP_CALIB_MEAS_EXCEPT

<b><i>On ground (pre-flight)</i></b>	<b><i>Product ID</i></b>
Current biases and measured laboratory values.	RPCLAPYYMMDD_CALIB_IBIAS
Voltage biases and measured laboratory values.	RPCLAPYYMMDD_CALIB_VBIAS
Fine bias voltage settings and measured laboratory values.	RPCLAPYYMMDD_CALIB_FINE
Transfer function probe 1, Density mode	RPCLAPYYMMDD_CALIB_FRQ_D_P1

Transfer function probe 2, Density mode	RPCLAPYYMMDD_CALIB_FRQ_D_P2
Transfer function probe 1, E-field mode	RPCLAPYYMMDD_CALIB_FRQ_E_P1
Transfer function probe 2, E-field mode	RPCLAPYYMMDD_CALIB_FRQ_E_P2

As mentioned in Section 2.5, the transfer functions are currently not used in the production of calibrated or edited data sets, but are provided for reference. All other products are used in producing the calibrated data sets. *YYMMDD* is the date on which the corresponding calibration was made.

### **3.6 Software**

There is no software included with the archive.

### **3.7 Documentation**

Relevant documentation is archived in the DOCUMENT directory of each data set (see detailed description in Section 4.4.3.5).

### **3.8 Derived and other Data Products**

There is as yet no DERIVED level data included in the archive.

### **3.9 Ancillary Data Usage**

We use time correlation packets to convert into UTC as described in RO-ESC-IF-5003 issue B6 page 106, sect 18.1.2.1.

Geometry files are prepared using SPICE, whose kernels are based on information provided by ESOC.

- 

## 4 Archive Format and Content

This section should be of interest as a reference to any user directly accessing the LAP archive.

### 4.1 Format and Conventions

#### 4.1.1 Deliveries and Archive Volume Format

We use conventions defined as in the RO-EST-PL-5011\_2\_Rosetta\_Archive\_GVT\_Plan, and conventions defined by the RPC team. For instance, our data directory naming conventions as in section 4.1.3 are RPC consistent. One Data Set corresponds to one Volume.

#### 4.1.2 Data Set ID Formation

Example:

RO-C-RPCLAP-3-ESC2-Description-V1.0

RO	= INSTRUMENT_HOST_ID
C	= TARGET_ID
RPCLAP	= INSTRUMENT_ID
3	= Data processing level (DPL) number
CVP	= Mission phase abbreviation

Description can be EDITED, CALIB, CALIB2, or DERIVED thus essentially displaying in words the same information as the processing level.

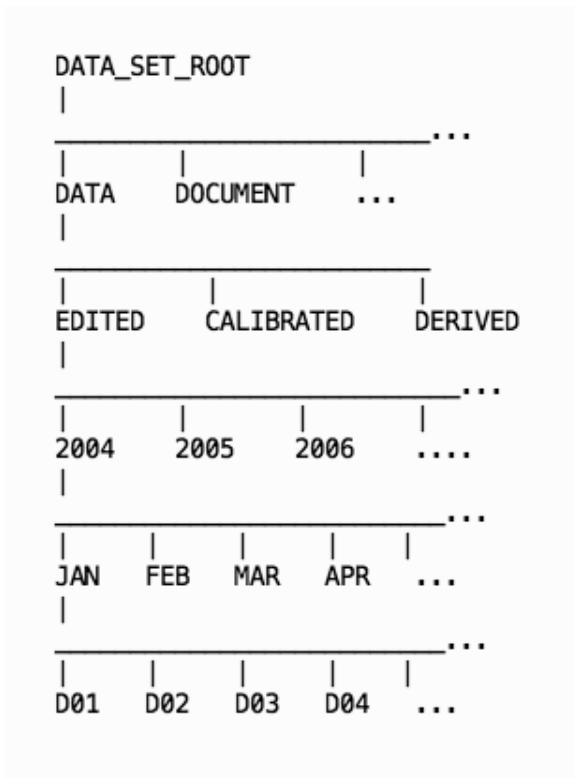
One data set will be produced for each processing level:

Edited data = 2, Calibrated data = 3.

Within each data set TARGET\_NAME and TARGET\_TYPE is used to identify the current target.

#### 4.1.3 Data Directory Naming Convention

Data files are stored in one directory per day, organized as shown in Figure 3.



**Figure 3.** Data directory structure.

#### 4.1.4 File Naming and Product ID Convention

This is the LAP file naming convention for files in the DATA directory. Product IDs follow the same convention as the file names, except that they omit the file extension.

For science data files, the file name contains detailed information on the type of data which makes it possible to partly avoid having to parse the corresponding PDS label file to understand the type of data.

(Edited) science data:	<i>RPCLAPYYMMDD_AAAa_bcdefghxx.ext</i>
(Calibrated) science data or sweep descriptions	<i>LAP_YYMMDD_hhmmss_iii_jek.ext</i>
(Calibrated) block list:	<i>LAP_YYMMDD_000000_BLKLIST.ext</i>
(Edited) Housekeeping:	<i>RPCLAPYYMMDD_AAA_H.ext</i>
Geometry:	<i>RPCLAPYYMMDD_L_GEOM.ext</i>

The meaning of codes (*italicized*) in the above product IDs can be found in Table 7.

<b>Code</b>	<b>Meaning</b>	<b>Values</b>
<i>YYMMDD</i>	Date	
<i>hhmmss</i>	Time of day	
<i>AAA</i>	Alphanumeric counter resetting to zero at the beginning of every day.	Three-digit alphanumeric counter running through the numbers 0 to 9 and then the letters A to Z, i.e. from 000 to ZZZ.
<i>a</i>	Indicates which ADC the data comes from	S = 16-bit ADC T = 20-bit ADC
<i>b</i>	Archiving level	R = Edited Raw (for historical reasons)
<i>c</i>	Instrument mode	E = E-Field (voltage measurements and current bias) D = Density (current measurements and voltage bias)
<i>d</i>	Bias mode	B = Fix-bias S = Sweeping
<i>e</i>	Sensor (probe)	1 = Probe 1 2 = Probe 2 3 = Derived from both probe 1 and 2.
<i>f</i>	Analog filters applied to the data sampled by the 16-bit ADCs. Note that this number (4 or 8) will be present also in the file name of data sampled with the 20-bit ADCs, which always use the analog filter cutting at 20 Hz. For more information on filters, see Section 2.2.	8 = 8 kHz 4 = 4 kHz
<i>g</i>	Telemetry rate	M = Minimum N = Normal B = Burst
<i>h</i>	For science data this character is always an "S".	S
<i>iii</i>	Macro number.	Three hexadecimal digits.
<i>j</i>	Type of data.	I = Measured current V = Measured voltage B = Sweep description
<i>k</i>	Type of measurement.	L = Low frequency (fix bias; ADC20) H = High frequency (fix bias; ADC16) S = Sweep (always ADC16)



x	For contingency. Not present if not needed.	
L	Archiving level	2 = EDITED 3 = CALIBRATED
H	Non-changing identifier “H” to indicate housekeeping files. EDITED only	H
.ext	File extension	.LBL = PDS label file .TAB = Text file with data

**Table 7.** The meaning of codes in the descriptions of product IDs.

## 4.2 Standards Used in Data Product Generation

### 4.2.1 PDS Standards

LAP complies with PDS version 3, and we use version 3.6 of the PDS standard reference.

### 4.2.2 Time Standards

Time references in the LAP PDS archive are UTC and spacecraft clock. UTC time is displayed in the PDS CCYY-MM-DDThh:mm:ss.sss format. Conversion from spacecraft clock to UTC is done by our own software using RSOC-issued time calibration packets, except geometry files which use SPICE and kernels based on information provided by ESOC for the same conversion.

### 4.2.3 Reference Systems

The geometry files provide spacecraft positions in the target-centered solar orbital coordinate system. For Rosetta at comet 67P, we use the Cheops system. The spacecraft pointing is described using angles which are defined using the Sun, the target, and the s/c coordinate axes, which are briefly described in Figure 1.

## 4.3 Data Validation

All data is checked with DVAL.

### 4.3.1 EDITED

Data are automatically scanned for internal consistency when processed into edited format.

#### 4.3.2 *CALIBRATED*

Data are visually scanned for noting obvious problems. Comparative investigations may be undertaken. Particularly noteworthy features are documented in the DATASET.CAT file in the CATALOG directory of each archive.

#### 4.3.3 *DERIVED*

There are currently no derived-level data in the LAP archive.

## 4.4 Content

### 4.4.1 Volume Set

According to Section 19.4 in AD1.

### 4.4.2 Data Set

Our naming convention for the data set follows principles similar to those for the DATA\_SET\_ID, Section 4.1.2.

```
DATA_SET_NAME="ROSETTA-ORBITER <TARGET> RPCLAP  
<LEVELNUM> <MPHASE> <LEVELWORD> V<X>"
```

The variable fields here are:

<TARGET>	= Target name, i.e. LUTETIA.
<LEVELNUM>	= Data processing level numbers (e.g. 2 for EDITED).
<MPHASE>	= Mission phase abbreviation, example AST1.
<LEVELWORD>	= Data processing level in text (e.g. CALIB for calibrated or EDITED for edited data).
<X>	= Archive version number, e.g. 2.0.

One data set will be used for each processing level and mission phase. The data set name fits in the full length thus 60 characters.

### 4.4.3 Directories

#### 4.4.3.1 Root Directory

Contents:

```
AAREADME.TXT  
CALIB  
CATALOG  
DATA  
DOCUMENT  
INDEX  
VOLDESC.CAT
```

See section 5.1 for more detail.

#### 4.4.3.2 Calibration Directory

The directory CALIB contains calibration files, described in Section 3.5. This includes in-flight calibration files, so this directory grows with time.

Example listing of CALIB directory:

<b>File name</b>	<b>Comment</b>
CALINFO.TXT	Information on directory contents
RPCLAP030101_CALIB_FINE.LBL	Ground calibration of fine sweep voltage bias.
RPCLAP030101_CALIB_FINE.TAB	
RPCLAP030101_CALIB_FRQ_D_P1.LBL	Ground calibration, frequency response (transfer function) for P1 in voltage bias mode.
RPCLAP030101_CALIB_FRQ_D_P1.TXT	
RPCLAP030101_CALIB_FRQ_D_P2.LBL	Ground calibration, frequency response (transfer function) for P2 in voltage bias mode.
RPCLAP030101_CALIB_FRQ_D_P2.TXT	
RPCLAP030101_CALIB_FRQ_E_P1.LBL	Ground calibration, frequency response (transfer function) for P1 in current bias mode.
RPCLAP030101_CALIB_FRQ_E_P1.TXT	
RPCLAP030101_CALIB_FRQ_E_P2.LBL	Ground calibration, frequency response (transfer function) for P2 in current bias mode.
RPCLAP030101_CALIB_FRQ_E_P2.TXT	
RPCLAP030101_CALIB_IBIAS.LBL	Ground calibration of current bias.
RPCLAP030101_CALIB_IBIAS.TAB	
RPCLAP030101_CALIB_MEAS.LBL	Ground calibration of voltage bias mode data, identical in format to subsequent in-flight calibrations.
RPCLAP030101_CALIB_MEAS.TAB	
RPCLAP030101_CALIB_VBIAS.LBL	Ground calibration of voltage bias.
RPCLAP030101_CALIB_VBIAS.TAB	
RPCLAPyymmdd_CALIB_MEAS.LBL	In-flight calibration of voltage

RPCLAPyymmdd_CALIB_MEAS.TAB	bias mode data. The TAB file contains measured offsets for P1 and P2 (voltage bias mode). Static calibration factors derived from ground calibrations are placed in the LBL as special keywords. A given CALIBRATED or DERIVED data set will contain one or several of these. Note that a data set may contain in-flight calibrations made outside of the time interval officially covered by the data set.
RPCLAP_CALIB_MEAS_EXCEPT.LBL	Manually selected exceptions to the default rule for selecting which RPCLAPyymmdd_CALIB_MEAS to use for calibrating at a given point in time. Only included in CALIBRATED and DERIVED data sets.
RPCLAP_CALIB_MEAS_EXCEPT.TAB	

#### 4.4.3.3 Catalog Directory

Contents:

File name	Description
CATINFO.TXT	This file contains a list of all catalog files located in the CATALOG directory, with brief descriptions (as this table).
DATASET.CAT	Description of the data in the present Data Set, including caveats.
ROSETTA_INSTHOST.CAT	ROSETTA spacecraft information. File provided by ESA.
ROSETTA_MSN.CAT	ROSETTA Mission information. File provided by ESA.
RPCLAP_INST.CAT	LAP instrument description.
RPCLAP_PERS.CAT	LAP key people with contact details.
RPCLAP_REF.CAT	Catalog of relevant publications. File provided by ESA.
RPCLAP_SOFTWARE.CAT	Software catalog file (only containing the information that there is no s/w).

#### 4.4.3.4 Index Directory

Contents:

INDXINFO.TXT  
INDEX.LBL  
INDEX.TAB

This directory contains the index files generated by the ESA S/W PVV.

#### 4.4.3.5 Document Directory

This directory contains relevant LAP documentation as described below.

The FLIGHT REPORTS subdirectory contains LAP operations reports from the relevant mission phase (and may contain reports for other mission phases as well). These reports summarize the commanding, data taking, anomalies and outcomes of each operation. Note that one mission phase may include several operations, documented in separate reports (for example, EAR2 includes not only the operations around the 2<sup>nd</sup> Earth swing-by, but also a payload checkout activity).

<b>LAP PDS Document Directory Contents</b>	
<b>Document</b>	<b>Description</b>
DOCINFO.TXT	Describes directory contents
ERIKSSON2007A.LBL ERIKSSON2007A.PDF	Instrument description, label file and document as PDF: A. I. Eriksson, R. Boström, R. Gill, L. Åhlén, S.-E. Jansson, J.-E. Wahlund, M. André, A. Mälkki, J. A. Holtet, B. Lybekk, A. Pedersen, L. G. Blomberg and the LAP team, RPC-LAP: The Rosetta Langmuir probe instrument, <i>Space Sci. Rev.</i> , 128, 729-744, 2007, <a href="https://doi.org/10.1007/s11214-006-9003-3">doi:10.1007/s11214-006-9003-3</a>
ERIKSSON2008A.LBL ERIKSSON2008A.PDF	Instrument description, label file and document as PDF: A. I. Eriksson, R. Gill, J.-E. Wahlund, M. André, A. Mälkki, B. Lybekk, A. Pedersen, J. A. Holtet, L. G. Blomberg and N. J. T. Edberg, RPC-LAP: The Langmuir probe instrument of the Rosetta Plasma Consortium, in <i>Rosetta: ESA's mission to the</i>

	<i>origin of the solar system</i> , eds. R. Schulz, C. Alexander, H. Boehnhardt and K.-H. Glassmeier, pp. 435-447, Springer, 2009, ISBN: 978-0-387-77517-3.
RO-IRFU-LAP-EAICD- <i>ver</i> .LBL RO-IRFU-LAP-EAICD- <i>ver</i> .PDF	EAICD (this document) as PDF, with label file ( <i>ver</i> = version number)
RO-IRFU-LAPMAC- <i>yymmdd</i> .LBL RO-IRFU-LAPMAC- <i>yymmdd</i> .PDF	Description of the LAP macros referred to by INSTRUMENT_MODE_ID, in PDF format, with label file. This replaces the outdated LAPMPF document present in previous releases. The date <i>yymmdd</i> is a version identifier.

#### 4.4.3.6 Data Directory

See Section 4.1.3 for overall structure, Sections 4.1.4 and 3.1 for data products in the data directory and Section 5.3.2 for detailed examples of data product design.

## 5 Detailed Interface Specifications

### 5.1 Structure and Organization Overview

The contents of the directories in an EDITED or CALIBRATED Data Set are discussed in Section 4. The general organization of the archive can be seen from the following example for the data set of CALIBRATED data from the Lutetia flyby:

```
DATASET_ROOT
|-CALIB
|-CATALOG
|-DATA
|---CALIBRATED
|----2010
|-----JUL
|-----D07
|-----D08
|-----D09
|-----D10
|-----D11
|-----D12
|-----D13
|-DOCUMENT
|---FLIGHT_REPORTS
|-INDEX
```

For the contents of these directories, please see Section 4.4.

### 5.2 Data Sets, Definition and Content

Please see Section 2.4.

### 5.3 Data Product Design

#### 5.3.1 *General Issues*

##### 5.3.1.1 File Characteristics Data Elements

Data are stored in ASCII files with the extension “.TAB”. The associated label file, describing the data file in detail, has the same name but with the extension “.LBL” instead.



### 5.3.1.2 Data Object Pointers Identification Data Elements

The only pointer which is used is the pointer from the \*.LBL file to the \*.TAB file.

### 5.3.1.3 Instrument and Detector Descriptive Data Elements

Please see Sections 2.2 and 2.3.

### 5.3.1.4 Data Object Definition

All data are stored in \*.TAB files. Their structure is defined in the OBJECT Table definition within the \*.LBL files. Each data definition block has a DESCRIPTION which explains the meaning of the assigned data column exactly.

### 5.3.1.5 Mission-Specific Keywords

We use some specific keywords for the LAP instrument in the label files, as illustrated by the following examples:

```
ROSETTA:LAP_TM_RATE = "BURST"  
ROSETTA:LAP_P1_SWEEP_START_BIAS = "0x00c0"  
ROSETTA:LAP_CURRENT_CAL_16B_G0_05 = "6.10360876E-9"
```

The instrument-specific keywords used are tabulated in Table 8 below. Most of them regard instrument internal settings and are mostly present for completeness: see the instrument descriptions in the DOCUMENTS archive for understanding of their meaning. Note that Hex word means values from 0x0000 to 0xffff, though they are stored as character strings. **Note that all values in Table 8 are DATA\_TYPE = CHARACTER and are enclosed in quotes in the label file.** The valid string values are separated by a colon (":") in Table 8, thus the colon is not part of the values themselves. Also note that the maximum character string length does not include counting quotes, null terminators, line feeds or carriage returns.

<i>Rosetta LAP-specific label keywords</i>	<i>Valid values separated by colon</i>	<i>Maximum character string length</i>	<i>Description</i>
LAP_BOOTSTRAP	ON:OFF	3	Bootstrapping on or off

LAP_CURRENT_CAL_1 6B_G0_05	<i>Ascii real string</i>	14	Convert TM to [A] ADC16's gain 0.05
LAP_CURRENT_CAL_1 6B_G1	<i>Ascii real string</i>	14	Convert TM to [A] ADC16's gain 1
LAP_CURRENT_CAL_2 0B_G0_05	<i>Ascii real string</i>	14	Convert TM to [A] ADC20's gain 0.05
LAP_CURRENT_CAL_2 0B_G1	<i>Ascii real string</i>	14	Convert TM to [A] ADC20's gain 1
LAP_FEEDBACK_P1, LAP_FEEDBACK_P2	DENSITY:E- FIELD	7	E-Field or Density feedback relay probe 1 or 2
LAP_IBIAS1, LAP_IBIAS2	<i>Hex word string</i>	6	Fix current bias sensor 1 or 2
LAP_P1_ADC16, LAP_P2_ADC16	DENSITY:E- FIELD	7	ADC16 probe 1 or 2 E- Field or Density mode
LAP_P1_ADC16_DIG_F ILT_CUTOFF, LAP_P2_ADC16_DIG_F ILT_CUTOFF	4688 Hz:2344 Hz:1172 Hz:586 Hz	7	Digital filter used on probe 1 or 2
LAP_P1_ADC16_DIG_F ILT_STATUS, LAP_P2_ADC16_DIG_F ILT_STATUS	DISABLED:ENAB LED	8	Digital filter on or off on probe 1 or 2
LAP_P1_ADC16_DOW NSAMPLE, LAP_P2_ADC16_DOW NSAMPLE	<i>Hex word string</i>	6	Data sensor 1 or 2 downsampled <i>n</i> times
LAP_P1_ADC16_FILTE R, LAP_P2_ADC16_FILTE R	4 KHz:8 KHz	5	Analog filter used
LAP_P1_ADC20, LAP_P2_ADC20	DENSITY:E- FIELD	7	ADC20 probe 1 or 2, E-Field or Density mode
LAP_P1_BIAS_MODE, LAP_P2_BIAS_MODE	E-FIELD:DENSIT Y	7	Probe 1 or 2 bias mode
LAP_P1_DENSITY_FIX DURATION, LAP_P2_DENSITY_FIX DURATION	<i>Hex word string</i>	6	Duration in samples of fix density bias data sensor 1 or 2
LAP_P1_EFIELD_FIX_D URATION, LAP_P2_EFIELD_FIX_D URATION	<i>Hex word string</i>	6	Duration in samples of fix E-field bias data sensor 1 or 2
LAP_P1_FINE_SWEEP OFFSET, LAP_P2_FINE_SWEEP OFFSET	<i>Hex word string</i>	6	Probe 1 or 2 fine sweep bias offset
LAP_P1_INITIAL_SWEE	<i>Hex word string</i>	6	Initial samples before a

P_SMPLS, LAP_P2_INITIAL_SWEE P_SMPLS			sweep starts on probe 1 and 2 respectively
LAP_P1_RANGE_DENS BIAS, LAP_P2_RANGE_DENS BIAS	+5:+32	3	Density bias range probe 1 or 2
LAP_P1_RX_OR_TX, LAP_P2_RX_OR_TX	ANALOG INPUT:TRANSMI TTER	12	Connected to transmitter or not
LAP_P1_STRATEGY_O R_RANGE, LAP_P2_STRATEGY_O R_RANGE	BIAS:FLOAT:GAI N 0.05:GAIN 1	9	E-Field strategy or density gain probe 1 or 2
LAP_P1_SWEEP_FOR MAT, LAP_P2_SWEEP_FOR MAT	UP:DOWN:DOW N UP:UP DOWN	7	Sweeping direction on probe 1 and 2 respectively
LAP_P1_SWEEP_PLAT EAU_DURATION, LAP_P2_SWEEP_PLAT EAU_DURATION	<i>Hex word string</i>	6	Samples on a plateau on probe 1 and 2 respectively
LAP_P1_SWEEP_RES OLUTION, LAP_P2_SWEEP_RES OLUTION	COARSE:FINE	6	Sweeping resolution on probe 1 and 2 respectively
LAP_P1_SWEEP_STAR T_BIAS, LAP_P2_SWEEP_STAR T_BIAS	<i>Hex word string</i>	6	Sweep start bias on probe 1 and 2 respectively
LAP_P1_SWEEP_STEP HEIGHT, LAP_P2_SWEEP_STEP HEIGHT	<i>Hex word string</i>	6	Height of a bias step on probe 1 and 2 respectively
LAP_P1_SWEEP_STEP S, LAP_P2_SWEEP_STEP S	<i>Hex word string</i>	6	Number of bias steps in sweep on probe 1 and 2 respectively
LAP_P1P2_ADC20_DO WNSAMPLE	<i>Hex word string</i>	6	Downsampling $n$ times on ADC20 data sensor 1 and 2
LAP_P1P2_ADC20_MA LENGTH	<i>Hex word string</i>	6	Length of moving average used
LAP_P1P2_ADC20_STA TUS	EMPTY:P2T:P1T: P1T & P2T:P2F:P1T P2F:P1F:P1F P2T:P1F & P2F	9	Status: P1 = Sensor 1 P2 = Sensor 2 T = Truncated to 16 bit F = Full 20 bit

LAP_SWEEPING_P1, LAP_SWEEPING_P2	NO:YES	3	A sweep or time series
LAP_TM_RATE	NONE:MINIMUM: NORMAL:BURST	7	Telemetry rate
LAP_TRANSMITTER_A AMPLITUDE	LTRO1:MTRO2:H TRO3:LTR1:MTR 2:HTR3	5	Amplitude of transmitter signal full description. Not used up to now.
LAP_TRANSMITTER_F FREQUENCY	<i>Hex word string</i>	6	Frequency of transmitter square wave in Hz. Not used up to now.
LAP_TRANSMITTER_S STATUS	DISABLED:ENAB LED	8	Transmitter on or off
LAP_VBIAS1, LAP_VBIAS2	<i>Hex word string</i>	6	Fix voltage bias sensor 1 or 2
LAP_VOLTAGE_CAL_1 6B	<i>Ascii real string</i>	14	Convert TM to [V] ADC16s
LAP_VOLTAGE_CAL_2 0B	<i>Ascii real string</i>	14	Convert TM to [V] ADC20s
<b>Table 8.</b> LAP instrument-specific keywords. The table is sorted in alphabetical order of the first keyword in every cell of the left-most column.			

We have also defined a set of instrument modes using the already existing keyword INSTRUMENT\_MODE\_ID and INSTRUMENT\_MODE\_DESC. Instrument modes are identified by the onboard macro producing the data (Section 2.3). The macro ID (MCID) is a hexadecimal number 0x0100 to 0x0A07 where the last digit cannot be higher than 7. The middle digit represents the version number of the macro, starting from 0.

### 5.3.2 Data Product Design

LAP data products are described in Section 3. The file naming convention, identifying the data product, is given in Section 4.1.4

All science data products in the EDITED data sets have the same structure: ASCII tables giving time (in UT), spacecraft time, probe current value (bias or measured), and probe voltage (measured or bias) for one of the probes. The one exception to this is the difference measurements sometimes taken between the probes: in these files, the bias of both probes are given, adding an extra column.

We here provide the detailed design of the science data products by displaying example label files for each of them. The fix bias products for the EDITED and CALIBRATED data sets are very similar: only the units and the lengths of the time series differ.

### 5.3.2.1 Edited Data Product Design

#### 5.3.2.1.1 Edited Housekeeping Data Product Design

```
PDS_VERSION_ID = PDS3
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 208
FILE_RECORDS = 16
FILE_NAME = "RPCLAP100707_01J_H.LBL"
^TABLE = "RPCLAP100707_01J_H.TAB"
DATA_SET_ID = "RO-A-RPCLAP-2-AST2-EDITED-V1.1"
DATA_SET_NAME = "ROSETTA-ORBITER LUTETIA RPCLAP 2 AST2 EDITED
V1.1"
DATA_QUALITY_ID = "1"
MISSION_ID = ROSETTA
MISSION_NAME = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME = "LUTETIA FLY-BY"
PRODUCER_INSTITUTION_NAME = "SWEDISH INSTITUTE OF SPACE PHYSICS,
UPPSALA"
PRODUCER_ID = EJ
PRODUCER_FULL_NAME = "ERIK P G JOHANSSON"
LABEL_REVISION_NOTE = "2015-02-25T19:31:28, V1.1: Erik P G
Johansson (IRFU); Seven renamed sweep keywords."
PRODUCT_ID = RPCLAP100707_01J_H
PRODUCT_TYPE = "EDR"
PRODUCT_CREATION_TIME = 2015-02-25T19:31:28
INSTRUMENT_HOST_ID = RO
INSTRUMENT_HOST_NAME = "ROSETTA-ORBITER"
INSTRUMENT_NAME = "ROSETTA PLASMA CONSORTIUM - LANGMUIR PROBE"
INSTRUMENT_ID = RPCLAP
INSTRUMENT_TYPE = "PLASMA INSTRUMENT"
INSTRUMENT_MODE_ID = MCID0X0503
INSTRUMENT_MODE_DESC = "N/A"
TARGET_NAME = "21 LUTETIA"
TARGET_TYPE = "ASTEROID"
PROCESSING_LEVEL_ID = "N"
START_TIME = 2010-07-07T23:51:23.596
STOP_TIME = 2010-07-07T23:59:23.596
SPACECRAFT_CLOCK_START_COUNT = "1/0237167442.42944"
SPACECRAFT_CLOCK_STOP_COUNT = "1/0237167922.42944"
DESCRIPTION = "LAP HK Data, Each line is a separate HK packet sent
every 32s"
OBJECT = TABLE
INTERCHANGE_FORMAT = ASCII
ROWS = 16
COLUMNS = 29
ROW_BYTES = 208
DESCRIPTION = "LAP HK Data table."
OBJECT = COLUMN
NAME = UTC_TIME
DATA_TYPE = TIME
START_BYTE = 1
BYTES = 26
DESCRIPTION = "UTC TIME"
END_OBJECT = COLUMN
OBJECT = COLUMN
```

```

NAME = OBT_TIME
START_BYTE = 28
BYTES = 16
DATA_TYPE = ASCII_REAL
UNIT = SECONDS
FORMAT = "F16.6"
DESCRIPTION = "SPACE CRAFT ONBOARD TIME SSSSSSSSS.FFFFFFF (TRUE
DECIMALPOINT)"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = PMAC
DATA_TYPE = ASCII_INTEGER
START_BYTE = 45
BYTES = 1
DESCRIPTION = "CURRENTLY PROGRAMMING MACRO"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = EMAC
DATA_TYPE = ASCII_INTEGER
START_BYTE = 47
BYTES = 1
DESCRIPTION = "CURRENTLY EXECUTING MACRO"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = WATCHD
DATA_TYPE = CHARACTER
START_BYTE = 49
BYTES = 8
DESCRIPTION = "WATCHDOG STATUS"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = PROMEN
DATA_TYPE = CHARACTER
START_BYTE = 58
BYTES = 8
DESCRIPTION = "PROM AND FLASH MEMORY STATUS"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = OSC
DATA_TYPE = ASCII_INTEGER
START_BYTE = 67
BYTES = 1
DESCRIPTION = "USING OSCILLATOR 0 or 1"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = LDLMODE
DATA_TYPE = CHARACTER
START_BYTE = 69
BYTES = 7
DESCRIPTION = "LDL MODE AND PHASE"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = TEMP
DATA_TYPE = CHARACTER
START_BYTE = 77
BYTES = 8

```

```

DESCRIPTION = "TEMPERATURE SENS STATUS, VALID TEMPERATURE IF IN E-
FIELD MODE"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = CDRIV2
DATA_TYPE = CHARACTER
START_BYTE = 86
BYTES = 4
DESCRIPTION = "RANGE PROBE 2 BIAS "
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = CDRIV1
DATA_TYPE = CHARACTER
START_BYTE = 91
BYTES = 4
DESCRIPTION = "RANGE PROBE 1 BIAS "
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = E2D216
DATA_TYPE = CHARACTER
START_BYTE = 96
BYTES = 7
DESCRIPTION = "ADC 16 PROBE 2 MODE"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = E1D116
DATA_TYPE = CHARACTER
START_BYTE = 104
BYTES = 7
DESCRIPTION = "ADC 16 PROBE 1 MODE"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = E2D120
DATA_TYPE = CHARACTER
START_BYTE = 112
BYTES = 7
DESCRIPTION = "ADC 20 PROBE 2 MODE"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = E1D120
DATA_TYPE = CHARACTER
START_BYTE = 120
BYTES = 7
DESCRIPTION = "ADC 20 PROBE 1 MODE"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = CNTRE2
DATA_TYPE = CHARACTER
START_BYTE = 128
BYTES = 7
DESCRIPTION = "P2 FEEDBACK"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = CNTRE1
DATA_TYPE = CHARACTER
START_BYTE = 136
BYTES = 7

```

```

DESCRIPTION = "P1 FEEDBACK"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = MIPLAP
DATA_TYPE = CHARACTER
START_BYTE = 144
BYTES = 3
DESCRIPTION = "INSTRUMENT USING PROBE 2"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = BTSTRP
DATA_TYPE = CHARACTER
START_BYTE = 148
BYTES = 8
DESCRIPTION = "INTERNAL BOOTSTRAP STATUS"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = F2122
DATA_TYPE = CHARACTER
START_BYTE = 157
BYTES = 2
DESCRIPTION = "P2 CONNECTED TO, RX=ANALOG INPUT TX=TRANSMITTER"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = F22ED
DATA_TYPE = CHARACTER
START_BYTE = 160
BYTES = 7
DESCRIPTION = "P2 BIAS MODE"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = F22EDDEDC
DATA_TYPE = CHARACTER
START_BYTE = 168
BYTES = 5
DESCRIPTION = "P2 DENSITY RANGE OR E-FIELD STRATEGY"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = F1121
DATA_TYPE = CHARACTER
START_BYTE = 174
BYTES = 2
DESCRIPTION = "P1 CONNECTED TO, RX=ANALOG INPUT TX=TRANSMITTER"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = F11ED
DATA_TYPE = CHARACTER
START_BYTE = 177
BYTES = 7
DESCRIPTION = "P1 BIAS MODE"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = F11EDDEDC
DATA_TYPE = CHARACTER
START_BYTE = 185
BYTES = 5
DESCRIPTION = "P1 DENSITY RANGE OR E-FIELD STRATEGY"

```



```

END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = CALIBRATIONA
DATA_TYPE = ASCII_INTEGER
START_BYTE = 191
BYTES = 3
DESCRIPTION = "FLASH CHECKSUM AT START, THEN FREE FOR OTHER USES"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = CALIBRATIONB
DATA_TYPE = ASCII_INTEGER
START_BYTE = 195
BYTES = 3
DESCRIPTION = "FLASH CHECKSUM AT START, THEN FREE FOR OTHER USES"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = TMP12
DATA_TYPE = ASCII_INTEGER
START_BYTE = 199
BYTES = 4
DESCRIPTION = "UNCALIBRATED TEMP, VALID IF TEMP IS ENABLED AND E-
FIELD MODE"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = SWVERSION
DATA_TYPE = ASCII_INTEGER
START_BYTE = 205
BYTES = 2
DESCRIPTION = "SOFTWARE VERSION"
END_OBJECT = COLUMN
END_OBJECT = TABLE
END

```

### 5.3.2.1.2 Edited Time Series Data Product Design

```

PDS_VERSION_ID = PDS3
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 59
FILE_RECORDS = 28
FILE_NAME = "RPCLAP100707_0B6T_REB18NS.LBL"
^TABLE = "RPCLAP100707_0B6T_REB18NS.TAB"
DATA_SET_ID = "RO-A-RPCLAP-2-AST2-EDITED-V1.1"
DATA_SET_NAME = "ROSETTA-ORBITER LUTETIA RPCLAP 2 AST2 EDITED
V1.1"
DATA_QUALITY_ID = "1"
MISSION_ID = ROSETTA
MISSION_NAME = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME = "LUTETIA FLY-BY"
PRODUCER_INSTITUTION_NAME = "SWEDISH INSTITUTE OF SPACE PHYSICS,
UPPSALA"
PRODUCER_ID = EJ
PRODUCER_FULL_NAME = "ERIK P G JOHANSSON"
LABEL_REVISION_NOTE = "2015-02-25T19:31:32, V1.1: Erik P G
Johansson (IRFU); Seven renamed sweep keywords."
PRODUCT_ID = "RPCLAP100707_0B6T_REB18NS"

```

```

PRODUCT_TYPE = "EDR"
PRODUCT_CREATION_TIME = 2015-02-25T19:31:32
INSTRUMENT_HOST_ID = RO
INSTRUMENT_HOST_NAME = "ROSETTA-ORBITER"
INSTRUMENT_NAME = "ROSETTA PLASMA CONSORTIUM - LANGMUIR PROBE"
INSTRUMENT_ID = RPCLAP
INSTRUMENT_TYPE = "PLASMA INSTRUMENT"
INSTRUMENT_MODE_ID = MCID0X0503
INSTRUMENT_MODE_DESC = "EE Cont. 20 bit down 64, Every 160s 16 Bit
P1"
TARGET_NAME = "21 LUTETIA"
TARGET_TYPE = "ASTEROID"
PROCESSING_LEVEL_ID = "2"
START_TIME = 2010-07-07T23:59:23.596
STOP_TIME = 2010-07-07T23:59:52.396
SPACECRAFT_CLOCK_START_COUNT = "1/0237167922.42944"
SPACECRAFT_CLOCK_STOP_COUNT = "1/0237167951.29837"
DESCRIPTION = "E_P1P2INTRL_TRNC_20BIT_RAW_BIP"
ROSETTA:LAP_TM_RATE = "NORMAL"
ROSETTA:LAP_BOOTSTRAP = "ON"
ROSETTA:LAP_FEEDBACK_P2 = "E-FIELD"
ROSETTA:LAP_P2_ADC20 = "E-FIELD"
ROSETTA:LAP_P2_ADC16 = "E-FIELD"
ROSETTA:LAP_P2_RANGE_DENS_BIAS = "+-32"
ROSETTA:LAP_P2_STRATEGY_OR_RANGE = "BIAS"
ROSETTA:LAP_P2_RX_OR_TX = "ANALOG INPUT"
ROSETTA:LAP_P2_ADC16_FILTER = "8 KHz"
ROSETTA:LAP_IBIAS2 = "0x0077"
ROSETTA:LAP_P2_BIAS_MODE = "E-FIELD"
ROSETTA:LAP_FEEDBACK_P1 = "E-FIELD"
ROSETTA:LAP_P1_ADC20 = "E-FIELD"
ROSETTA:LAP_P1_ADC16 = "E-FIELD"
ROSETTA:LAP_P1_RANGE_DENS_BIAS = "+-32"
ROSETTA:LAP_P1_STRATEGY_OR_RANGE = "BIAS"
ROSETTA:LAP_P1_RX_OR_TX = "ANALOG INPUT"
ROSETTA:LAP_P1_ADC16_FILTER = "8 KHz"
ROSETTA:LAP_IBIAS1 = "0x00d6"
ROSETTA:LAP_P1_BIAS_MODE = "E-FIELD"
ROSETTA:LAP_P1P2_ADC20_STATUS = "P1T & P2T"
ROSETTA:LAP_P1P2_ADC20_MA_LENGTH = "0x0040"
ROSETTA:LAP_P1P2_ADC20_DOWNSAMPLE = "0x0040"
OBJECT = TABLE
INTERCHANGE_FORMAT = ASCII
ROWS = 28
COLUMNS = 4
ROW_BYTES = 59
DESCRIPTION = "E_P1P2INTRL_TRNC_20BIT_RAW_BIP"
OBJECT = COLUMN
NAME = UTC_TIME
DATA_TYPE = TIME
START_BYTE = 1
BYTES = 26
DESCRIPTION = "UTC TIME"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = OBT_TIME
START_BYTE = 28

```

```

BYTES          = 16
DATA_TYPE      = ASCII_REAL
UNIT           = SECONDS
FORMAT         = "F16.6"
DESCRIPTION    = "SPACE CRAFT ONBOARD TIME SSSSSSSSS.FFFFFFF (TRUE
DECIMALPOINT)"
END_OBJECT     = COLUMN
OBJECT         = COLUMN
NAME           = P1_CURRENT
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 45
BYTES          = 6
DESCRIPTION    = "CURRENT BIAS"
END_OBJECT     = COLUMN
OBJECT         = COLUMN
NAME           = P1_VOLTAGE
DATA_TYPE      = ASCII_INTEGER
START_BYTE     = 52
BYTES          = 6
DESCRIPTION    = "MEASURED VOLTAGE"
END_OBJECT     = COLUMN
END_OBJECT     = TABLE
END

```

### 5.3.2.1.3 Edited Sweep Data Product Design

```

PDS_VERSION_ID = PDS3
RECORD_TYPE    = FIXED_LENGTH
RECORD_BYTES   = 59
FILE_RECORDS   = 200
FILE_NAME      = "RPCLAP100707_05HS_RDS18NS.LBL"
^TABLE        = "RPCLAP100707_05HS_RDS18NS.TAB"
DATA_SET_ID    = "RO-A-RPCLAP-2-AST2-EDITED-V1.1"
DATA_SET_NAME  = "ROSETTA-ORBITER LUTETIA RPCLAP 2 AST2 EDITED
V1.1"
DATA_QUALITY_ID = "1"
MISSION_ID     = ROSETTA
MISSION_NAME   = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME = "LUTETIA FLY-BY"
PRODUCER_INSTITUTION_NAME = "SWEDISH INSTITUTE OF SPACE PHYSICS,
UPPSALA"
PRODUCER_ID    = EJ
PRODUCER_FULL_NAME = "ERIK P G JOHANSSON"
LABEL_REVISION_NOTE = "2015-02-25T19:31:29, V1.1: Erik P G
Johansson (IRFU); Seven renamed sweep keywords."
PRODUCT_ID     = "RPCLAP100707_05HS_RDS18NS"
PRODUCT_TYPE   = "EDR"
PRODUCT_CREATION_TIME = 2015-02-25T19:31:29
INSTRUMENT_HOST_ID = RO
INSTRUMENT_HOST_NAME = "ROSETTA-ORBITER"
INSTRUMENT_NAME = "ROSETTA PLASMA CONSORTIUM - LANGMUIR PROBE"
INSTRUMENT_ID = RPCLAP
INSTRUMENT_TYPE = "PLASMA INSTRUMENT"
INSTRUMENT_MODE_ID = MCID0X0600

```

```

INSTRUMENT_MODE_DESC = "As MCID0x212 but with 20 V bias and 8KHz
filters"
TARGET_NAME = "21 LUTETIA"
TARGET_TYPE = "ASTEROID"
PROCESSING_LEVEL_ID = "2"
START_TIME = 2010-07-07T20:20:43.595
STOP_TIME = 2010-07-07T20:20:44.981
SPACECRAFT_CLOCK_START_COUNT = "1/0237154802.42944"
SPACECRAFT_CLOCK_STOP_COUNT = "1/0237154804.2684"
DESCRIPTION = "D_SWEEP_P1_RAW_16BIT_BIP"
ROSETTA:LAP_P1_INITIAL_SWEEP_SMPLS = "0x0005"
ROSETTA:LAP_P1_ADC16_DOWNSAMPLE = "0x0080"
ROSETTA:LAP_TM_RATE = "NORMAL"
ROSETTA:LAP_BOOTSTRAP = "ON"
ROSETTA:LAP_FEEDBACK_P1 = "DENSITY"
ROSETTA:LAP_P1_ADC20 = "DENSITY"
ROSETTA:LAP_P1_ADC16 = "DENSITY"
ROSETTA:LAP_P1_RANGE_DENS_BIAS = "+-32"
ROSETTA:LAP_P1_STRATEGY_OR_RANGE = "GAIN 1"
ROSETTA:LAP_P1_RX_OR_TX = "ANALOG INPUT"
ROSETTA:LAP_P1_ADC16_FILTER = "8 KHz"
ROSETTA:LAP_SWEEPING_P1 = "YES"
ROSETTA:LAP_P1_FINE_SWEEP_OFFSET = "0x0000"
ROSETTA:LAP_P1_SWEEP_FORMAT = "DOWN"
ROSETTA:LAP_P1_SWEEP_RESOLUTION = "COARSE"
ROSETTA:LAP_P1_SWEEP_PLATEAU_DURATION = "0x0200"
ROSETTA:LAP_P1_SWEEP_STEPS = "0x0030"
ROSETTA:LAP_P1_SWEEP_STEP_HEIGHT = "0x0004"
ROSETTA:LAP_P1_SWEEP_START_BIAS = "0x00c0"
OBJECT = TABLE
INTERCHANGE_FORMAT = ASCII
ROWS = 200
COLUMNS = 4
ROW_BYTES = 59
DESCRIPTION = "D_SWEEP_P1_RAW_16BIT_BIP"
OBJECT = COLUMN
NAME = UTC_TIME
DATA_TYPE = TIME
START_BYTE = 1
BYTES = 26
DESCRIPTION = "UTC TIME"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = OBT_TIME
START_BYTE = 28
BYTES = 16
DATA_TYPE = ASCII_REAL
UNIT = SECONDS
FORMAT = "F16.6"
DESCRIPTION = "SPACE CRAFT ONBOARD TIME SSSSSSSS.FFFFFFF (TRUE
DECIMALPOINT)"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = P1_CURRENT
DATA_TYPE = ASCII_INTEGER
START_BYTE = 45
BYTES = 6

```

```

DESCRIPTION = "MEASURED CURRENT"
END_OBJECT = COLUMN
OBJECT      = COLUMN
NAME       = P1_VOLTAGE
DATA_TYPE  = ASCII_INTEGER
START_BYTE = 52
BYTES     = 6
DESCRIPTION = "VOLTAGE BIAS"
END_OBJECT = COLUMN
END_OBJECT = TABLE
END

```

### 5.3.2.1.4 Edited Difference Measurements Data Product Design

```

PDS_VERSION_ID = PDS3
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 66
FILE_RECORDS = 272
FILE_NAME = "RPCLAP071107_29FS_REB38NS.LBL"
^TABLE = "RPCLAP071107_29FS_REB38NS.TAB"
DATA_SET_ID = "RO-E-RPCLAP-2-EAR2-EDITED-V0.5"
DATA_SET_NAME = "ROSETTA-ORBITER EARTH RPCLAP 2 EAR2 EDITED V0.5"
DATA_QUALITY_ID = "1"
MISSION_ID = ROSETTA
MISSION_NAME = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME = "EARTH SWING-BY 2"
PRODUCER_INSTITUTION_NAME = "SWEDISH INSTITUTE OF SPACE PHYSICS,
UPPSALA"
PRODUCER_ID = EJ
PRODUCER_FULL_NAME = "ERIK P G JOHANSSON"
LABEL_REVISION_NOTE = "2015-03-29: Erik P G Johansson (IRFU);
Seven renamed sweep keywords."
PRODUCT_ID = "RPCLAP071107_29FS_REB38NS"
PRODUCT_TYPE = "EDR"
PRODUCT_CREATION_TIME = 2016-04-07T07:52:43
INSTRUMENT_HOST_ID = RO
INSTRUMENT_HOST_NAME = "ROSETTA-ORBITER"
INSTRUMENT_NAME = "ROSETTA PLASMA CONSORTIUM - LANGMUIR PROBE"
INSTRUMENT_ID = RPCLAP
INSTRUMENT_TYPE = "PLASMA INSTRUMENT"
INSTRUMENT_MODE_ID = MCID0X0705
INSTRUMENT_MODE_DESC = "E-Field,Cont. 20 Bit down 64, Every 160s
16 bit diff"
TARGET_NAME = "EARTH"
TARGET_TYPE = "PLANET"
PROCESSING_LEVEL_ID = "2"
START_TIME = 2007-11-07T23:58:02.875
STOP_TIME = 2007-11-07T23:58:02.890
SPACECRAFT_CLOCK_START_COUNT = "1/0153100650.1600"
SPACECRAFT_CLOCK_STOP_COUNT = "1/0153100650.2547"
DESCRIPTION = "E_DIFF_P1P2"
ROSETTA:LAP_P2_ADC16_DOWNSAMPLE = "0x0001"
ROSETTA:LAP_P1_ADC16_DOWNSAMPLE = "0x0001"
ROSETTA:LAP_TM_RATE = "NORMAL"
ROSETTA:LAP_BOOTSTRAP = "ON"

```

```

ROSETTA:LAP_FEEDBACK_P2 = "E-FIELD"
ROSETTA:LAP_P2_ADC20 = "E-FIELD"
ROSETTA:LAP_P2_ADC16 = "E-FIELD"
ROSETTA:LAP_P2_RANGE_DENS_BIAS = "+-32"
ROSETTA:LAP_P2_STRATEGY_OR_RANGE = "BIAS"
ROSETTA:LAP_P2_RX_OR_TX = "ANALOG INPUT"
ROSETTA:LAP_P2_ADC16_FILTER = "8 KHz"
ROSETTA:LAP_P2_EFIELD_FIX_DURATION = "0x0002"
ROSETTA:LAP_IBIAS2 = "0x0077"
ROSETTA:LAP_P2_BIAS_MODE = "E-FIELD"
ROSETTA:LAP_FEEDBACK_P1 = "E-FIELD"
ROSETTA:LAP_P1_ADC20 = "E-FIELD"
ROSETTA:LAP_P1_ADC16 = "E-FIELD"
ROSETTA:LAP_P1_RANGE_DENS_BIAS = "+-32"
ROSETTA:LAP_P1_STRATEGY_OR_RANGE = "BIAS"
ROSETTA:LAP_P1_RX_OR_TX = "ANALOG INPUT"
ROSETTA:LAP_P1_ADC16_FILTER = "8 KHz"
ROSETTA:LAP_P1_EFIELD_FIX_DURATION = "0x0002"
ROSETTA:LAP_IBIAS1 = "0x00d6"
ROSETTA:LAP_P1_BIAS_MODE = "E-FIELD"
OBJECT = TABLE
INTERCHANGE_FORMAT = ASCII
ROWS = 272
COLUMNS = 5
ROW_BYTES = 66
DESCRIPTION = "E_DIFF_P1P2"
OBJECT = COLUMN
NAME = UTC_TIME
DATA_TYPE = TIME
START_BYTE = 1
BYTES = 26
DESCRIPTION = "UTC TIME"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = OBT_TIME
START_BYTE = 28
BYTES = 16
DATA_TYPE = ASCII_REAL
UNIT = SECONDS
FORMAT = "F16.6"
DESCRIPTION = "SPACECRAFT ONBOARD TIME SSSSSSSSS.FFFFFFF (TRUE
DECIMALPOINT)"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = P1_CURRENT
DATA_TYPE = ASCII_INTEGER
START_BYTE = 45
BYTES = 6
DESCRIPTION = "CURRENT BIAS"
END_OBJECT = COLUMN
OBJECT = COLUMN
NAME = P2_CURRENT
DATA_TYPE = ASCII_INTEGER
START_BYTE = 52
BYTES = 6
DESCRIPTION = "CURRENT BIAS"
END_OBJECT = COLUMN

```

```

OBJECT      = COLUMN
NAME        = P1-P2_VOLTAGE
DATA_TYPE   = ASCII_INTEGER
START_BYTE  = 59
BYTES       = 6
DESCRIPTION = "MEASURED VOLTAGE"
END_OBJECT  = COLUMN
END_OBJECT  = TABLE
END

```

### 5.3.2.1.5 Geometry Data Product Design

```

PDS_VERSION_ID          = PDS3
RECORD_TYPE              = FIXED_LENGTH
RECORD_BYTES            = 203
FILE_RECORDS            = 2700
FILE_NAME                = "RPCLAP150311_3_GEOM.LBL"
^TABLE                  = "RPCLAP150311_3_GEOM.TAB"
DATA_SET_ID             = "RO-C-RPCLAP-3-ESC2-CALIB2-V1.0"
DATA_SET_NAME           = "ROSETTA-ORBITER 67P RPCLAP 3 ESC2
CALIB2 V1.0"
MISSION_PHASE_NAME      = "COMET ESCORT 2"
PRODUCER_ID             = EJ
PRODUCER_FULL_NAME      = "ERIK P G JOHANSSON"
LABEL_REVISION_NOTE     = "2015-12-15, EJ: Updated
descriptions, added OBT_TIME, SEA, TEA."
PRODUCT_ID              = "RPCLAP150311_3_GEOM"
PRODUCT_TYPE            = "RDR"
PRODUCT_CREATION_TIME   = 2016-08-19T11:18:16.815
INSTRUMENT_HOST_NAME    = "ROSETTA-ORBITER"
INSTRUMENT_NAME         = "ROSETTA PLASMA CONSORTIUM -
LANGMUIR PROBE"
INSTRUMENT_ID           = RPCLAP
TARGET_NAME              = "67P/CHURYUMOV-GERASIMENKO 1 (1969
R1)"
TARGET_TYPE             = "COMET"
PROCESSING_LEVEL_ID     = "3"
START_TIME               = 2015-03-11T00:00:16.000
STOP_TIME                = 2015-03-11T23:59:44.000
SPACECRAFT_CLOCK_START_COUNT = "1/0384652741.32445"
SPACECRAFT_CLOCK_STOP_COUNT = "1/0384739109.30645"
OBJECT = TABLE
  INTERCHANGE_FORMAT = ASCII
  ROWS                = 2700
  COLUMNS            = 12
  ROW_BYTES           = 203
  DESCRIPTION         = "Geometry information for some of the
relative positions and orientations of the spacecraft, target, and
Sun."
  OBJECT = COLUMN
    NAME              = TIME_UTC
    START_BYTE        = 1
    BYTES             = 23
    DATA_TYPE        = TIME
    DESCRIPTION       = "UTC TIME YYYY-MM-DD HH:MM:SS.FFF"

```

```

END_OBJECT = COLUMN
OBJECT = COLUMN
  NAME           = OBT_TIME
  START_BYTE     = 26
  BYTES         = 16
  DATA_TYPE     = ASCII_REAL
  DESCRIPTION    = "SPACECRAFT ONBOARD TIME
SSSSSSSS.FFFFFFF (TRUE DECIMALPOINT)"
END_OBJECT = COLUMN
OBJECT = COLUMN
  NAME           = X_TSO
  START_BYTE     = 44
  BYTES         = 14
  DATA_TYPE     = ASCII_REAL
  UNIT          = "KM"
  DESCRIPTION    = "The spacecraft X coordinate in the
target-centric solar orbital coordinate system."
END_OBJECT = COLUMN
OBJECT = COLUMN
  NAME           = Y_TSO
  START_BYTE     = 60
  BYTES         = 14
  DATA_TYPE     = ASCII_REAL
  UNIT          = "KM"
  DESCRIPTION    = "The spacecraft Y coordinate in the
target-centric solar orbital coordinate system."
END_OBJECT = COLUMN
OBJECT = COLUMN
  NAME           = Z_TSO
  START_BYTE     = 76
  BYTES         = 14
  DATA_TYPE     = ASCII_REAL
  UNIT          = "KM"
  DESCRIPTION    = "The spacecraft Z coordinate in the
target-centric solar orbital coordinate system."
END_OBJECT = COLUMN
OBJECT = COLUMN
  NAME           = LATITUDE
  START_BYTE     = 92
  BYTES         = 14
  DATA_TYPE     = ASCII_REAL
  UNIT          = "DEGREES"
  DESCRIPTION    = "The spacecraft latitude on the
target."
END_OBJECT = COLUMN
OBJECT = COLUMN
  NAME           = LONGITUDE
  START_BYTE     = 108
  BYTES         = 14
  DATA_TYPE     = ASCII_REAL
  UNIT          = "DEGREES"
  DESCRIPTION    = "The spacecraft longitude on the
target."
END_OBJECT = COLUMN
OBJECT = COLUMN
  NAME           = SZA
  START_BYTE     = 124

```



```

        BYTES          = 14
        DATA_TYPE     = ASCII_REAL
        UNIT           = "DEGREES"
        DESCRIPTION    = "Solar zenith angle, the angle between
the spacecraft and the Sun as seen from the target."
        END_OBJECT = COLUMN
        OBJECT = COLUMN
        NAME           = SAA
        START_BYTE     = 140
        BYTES          = 14
        DATA_TYPE     = ASCII_REAL
        UNIT           = "DEGREES"
        DESCRIPTION    = "Solar aspect angle, longitude of the
Sun in the spacecraft coordinate system, counted positive from +Z
toward +X."
        END_OBJECT = COLUMN
        OBJECT = COLUMN
        NAME           = TAA
        START_BYTE     = 156
        BYTES          = 14
        DATA_TYPE     = ASCII_REAL
        UNIT           = "DEGREES"
        DESCRIPTION    = "Target aspect angle, longitude of the
target in the spacecraft coordinate system, counted positive from
+Z toward +X."
        END_OBJECT = COLUMN
        OBJECT = COLUMN
        NAME           = SEA
        START_BYTE     = 172
        BYTES          = 14
        DATA_TYPE     = ASCII_REAL
        UNIT           = "DEGREES"
        DESCRIPTION    = "Solar elevation angle, latitude of the
Sun in the spacecraft coordinate system, counted positive above
the XZ plane toward +Y."
        END_OBJECT = COLUMN
        OBJECT = COLUMN
        NAME           = TEA
        START_BYTE     = 188
        BYTES          = 14
        DATA_TYPE     = ASCII_REAL
        UNIT           = "DEGREES"
        DESCRIPTION    = "Target elevation angle, latitude of
the target in the spacecraft coordinate system, counted positive
above the XZ plane toward +Y."
        END_OBJECT = COLUMN
END_OBJECT = TABLE
END

```

### 5.3.2.2 Calibrated Data Product Designs

#### 5.3.2.2.1 Calibrated LF Fix Bias Measurement Data Product Design

PDS\_VERSION\_ID = PDS3

RECORD_TYPE	=	FIXED_LENGTH
RECORD_BYTES	=	83
FILE_RECORDS	=	3883277
FILE_NAME	=	
"LAP_20150620_000208_807_I1L.LBL"	=	
^TABLE	=	
"LAP_20150620_000208_807_I1L.TAB"	=	
DATA_SET_ID	=	"RO-C-RPCLAP-3-ESC2-CALIB2-V1.0"
DATA_SET_NAME	=	"ROSETTA-ORBITER 67P RPCLAP 3 ESC2 CALIB2 V1.0"
DATA_QUALITY_ID	=	"1"
MISSION_ID	=	ROSETTA
MISSION_NAME	=	"INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME	=	"COMET ESCORT 2"
PRODUCER_INSTITUTION_NAME	=	"SWEDISH INSTITUTE OF SPACE PHYSICS, UPPSALA"
PRODUCER_ID	=	EJ
PRODUCER_FULL_NAME	=	"ERIK P G JOHANSSON"
LABEL_REVISION_NOTE	=	"2016-08-18, EJ, Initial release"
PRODUCT_ID	=	"LAP_20150620_000208_807_I1L"
PRODUCT_TYPE	=	"RDR"
PRODUCT_CREATION_TIME	=	2016-08-30T12:01:44.975
INSTRUMENT_HOST_ID	=	RO
INSTRUMENT_HOST_NAME	=	"ROSETTA-ORBITER"
INSTRUMENT_NAME	=	"ROSETTA PLASMA CONSORTIUM - LANGMUIR PROBE"
INSTRUMENT_ID	=	RPCLAP
INSTRUMENT_TYPE	=	"PLASMA INSTRUMENT"
INSTRUMENT_MODE_ID	=	MCID0X0807
INSTRUMENT_MODE_DESC	=	"Density,Cont. 20 bit trun, LDL BM, 16 bit and Sweep P1"
TARGET_NAME	=	"67P/CHURYUMOV-GERASIMENKO 1 (1969 R1)"
TARGET_TYPE	=	"COMET"
PROCESSING_LEVEL_ID	=	"3"
START_TIME	=	2015-06-20T00:02:08.596
STOP_TIME	=	2015-06-20T23:59:27.714
SPACECRAFT_CLOCK_START_COUNT	=	"1/0393379251.15680"
SPACECRAFT_CLOCK_STOP_COUNT	=	"1/393465490.21576"
DESCRIPTION	=	"D_P1_TRNC_20_BIT_RAW_BIP"
ROSETTA:LAP_TM_RATE	=	"BURST"
ROSETTA:LAP_BOOTSTRAP	=	"ON"
ROSETTA:LAP_FEEDBACK_P1	=	"DENSITY"
ROSETTA:LAP_P1_ADC20	=	"DENSITY"
ROSETTA:LAP_P1_ADC16	=	"DENSITY"
ROSETTA:LAP_P1_RANGE_DENS_BIAS	=	"+-32"
ROSETTA:LAP_P1_STRATEGY_OR_RANGE	=	"GAIN 1"
ROSETTA:LAP_P1_RX_OR_TX	=	"ANALOG INPUT"
ROSETTA:LAP_P1_ADC16_FILTER	=	"8 KHz"
ROSETTA:LAP_VBIAS1	=	"0x00a8"
ROSETTA:LAP_P1_BIAS_MODE	=	"DENSITY"
ROSETTA:LAP_P1P2_ADC20_STATUS	=	"P1T"
ROSETTA:LAP_P1P2_ADC20_MA_LENGTH	=	"0x0001"
ROSETTA:LAP_P1P2_ADC20_DOWNSAMPLE	=	"0x0001"

```

OBJECT = TABLE
  INTERCHANGE_FORMAT = ASCII
  ROWS = 3883277
  COLUMNS = 5
  ROW_BYTES = 83
  DESCRIPTION = "D_P1_TRNC_20_BIT_RAW_BIP"
  OBJECT = COLUMN
    NAME = UTC_TIME
    START_BYTE = 1
    BYTES = 26
    DATA_TYPE = TIME
    UNIT = "SECONDS"
    DESCRIPTION = "UTC TIME"
  END_OBJECT = COLUMN
  OBJECT = COLUMN
    NAME = OBT_TIME
    START_BYTE = 29
    BYTES = 16
    DATA_TYPE = ASCII_REAL
    UNIT = "SECONDS"
    DESCRIPTION = "SPACECRAFT ONBOARD TIME SSSSSSSS.FFFFFFFF
(TRUE DECIMALPOINT)"
  END_OBJECT = COLUMN
  OBJECT = COLUMN
    NAME = P1_CURRENT
    START_BYTE = 47
    BYTES = 14
    DATA_TYPE = ASCII_REAL
    UNIT = "AMPERE"
    DESCRIPTION = "MEASURED CALIBRATED CURRENT"
  END_OBJECT = COLUMN
  OBJECT = COLUMN
    NAME = P1_VOLTAGE
    START_BYTE = 63
    BYTES = 14
    DATA_TYPE = ASCII_REAL
    UNIT = "VOLT"
    DESCRIPTION = "CALIBRATED VOLTAGE BIAS"
  END_OBJECT = COLUMN
  OBJECT = COLUMN
    NAME = QUALITY
    START_BYTE = 79
    BYTES = 3
    DATA_TYPE = ASCII_INTEGER
    UNIT = "N/A"
    DESCRIPTION = "QUALITY FACTOR FROM 000 (best) to 999."
  END_OBJECT = COLUMN
END_OBJECT = TABLE
END

```

### 5.3.2.2.2 Calibrated HF Fix Bias Data Product Design

```

PDS_VERSION_ID = PDS3
RECORD_TYPE = FIXED_LENGTH
RECORD_BYTES = 83

```

```

FILE_RECORDS = 5495760
FILE_NAME =
"LAP_20150620_000208_807_I1H.LBL"
^TABLE =
"LAP_20150620_000208_807_I1H.TAB"
DATA_SET_ID = "RO-C-RPCLAP-3-ESC2-CALIB2-
V1.0"
DATA_SET_NAME = "ROSETTA-ORBITER 67P RPCLAP
3 ESC2 CALIB2 V1.0"
DATA_QUALITY_ID = "1"
MISSION_ID = ROSETTA
MISSION_NAME = "INTERNATIONAL ROSETTA
MISSION"
MISSION_PHASE_NAME = "COMET ESCORT 2"
PRODUCER_INSTITUTION_NAME = "SWEDISH INSTITUTE OF SPACE
PHYSICS, UPPSALA"
PRODUCER_ID = EJ
PRODUCER_FULL_NAME = "ERIK P G JOHANSSON"
LABEL_REVISION_NOTE = "2016-08-18, EJ, Initial
release"
PRODUCT_ID =
"LAP_20150620_000208_807_I1H"
PRODUCT_TYPE = "RDR"
PRODUCT_CREATION_TIME = 2016-08-30T12:01:44.975
INSTRUMENT_HOST_ID = RO
INSTRUMENT_HOST_NAME = "ROSETTA-ORBITER"
INSTRUMENT_NAME = "ROSETTA PLASMA CONSORTIUM -
LANGMUIR PROBE"
INSTRUMENT_ID = RPCLAP
INSTRUMENT_TYPE = "PLASMA INSTRUMENT"
INSTRUMENT_MODE_ID = MCID0X0807
INSTRUMENT_MODE_DESC = "Density,Cont. 20 bit trun,
LDL BM, 16 bit and Sweep P1"
TARGET_NAME = "67P/CHURYUMOV-GERASIMENKO 1
(1969 R1)"
TARGET_TYPE = "COMET"
PROCESSING_LEVEL_ID = "3"
START_TIME = 2015-06-20T00:02:40.596
STOP_TIME = 2015-06-20T23:58:24.842
SPACECRAFT_CLOCK_START_COUNT = "1/0393379283.15680"
SPACECRAFT_CLOCK_STOP_COUNT = "1/393465427.29937"
DESCRIPTION = "D_P1_RAW_16BIT"
ROSETTA:LAP_TM_RATE = "BURST"
ROSETTA:LAP_BOOTSTRAP = "ON"
ROSETTA:LAP_FEEDBACK_P1 = "DENSITY"
ROSETTA:LAP_P1_ADC20 = "DENSITY"
ROSETTA:LAP_P1_ADC16 = "DENSITY"
ROSETTA:LAP_P1_RANGE_DENS_BIAS = "+-32"
ROSETTA:LAP_P1_STRATEGY_OR_RANGE = "GAIN 1"
ROSETTA:LAP_P1_RX_OR_TX = "ANALOG INPUT"
ROSETTA:LAP_P1_ADC16_FILTER = "8 KHz"
ROSETTA:LAP_VBIAS1 = "0x00a8"
ROSETTA:LAP_P1_BIAS_MODE = "DENSITY"
ROSETTA:LAP_P1_ADC16_DOWNSAMPLE = "0x0001"
ROSETTA:LAP_P1_DENSITY_FIX_DURATION = "0x0001"
OBJECT = TABLE
INTERCHANGE_FORMAT = ASCII

```

```

ROWS                = 5495760
COLUMNS            = 5
ROW_BYTES           = 83
DESCRIPTION         = "D_P1_RAW_16BIT"
OBJECT = COLUMN
  NAME              = UTC_TIME
  START_BYTE       = 1
  BYTES             = 26
  DATA_TYPE       = TIME
  UNIT              = "SECONDS"
  DESCRIPTION      = "UTC TIME"
END_OBJECT = COLUMN
OBJECT = COLUMN
  NAME              = OBT_TIME
  START_BYTE       = 29
  BYTES             = 16
  DATA_TYPE       = ASCII_REAL
  UNIT              = "SECONDS"
  DESCRIPTION      = "SPACECRAFT ONBOARD TIME SSSSSSSS.FFFFFFFF
(TRUE DECIMALPOINT)"
END_OBJECT = COLUMN
OBJECT = COLUMN
  NAME              = P1_CURRENT
  START_BYTE       = 47
  BYTES             = 14
  DATA_TYPE       = ASCII_REAL
  UNIT              = "AMPERE"
  DESCRIPTION      = "MEASURED CALIBRATED CURRENT"
END_OBJECT = COLUMN
OBJECT = COLUMN
  NAME              = P1_VOLTAGE
  START_BYTE       = 63
  BYTES             = 14
  DATA_TYPE       = ASCII_REAL
  UNIT              = "VOLT"
  DESCRIPTION      = "CALIBRATED VOLTAGE BIAS"
END_OBJECT = COLUMN
OBJECT = COLUMN
  NAME              = QUALITY
  START_BYTE       = 79
  BYTES             = 3
  DATA_TYPE       = ASCII_INTEGER
  UNIT              = "N/A"
  DESCRIPTION      = "QUALITY FACTOR FROM 000 (best) to 999."
END_OBJECT = COLUMN
END_OBJECT = TABLE
END

```

### 5.3.2.2.3 Calibrated Fix Bias Difference Measurement Data Product Design

```

PDS_VERSION_ID     = PDS3
RECORD_TYPE        = FIXED_LENGTH
RECORD_BYTES       = 99
FILE_RECORDS       = 2048

```

```

FILE_NAME =
"RPCLAP_20050304_173213_603_I3H.LBL"
^TABLE =
"RPCLAP_20050304_173213_603_I3H.TAB"
DATA_SET_ID = "RO-E-RPCLAP-5-EAR1-DERIV-
V0.5"
DATA_SET_NAME = "ROSETTA-ORBITER EARTH
RPCLAP 5 EAR1 DERIV V0.5"
DATA_QUALITY_ID = "1"
MISSION_ID = ROSETTA
MISSION_NAME = "INTERNATIONAL ROSETTA
MISSION"
MISSION_PHASE_NAME = "EARTH SWING-BY 1"
PRODUCER_INSTITUTION_NAME = "SWEDISH INSTITUTE OF SPACE
PHYSICS, UPPSALA"
PRODUCER_ID = EJ
PRODUCER_FULL_NAME = "ERIK P G JOHANSSON"
LABEL_REVISION_NOTE = "2015-02-27T12:00:00, EJ,
4th draft"
PRODUCT_ID =
"RPCLAP_20050304_173213_603_I3H"
PRODUCT_TYPE = "DDR"
PRODUCT_CREATION_TIME = 2016-08-02T19:59:47.579
INSTRUMENT_HOST_ID = RO
INSTRUMENT_HOST_NAME = "ROSETTA-ORBITER"
INSTRUMENT_NAME = "ROSETTA PLASMA CONSORTIUM -
LANGMUIR PROBE"
INSTRUMENT_ID = RPCLAP
INSTRUMENT_TYPE = "PLASMA INSTRUMENT"
INSTRUMENT_MODE_ID = MCID0X0603
INSTRUMENT_MODE_DESC = "As MCID0x212 but with
difference measurments"
TARGET_NAME = "EARTH"
TARGET_TYPE = "PLANET"
PROCESSING_LEVEL_ID = "5"
START_TIME = 2005-03-04T17:32:13.417
STOP_TIME = 2005-03-04T17:55:09.430
SPACECRAFT_CLOCK_START_COUNT = "1/0068578314.1600"
SPACECRAFT_CLOCK_STOP_COUNT = "1/0068579690.2491"
DESCRIPTION = "D_DIFF_P1P2"
ROSETTA:LAP_TM_RATE = "NORMAL"
ROSETTA:LAP_BOOTSTRAP = "ON"
ROSETTA:LAP_FEEDBACK_P1 = "DENSITY"
ROSETTA:LAP_P1_ADC20 = "DENSITY"
ROSETTA:LAP_P1_ADC16 = "DENSITY"
ROSETTA:LAP_P1_RANGE_DENS_BIAS = "+-32"
ROSETTA:LAP_P1_STRATEGY_OR_RANGE = "GAIN 1"
ROSETTA:LAP_P1_RX_OR_TX = "ANALOG INPUT"
ROSETTA:LAP_P1_ADC16_FILTER = "8 KHz"
ROSETTA:LAP_VBIAS1 = "0x00d0"
ROSETTA:LAP_P1_BIAS_MODE = "DENSITY"
ROSETTA:LAP_P1_ADC16_DOWNSAMPLE = "0x0001"
ROSETTA:LAP_P1_DENSITY_FIX_DURATION = "0x0100"
ROSETTA:LAP_FEEDBACK_P2 = "DENSITY"
ROSETTA:LAP_P2_ADC20 = "DENSITY"
ROSETTA:LAP_P2_ADC16 = "DENSITY"
ROSETTA:LAP_P2_RANGE_DENS_BIAS = "+-32"

```

```

ROSETTA:LAP_P2_STRATEGY_OR_RANGE      = "GAIN 1"
ROSETTA:LAP_P2_RX_OR_TX                = "ANALOG INPUT"
ROSETTA:LAP_P2_ADC16_FILTER            = "8 KHz"
ROSETTA:LAP_VBIAS2                     = "0x00d0"
ROSETTA:LAP_P2_BIAS_MODE                = "DENSITY"
ROSETTA:LAP_P2_ADC16_DOWNSAMPLE        = "0x0001"
ROSETTA:LAP_P2_DENSITY_FIX_DURATION    = "0x0100"
OBJECT = TABLE
  INTERCHANGE_FORMAT = ASCII
  ROWS                = 2048
  COLUMNS            = 6
  ROW_BYTES           = 99
  DESCRIPTION         = "D_DIFF_P1P2"
  OBJECT = COLUMN
    NAME              = UTC_TIME
    START_BYTE        = 1
    BYTES              = 26
    DATA_TYPE         = TIME
    UNIT               = SECONDS
    DESCRIPTION       = "UTC TIME"
  END_OBJECT = COLUMN
  OBJECT = COLUMN
    NAME              = OBT_TIME
    START_BYTE        = 29
    BYTES              = 16
    DATA_TYPE         = ASCII_REAL
    UNIT               = SECONDS
    DESCRIPTION       = "SPACECRAFT ONBOARD TIME"
SSSSSSSS.FFFFFFF (TRUE DECIMALPOINT) "
  END_OBJECT = COLUMN
  OBJECT = COLUMN
    NAME              = P1-P2_CURRENT
    START_BYTE        = 47
    BYTES              = 14
    DATA_TYPE         = ASCII_REAL
    UNIT               = AMPERE
    DESCRIPTION       = "MEASURED CALIBRATED CURRENT"
  END_OBJECT = COLUMN
  OBJECT = COLUMN
    NAME              = P1_VOLTAGE
    START_BYTE        = 63
    BYTES              = 14
    DATA_TYPE         = ASCII_REAL
    UNIT               = VOLT
    DESCRIPTION       = "CALIBRATED VOLTAGE BIAS"
  END_OBJECT = COLUMN
  OBJECT = COLUMN
    NAME              = P2_VOLTAGE
    START_BYTE        = 79
    BYTES              = 14
    DATA_TYPE         = ASCII_REAL
    UNIT               = VOLT
    DESCRIPTION       = "CALIBRATED VOLTAGE BIAS"
  END_OBJECT = COLUMN
  OBJECT = COLUMN
    NAME              = QUALITY
    START_BYTE        = 95

```

```

        BYTES                = 3
        DATA_TYPE           = ASCII_REAL
        UNIT                  = "N/A"
        DESCRIPTION          = "QUALITY FACTOR FROM 000 (best) to
999."
        END_OBJECT = COLUMN
END_OBJECT = TABLE
END

```

### 5.3.2.2.4 Calibrated Sweep Measurement Data Product Design

```

PDS_VERSION_ID           = PDS3
RECORD_TYPE              = FIXED_LENGTH
RECORD_BYTES            = 3953
FILE_RECORDS            = 1348
FILE_NAME                =
"LAP_20150620_000208_807_I1S.LBL"
^TABLE                  =
"LAP_20150620_000208_807_I1S.TAB"
DATA_SET_ID             = "RO-C-RPCLAP-3-ESC2-
CALIB2-V1.0"
DATA_SET_NAME           = "ROSETTA-ORBITER 67P
RPCLAP 3 ESC2 CALIB2 V1.0"
DATA_QUALITY_ID         = "1"
MISSION_ID              = ROSETTA
MISSION_NAME            = "INTERNATIONAL ROSETTA
MISSION"
MISSION_PHASE_NAME      = "COMET ESCORT 2"
PRODUCER_INSTITUTION_NAME = "SWEDISH INSTITUTE OF
SPACE PHYSICS, UPPSALA"
PRODUCER_ID             = EJ
PRODUCER_FULL_NAME      = "ERIK P G JOHANSSON"
LABEL_REVISION_NOTE     = "2016-08-18, EJ, Initial
release"
PRODUCT_ID              =
"LAP_20150620_000208_807_I1S"
PRODUCT_TYPE            = "RDR"
PRODUCT_CREATION_TIME   = 2016-08-30T12:01:44.975
INSTRUMENT_HOST_ID      = RO
INSTRUMENT_HOST_NAME    = "ROSETTA-ORBITER"
INSTRUMENT_NAME         = "ROSETTA PLASMA CONSORTIUM
- LANGMUIR PROBE"
INSTRUMENT_ID           = RPCLAP
INSTRUMENT_TYPE         = "PLASMA INSTRUMENT"
INSTRUMENT_MODE_ID      = MCID0X0807
INSTRUMENT_MODE_DESC    = "Density,Cont. 20 bit
trun, LDL BM, 16 bit and Sweep P1"
TARGET_NAME             = "67P/CHURYUMOV-GERASIMENKO
1 (1969 R1)"
TARGET_TYPE             = "COMET"
PROCESSING_LEVEL_ID     = "3"
START_TIME              = 2015-06-20T00:02:08.596
STOP_TIME               = 2015-06-20T23:59:03.253
SPACECRAFT_CLOCK_START_COUNT = "1/0393379251.15680"
SPACECRAFT_CLOCK_STOP_COUNT = "1/393465465.56881"

```



```

DESCRIPTION = "D_SWEEP_P1_RAW_16BIT_BIP"
ROSETTA:LAP_TM_RATE = "BURST"
ROSETTA:LAP_BOOTSTRAP = "ON"
ROSETTA:LAP_FEEDBACK_P1 = "DENSITY"
ROSETTA:LAP_P1_ADC20 = "DENSITY"
ROSETTA:LAP_P1_ADC16 = "DENSITY"
ROSETTA:LAP_P1_RANGE_DENS_BIAS = "+-32"
ROSETTA:LAP_P1_STRATEGY_OR_RANGE = "GAIN 1"
ROSETTA:LAP_P1_RX_OR_TX = "ANALOG INPUT"
ROSETTA:LAP_P1_ADC16_FILTER = "8 KHz"
ROSETTA:LAP_P1_INITIAL_SWEEP_SMPLS = "0x0005"
ROSETTA:LAP_P1_SWEEP_PLATEAU_DURATION = "0x0200"
ROSETTA:LAP_P1_SWEEP_STEPS = "0x00f0"
ROSETTA:LAP_P1_SWEEP_START_BIAS = "0x00f8"
ROSETTA:LAP_P1_SWEEP_FORMAT = "DOWN"
ROSETTA:LAP_P1_SWEEP_RESOLUTION = "COARSE"
ROSETTA:LAP_P1_SWEEP_STEP_HEIGHT = "0x0001"
ROSETTA:LAP_P1_ADC16_DOWNSAMPLE = "0x0080"
ROSETTA:LAP_SWEEPING_P1 = "YES"
ROSETTA:LAP_P1_FINE_SWEEP_OFFSET = "0x0000"
OBJECT = TABLE
  INTERCHANGE_FORMAT = ASCII
  ROWS = 1348
  COLUMNS = 246
  ROW_BYTES = 3953
  DESCRIPTION = "D_SWEEP_P1_RAW_16BIT_BIP"
  OBJECT = COLUMN
    NAME = START_TIME_UTC
    START_BYTE = 1
    BYTES = 26
    DATA_TYPE = TIME
    UNIT = "SECONDS"
    DESCRIPTION = "START UTC TIME YYYY-MM-DD HH:MM:SS.FFFFFFFF"
  END_OBJECT = COLUMN
  OBJECT = COLUMN
    NAME = STOP_TIME_UTC
    START_BYTE = 29
    BYTES = 26
    DATA_TYPE = TIME
    UNIT = "SECONDS"
    DESCRIPTION = "STOP UTC TIME YYYY-MM-DD HH:MM:SS.FFFFFFFF"
  END_OBJECT = COLUMN
  OBJECT = COLUMN
    NAME = START_TIME_OBT
    START_BYTE = 57
    BYTES = 16
    DATA_TYPE = ASCII_REAL
    UNIT = "SECONDS"
    DESCRIPTION = "START SPACECRAFT ONBOARD TIME
SSSSSSSS.FFFFFFF (TRUE DECIMALPOINT)"
  END_OBJECT = COLUMN
  OBJECT = COLUMN
    NAME = STOP_TIME_OBT
    START_BYTE = 75
    BYTES = 16
    DATA_TYPE = ASCII_REAL
    UNIT = "SECONDS"

```

```

        DESCRIPTION = "STOP SPACECRAFT ONBOARD TIME
SSSSSSSS.FFFFFFF (TRUE DECIMALPOINT)"
    END_OBJECT = COLUMN
    OBJECT = COLUMN
        NAME          = QUALITY
        START_BYTE    = 93
        BYTES         = 3
        DATA_TYPE    = ASCII_INTEGER
        UNIT          = "N/A"
        DESCRIPTION   = "QUALITY FACTOR FROM 000 (best) to 999."
    END_OBJECT = COLUMN
    OBJECT = COLUMN
        NAME          = P1_SWEEP_CURRENT
        START_BYTE    = 98
        BYTES         = 3854
        DATA_TYPE    = ASCII_REAL
        UNIT          = "AMPERE"
        ITEMS         = 241
        ITEM_BYTES    = 14
        ITEM_OFFSET   = 16
        DESCRIPTION   = "One current for each of the voltage
potential sweep steps described by
RPCLAP_20150620_000208_807_B1S.TAB. Each current is the average
over multiple measurements on a single potential step. A value of
-1.0e3 implies the absense of a value."
        MISSING_CONSTANT = -1.0e3
    END_OBJECT = COLUMN
END_OBJECT = TABLE
END

```

### 5.3.2.2.5 Calibrated Sweep Description Product Design

```

PDS_VERSION_ID          = PDS3
RECORD_TYPE             = FIXED_LENGTH
RECORD_BYTES            = 32
FILE_RECORDS            = 241
FILE_NAME                =
"LAP_20150620_000208_807_B1S.LBL"
^TABLE                  =
"LAP_20150620_000208_807_B1S.TAB"
DATA_SET_ID             = "RO-C-RPCLAP-3-ESC2-
CALIB2-V1.0"
DATA_SET_NAME           = "ROSETTA-ORBITER 67P
RPCLAP 3 ESC2 CALIB2 V1.0"
DATA_QUALITY_ID         = "1"
MISSION_ID              = ROSETTA
MISSION_NAME            = "INTERNATIONAL ROSETTA
MISSION"
MISSION_PHASE_NAME      = "COMET ESCORT 2"
PRODUCER_INSTITUTION_NAME = "SWEDISH INSTITUTE OF
SPACE PHYSICS, UPPSALA"
PRODUCER_ID            = EJ
PRODUCER_FULL_NAME      = "ERIK P G JOHANSSON"
LABEL_REVISION_NOTE     = "2016-08-18, EJ, Initial
release"

```

```

PRODUCT_ID =
"LAP_20150620_000208_807_B1S"
PRODUCT_TYPE = "RDR"
PRODUCT_CREATION_TIME = 2016-08-30T12:01:44.975
INSTRUMENT_HOST_ID = RO
INSTRUMENT_HOST_NAME = "ROSETTA-ORBITER"
INSTRUMENT_NAME = "ROSETTA PLASMA CONSORTIUM
- LANGMUIR PROBE"
INSTRUMENT_ID = RPCLAP
INSTRUMENT_TYPE = "PLASMA INSTRUMENT"
INSTRUMENT_MODE_ID = MCID0X0807
INSTRUMENT_MODE_DESC = "Density,Cont. 20 bit
trun, LDL BM, 16 bit and Sweep P1"
TARGET_NAME = "67P/CHURYUMOV-GERASIMENKO
1 (1969 R1)"
TARGET_TYPE = "COMET"
PROCESSING_LEVEL_ID = "3"
START_TIME = 2015-06-20T00:02:08.596
STOP_TIME = 2015-06-20T23:59:03.253
SPACECRAFT_CLOCK_START_COUNT = "1/0393379251.15680"
SPACECRAFT_CLOCK_STOP_COUNT = "1/393465465.56881"
DESCRIPTION = "D_SWEEP_P1_RAW_16BIT_BIP"
ROSETTA:LAP_TM_RATE = "BURST"
ROSETTA:LAP_BOOTSTRAP = "ON"
ROSETTA:LAP_FEEDBACK_P1 = "DENSITY"
ROSETTA:LAP_P1_ADC20 = "DENSITY"
ROSETTA:LAP_P1_ADC16 = "DENSITY"
ROSETTA:LAP_P1_RANGE_DENS_BIAS = "+-32"
ROSETTA:LAP_P1_STRATEGY_OR_RANGE = "GAIN 1"
ROSETTA:LAP_P1_RX_OR_TX = "ANALOG INPUT"
ROSETTA:LAP_P1_ADC16_FILTER = "8 KHz"
ROSETTA:LAP_P1_INITIAL_SWEEP_SMPLS = "0x0005"
ROSETTA:LAP_P1_SWEEP_PLATEAU_DURATION = "0x0200"
ROSETTA:LAP_P1_SWEEP_STEPS = "0x00f0"
ROSETTA:LAP_P1_SWEEP_START_BIAS = "0x00f8"
ROSETTA:LAP_P1_SWEEP_FORMAT = "DOWN"
ROSETTA:LAP_P1_SWEEP_RESOLUTION = "COARSE"
ROSETTA:LAP_P1_SWEEP_STEP_HEIGHT = "0x0001"
ROSETTA:LAP_P1_ADC16_DOWNSAMPLE = "0x0080"
ROSETTA:LAP_SWEEPING_P1 = "YES"
ROSETTA:LAP_P1_FINE_SWEEP_OFFSET = "0x0000"
OBJECT = TABLE
  INTERCHANGE_FORMAT = ASCII
  ROWS = 241
  COLUMNS = 2
  ROW_BYTES = 32
  DESCRIPTION = "D_SWEEP_P1_RAW_16BIT_BIP Sweep step bias
and time between each step"
  OBJECT = COLUMN
    NAME = SWEEP_TIME
    START_BYTE = 1
    BYTES = 14
    DATA_TYPE = ASCII_REAL
    UNIT = "SECONDS"
    DESCRIPTION = "LAPSED TIME (S/C CLOCK TIME) FROM FIRST
SWEEP MEASUREMENT"
  END_OBJECT = COLUMN

```

```

OBJECT = COLUMN
  NAME      = P1_VOLTAGE
  START_BYTE = 17
  BYTES     = 14
  DATA_TYPE = ASCII_REAL
  UNIT      = "VOLT"
  DESCRIPTION = "CALIBRATED VOLTAGE BIAS"
END_OBJECT = COLUMN
END_OBJECT = TABLE
END

```

### 5.3.2.2.6 Calibrated Block List Data Product Design

```

PDS_VERSION_ID      = PDS3
RECORD_TYPE         = FIXED_LENGTH
RECORD_BYTES        = 55
FILE_RECORDS        = 1
FILE_NAME           = "LAP_20150620_000000_BLKLIST.LBL"
^TABLE             = "LAP_20150620_000000_BLKLIST.TAB"
DATA_SET_ID         = "RO-C-RPCLAP-3-ESC2-CALIB2-V1.0"
DATA_SET_NAME       = "ROSETTA-ORBITER 67P RPCLAP 3 ESC2
CALIB2 V1.0"
DATA_QUALITY_ID     = "1"
MISSION_ID          = ROSETTA
MISSION_NAME        = "INTERNATIONAL ROSETTA MISSION"
MISSION_PHASE_NAME  = "COMET ESCORT 2"
PRODUCER_INSTITUTION_NAME = "SWEDISH INSTITUTE OF SPACE
PHYSICS, UPPSALA"
PRODUCER_ID         = EJ
PRODUCER_FULL_NAME  = "ERIK P G JOHANSSON"
LABEL_REVISION_NOTE = "2016-08-18, EJ, Initial release"
PRODUCT_ID          = "LAP_20150620_000000_BLKLIST"
PRODUCT_TYPE        = "RDR"
PRODUCT_CREATION_TIME = 2016-08-30T12:01:44.975
INSTRUMENT_HOST_ID  = RO
INSTRUMENT_HOST_NAME = "ROSETTA-ORBITER"
INSTRUMENT_NAME     = "ROSETTA PLASMA CONSORTIUM -
LANGMUIR PROBE"
INSTRUMENT_ID       = RPCLAP
INSTRUMENT_TYPE     = "PLASMA INSTRUMENT"
TARGET_NAME         = "67P/CHURYUMOV-GERASIMENKO 1 (1969
R1) "
TARGET_TYPE         = "COMET"
PROCESSING_LEVEL_ID = "3"
START_TIME          = 2015-06-20T00:00:00.000
STOP_TIME           = 2015-06-21T00:00:00.000
SPACECRAFT_CLOCK_START_COUNT = "1/0393379122.42145"
SPACECRAFT_CLOCK_STOP_COUNT = "1/0393465522.40266"
OBJECT = TABLE
  INTERCHANGE_FORMAT = ASCII
  ROWS                = 1
  COLUMNS            = 3
  ROW_BYTES           = 55

```

```

DESCRIPTION          = "BLOCKLIST DATA. START & STOP TIME OF
MACRO BLOCK AND MACRO ID."
OBJECT = COLUMN
  NAME                = START_TIME_UTC
  START_BYTE          = 1
  BYTES               = 23
  DATA_TYPE          = TIME
  UNIT                = "SECONDS"
  DESCRIPTION         = "START TIME OF MACRO BLOCK YYYY-MM-DD
HH:MM:SS.sss"
END_OBJECT = COLUMN
OBJECT = COLUMN
  NAME                = STOP_TIME_UTC
  START_BYTE          = 26
  BYTES               = 23
  DATA_TYPE          = TIME
  UNIT                = "SECONDS"
  DESCRIPTION         = "LAST START TIME OF MACRO BLOCK FILE YYYY-
MM-DD HH:MM:SS.sss"
END_OBJECT = COLUMN
OBJECT = COLUMN
  NAME                = MACRO_ID
  START_BYTE          = 51
  BYTES               = 3
  DATA_TYPE          = CHARACTER
  UNIT                = "N/A"
  DESCRIPTION         = "HEXADECIMAL MACRO IDENTIFICATION NUMBER."
END_OBJECT = COLUMN
END_OBJECT = TABLE
END

```