ESL SWARM

Swarm Expert Support Laboratories

EFI LP Preliminary Data Release Notes

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Doc. no: SW-RN-IRF-GS-002, Rev: 1, 2015-02-06

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Record of Changes

Reason	Description	Rev	Date
Initial vers.	Released	1 dA	2015-02-06
Signature		1	2015-02-06

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None.

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1 Introduction

1.1 Purpose and Scope

The purpose of this document is to provide notes on the latest preliminary Swarm EFI Langmuir Probe (LP) data release.

2 Applicable and Reference Documentation

2.1 Applicable Documents

[AD-1] SW-TN-IRF-EF-003, Level 1b Algorithms (LP)

2.2 Reference Documents

[RD-1] SW-RS-DSC-SY-0007, Level 1b Product Definition

2.3 Abbreviations

Acronym ***or abbreviation***	***Description***
EFI	Electric Field Instrument, including the TII and the LP
ESA	European Space Agency
ESL	Swarm Expert Support Laboratories
ICDB	Instrument Calibration DataBase
JIRA	Atlassian JIRA internet based tool for tracking issues with server located at DTU https://jira.spacecenter.dk/
L0	Level 0 (satellite data)
L1	Level 1 (satellite data)
L1b	Level 1b (satellite data)
LP	Langmuir Probe, part of the Electrical Field Instrument
SVN	SVN Repository with server located at DTU. Presently, the following URLs apply: https://smart-svn.spacecenter.dk/svn/smart/SwarmESL-All https://smart-svn.spacecenter.dk/svn/smart/SwarmL2 (heritage from the L2PS Project)
SW	Software
Swarm	Constellation of 3 ESA satellites, http://www.esa.int/esaLP/ESA3QZJE43D_LPswarm_0.html
TBC	To Be Confirmed

Acronym ***or abbreviation***	***Description***
TBD	To Be Defined
TLE	Two-Line Element, a data format describing orbital elements of satellites
TDS	Test Data Set
TII	Thermal Ion Imager, part of the Electrical Field Instrument
IRF	Swedish Institute of Space Physics (“Institutet för RymdFysik” in Swedish)
UoC	University of Calgary (CA)

3 L1b data release overview

This release note describes the preliminary Swarm EFI Level 1b electron density, electron temperature and spacecraft potential measurements obtained with a development, or "sandbox", L1b processor that was implemented at IRF.

3.1 Data periods

We have processed all EFI L0 normal mode files available to us from December 9, 2013 and thereafter, but not EFI TII or LP calibration modes. The processed data include (rare) periods when the spacecraft were flown with unusual attitude or other unusual configurations that a user might want to exclude in her analysis. Generally this LP data set has only information about the state of the LP. At the end of these notes is a list of email addresses and web site where more information can be obtained.

3.2 File format and names

Data are provided in ZIP-archived files with the following naming convention:

SW_PREL_EFIX_LP_1B_YYYYMMDDTHHMMSS_yyyymmddThhmss_VVVV.zip

where

- PREL indicates the data are preliminary;
- X is the satellite letter, one of A, B or C;
- LP_1B indicates this file contain a subset of LP-related L1b plasma products;
- YYYYMMDDTHHMMSS is the beginning of the interval;
- yyyymmddThhmmss is the end of the interval;
- VVVV maps to the following configurations:

Table 1 Interpretation of PREL filename versions.

VVVV	Description
0101	Released on Nov 18, 2014 to Cal/Val
0102	Minor modifications after feedback from Cal/Val

Each file uncompresses to a header and a text file with endings ".hdr" and ".txt". For easier reading header and text can be concatenated. To obtain larger data sets, ".txt" files can be concatenated.

3.3 Data fields

The text files contain the following columns:

Table 2 LP text data file contents

Variable	Type	Unit	Note
Satellite	Character	N/A	Values are "A", "B", or "C"

Variable	Type	Unit	Note
Timestamp	String	N/A	ISO8601 formatted timestamp
Day2000	Integer	day	Days since Jan 1, 2000, 0 UTC
Msec	Integer	ms	Milliseconds of day.
Latitude	Float	deg	Geodetic latitude.
Longitude	Float	deg	Geodetic longitude.
Height	Float	km	Height above WGS84 reference ellipsoid.
Radius	Float	km	Distance from the Earth's centre.
SZA	Float	deg	Solar Zenith Angle.
SAz	Float	deg	Solar azimuth in Earth frame, north is 0 deg.
Ne	Float	/cm3	Plasma density per cubic centimetre.
Te	Float	K	Electron temperature in K.
Vs	Float	V	Spacecraft potential in V.
Flag	Integer	N/A	Flag bits indicate data quality/details.

Satellite positions are calculated from TLEs, kindly provided by ESOC FOS, and the usual sgdp4 Software.

3.4 Latest version of LP L1b processor

This release of the Swarm EFI Level 1b preliminary LP data was processed using the IRF sandbox LP processor revision 07c, which is stored in subversion revision 6994 at the following URL:

https://smart-svn.spacecenter.dk/svn/smart/SwarmESL-Exchange/DTU-IRF/IRF_to_DTU/l1b_andbox/

4 Release Notes

4.1 Dataset Version 0101

The initial release is based on algorithms described in [AD-1], however, the plasma density is derived from the ion admittance, equation 4.6 in [AD-1]. No version controlled sandbox processor is available for this release.

4.2 Dataset Version 0102

4.2.1 Configuration

Presently the sandbox processor reads only L0 data, it doesn't receive any input from the ICDB or post-calibration files. Configuration parameters are determined by the code.

4.2.2 Changes

After input from ESL and Cal-Val users the following changes were done

- the electron temperature is in Kelvin
- corrected formatting, absolutely small values of floating points numbers had been malformatted in version 0101
- in version 0101 occasional NaN/NULL values were printed as empty strings which causes problems when reading the data in text format. Now a fill value of 99 is used for invalid data (Naturally 99 should never occur for Ne, Te, or Vs).
- the timestamps reflect now the time when Ne is measured. Te and Vs are measured about 100 milliseconds after this timestamp. An exact value cannot be given due to the inherent method of LPs to measure at several points of the current-voltage characteristics, which takes a finite, non-zero time.
- the data rows are always listed ordered in time. In version 0101, because of a bug, occasionally data were not listed in the right time order.
- also very small floating point values are now formatted correctly. In version 0101 malformatted values occurred.

4.2.3 Known problems or limitations

The IRF sandbox processor differs from the algorithms described in [AD-1] as follows:

1. The plasma density is derived using the ion admittance, equation 4.6 in [AD-1]. The values suffer less from outliers and disturbances, are not affected by some instrumental problems such as failed 0-tracking.
2. The spacecraft potential is always derived from the low gain probe.
3. Measurement errors are not calculated.

4. The electron temperature is calculated from the low gain probe for high densities and from the high gain probe for low densities. In a transition region between high and low density a blended temperature value is calculated. The high and low limits of the transition region are coded.

All data should be treated with caution as to its interpretation. The following issues are known, but not yet always properly flagged:

1. Bursts of very high electron temperatures and erratic spacecraft potential seem to occur mainly at high latitudes.