	RPW Calibration Software User Manual Template	Ref: RPW-MEB-LFR-SRS-000268
		<b>Issue: 01</b> Revision: 00 Date: 20/01/20178 - 1 / 11 -



# RPW Operation Centre

## LFR Calbut Software Requirement Specification


RPW-MEB-LFR-SRS-XXXX

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### Change Record

Issue	Rev.	Date	Authors	Modifications
1	0	15/03/2017	R.Piberne B.Katra	First issue

### Acronym List

Acronym	Definition
RCS	RPW Calibration Software
ROC	RPW Operation Centre
RPW	Radio and Plasma Waves instrument
SUM	Software User Manual
LFR	Low Frequency Receiver
CALBUT	CALiBration software UniT
RPW	Radio and Plasma Wave analyzer
BP1	Basic Parameters set 1
BP2	Basic Parameters set 2
WF	Waveform
CWF	Continuous Waveform
SWF	Snapshot Waveform
ASM	Average Spectral Matrix
SBM1	Selected Burst Mode 1
SBM2	Selected Burst Mode 2
SURV	Survey Mode

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## Introduction

This document provides a specification of the ground calibration software for RPW LFR data (calbut).

# 1 APPLICABLE AND REFERENCE DOCUMENTS

## 1.1 Applicable Documents

This document responds to the requirements of the documents listed in the following table:

Mark	Reference/Iss/Rev	Title of the document	Authors	Date
AD1	ROC-PRO-PIP-ICD-00037/1/02	RPW Calibration Software Interface Control Document	M.Duarte, X.Bonnin	16/11/2016
AD2	ROC-PRO-DAT-NTT-00006-LES/1/2	RPW Data Products	X.Bonnin	17/11/2017
AD3	ROC-GEN-SYS-NTT-00019-LES/2/01	ROC_Engineering_Guidelines	X.Bonnin	30/05/2017

**Table 1: List of applicable documents**

## 1.2 Reference Documents

This document is based on the documents listed in the following table:

Mark	Reference/Iss/Rev	Title of the document	Authors	Date
RD1	RPW-MEB-LFR-SUM-00254/1/02	Calbut Software User Manual	R. Piberne B. Katra	26/09/2017

**Table 2: List of reference documents**



## 2 LFR MODES AND DATA PRODUCTS

### 2.1 LFR Overview

The LFR instrument is designed to produce and transmit waveforms (WF), averaged spectral matrices (ASM) and basic parameters (BP) from low frequency electromagnetic measurements (quasi DC- 10kHz). The LFR analyzer acquires eleven analogical input signals: BIAS\_1, BIAS\_2, BIAS\_3, BIAS\_4, BIAS\_5, VHF\_1, VHF\_2, VHF\_3, SCM\_1, SCM\_2, SCM\_3. The LFR block diagram (Figure 1: LFR Block Diagram) shows these eleven inputs.

On each channel, an anti-aliasing filter is applied before converting the analog data to device data and then, down-sampling and decimating the data to produce waveforms at four different sampling frequencies:

- $f_0 = 24\,576$  Hz
- $f_1 = 4096$  Hz
- $f_2 = 256$  Hz
- $f_3 = 16$  Hz

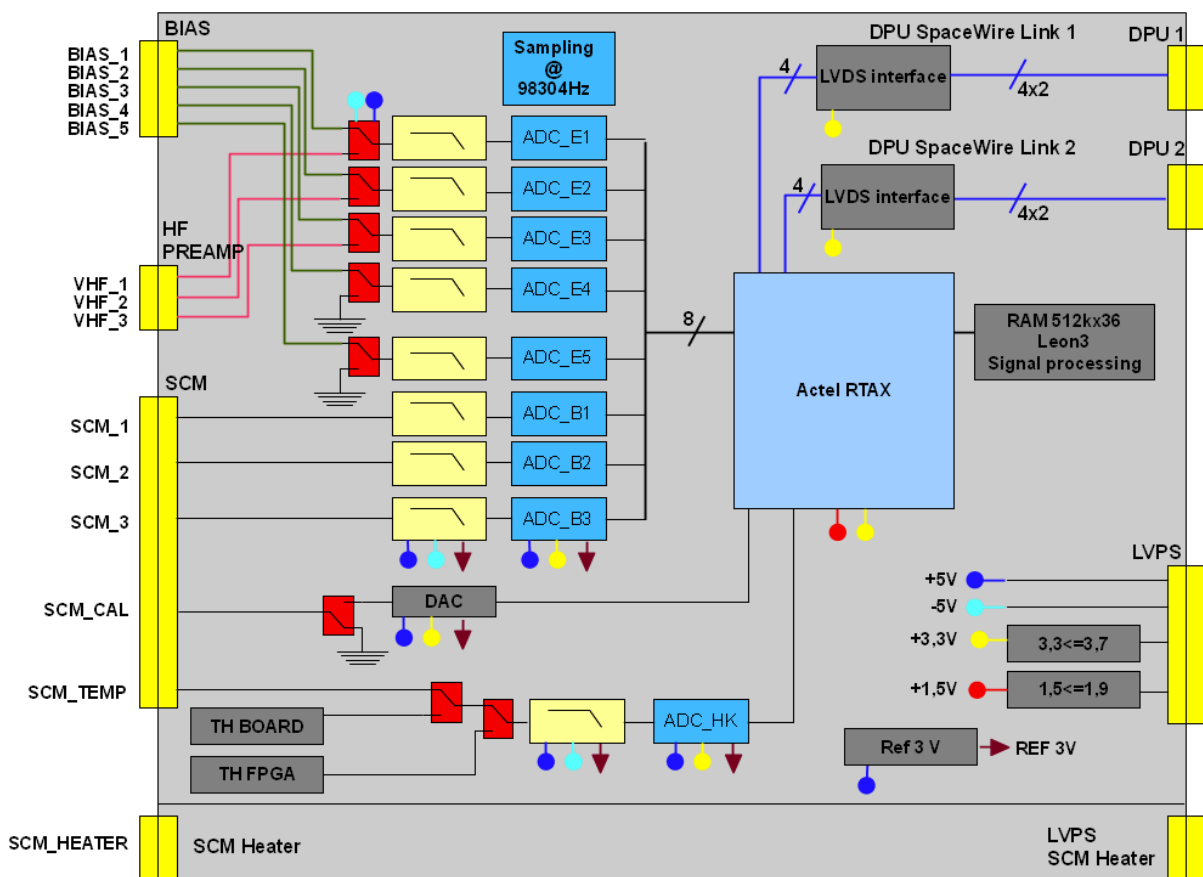


Figure 1: LFR Block Diagram

## 2.2 LFR modes

LFR can run in four modes:


- **NORMAL**: low cadence mode basically runs all the time along the orbit.
- **BURST**: high cadence mode.
- **SBM1**: high cadence mode for the interplanetary shocks measurements.
- **SBM2**: high cadence mode for in-situ type III measurements.

NORMAL and BURST modes are exclusive, but SBM1 runs in parallel with NORMAL mode and SBM2 also runs in parallel with NORMAL mode.

## 2.3 LFR Data Products

Calbut is a software developed in order to convert LFR Level 1 CDF files to higher level products (L1R or L2). Here follows a list of dataset produced by calbut with their input parameters:

Dataset	From	Description
ROC-SGSE_L2_RPW-LFR-SBM1-BP1	ROC-SGSE_L1_RPW-LFR-SBM1-BP1	RPW Low Frequency Receiver Basic parameters set 1 data in SBM1 mode
ROC-SGSE_L2_RPW-LFR-SBM1-BP2	ROC-SGSE_L1_RPW-LFR-SBM1-BP2	RPW Low Frequency Receiver Basic parameters set 2 data in SBM1 mode
ROC-SGSE_L1R_RPW-LFR-SBM1-CWF-B	ROC-SGSE_L1_RPW-LFR-SBM1-CWF	RPW Low Frequency Receiver Continuous Waveform magnetic data in SBM1 mode
ROC-SGSE_L1R_RPW-LFR-SBM1-CWF-E		RPW Low Frequency Receiver Continuous Waveform electric data in SBM1 mode
ROC-SGSE_L2_RPW-LFR-SBM2-BP1	ROC-SGSE_L1_RPW-LFR-SBM2-BP1	RPW Low Frequency Receiver Basic parameters set 1 data in SBM2 mode
ROC-SGSE_L2_RPW-LFR-SBM2-BP2	ROC-SGSE_L1_RPW-LFR-SBM2-BP2	RPW Low Frequency Receiver Basic parameters set 2 data in SBM2 mode
ROC-SGSE_L1R_RPW-LFR-SBM2-CWF-B_V02	ROC-SGSE_L1_RPW-LFR-SBM2-CWF	RPW Low Frequency Receiver Continuous Waveform magnetic data in SBM2 mode
ROC-SGSE_L1R_RPW-LFR-SBM2-CWF-E		RPW Low Frequency Receiver Continuous Waveform electric data in SBM2 mode
ROC-SGSE_L2_RPW-	ROC-SGSE_L1_RPW-	RPW Low Frequency Receiver

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LFR-SURV-ASM	LFR-SURV-ASM	Average Spectral Matrices data in survey mode
ROC-SGSE_L2_RPW-LFR-SURV-BP1_V02	ROC-SGSE_L1_RPW-LFR-SURV-BP1	RPW Low Frequency Receiver Basic parameters set 1 data in Survey mode
ROC-SGSE_L2_RPW-LFR-SURV-BP2_V02	ROC-SGSE_L1_RPW-LFR-SURV-BP2	RPW Low Frequency Receiver Basic parameters set 2 data in Survey mode
ROC-SGSE_L1R_RPW-LFR-SURV-CWF-B_V02	ROC-SGSE_L1_RPW-LFR-SURV-CWF	RPW Low Frequency Receiver Continuous Waveform magnetic data in survey mode
ROC-SGSE_L1R_RPW-LFR-SURV-CWF-E_V02		RPW Low Frequency Receiver Continuous Waveform electric data in survey mode
ROC-SGSE_L1R_RPW-LFR-SURV-SWF-B_V02	ROC-SGSE_L1_RPW-LFR-SURV-SWF	RPW Low Frequency Receiver Snapshot Waveform magnetic data in survey mode
ROC-SGSE_L1R_RPW-LFR-SURV-SWF-E_V02		RPW Low Frequency Receiver Snapshot Waveform electric data in survey mode

**Table 3: Summary of dataset produced by calbut**

### 3 CALBUT REQUIREMENTS

#### 3.1 Algorithm

**REQ-RCS-LFR-3100** : Modes

The software will have one mode per output dataset as described in AD1.

**REQ-RCS-LFR-3101** : Global attributes reported

Some of the global attributes must be copied from the input file to the output file. This concerns the global attributes in the list below:

*PROVIDER, TEST\_ID ...*

This list is not exhaustive and may depend on the dataset to produce. The meaning of the attributes is given in AD2.


**REQ-RCS-LFR-3102** : Global attributes computed

Some of the global attributes must be computed from data. This concerns the global attributes in the list below:

*SOFTWARE\_NAME, SOFTWARE\_VERSION, ...*

This list is not exhaustive and may depend on the dataset to produce. The meaning of the attributes is given in AD2.

**REQ-RCS-LFR-3103** : Producing L1R and L2 data

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Calbut should produce LFR L1R waveform data from L1 data and LFR L2 spectrum data from L1 data.

**REQ-RCS-LFR-3104** : Separating magnetic and electric data

When converting L1 to L1R data, magnetic and electric data will be separated. Only magnetic variables should appear in L1R magnetic data and only electric variables should appear in L1R electric data.

**REQ-RCS-LFR-3105** : Using master CDF

For each mode, the calibration software should copy the dedicated master CDF as the initial output file. A master CDF defines the structure of the output file (variables and attributes) and gives values of constant attributes and constant variables.

**REQ-RCS-LFR-3106** : Computation of variable attributes

Variables have attributes, some are constant and their values are fixed in the master CDF. Some others have to be computed because they depend on the data. This concerns the attributes `SCALMIN`, `SCALEMAX`, `VALIDMIN`, `VALIDMAX`, ... of the variables representing the output magnetic waveform and the sampling frequency. This list is not exhaustive.

### 3.2 Interfaces

**REQ-RCS-LFR-3201** : Respect of interfaces

The calibration software should respect the interfaces defined in AD1. Special attention must be taken about the file descriptor when a new mode is added or versions are updated.

### 3.3 Conception and development

**REQ-RCS-LFR-3301** : Language

Calbut will be written in Python3 (version  $\geq 3.5$ ) and will use the following extra packages: `spacepy` and `numpy`.

**REQ-RCS-LFR-3302**: Environment

Calbut should use a specific virtual environment for execution.

**REQ-RCS-LFR-3303** : Operating system

Calbut should run under Linux system (kernel  $\geq 4.9$ ).

**REQ-RCS-LFR-3304** : Versioning

Calbut development should use git as a versioning control system.

**REQ-RCS-LFR-3305** : Tagging version

RPW-MEB-LFR-SUM-00254-Calbut\_Software\_User\_Manual\_Iss01\_Rev01.docx







## 5 DISTRIBUTION LIST

<p>LISTS</p> <p>See Contents lists in "Baghera Web":</p> <p>Project's informations / Project's actors / RPW_actors.xls</p> <p>and tab with the name of the list</p> <p>or NAMES below</p>	Tech_LESIA
	Tech_MEB
	Tech_RPW
	[Lead-]Cols
	Science-Cols

### INTERNAL


LESIA CNRS		

LESIA CNRS		

### EXTERNAL (To modify if necessary)

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