



# RPW/THR\_Calbar Software Requirements Specification

Ref: ROC-PRO-SFT-SPC-00125-LES  
Issue: 01  
Revision: 01  
Date: 09/10/2020

- 1 / 7 -

SOLAR ORBITER



## RPW Operation Centre

# RPW/THR THR\_Calbar Software Requirements Specification

ROC-PRO-SFT-SPC-00125-LES  
Iss.01, Rev.01

Prepared by:	Function:	Signature:	Date
Antonio Vecchio	THR Instrument Scientist and Co-I		09/10/2020
Verified by:	Function:	Signature:	Date
Xavier Bonnin	RPW Ground Segment Project Manager		Dd/mm/yyyy
Approved by:	Function:	Signature:	Date
Milan Maksimovic	RPW PI		Dd/mm/yyyy
For application:	Function:	Signature:	Date
			Dd/mm/yyyy

CLASSIFICATION

PUBLIC



RESTRICTED



Laboratoire d'Études Spatiales et d'Instrumentation en Astrophysique

CNRS-Observatoire de PARIS  
Section de MEUDON – LESIA  
5, place Jules Janssen  
92195 Meudon Cedex – France



# RPW/THR\_Calbar Software Requirements Specification

Ref: ROC-PRO-SFT-SPC-00125-LES

Issue: 01

Revision: 01

Date: 09/10/2020

- 2 / 7 -

## Change Record

Issue	Rev.	Date	Authors	Modifications
1	0	31/08/2020	A.Vecchio	First issue
1	1	09/10/2020	A.Vecchio	Add description of Calibration data

## Acronym List

Acronym	Definition
RCS	RPW Calibration Software
ROC	RPW Operation Centre
RPW	Radio and Plasma Waves instrument
SUM	Software User Manual



# RPW/THR\_Calbar Software Requirements Specification

Ref: ROC-PRO-SFT-SPC-00125-LES

Issue: 01

Revision: 01

Date: 09/10/2020

- 3 / 7 -

## Table of Contents

<b>General</b> .....	<b>4</b>
1.1 Scope of the Document.....	4
1.2 Applicable Documents.....	4
1.3 Reference Documents.....	4
<b>2 THR modes and data products</b> .....	<b>5</b>
2.1 Modes of operation.....	5
<b>3 The THR_CALBAR software products</b> .....	<b>5</b>
3.1 TNR electric spectra (mode tnr_l2_cal) .....	5
3.2 TNR magnetic spectra (mode tnr_l2_cal) .....	5
3.3 HFR electric spectra (mode hfr_l2_cal).....	5
3.4 Internal calibration (modes tnr_l2_cal and hfr_l2_cal) .....	6
<b>4 THR_CALBAR software requirements</b> .....	<b>6</b>
4.1 General requirements .....	6
4.2 TNR calibration requirements.....	6
4.3 HFR calibration requirements.....	6
<b>5 Distribution list</b> .....	<b>7</b>



# RPW/THR\_Calbar Software Requirements Specification

Ref: ROC-PRO-SFT-SPC-00125-LES

Issue: 01

Revision: 01

Date: 09/10/2020

- 4 / 7 -

## GENERAL

### 1.1 Scope of the Document

This document provides a specification of the ground calibration software for RPW-THR data (THR\_CALBAR). This version of the document applies to THR\_CALBAR version 2.2.2

### 1.2 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-LES_Iss01_Rev03	RPW_Calibration_Software_ICD	X.Bonnin	19/05/2020
AD2	ROC-PRO-DAT-NTT-00006-LES_Iss01_Rev02	ROC_Data_Products	X.Bonnin	18/04/2019
AD3	ROC-GEN-SYS-NTT-00019-LES_Iss.02_Rev00	ROC Engineering Guidelines For External Users	X.Bonnin	12/10/2017

### 1.3 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	ROC-PRO-SFT-SUM-00124-LES_Iss01_Rev00	RPW Calibration Software User Manual for THR_CALBAR	A.Vecchio	27/08/2020



# RPW/THR\_Calbar Software Requirements Specification

Ref: ROC-PRO-SFT-SPC-00125-LES

Issue: 01

Revision: 01

Date: 09/10/2020

- 5 / 7 -

## 2 THR MODES AND DATA PRODUCTS

### 2.1 Modes of operation

The THR software implements two modes of operation for the two receivers, TNR and HFR.

## 3 THE THR\_CALBAR SOFTWARE PRODUCTS

THR\_CALBAR is a software designed to convert THR Level 1 CDF files to Level 2 CDF files where the measured electrical (TNR and HFR) and magnetic (TNR) spectral densities are provided in physical units [RD1].

The mode determines what science TM is generated as defined in the table below.

Mode	Description	Data Product
tnr_l2_cal	Calibration of TNR data	RPW-TNR- SURV
hfr_l2_cal	Calibration of HFR data	RPW-HFR- SURV

### 3.1 TNR electric spectra (mode tnr\_l2\_cal)

TNR receiver provides both the Automatic Gain Control (AGC) value, from the analog part of the receiver, and the digitalized frequency dependent Auto and Cross values. The THR\_CALBAR combines AGC, Auto and Cross providing as output the electric spectral density in physical units  $V^2/Hz$  and  $W/(m^2 Hz)$ , when the effective length of the antenna is taken into account. The phase difference in degrees between the two TNR channels, corrected for the instrumental contribution, is also provided. The calibration is performed by using calibration tables obtained during the system level calibration performed on ground when all the instruments of the RPW suite were connected with the respective preamplifier and the Main Electronic Box (MEB).

### 3.2 TNR magnetic spectra (mode tnr\_l2\_cal)

The THR\_CALBAR combines AGC, Auto and Cross providing as output the magnetic spectral density in physical units  $nT^2/Hz$ . The phase difference in degrees between the two TNR channels, corrected for the instrumental contribution, is also provided. The calibration is performed by using the MF spectral transfer function provided by the SCM team and the calibration tables obtained during the TNR-HFR standalone calibration performed on ground.

### 3.3 HFR electric spectra (mode hfr\_l2\_cal)

The receiver HFR only provides the Automatic Gain Control (AGC) values. The THR\_CALBAR provides, as output, the electric spectral density in physical units  $V^2/Hz$  and  $W/(m^2 Hz)$ , when the effective length of the antenna is taken into account. The calibration is performed by using the calibration tables obtained during the system level calibration performed on ground when all the instruments of the RPW suite were connected with the respective preamplifier and the Main Electronic Box (MEB).



## RPW/THR\_Calbar Software Requirements Specification

Ref: ROC-PRO-SFT-SPC-00125-LES

Issue: 01

Revision: 01

Date: 09/10/2020

- 6 / 7 -

### 3.4 Internal calibration (modes tnr\_l2\_cal and hfr\_l2\_cal)

Measurement runs are carried out on a regular basis for the internal calibration of TNR and HFR. The signal of an internal source for 9 different amplitudes are measured for each TNR band and for some HFR frequency. Raw calibration data (uncalibrated AGC and AUTO values) are stored in a separate file with respect to the science data.

## 4 THR\_CALBAR SOFTWARE REQUIREMENTS

In this section, the requirements on the functionality of THR\_CALBAR software are outlined.

### 4.1 General requirements

**Basic function:** THR\_CALBAR software shall allow processing any properly formatted THR L1 CDF file (described in AD2) and convert it into corresponding L2 files and L1 internal calibration files (when available). Any anomalies in the source file shall be reported.

**Additional input files:** to properly calibrate magnetic data, the LFR HK L1 file, including the SCM instantaneous temperature, is also required as input of the THR\_CALBAR

**Programming language:** THR\_CALBAR is written in IDL language with the aid of bash scripts.

**Version control:** The version control is maintained in the ROC git software repository.

**Master CDF:** For each data product, THR\_CALBAR uses a dedicated master CDF. The master files are generated from skeletons and maintained in the ROC git repository.

**Global attributes:** They follows the specification in AD2 are included in the output L2 files. These can be copied from the master CDF, from the source L1 file or calculated based on data and configuration.

**Software Interface:** The interface of the software (command line parameters, environment variables and configuration file) shall be compliant with AD1 and described in RD1.

### 4.2 TNR calibration requirements

THR\_CALBAR process data products L1\_RPW-THR-SURV, where the data are in uncalibrated integer units, into L2 files and L1 internal calibration files (when available). A single TNR L1 file, containing both electric and magnetic data, should be provided. In L2 files, calibrated electric and magnetic data are provided in  $V^2/Hz$  in the variables AUTO. Values in  $W/m^2/Hz$  and  $nT/\sqrt{Hz}$  are provided in the variables FLUX\_DENSITY and MAGNETIC\_SPECTRAL\_POWER.

### 4.3 HFR calibration requirements

THR\_CALBAR process data products L1\_RPW-THR-SURV, where the data are in uncalibrated integer units, into L2 files and L1 internal calibration files (when available). A single HFR L1 file containing electric data only, should be provided. In L2 files, calibrated electric data are provided in  $V^2/Hz$  in the variables AUTO. Values in  $W/m^2/Hz$  and  $nT/\sqrt{Hz}$  are provided in the variables FLUX\_DENSITY.



# RPW/THR\_Calbar Software Requirements Specification

Ref: ROC-PRO-SFT-SPC-00125-LES  
 Issue: 01  
 Revision: 01  
 Date: 09/10/2020

## 5 DISTRIBUTION LIST

<p style="text-align: center;"><b>LISTS</b></p> <p>See Contents lists in “Baghera Web”:          Project’s informations / Project’s actors / RPW_actors.xls          and tab with the name of the list          or NAMES below</p>	Tech_LESIA
	Tech_MEB
	Tech_RPW
	[Lead-]Cols
	Science-Cols

### INTERNAL

LESIA CNRS	

LESIA CNRS	

### EXTERNAL (To modify if necessary)

CNES	C. FIACHETTI
	C. LAFFAYE
	R.LLORCA-CEJUDO
	E.LOURME
	M-O. MARCHE
	E.GUILHEM
	J.PANH
	B.PONTET
IRFU	L. BYLANDER
	C.CULLY
	A.ERIKSSON
	SE.JANSSON
	A.VAIVADS
LPC2E	P. FERGEAU
	G. JANNET
	T.DUDOK de WIT
	M. KRETZSCHMAR
	V. KRASNOSELSKIKH
SSL	S.BALE

Asi/CSRC	J.BRINEK
	P.HELLINGER
	D.HERCIK
	P.TRAVNICEK
IAP	J.BASE
	J. CHUM
	I. KOLMASOVA
	O.SANTOLIK
	J. SOUCEK
IWF	L.UHLIR
	G.LAKY
	T.OSWALD
	H. OTTACHER
	H. RUCKER
	M.SAMPL
LPP	M. STELLER
	T.CHUST
	A. JEANDET
	P.LEROY
	M.MORLOT