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RPW Instrument - BIAS

Technical Specifications of the BIAS Calibration Software

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Change Record

Issue	Rev.	Date	Authors	Modifications
1	0	2018.01.25	E. Johansson	Initial release

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1 GENERAL

1.1 Scope of the Document

This document provides the technical specifications for the BIAS calibration software (BICAS), and applies to both data processing pipelines, ROC-SGSE and RODP.

1.2 Applicable Documents

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

Mark	Reference	Title of Document	Authors	Date
AD1	ROC-PRO-PIP-ICD-00037-LES/1/1	RPW Calibration Software ICD Documentation	Manuel Duarte, Xavier Bonnin	2017.10.12
AD2	ROC-GEN-SYS-NTT-00019-LES/2/0	ROC Engineering Guidelines For External Users	Xavier Bonnin	2017.11.17
AD3	ROC-PRO-DAT-NTT-00006-LES/1/1	RPW Data Products	Xavier Bonnin	2017.11.17
AD4	ROC-TST-GSE-NTT-00017-LES/2/1	Data format and metadata definition for the ROC-SGSE data	Xavier Bonnin	2016.10.14

1.3 Reference Documents

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

Mark	Reference	Title of the document	Authors	Date
RD1	RPW-SYS-MEB-BIA-SPIC-00001-IRF/1/16	BIAS Specification	Vicki Cripps	2014.12.05
RD2	RPW-SYS-MEB-BIA-DRP-00013-IRF	Design Description BIAS	Vicki Cripps	2014.12.05

2 INTRODUCTION

The BIAS h/w subsystem is described in RD1 and RD2. In particular Tables 3, 4, 7 in RD1 are relevant for this document.

The BIAS team's RCS, named BICAS,

(1) calibrates bias currents (convert current in TC/TM units to current in physical units),
(2) does part of the calibration for electric LF data, *approximately* corresponding to the analogue signal's path from the antennas to the interface between BIAS and LFR/TDS (convert voltage to voltage, both in physical units). This corresponds to taking level L1R datasets as input (ROC-SGSE or RODP) and using them to produce L2S (ROC-SGSE) or L2 datasets (RODP).

3 CALLER INTERFACE

The software's interface is largely defined by AD1 and AD2, but the exact s/w modes are defined in this document in Section 5.

4 CALIBRATION METHOD

4.1 Set bias currents

BICAS shall calibrate antenna bias currents from the TC currents. The calibration is defined by

$$I_{\text{physical},j} = A_j + B_j \cdot I_{\text{TC},j}$$

where j=1, 2 or 3 is the antenna number, $I_{\text{physical},j}$ is the current in ampere, and $I_{\text{TC},j}$ is the current in TM (TC) units. A_j and B_j are calibration constants (potentially slowly time dependent).

4.2 Measured voltages

BICAS shall, calibrate both (1a) single antenna voltages, and (1b) differential antenna voltages which are received by the BIAS LF preamplifiers, from (2) the approximately the physical voltages BIAS_l which are passed on from BIAS to the LFR (l=1..5) and TDS subsystems (l=1..3).

More precisely, BICAS shall produce (calibrate, derive) the following output:

(1) DC single antenna voltages, $V_{\text{DC,single},j}$
(2) DC differential antenna voltages, $V_{\text{DC,diff},j,k}$
(3) AC differential antenna voltages with low-gain, $V_{\text{AC,lg},j,k}$
(4) AC differential antenna voltages with high-gain, $V_{\text{AC,hg},j,k}$

using the following input

(5) voltages U_l which approximate the physical voltages BIAS_l

U_l and BIAS_l relate to each other through

$$T_{\text{LFR/TDS},x}[\text{BIAS}_l(t)] = U_l(t) \quad (1)$$

where $T_{\text{LFR/TDS},x}$ refers to the application of the relevant LFR or TDS transfer function ("x") which describes the modification of the physical signal w.r.t. frequency as it travels from BIAS_l to the corresponding LFR/TDS ADC. LFR/TDS L1R datasets contain the reference "x" to the right LFR/TDS transfer function.

To derive these values, BICAS shall use the relationships below.

(1) $V_{\text{DC,single},j}(t) = T_{\text{BIAS,DC,single}}^{-1}[T_{\text{LFR/TDS},x}^{-1}[U_l(t)]] + A_{\text{DC,single},j}$
(2) $V_{\text{DC,diff},j,k}(t) = T_{\text{BIAS,DC,diff}}^{-1}[T_{\text{LFR/TDS},x}^{-1}[U_l(t)]] + A_{\text{DC,diff},j,k}$
(3) $V_{\text{AC,lg},j,k}(t) = T_{\text{BIAS,AC,lg}}^{-1}[T_{\text{LFR/TDS},x}^{-1}[U_l(t)]]$
(4) $V_{\text{AC,hg},j,k}(t) = T_{\text{BIAS,AC,hg}}^{-1}[T_{\text{LFR/TDS},x}^{-1}[U_l(t)]]$

The variables which are actually available at a given time is determined by the combination of BIAS MUX mode and a latching relay, both available in the BIAS HK. These combinations are enumerated by Table 4 in AD1.

$T_{\text{BIAS,...}}^{-1}[\ldots]$ refer to the inverse of the transfer function which describes how the physical signal is modified as it travels through BIAS, $T_{\text{LFR/TDS}}^{-1}[\ldots]$ is the inverse of the transfer function in equation (1), and $A_{\text{DC,single},j}$ and $A_{\text{DC,diff},j,k}$ are calibration offsets. $T_{\text{BIAS,...}}^{-1}[\ldots]$,

$A_{DC,single,j}$, and $A_{DC,diff,j,k}$ are potentially slowly time-dependent.

5 BICAS S/W MODES

The concept of RCS s/w modes is defined in AD1 and define which datasets are BICAS input and output and in what combinations. BICAS's s/w modes are summarized in Table 1 and Table 2. The datasets referred to here are defined in AD3 (RODP) and AD4 (ROC-SGSE).

s/w mode	Input datasets (dataset ID)	Output datasets (dataset ID)
LFR-SBM1-CWF-E	ROC-SGSE_HK_RPW-BIA ROC-SGSE_L1R_RPW-LFR-SBM1-CWF-E	ROC-SGSE_L2S_RPW-LFR-SBM1-CWF-E
LFR-SBM2-CWF-E	ROC-SGSE_HK_RPW-BIA ROC-SGSE_L1R_RPW-LFR-SBM2-CWF-E	ROC-SGSE_L2S_RPW-LFR-SBM2-CWF-E
LFR-SURV-CWF-E	ROC-SGSE_HK_RPW-BIA ROC-SGSE_L1R_RPW-LFR-SURV-CWF-E	ROC-SGSE_L2S_RPW-LFR-SURV-CWF-E
LFR-SURV-SWF-E	ROC-SGSE_HK_RPW-BIA ROC-SGSE_L1R_RPW-LFR-SURV-SWF-E	ROC-SGSE_L2S_RPW-LFR-SURV-SWF-E
TDS-LFM-CWF-E	ROC-SGSE_HK_RPW-BIA ROC-SGSE_L1R_RPW-TDS-LFM-CWF-E	ROC-SGSE_L2S_RPW-TDS-LFM-CWF-E
TDS-LFM-RSWF-E	ROC-SGSE_HK_RPW-BIA ROC-SGSE_L1R_RPW-TDS-LFM-RSWF-E	ROC-SGSE_L2S_RPW-TDS-LFM-RSWF-E

Table 1. BICAS s/w modes and their associated datasets for the ROC-SGSE pipeline.

s/w mode	Input datasets (dataset ID)	Output datasets (dataset ID)
LFR-SBM1-CWF-E	SOLO_HK_RPW-BIA SOLO_L1R_RPW-LFR-SBM1-CWF	SOLO_L2_RPW-LFR-SBM1-CWF-E
LFR-SBM2-CWF-E	SOLO_HK_RPW-BIA SOLO_L1R_RPW-LFR-SBM2-CWF	SOLO_L2_RPW-LFR-SBM2-CWF-E
LFR-SURV-CWF-E	SOLO_HK_RPW-BIA SOLO_L1R_RPW-LFR-SURV-CWF	SOLO_L2_RPW-LFR-SURV-CWF-E
LFR-SURV-SWF-E	SOLO_HK_RPW-BIA SOLO_L1R_RPW-LFR-SURV-SWF	SOLO_L2_RPW-LFR-SURV-SWF-E
TDS-LFM-CWF-E	SOLO_HK_RPW-BIA SOLO_L1R_RPW-TDS-LFM-CWF	SOLO_L2_RPW-TDS-LFM-CWF-E
TDS-LFM-RSWF-E	SOLO_HK_RPW-BIA SOLO_L1R_RPW-TDS-LFM-RSWF	SOLO_L2_RPW-TDS-LFM-RSWF-E
BIA-SWEEP	SOLO_L1_RPW-BIA-SWEEP	TBD

Table 2. BICAS s/w modes and their associated datasets for the RODP pipeline.

Important note: *The non-sweep s/w modes should additionally require TBD L1 datasets for TC fix-bias (i.e. non-sweep) bias currents as input.*

6 ACRONYMS

ADC	Analogue-to-Digital Converter
BICAS	BIAS Calibration Software
Co-I	Co-Investigator
HK	House Keeping
LF	Low Frequency
LFR	Low Frequency Receiver

MEB	Main Electronics Box
NA	Not Applicable
PI	Principal Investigator
RCS	RPW Calibration Software
ROC	RPW Operation Centre
RPW	Radio and Plasma Waves instrument
RODP	ROC Operations and Data Pipeline
SGSE	Software Ground Support Equipment
TBC	To Be Confirmed
TBD	To Be Defined
TC	TeleCommand
TDS	Time Domain Sampler
TM	TeleMetry / Technical Manager