RPW Operation Centre

Bias Operations Interface Control Document

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Change Record

Issue	Rev.	Date	Authors	Modifications
1	0		X.Bonnin	First issue

Acronym List

Acronym	Definition
BCOR	Bias Current Operation Request
BP	Basic Parameters
CDF	Common Data Format
CLI	Command Line Interface
CSV	Comma Separated Values
ICD	Interface Control Document
ID	Identifier
I/F	Interface
I/O	Input/Output
JSON	JavaScript Object Notation
ROC	RPW Operation Centre
RPW	Radio and Plasma Waves instrument
SCM	Search Coil Magnetometer
SGSE	Software Ground Support Equipment
SVN	SubVersioN
S/W	Software
TDS	Time Domain Sampler
LFR	Low Frequency Receiver
THR	Thermal Noise and High Frequency Receivers
WF	Waveform

XML	eXtended Markup Language

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1 GENERAL

1.1 Scope of the Document

The Bias operations Interface Control Document (BOICD) describes the interfaces to be implemented between the ROC and Bias teams, in order to perform the operations related to the RPW Bias unit during the Solar Orbiter mission.

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				
AD2				
AD3				
AD4				

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-DAT-NTT-00075-LES/1/0	RPW Data Product Description Document (DPDD)	X.Bonnin	2019/02/15
RD2	ROC-GEN-MGT-PLN-00041-LES/1/1	RPW Operations Management Plan (OMP)	X.Bonnin	21/12/2018
RD3				
RD4				
RD5				
RD6				
RD7				
RD8				

2 CONSIDERATIONS & OBJECTIVES

2.1 Context

Solar Orbiter is an "off-line" mission: regular spacecraft (S/C) visibilities are not guaranteed, and the downlink data rates can be very low or null during some periods of time.

It results that the overall mission operations planning must be scheduled in advance, in order to optimize the science return, even when the S/C is out of visibility.

In the same time, the cadence of payload operations requests is about once a week during the mission nominal phase (NMP), and thus the reaction time for the instrument teams (IT) to discuss, prepare and submit commands for a given week of operations is short.

This requires the chain of processes, which leads to the instrument operation submission, must be as much as possible optimized and automated.

2.2 Bias operations strategy

During the mission, the bias currents applied on each of the three RPW antennas shall ensure that the electrical potential Va of the antennas is always close to the local plasma value Vp (ideally, we should have Va = Vp).

The setting of the Bias current values is commanded from ground. The frequency at which the on-board current values must be set depends on the ambient plasma environment and the distance from the sun, which evolve with the spacecraft location along the orbit.

In practice the ROC plans to be able to execute this command at least every week from the inputs provided by the Bias team. It does not mean the Bias team needs to deliver updated inputs every week, but the ROC must be capable of preparing and submitting the command within a week.

In the same time, the ROC shall be able to provide all of the necessary products required to the Bias team to prepare and deliver the inputs.

2.3 Objectives of the document

The objectives of the present document are to:

- Define the inputs to be delivered to the ROC by the Bias team, in order to prepare and submit the Bias current setting command.
- Identify the products required by the Bias team to prepare and submit the inputs to the ROC.
- Specify the way the data will be exchanged between the ROC and Bias teams.

3 BIAS OPERATIONS INPUTS

3.1 Bias operations inputs overview

Three types of inputs are needed by the ROC to perform the Bias operations:

- A Bias current setting operation request (BJOR), which gives the expected current values to be applied on-board over time. This model will serve as a baseline to the ROC to define command values as explained in the section 3.2.

- The Bias calibration operation request (BCOR), which is the list of command parameters to be applied when executing a Bias unit calibration on-board.
- The Bias sweep operation request (BSOR), which is the list of command parameters to be applied when executing a Bias sweep on-board.

3.2 Bias current setting operation request (BJOR)

3.2.1 Description

The BJOR will be used by the ROC to set the on-board current values for the three RPW antennas. The BJOR shall contain Bias current values at the times they shall be applied on-board.

The BJOR shall cover the entire Solar Orbiter mission timeline. The Bias team will have a possibility to update it as often as required during the mission.

3.2.2 Format

The Bias current predictive model shall be delivered as an XML 1.0 file.

3.2.3 file naming

The file naming convention shall be:

RPW_BIA_BJOR_VYYYMMDDHHNNSS.xml

Where YYYY, MM, DD, HH, NN and SS are respectively the year, month, day, hour, minute and second of the file release date. Same date and time shall be reported in the **`ReleaseDate`** element in the file (see section 3.2.4.1).

3.2.4 Data organization

The tables below give the description of the expected structure. The first column (**Field**) provides the name of the element (tag value) or attribute as seen in the resulting XML file. The second column (**E/A**) indicates whether the field is an XML element (using 'E'), or an attribute (using 'A') of an XML element. The third column (**Type**), describes the basic type of the field. The fourth field (**Description**) provides a textual definition of the field which may contain examples, format specifications and conditional statements about what the field may contain. The final column (**Need**) indicates whether the field's value is Mandatory (M), Optional (O), or Qualified (Q) – the latter requiring explanation in the Description column.

The XML Schema Definition (xsd) is given in §7.1.

3.2.4.1 Header

Field	E/A	Type	Description	Need
`Project`	E	string	It shall be "RPW"	M
`Description`	E	string	Short description of the file content	M
`Author`	E	string	Author of the file	M
`ReleaseDate`	E	dateTime	Local date/time of the file release	M
`Changes`	E	string	Short text giving the	M

			changes introduced in the current version of the file	
Reference	E	string	Reference to the document used to compute the Bias current model over the orbit (the reference shall include the version of the document)	M
ValidityRange	E	ComplexType	ComplexType containing the validity range start/end time	M
IcdVersion	E	String	Issue.revision of the BOICD (e.g., 01.00)	

Table 1. Bias current setting request - header content.

The **ValidityRange** ComplexType must contain the following fields.

Field	E/A	Type	Description	Need
StartTime	E	dateTime	Validity range start time in UTC	M
EndTime	E	dateTime	Validity range end time in UTC	M

Table 2. Bias current setting request - ValidityRange content.

3.2.4.2 BiasCurrent

Field	E/A	Type	Description	Need
Value	E	ComplexType	ComplexType containing the list of current values and time from Bias model	M

Table 3. Bias current setting request – BiasCurrent content.

The **Value** ComplexType must contain the following fields.

Field	E/A	Type	Description	Need
Bias_1	E	FloatType	Current value in uA to be applied on the antenna 1	M
Bias_2	E	FloatType	Current value in uA to be applied on the antenna 2	M

Bias_3	E	FloatType	Current value in uA to be applied on the antenna 3	M
ExecutionTime	A	dateTime	UTC date/time when the current values must be applied on-board.	M
PhSatCur_1	E	FloatType	Photo-saturation current in uA for the antenna 1	O
PhSatCur_2	E	FloatType	Photo-saturation current in uA for the antenna 2	O
PhSatCur_3	E	FloatType	Photo-saturation current in uA for the antenna 3	O

Table 4. Bias current setting request - Value content.

3.3 Bias calibration and sweeping configuration mechanism

The configuration of the Bias calibration and sweeping operations will be performed by the ROC using the dedicated commands.

The default values of the command parameters will be defined by the ROC prior to the launch, with the help of the Bias team. Furthermore, the parameters tagged as “formal parameters” (FP) in the corresponding command sequences will be also identified at this stage.

During the mission, the initial configurations may be refined if necessary.

4 BIAS OPERATIONS PRODUCTS

4.1 Bias operations products overview

Three data products will be provided by the ROC to the Bias team:

- Bias sweep data
- Bias calibration data
- Bias current values actually applied on-board

4.2 Bias sweeping data

Execution of the Bias sweeps will be performed as a routine operation, at least every week during the nominal phase.

The resulting telemetry will be downlinked through the Low Latency data stream, but processed as an RPW L1 data product by the ROC at LESIA. This product shall contain the measured LFR voltage and the corresponding current values for each step of the sweep. The current values will be extracted by the ROC from the sweep table loaded on-board.

The content of the L1 Bias sweep data is described in [RD1].

4.3 Bias calibration data

The calibration of the Bias unit will be also executed on-board at least every week during the nominal phase.

The resulting telemetry will be downlinked through the science survey data stream and processed at ROC. The data acquired during Bias calibration will not be written into a specific L1 data set, but will be provided in the daily science survey data files at level L1 and L2. Moreover, the status of the Bias unit over time will be indicated in the files, in order to promptly identify calibration time windows in the data.

The content of the L1 science survey data files is described in [RD1].

4.4 On-board Bias current data

The ROC shall generate a specific L1 data product to store the Bias currents actually applied on-board.

The content of on-board Bias current data files is described in [RD1].

5 BIAS OPERATIONS INTERFACES

5.1 Mechanism to deliver the BJOR

Any new version of the BJOR file shall be uploaded by the Bias team on the following directory accessible by SSH from the roc-dev.obspm.fr server[1]:

`/volumes/plasma/rpw/roc/data/https/private/solo/rpw/ops/bia/bjor`

In the same time, the Bias team shall inform the ROC that a new file has been delivered.

5.2 Mechanism to distribute the Bias operations related products

The Bias operations products shall be distributed using the same interface as the other RPW data products.

6 BIAS OPERATIONS PLAN

The BIAS operation plan is presented in the

6.1 Bias current setting operation life-cycle

The overall life cycle is illustrated on the figure below:

1. Before the launch, the Bias team builts a first initial BJOR file from a predictive model of the expected Bias currents over the mission duration.
2. This initial BJOR is delivered to the ROC to be used as a baseline to prepare on-board Bias current setting operations. Specifically, the ROC will generate commands from the current values provided in this file.
3. Commands to set the on-board Bias current values are submitted to the SOC through the Instrument Operations Request (IOR) mechanism. This task should be done at least

[1] The access to the roc-dev.obspm.fr server is restricted and only possible from the Paris Observatory Intranet or through the styx.obspm.fr proxy server. Contact the ROC team to get an access.

every Short Term Planning cycle (~1 week during the NMP). In addition, execution of Bias calibration and sweeps will be also requested.

4. Resulting Bias calibration/sweep telemetry is retrieved and processed by the ROC, in order to generate "digest" data products as described in the section 4. These products are then distributed to the Bias team for analysis.
5. From the analysis results, the Bias team can decide at some point to refine the predictive model. In this case, a new version of the model file shall be delivered to the ROC. This new version will be used for operations.

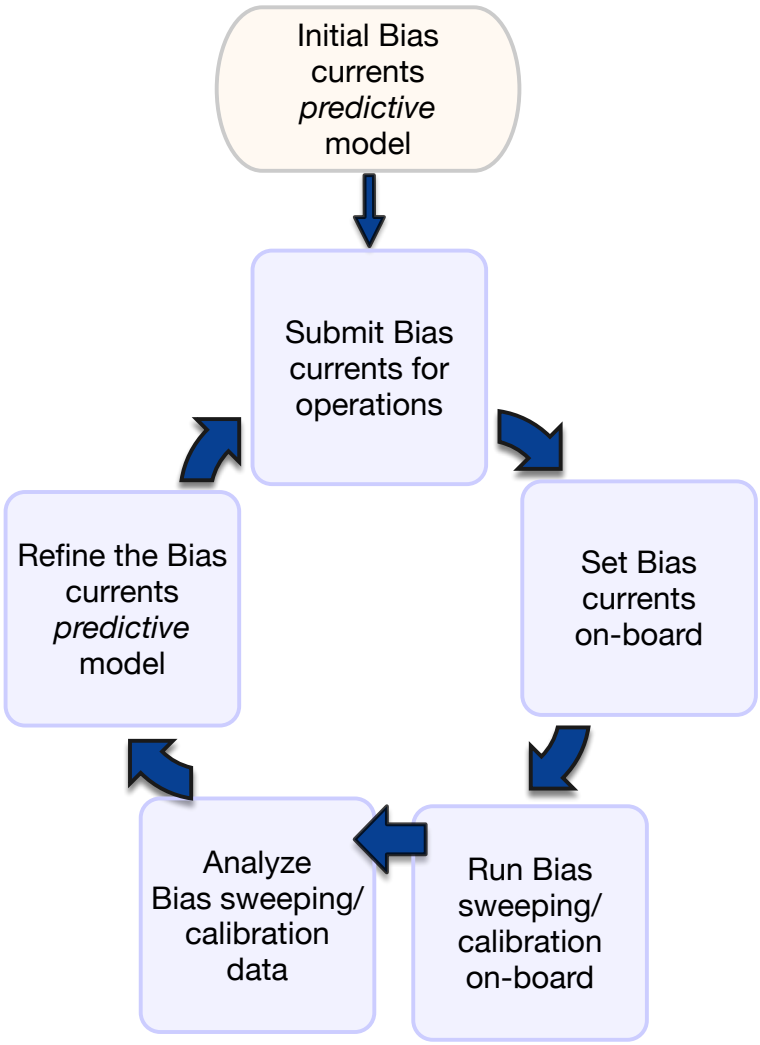

Figure 1. Bias current setting operation life-cycle.

7 APPENDIX

7.1 BJOR XML Schema Definition

```
<?xml version="1.0" encoding="UTF-8"?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
```

```
     <xsd:element name="BJOR">
     <xsd:complexType>
               <xsd:sequence>
                    <xsd:element name="Header" type="HeaderType"/>
                    <xsd:element                  name="BiasCurrent"
type="BiasCurrentType"/>
               </xsd:sequence>
          </xsd:complexType>
     </xsd:element>

   <xsd:complexType name="HeaderType">
     <xsd:sequence>
       <xsd:element name="Project" type="xsd:string" fixed="RPW"/>
       <xsd:element name="Author" type="xsd:string" />
       <xsd:element name="Description" type="xsd:string" />
       <xsd:element name="ReleaseDate" type="xsd:dateTime" />
       <xsd:element name="Changes" type="xsd:string" />
       <xsd:element name="Reference" type="xsd:string" />
       <xsd:element name="ValidityRange" type="ValidityRangeType"/>
       <xsd:element       name="IcdVersion"       type="xsd:string"
fixed="01.00"/>
     </xsd:sequence>
   </xsd:complexType>

   <xsd:complexType name="BiasCurrentType">
     <xsd:sequence>
       <xsd:element   name="Value"   type="ValueType"   minOccurs="1"
maxOccurs="unbounded"/>
     </xsd:sequence>
   </xsd:complexType>

   <xsd:complexType name="ValidityRangeType">
     <xsd:sequence>
       <xsd:element name="StartTime" type="xsd:dateTime" />
       <xsd:element name="EndTime" type="xsd:dateTime" />
```

```
      </xsd:sequence>
    </xsd:complexType>


     <xsd:complexType name="ValueType">
        <xsd:attribute    name="ExecutionTime"    type="xsd:dateTime"
use="required"/>
          <xsd:sequence>
            <xsd:element name="Bias_1" type="xsd:float" />
            <xsd:element name="Bias_2" type="xsd:float" />
            <xsd:element name="Bias_3" type="xsd:float" />
            <xsd:element      name="PhSatCur_1"      type="xsd:float"
minOccurs="0" maxOccurs="1"/>
            <xsd:element      name="PhSatCur_2"      type="xsd:float"
minOccurs="0" maxOccurs="1"/>
            <xsd:element      name="PhSatCur_3"      type="xsd:float"
minOccurs="0" maxOccurs="1"/>
      </xsd:sequence>
    </xsd:complexType>
</xsd:schema>
```

8 LIST OF TBC/TBD/TBWS

TBC/TBD/TBW			
Reference/Page/Location	Description	Type	Status

9 DISTRIBUTION LIST

LISTS 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		Tech_LESIA
		Tech_MEB
		Tech_RPW
		[Lead-]CoIs
		Science-CoIs

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
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		V. KRASNOSSELSKIKH
SSL		S.BALE

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		T.OSWALD
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		M. STELLER
LPP		T.CHUST
		A. JEANDET
		P.LEROY
		M.MORLOT