RA-2 In-Flight

Instrument Calibration & Level1b Verification

Plan

Prepared by:	In-flight Verification Team	2001
Checked by:	M. Roca	Dec'2001
Approved by:		

EnviSat Ground Segment
•
ESTEC
Noordwijk
The Netherlands
•

Change Record

Issue	Date	Sheet	Description of Change
draft	Nov 2000	all	initial published Issue
Issue 1.a	27 Jan 2001	all	new functions included and better procedures definition
Issue 2.a	9 Dec 2001	all	inputs from the In-flight Verification group inserted

Table of Contents

1 SCOPE

EnviSat, to be launched in the first quarter of year 2002, will carry an altimeter with considerably improved performance compared to ERS.

Several activities are to be performed during the EnviSat Commissioning Phase regarding the calibration of the radar altimeter, RA-2. The activities have been classified as two major blocks, being carried out by two different groups:

RA-2 Absolute Calibration, and

RA-2/MWR Cross-Calibration and Geophysical Validation

A distinction is made between Absolute Calibration, Geophysical Validation and In-flight Instrument Calibration and Level 1b Verification. For more details refer to AD-1.

From the first, further subdivision can be made as:

RA-2 Absolute Range calibration,

RA-2 Absolute Sigma-0 calibration, and

RA-2 In-flight Instrument Calibration and Level 1b Verification.

This document describes the plan for the RA-2 In-flight Instrument Calibration and Level 1b Verification procedures, as defined later in this document.

2 APPLICABLE AND REFERENCE DOCUMENTS

2.1 Applicable Documents

AD-1 EnviSat Calibration and Validation Plan - (PO-PL-ESA-GS-1092, Issue1, Rev. 2)

AD-2 RA-2 Instrument Requirements Specification

AD-3 Instrument Operational Manual (IOM) - (PO-MA-ALS-RA-0006)

AD-4 ROP Generation Tool URD - (PO-SW-ESA-SY-712 Annex A)

AD-5 Payload to Ground Segment Interface Control Document, Vol.10 Measurement Data Definition and format description for RA-2 - (PO-ID-DOR-SY-0032, Issue5)

AD-6 RA-2 Algorithm Specifications for Level 1b Software Prototyping - (TNO/RAS/0018/ALS, Issue 8(

AD-7 EnviSat Instrument Calibration Detailed Processing Model; Volume 3: RA-2/MWR Calibration; 190190-PA-NOT-005

AD-8 ENVISAT-1 Instrument Engineering Calibration Facility (IECF) SoW - PO-SW-ESA-GS-0505

AD-9 IECF CTI Tables Specification - PO-TN-ESA-GS-0830

AD-10 RA-2 SODAP Plan - (PO-PL-DOR-RA-0213)

AD-11 "Envisat Switch-on and Data Acquisition Plan", (PO-PL-ESA-SY-1027, Issue 3.1)

AD-12 RA-2 Operations description (PO-TN-ESA-GS-0835, Issue 3b)

AD-13 REMASE-3 URD RA_PRESET_LOOP (PO-IS-ESA-GS-957, Issue 2.0)

AD-14 REMASE-3 URD RA_INDIVIDUAL_ECHO (PO-IS-ESA-GS-973, Issue 2.0)

AD-15 Signal processor Sub-Assembly Requirement Specification, (PO-RS-ALS-RA-0005, 07/01/97)

AD-16 SPSA-SW Architectural Design (PO-DS-ALS-RA-0011, Issue 5, 12/06/96)

2.2 Reference Documents

RD-1 RA-2 Instrument Detail Description

RD-2 RA-2 Product Specification

RD-3 Instrument Performance Evaluation and Analysis Summary (PO-TR-ALS-RA-0042, 01/12/99)

RD-4 RA-2 Absolute Range Calibration Plan (PO-PL-ESA-GS-0714)

RD-5 RA-2 Absolute Sigma-0 Calibration Plan (PO-PL-ESA-GS-0900)

RD-6 RA-2 Individual Echoes Processing Algorithm Description (PO-TN-ESA-GS-0749, Issue 1.0)

RD-7 RA-2/MWR Cross-Calibration and Validation Plan, PO-PL-ESR-RA-0005, is. 0.7)

RD-8 FRAPPE SRD and/or URD

RD-9 The RA-2 On-board Tracker and its Autonomous Adaptable Resolution, M. Roca, Technical Note.

3 INTRODUCTION

3.1 General Objectives

The objective of the RA-2 In-flight Instrument Calibration and Level 1b Verification is to ensure the correct and optimised functionality of the instrument in-flight, and the quality of the data to be used for calibration and validation purposes. For this second reason it must be possible to complete this activity by the end of the EnviSat Commissioning Phase.

A diagram that depicts the overall approach is given in Figure 1. While the cross-calibration and geophysical validation is a total independent exercise, the absolute range and sigma-0 calibrations belong to the same major group, and they are given an special consideration as far as the interactions is concerned. The diagram only tries to show activities and their timelines. Although they are carried out by different teams, there is a clear link among all the calibration activities. An important task, thus, of each of the activities is the link with the other activities: needs from and to other activities.

To understand the procedures followed to perform this activity it is necessary to understand the altimeter and its errors. To make sure that we meet our objectives the best approach is to compare the results with the instrument requirements. A description of both is given below.

3.2 The Altimeter and its errors

The EnviSat satellite will embark an innovative radar altimeter, the RA-2 which represents a new generation of radar altimeters compared to previous instruments such as the ERS altimeters and TOPEX/Poseidon. This is due to its integration of many important features, specifically:

- low height noise (~2 cm at significant waveheight, SWH = 4 m) thanks to a higher Pulse Repetition Frequency (PRF) of almost 2000 Hz, which allows the average of N_A=100 individual echoes to form the average waveform;
- separation of a robust on-board tracking function from a high-quality on-ground estimation of the engineering and geophysical parameters;
- autonomous resolution control (0.5 m, 2 m, 8 m);
- dual frequency (Ku and S-band) for correction of ionospheric delay (3 mm residual error);
- samples of full-rate non-averaged data are sent to ground as the I and Q video signal (Burst Mode);
- high-quality near real-time (NRT) geophysical data products.

During both the Calibration and the following Routine Phase, the EnviSat will be flying in a 35 days repeat cycle orbit. The ground-track has a spatial separation of about 80 km at the equator. The EnviSat orbit is sun-synchronous with an ascending node at 22:00 local solar time.

The altimeter errors, which is to say the errors in the measured range to the mean sea surface after processing the altimeter data, will form part of the final error budget for the cali-

Figure 1 Overall Absolute Range and Sigma-0 Calibration and In-flight Verification organisation approach and timeliness

bration. This processing includes compensation for instrumental effects. The error characteristics are a function of frequency (being different for Ku-band and S-band) and wave height. They also are characterised by their time variations into bias, drift, harmonic and random errors.

The altimeter bias is an invariant offset, the determination of which is the purpose of the absolute calibration (see RD-4).

Drift is a long-term slow variation in the altimeter measurement. Over a short period it is indistinguishable from bias. It can only be detected by repeated estimations of the bias.

Harmonic errors are variations linked to the orbital period. These cannot be detected in a single regional calibration and, being rather small, cannot be reliably determined by measurement. They will be considered as an intrinsic altimeter error.

Random errors correspond to noise in the measurements.

3.2.1 Ku-Band Performance

[to be inserted]

3.2.2 S-Band Performance

[to be inserted]

3.3 RA-2 Requirement specification summary

The performance is essentially measured with the three main parameters described above in Section 3.2. However, other figures have to be measured, such as the maximum time to reach a certain resolution. These other parameters are fully described in AD-2, but a summary of the ones considered more important, to which a specific test algorithm will be devoted to test them, are given below in this chapter.

3.3.1 Measurement Initialisation and Maintenance Requirement

1 The instrument shall automatically detect and acquire the radar echoes from the surface independently of the surface type and adapt the operating parameters so that tracking can be started (req.4.3.2-(2) from AD-2).

2 Over surfaces with Sigma-0 greater than 6dB, acquisition shall occur in less than 1 second in 95% of the cases (req.4.3.2-(2) from AD-2).

3 At transitions from non-ocean surfaces to ocean surfaces (during tracking) the instrument shall reach operation with the highest resolution after the -3 dB footprint antenna has left the non-ocean surface, in less than 0.8 sec with a probability of 95% (req. 4.3.2-(3) from AD-2).

4 The instrument shall be able to determine over all surface types, when the earliest part of the echo waveform is no longer within the range window such that tracking cannot be continued and loss of lock occurs. The instrument shall autonomously recover from this condition (req. 4.3.2-(4) from AD-2).

3.3.2 Tracking Requirements

[to be inserted]

3.3.3 Point Target Response (PTR) Requirements

[to be inserted]

3.3.4 IF Mask Requirements

[to be inserted]

3.4 Testing Approach

Several types of tests have been defined depending on what the test is dedicated to verify. These tests are:

Functional / Operational Tests (FO). These tests are dedicated to verify that the instrument follows the requirements regarding the Instrument Modes MCMD execution, Telemetry generation, etc. This type of test will be used during the Switch-on phase (or SODAP). (See Chapter 6).

Characterisation and Parameter Optimisation (ChT). These tests are devoted to verify that the operating characteristics of the instrument (e.g. Tx peak power, Rx gain, etc.) are within the specified limits. These tests will also try to ameliorate the tuning of the instrument parameters by fine varying when necessary parameters of the dispatch area or the look up tables. This type of test will be used during the Phase 1 (see Chapter 7).

Performance Tests (PT). These tests are devoted to verify the instrument performance as a measurement device. The adequate scenarios have to be selected from natural targets to be able to trace the performance requirement defined in AD-2 and summarised in Section 3.3. This type of test will be used during the Phase 1 and Phase 2 (see Chapter 7 and Chapter 8).

4 GENERAL APPROACH

4.1 Description and Detailed Objectives

During the six month of commissioning an *In-flight Instrument Calibration and Level 1b Verification* activity will be performed with the following detailed objectives:

1 Instrument verification of main capabilities and operations in all its modes.

2 Instrument parameter tuning and optimisation: verification of optimum setting of the instrument parameter performed in the lab on-ground, can only be done in-flight, once the instrument is acquiring scientifically meaningful data.

Optimisation and verification of the auxiliary data retrieval approach.

3 Algorithm parameter optimisation, and verification of the use of auxiliary data in these algorithms.

4 Instrument routine verification: specific operations that continue after the Commissioning Phase for monitoring purposes.

This verification is crucial for any calibration to be accurate. Therefore, despite the 6 months duration of the commissioning and the verification activity, sometime after the RA-2 switch-on, the data shall be such that is accurate enough for calibration purposes.

Once the instrument main capabilities and the operations have been verified, which is the first objective after the switch-on of the instrument, an important issue will be to verify that the parameter setting done in the lab on-ground before the launch are the optimum. This can only be done in-flight, once the instrument is acquiring scientifically meaningful data. This is an important objective of the in-flight verification, and it is required for any calibration to be accurate.

Algorithms are applied to the raw data to allow the scientist able to work with them. From the Level 0 data (which are basically telemetry data) the Level 1b processor is applied to create the Level 1b product. In doing this auxiliary data is used. Some parameters used in this process may also be tuned, for both the processor itself and the retrieval and construction of the auxiliary data.

Other algorithms are applied to build, from the Level 1b data, the Level 2 data which are the geophysical products. Auxiliary data are also used in this process. This activity does not cover the optimisation of the Level 2 processor, neither its parameters. However both the activities have to be coordinated so that fully coherence and consistency between the two processors is ensured.

It is important to remark that all sorts of data will be used during the in-flight verification, depending on the purpose of the specific verification and its status.

This activity will be mainly performed using the Instrument Engineering Calibration Facility (IECF) functions and the FRAPPE tool, both run at ESTEC. For details on the description of these functions refer to AD-7 and RD-8.

4.2 Primarily Calibration Activities Schedule and Approach

The schedule of the activities related to the above given objectives are described below.

The Calibration Commissioning Phase is divided into 2 sub-phases when regards to the In-flight activities. These phases are in-line with the objectives described in Section 4.1. Phase 1 will cover objective 1 and 2, and Phase 2 objective 3. As the name shows, objective 4 is a monitoring activity and therefore it belongs to the Routine Phase.

Objective1 of Section 4.1 will be carried out just after the launch of EnviSat. This objective is actually within the scope of another activity common to all EnviSat instruments, the SODAP Phase. This overall activity will last approximately 5 weeks. However, the RA-2 is one of the first instruments to be switched-on, and therefore it will be able to conclude it SODAP phase and move to the calibration phase itself, in about 2 weeks. The description of the activities to be carried out during the RA-2 SODAP phase are covered in the SODAP plan, and in particular in the RA-2 SODAP Plan (see AD-10). However, the procedures to analyse these SODAP data, will be defined within the in-flight verification (see Chapter 6).

Objective 2 described in Section 4.1 will nominally be carried out after the satellite switch-on period (L+2 weeks) and until three months after the launch (L+3M), for a total nominal period of 11 weeks[1]. During this time the team should be able to investigate all the instrument parameters so that any possible on-board parameter changes and are completed before the end of this period, and to ensure the proper retrieval of the auxiliary data so that the approach to be followed for the auxiliary data retrieval is fixed. The detail description of the strategies and procedures to be followed is given in Chapter 7.

This is considered the end of Phase 1 of the in-flight instrument calibration activities. Therefore, objectives 1 and 2 are within this Phase 1. The data will then be considered ready for their use in the calibration activities. However, that does not necessarily mean that previous data can not be used. Depending on the type of on-board parameter change that had to be performed, the team will decide whether these data can be directly used, have to be underweighted before their use, or should not be used for calibration purposes.

Objective 3 described in Section 4.1 will continue until the end of Commissioning Phase (L+6M). During this time the team should be able to investigate all the Level 1b parameters so that all possible parameter changes related to the Level 1b processor are done before the end of this period. The type of parameters the team shall optimise are both the processor and the characterisation and configuration parameters. The detail description of the strategies and procedures to be followed is given in Chapter 8.

This is considered the end of Phase 2, that coincides with the end of the Commissioning Phase.

Objective 4 described in Section 4.1 will be carried out during the complete satellite life time.

1. Note that in case the switch-on period assigned to the whole satellite, or in particular for the RA-2, takes longer than expected, this activity may suffer from this delay.

4.3 Constrains

4.3.1 Interaction with other groups

From: Orbits Group,

- global orbits are required to be better than TBD cm in radial. Note that preliminary datation verification has to be performed before the end of the first phase (L+3M). Therefore, in order to be able to perform this activity, an accurate orbit (accuracy TBD) before the end of this phase is needed.

To: RA-2 Absolute Range Calibration, RA-2 Absolute Sigma-0 Calibration and Cross-Calibration and Validation groups,

- quality data for calibration purposes.

After the end of phase 1 the raw data shall be optimum for the RA-2 Absolute Range Calibration and to the RA-2 Absolute Sigma-0 Calibration activities. The in-flight verification activity has to ensure the quality of the data is enough for calibration purposes at this point in time.

The in-flight verification recommends to the other calibration and validation groups not to use the data before the phase 1 is finalised. However, in the case that the data is used in order to save time, a possibility is that after changes of the on-board parameters, the conclusions obtained with the wrong parameters are meaningless. Therefore, at the end of Phase 1 the In-flight Verification team together with the other calibration and validation teams will decide whether the changes made at instrument level are relevant to their activities.

During phase 2 the in-flight verification activity is qualifying the Level 1b data. Level 2 data is used by the other calibration and validation teams. Changes in the parameters used in the Level 1b processor may influence the Level 2 processor. Therefore, at the end of this phase the In-flight Verification team together with the other calibration and validation teams, have to decide whether the changes made to the Level 1b parameters are relevant to the other calibration and validation activities and whether the data need to be re-processed.

The In-flight activities require several instrument operations (instrument moved to an specific mode, modification of on-board parameters for their testing and optimisation, etc.). Therefore, a very close interaction with the operations team will be needed, which may be linked to the orbit team for manoeuvres constraints.

4.3.2 Calibration Sites Identification

A calibration site is a major area where important activities related to calibration will take place. They will have to be respected during the verification activities in the sense that some specific procedures (like specific instrument modes or parameter setting) will have to be used when the altimeter over flies these sites, or, alternatively, over which no change of the nominal parameter have to be allowed.

So far these areas have been identified as:

- **IF Cal Site**: Intermediate Frequency (IF) Calibration site. The instrument goes into IF calibration mode, and therefore the mode is fixed and non other type of verification can be performed (see Chapter 7, Section 7.2.5 and Section 7.3.1, and Chapter 8, Section 8.4.1).
- **Range Cal Site**: RA-2 Absolute Range Calibration Site - NorthWestern part of the Mediterranean (see RD-4).
- **Sigma-0 Cal Site**: RA-2 Absolute Sigma-0 Calibration Site - Sigma-0 Transponder location (see RD-5)
- **Zone # Cal Site**: Other calibration sites related to both RA-2 absolute range calibration and RA-2 absolute sigma-0 calibration defined in the Zone File specified in AD-4.

They will be referred in both Chapter 7 and Chapter 8 as above. Later in this plan these sites will be further detailed.

4.4 Tools Available

The primary tools that will be used during the Commissioning Phase to carry this activity out will be the Instrument Engineering Calibration Facility (IECF). The IECF is the tool that contains the functions that have been defined with the purpose of instrument calibration and optimisation of the on-board parameters, verification and optimisation of the on-ground parameters used by the processors, and monitoring of the instrument behaviour all through the satellite life time. On top of that, the IECF has the important role of creating the Auxiliary data used in the on-ground processors.

The interaction between the IECF and the Product Data Segment (PDS) was illustrated with Figure 4.4-1.

Details on the IECF general bases, generic functions so called "reporting functions", structure, links, etc can be found in AD-8.

Another tool that will be used is FRAPPE. FRAPPE is particularly useful for extracting the data from Level 0 to Level 2, with a very high flexibility in the way the output is reported....

4.4.1 The RA-2 IECF Functions

The specific RA-2 functions available in the IECF are given in Table 4.4-1. Detailed description of these functions can be found in AD-7. This table contains the function identifier, the title of the function that self explains a little the function itself, the type of function, such as a new processor or a monitoring function, etc., and whether this function has been implemented. This last column is been introduced because not all the functions that were defined had been implemented. However, they might be in the future.

ID	Title	Type	Impl.
RA2-01	RA-2 Level 0 products time referencing and geolocation at SP level	Tool	yes

Table 4.4-1 RA-2 IECF Functions.

ID	Title	Type	Impl.
RA2-02	General View of features (orbital plots)	Monitoring	yes
RA2-03	Level 0 summary histogram generation	Monitoring	yes
RA2-04	Acquisition Duration summary histogram Generation	Checking for optimisation of parameters/SW	RA2-10
RA2-05	Level 2 summary histogram generation	Monitoring	no
RA2-09	RA-2 Level 2 World Maps (2-D) grid generation	Monitoring	yes
RA2-10	RA-2 Level 0 World Maps (2-D) grid and acquisition/tracking statistics generation	Monitoring	yes
RA2-12	Burst Data Processing	New Processing	yes
RA2-13	Processed and IF Calibrated Burst Data / Average waveform computation	New Processing	yes
RA2-14	1D spectrum analysis	Monitoring	no
RA2-16	Absolute Calibration measurements (PTR)	Checking for optimisation of parameters/SW	yes
RA2-18	IF filter shape computation	Auxiliary Data	yes
RA2-19	IF averaging	Auxiliary Data	yes
RA2-20	Antenna Mispointing estimation	Checking and Monitoring	yes
RA2-22	Ionospheric correction monitoring	Monitoring	no
RA2-24	Datation verification	Checking for optimisation of parameters/SW	yes
RA2-25	USO Monitoring	Auxiliary Data and Monitoring	yes
RA2-26	USO Drift Range Error computation	Auxiliary Data	yes
RA2-30	Level 0 SP Surface type discrimination	Tool	yes
RA2-31	Level 1b and Level 2 MDSR's Surface type discrimination	Tool	yes
RA2-32	Input extraction for Datation verification	Input for RA2-24	yes
RA2-33	Transponder Waveforms Processing for Range Absolute Calibration	New Processing	yes
RA2-34	Transponder Waveforms Processing for Sigma-0 Absolute Calibration	New Processing	yes

Table 4.4-1 RA-2 IECF Functions.

The interaction of the IECF with the PDS is depicted in Figure 4.4-1.

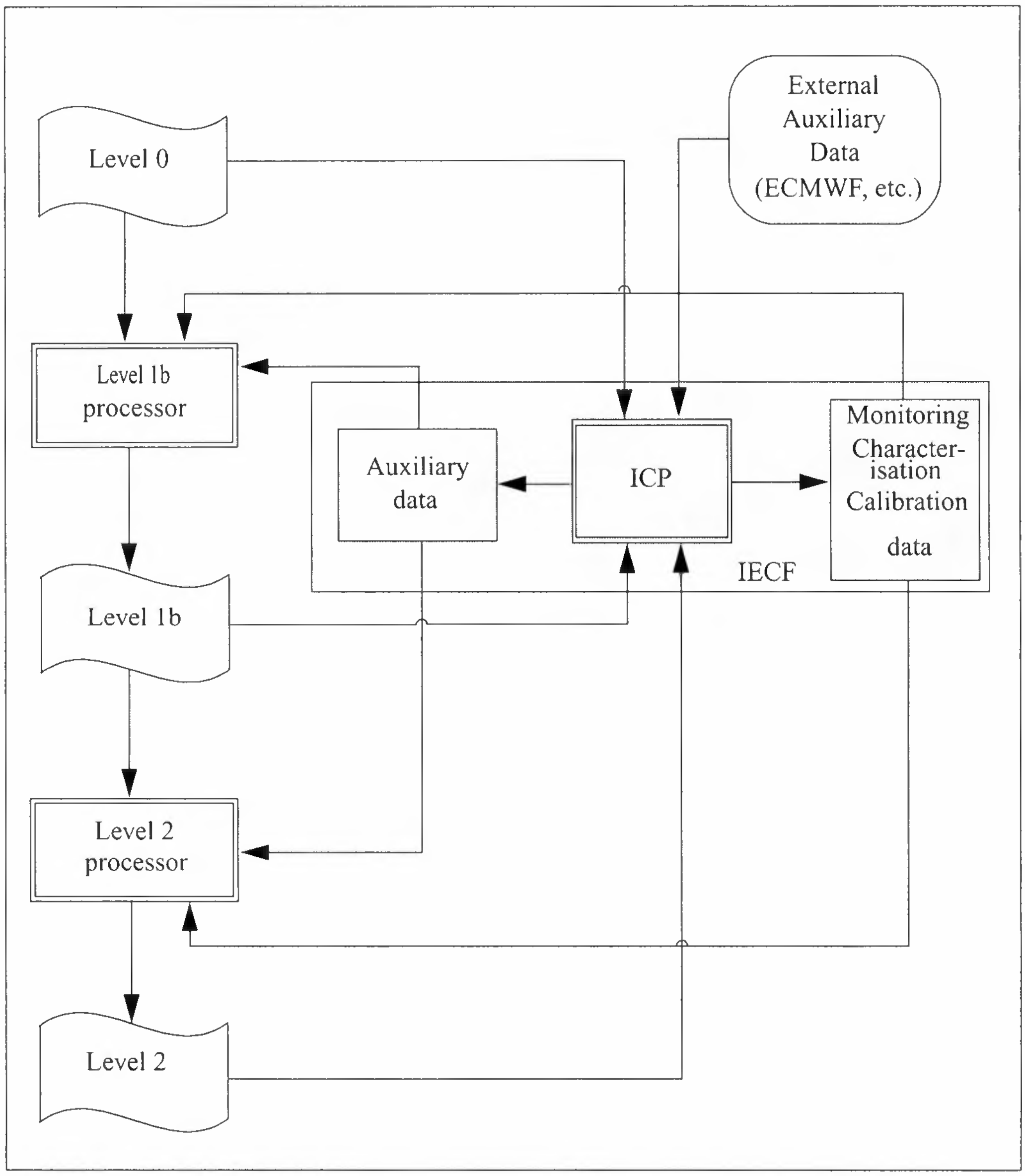

Fig4.4-1 IECF-PDS Interaction Block Diagram.

Other tools defined by the group may definitely be used. The tools shall be as much as possible integrated in the IECF for the sake of reliability and configuration control. The IECF provides the means for interacting with other groups related in the project, such as operations, and keeps secure history of all changes made. However, it is clear that the necessary effort required to integrate new tools to the IECF shall be studied specially for tools or functions that heritage, with only little adaptation, from either ERS or the RA-2 testing.

4.4.2 The FRAPPE tool

[To Be Completed]

4.5 RA-2 Operations

4.5.1 The On-board Parameters, Tables and how to update them

To load an on-board table - resident within an instrument carried on-board the EnviSat-1 satellite - with an updated set of parameters, the Flight Operation Control Centre (FOCC) has to send a Macro-Command (MCMD) to the satellite. This MCMD is uniquely identified such that

- an instrument recognises the MCMD as its own, and
- the instrument will load the contents of the MCMD into the correct instrument table.

The format of the MCMD is such that the instrument loads the parameters into the correct locations within the on-board table. It is the responsibility of the ground to ensure that the MCMD has the correct format and data content.

Although the FOCC uplinks all MCMD's, it is not responsible for defining the content of all on-board instrument tables. The content of some tables are actually determined by other sources such as the Instrument Engineering Calibration Facility (IECF) and the ROP Generation Tool (RGT). Consequently, an agreed Configuration Table Interface (CTI) has been specified between the IECF and the FOCC, as well as for the RGT tables between the RGT and the FOCC, in order to transfer instrument table parameters.

These on-board tables can be responsibility of the IECF (CTI tables) or responsibility of the RGT (RGT Tables). In the RA-2 case the distinction is very clear:

- the IECF is responsible for the tables, the parameters of which are changed manually;
- the RGT is responsible for the tables, the parameters of which require some computation needed to be performed within the RGT (e.g. need of the orbital file).

4.5.1.1 The RA-2 CTI Tables

The concept of CTI Tables is further detailed explained in (AD-9).

The RA-2 CTI tables, which are responsibility of the IECF, are given in Table 4.5.1.1-1. For their detailed structure refer to AD-9. Note that the Parameter number given in the third column of the table refers to the offset of the parameter in the on-board dispatch area (see later Chapter 7 or AD-3, for more details).

Table ID	Table Name	Parameters #
CTI_ACQ_RA	Acquisition Parameters	00 - 18
CTI_TRK_RA	Tracking Parameters	20 - 30
CTI_ABF_RA	Alpha-Beta Filter Coefficients	32 - 40
CTI_MFT_RA	MFT Parameters	42 - 55
CTI_ABT1RA	Alpha-Beta Tracker	156 - 72
CTI_ABT2RA	Alpha-Beta Tracker	274 - 88
CTI_LOL1RA	RSL or LOL 1	90 - 103
CTI_LOL2RA	RSL or LOL 2	104 - 114
CTI_NPM_RA	Noise Power	116 - 132
CTI_PTR_RA	PTR or IRF	134 - 136
CTI_IFC_RA	IF Cal	138 - 140
CTI_RFB1RA	RF Bite 1	142 - 156
CTI_RFB2RA	RF Bite 2	158 - 172
CTI_RFB3RA	RF Bite 3	174 - 188
CTI_RFB4RA	RF Bite 4	190 - 202
CTI_DGB_RA	Digital Bite	204 - 206
CTI_SEQ_RA	Acquisition and Tracking Sequences	216 - 217

Table 4.5.1.1-1 CTI tables, responsibility of the IECF

4.5.1.2 *The RA-2 RGT Tables*

The missing on-board parameters from the table above, Table 4.5.1.1-1, compared with the complete list of on-board parameters, are not the responsibility of the IECF but directly of the RGT. The on-board dispatch area parameters from 207 to 215, will be calculated by the CFI so called "preset_loop".

Detailed procedures of how the values shall be obtained can be found in AD-12, and details in the concept of RGT tables and their structure are given in AD-4.

The RA-2 RGT tables are given in Table 4.5.1.2-1.

File ID	File Name	Purpose
MPL_MAI_RA	RA-2 Maintenance Segment	Specification of Orbital Segments for the scheduling of IF Calibration Mode, RF Bite Mode and Digital Bite Mode
MPL_PLO_RA	RA-2 Preset-Loop Output Planning	Specification of the file to provide planning information for the PLO activities for a specified planning period.
MPL_PLT_RA	RA-2 Preset-Loop Output Transponder Definition	Specification of the file to transfer the Transponder parameters
MPL_IDE_RA	RA-2 Individual Echo Planning File	Specification of the file to provide the planning for Individual Echo activities
MPL_IEZ_RA	RA-2 Individual Echo Zone Definition	Specification of the file to provide the planning for Individual Echo activities.

Table 4.5.1.2-1 RGT tables, responsibility of the RGT

5 Group Composition and their Tasks

5.1 Group Composition

The team shall be composed by the following experts:

A scientist, expert in radar altimeter data.

An instrument expert, with experience in ERS operations.

A Level 1b expert.

Links to the other calibration and validation activities (Absolute Range and Sigma-0 and Cross-Calibration and Validation).

A coordinator.

5.2 Description of the tasks to be performed by the group

A description of the tasks that the group shall perform in preparation for the in-flight activities during the commissioning phase and during the commissioning phase itself are given in the following sections, together with the inputs required to perform the tasks and the outputs expected. The parameters to be optimised, the strategies and procedures used for their optimisation and the schedule will be described in the next chapters of this document, Chapter 7 for the instrument related parameters, and Chapter 8 for the Level 1b related ones. These chapters will be updated in the following issues including the different group members contributions, to reflect the decisions taken among the group, the new procedures to be developed, etc.

5.2.1 RA-2 IECF Functions

Task1.1. the group members shall familiarise with the IECF general and reporting functions and RA-2 specific functions.

Task1.2. the group members shall review the RA-2 IECF defined functions (TPZ DPM, see AD-7)

Inputs:

- The RA-2 IECF DPM (AD-7).
- The IECF general and reporting functions (AD-8).
- A specific demonstration will be held at ESTEC for this purpose.

Output:

- Short technical note or report containing the review of the RA-2 IECF specific functions as output of Task1.2 - **RP /1**.

5.2.2 In-Flight Verification Procedures Review (Chapter 7 and Chapter 8)

Task2.1. the group members shall review the procedures defined in Chapter 7 andChapter 8 every time is updated.

Task2.2. the group members shall participate in the definition of the algorithms proposed in Chapter 7 andChapter 8 that are not covered in the below defined specific tasks, as well as in their testing.

Outputs:

- Comments and algorithms proposals of the current version of the plan, as output of Task2.2 - **RP/2**.

5.2.3 On-board Parameters Algorithms

Task3.1. Focused on the optimisation of the parameters from the parameter point of view, the group shall study the on-board instrument parameters and how they influence the data, by:

- studying the susceptibility of each of the dispatch area parameter to be not properly optimised on-ground;
- studying the way this non-optimised parameters effect on the data.

Out of those parameters that are likely to be non-optimum and with a visible effect on the data, a study will be performed (see Task4.1, RP/6, in Section 5.2.4) to understand how this effect on the data effects the geophysics.

Task3.2. the group members shall participate in the group discussion, and all the group together shall decide which of the above parameters have an influence to the Absolute Range and Sigma-0 Calibration and Cross Calibration and Validation.

Task3.3. Fro m the list of selected parameters in Task3.2 the group members shall propose procedures to identify and estimate the optimum parameter value in-flight from the instrument point of view, following the approach given in Chapter 7.

Task3.4. From the list of not selected parameters in Task3.2 the group members shall propose procedures to identify and estimate the optimum parameter value in-flight from the instrument point of view, following the approach given in Chapter 7.

Inputs:

- **RP/S3** as result of Task4.1, specified in Section 5.2.4.

Outputs:

- Report on the study of Task3.1 - **RP/3**.
- Report containing the procedure description for the parameters optimisation during Phase 1, as a result of Task3.3 - **RP/4**.
- Report containing the procedure description for the parameters optimisation during Phase 2, as a result of Task3.4 - **RP/5**.

5.2.4 On-board Parameters Geophysical Algorithms

The susceptibility of each of the instrument on-board parameters to be not properly optimised and the way this non-optimisation influence the data, have been studied in Section 5.2.3, Task3.1, RP/3.

Task4.1. The group shall perform a study to understand, out of those parameters that are likely to be non-optimum and with a visible effect on the data, how this effect on the data effects the geophysics.

Task4.2. The group shall participate in the group discussion, and all the group together shall decide which of the above parameters have an influence to the Absolute Range and Sigma-0 calibration.

Task4.3. Fro m the list of selected parameters in Task4.2 the group shall propose an algorithm to estimate the optimum parameter value in-flight, based on the geophysical data, selecting the adequate regions, boundaries or transitions, resolutions, duration, etc. following the approach given in Chapter 7.

Task4.4. Fro m the list of selected parameters in Task4.2 the group shall propose an algorithm to estimate the optimum parameter value in-flight, based on the geophysical data, selecting the adequate regions, boundaries or transitions, resolutions, duration, etc. following the approach given in Chapter 7.

Inputs:

- **RP/3** as result of Task3.1, specified in Section 5.2.3.

Outputs:

- Report on the study of Task4.1 - **RP/6**.
- Report containing the algorithm description of the parameters to be tuned during Phase 1, as a result of Task4.3 - **RP/7**
- Report containing the algorithm description of the parameters to be tuned during Phase 2, as a result of Task4.4 - **RP/8**.

5.2.5 Level 1b Parameters Algorithms

Task5.1. the group members shall study of the parameters used in the Level 1b processor[1] and how they influence the data, by studying:

- the susceptibility of each of the Level 1b parameter to be not properly optimised during the testing activity prior to launch;
- the way this non-optimised parameters effect on the output data.

Out of those parameters that are likely to be non-optimum and with a visible effect on the data, a study will be performed (see Task6.1, RP/11, in Section 5.2.6) to understand how this effect on the data effects the geophysics.

1. Note that these parameters can be found in each Data Record of the 1st, 2nd, and 3rd Level 1b Data Sets, and in the Level 1b auxiliary data like the Configuration file (RA2_CON_AUX),.

Task5.2. The group shall participate in the group discussion, and all the group together shall decide for which of the above parameters an algorithm has to be defined in order to optimise them.

Task5.3. Fro m the list of selected parameters in Task5.2 the group shall participate in the development of the procedures to estimate the optimum parameter value in-flight, following the approach given in Chapter 8.

Inputs:

- **RP/11** as result of Task6.1, Section 5.2.6.

Outputs:

- Report on the study of Task5.1 - **RP/9**.
- Report containing the procedure description for the parameters optimisation during Phase 2, as a result of Task5.3 - **RP/10**.

5.2.6 Level 1b Parameters Geophysical Algorithms

The susceptibility of each of the parameters used in the Level 1b processor[1] to be not properly optimised and the way this non-optimisation effects the data, have been studied inSection 5.2.5, Task5.1, RP/9.

Task6.1. The group shall perform a study to understand, out of those parameters that are likely to be non-optimum and with a visible effect on the data, how this effect on the data effects the geophysics.

Task6.2. The group shall participate in the group discussion, and all the group together shall decide which of the above parameters have an influence to the Absolute Range and Sigma-0 calibration.

Task6.3. Fro m the list of selected parameters in Task6.2 the group shall propose an algorithm to estimate the optimum parameter value in-flight, based on the geophysical data, selecting the adequate regions, boundaries or transitions, resolutions, duration, etc. following the approach given Chapter 8.

Inputs:

- **RP/9** as result of Task5.1, Section 5.2.5.

Outputs:

- Report on the study of Task6.1 - **RP/11**.
- Report containing the algorithm description of the parameters to be tuned during Phase 2, as a result of Task6.3 - **RP/12**.

1. Note that the configuration parameters of the Level 1b processor are defined in the Configuration file (RA2_CON_AUX).

5.2.7 Instrument Command & Control Verification & SODAP Plan

All the procedures described above will imply preparation of the strategy, algorithm and also Command & Control activities. This section is intended to cover the definition of the Command and Control activities, as the preparation of the macrocommands (MCMD's), involved in these procedures defined above.

Regarding Phase 1 and 2 of the Commissioning phase this procedures will be mostly defined in advance during this preparation phase, and so they will the MCMD's involved. However, in some cases new procedures will be defined or modified in real time, and so the MCMD's involved will.

Regarding the ΔSODAP phase the group shall review to the current SODAP plan with two objectives:

- ensuring that anything that has not been covered by the SODAP plan is included in the Phase 1 activities;
- optimising it so that the in-flight activities can benefit as much as possible from the SODAP phase, e.g. leaving the instrument in the proper mode so that the data can be used during the SODAP phase without interfering the other instrument activities.

Task7.1. the group shall support the activities related to Command & Control, defining the MCMD's involved in the preparation of the procedures described above in Section 5.2.2, Section 5.2.3 and Section 5.2.4.

Task7.2. the group shall ensure that anything that is not covered by the current SODAP Plan is included in the Phase 1 activities, and propose new strategies that be benefit the in-flight activities.

Inputs:

- Outputs generated in Section 5.2.2, Section 5.2.3 and Section 5.2.4 of this document.
- The SODAP Plan (AD-10).

Outputs:

- Report as result of Task7.2- **RP/13**.

5.2.8 Scientific Requirements Coordination

Task8.1. The group shall contact the different scientific communities and obtain their requirements or preferences in terms of:

- agility of the instrument in recovering from lose of tracking after boundaries, e.g. coastal regions;
- requirements of specific instrument resolution over specific target areas;

or other the group finds important.

Task8.2. The group shall be responsible for coordinating and integrating all the scientific requirements, deciding, in the cases of conflict, which is the final requirement, based on the mission scientific requirements.

Inputs:

- Mission scientific requirements.

Outputs:

- Report summarising the scientific requirements, as result of Task8.2 - **RP/14**.

5.2.9 Level 1b Test Data Generation

Task9.1. The group shall convert ERS RA (35 day) data set to RA-2 L1b to test the IECF functionality, accordingly to the above requirements, by using the current FRAPPE system.

Inputs:

- Level 1b data format.

Outputs:

- Test Data Set as output of Task9.1 - **DS/1**.

5.2.10 Commissioning Phase Activities

The Commissioning Phase has a scheduled duration of about 6 months. As explained in Chapter 4 of this document, this activity is divided into two different phases. The required group dedication is different in each phase:

SODAP Phase and Phase 1

The SODAP phase starts at the RA-2 switch-on and has a duration determined by the SODAP plan, which is of about 5 weeks.

Phase 1 starts at the end of the SODAP phase and lasts until 3 months after the RA-2 switch-on, which means that has a duration of about 2 months. The dedication required during these 2 phase is equal, and described below.

Dedication of 90% of time is required for the:

- instrument expert, and
- the scientist;

with a time distribution of:

- half of this time (45% of their total time) the group members shall be physically located at ESTEC, for them to be able to use the IECF (equivalent to 2 or 3 days per week);
- the rest of the time the group members can be located at their own establishments using his own equipment (the 2 or 3 days left per week).

Dedication of 10% of time is required for the:

- Level 1b expert;

with a time distribution of:

- generally located and their own establishment,

- 1 coordination/working meeting every second week.

At the end of this phase a document shall be produced reporting all changes performed to the on-board parameters, as well as the operations performed and their results.

Phase 2

This phase starts as soon as Phase 1 is concluded and has a duration of 3 more months, lasting until the end of the Commissioning Phase.

Dedication of 50% of time is required for the:

- scientist, and
- Level 1b expert;

with a time distribution of:

- generally located at his own establishments,
- 1 weekly coordination/working meeting of 1 day duration at ESTEC.

Dedication of 10% of time is required for the:

- instrument expert;

with a time distribution of:

- generally located at his own establishments,
- 2 coordination/working meetings of 1 day duration at ESTEC during this phase.

It is assumed that the exchange of information and results will be done via telephone or e-mail whenever the group members are not located at ESTEC.

At the end of this phase a document shall be produced reporting all changes performed to the algorithms parameters and the on-board parameters that were moved to Phase 2, the operations performed and their results during this phase, and any other changes that have occurred.

Routine Phase

Dedication of 10% of his time is required during 1.5 years (until 2 years after the launch) and only 5% of his time is required for the following 3 years, which is until the end of the EnviSat life time, 5 years after its launch. The work approach for this time is:

- working from their establishment and in e-mail bases information exchange,
- meetings will only be required when an special event occur.

Task10.1. the group members shall dedicate their required percentage of time during Phase 1 to run the functions developed during the pre-launch activities, using RA-2 data, studying the results, and proposing solutions to optimise the parameters being under test.

Task10.2. the group members shall participate in producing the document at the end of Phase1 that will report all changes performed to the on-board parameters, as well as the operations performed and their results.

Task10.3. the group members shall dedicate their required percentage of time during Phase 2 to run the functions developed during the pre-launch activities, using RA-2 data, studying the results, and proposing solutions to optimise the on-board parameters left from Phase 1.

Task10.4. the group members shall participate in producing the document at the end of Phase2 that will report all changes performed to the on-board parameters that were moved to Phase 2, the algorithms parameters and any other changes that have occurred.

Outputs:

- Report (as contribution to the overall group report above described) containing changes performed to the on-board parameters, the operations performed and their results, during Phase 1, as output of Task10.2 - **RP/15**.
- Report (as contribution to the overall group report above described) containing changes performed to the left on-board parameters, the operations performed and their results, during Phase 2, as output of Task10.4 - **RP/16**.

6 IN-FLIGHT INSTRUMENT CALIBRATION - SODAP PHASE

6.1 Definition and Duration

The SODAP Phase is the Switch-On phase (Switch On and Data Acquisition Phase), in which all the instruments on-board EnviSat are being switched-on one after the other. In this phase the main capabilities of the instrument are analysed.

During the SODAP phase few checks will be performed to the instrument with the idea of getting data as soon as possible. The tasks are described in the SODAP Plan (AD-10), which contains the detail schedule of the instrument modes changes, MCMD's and data retrieved. The algorithms that will be used in order to process these data are described below in this chapter.

The RA-2 modes are the following,

Measurement Mode:

Measurement (nominal);

Preset_Loop_Output, submode;

Preset_Tracking, submode;

including Individual Echoes.

Calibration Mode

RF BITE Mode

Digital BITE Mode

The list of tasks to be performed during this phase is the following (see the SODAP plan in AD-10):

Switch on and initialisation of the instrument

Transition to Heater 2 Mode

Measurement Mode:

- Acquisition / Tracking
- Preset_Loop_Output sub-mode
- Preset_Tracking sub-mode
- Individual Echoes

IF Calibration Mode / IF Auxiliary data

Datation check for Source Packets: OBDH + USO

The capability instrument to be able to go into all possible different modes and submodes has to be checked. The functionality of the MCMD associated to all these modes and sub-modes has to be demonstrated: preparation of all the MCMD themselves, generation IECF and RGT files associated, etc.

Note that the measurement mode is the mode in which the instrument is acquiring scientific meaningful data measurements. This mode can also function in different submodes:

Preset_Loop_Output and Preset_Tracking submodes. The data will always be scientifically meaningful, but the instrument is set to different behaviour or with different parameters.

Several other features will have to be check in these modes (e.g. Acquisition/Tracking, preliminary SPTR, etc.), however, they are of the scope of phase 1, described in Chapter 7.

6.2 IF Calibration Mode

[Short description of the IF Calibration Mode]

In the RA-2 SODAP plan (AD-10) there is already a function defined to analyse the data in IF Calibration mode during the SODAP phase, the so called function S-H-S-02 of Phase 3-Short Functional Check. This function evaluate the Source Packets analysing the IF amplitude ripples and ensuring they are typical (as from the ground testing).

Further check will be done using IECF functions.

Build single IF mask

Build averaged IF mask (the instrument has to be left in Cal mode for a while)

Compare the new IF mask with the ones on ground.

6.2.1 Frequency of Execution and Schedule

Only once.

See AD-11 for schedule.

6.2.2 Data Required

Level 0 data in IF Calibration mode.

6.2.3 MCMD involved

IF CALIBRATION MCMD (or procedure P-H-N-08 defined in AD-3)

6.2.4 IECF functions used and/or procedure

IECF function: RA2-18 and RA2-19.

6.2.5 Expected Results

The IF mask obtained shall be comparable to the IF measured on-ground (RA2_IFA_AUX and RA2_IFB_AUX, depending on the chain used, most probably chain A).

6.2.6 Pass/Failure Criteria

See Expected Results Section 6.2.5.

6.2.7 Actions

See Section 7.2.5.

6.3 Measurement Mode - Engineering Parameters Evaluation

In the SODAP plan (AD-10) there is already a function defined to analyse the data in measurement mode during the SODAP phase. Function S-H-S-04 of Phase 5 - Measurement Data Acquisition, evaluates the Source Packets by comparing the standard deviation of the data parameters to the required standard deviation given by the instrument requirements (see AD-2).

The group will, obviously, benefit from these results, however some extra checking will be performed. this extra checking will not be very extensive but only through histograms using RA-2 IECF available functions.

6.3.1 Frequency of Execution and Schedule

Only once.

See AD-11 for schedule.

6.3.2 Data Required

Level 0 data in measurement mode.

6.3.3 MCMD involved and when

MEASUREMENT MCMD (or procedure P-H-N-06 defined in AD-3).

6.3.4 IECF functions used and/or procedure

The following IECF functions, from Table 4.4-1 in Chapter 4, will be used to study the

Source Packet data:

RA-01

RA-02

RA-03

RA-10

6.3.5 Expected Results

NA.

6.3.6 Pass/Failure Criteria

NA.

6.3.7 Actions

NA.

6.4 Individual Echoes Sub-mode

The RA-2 has the capability to provide limited bursts of individual, un-averaged echo sample data at the full PRF rate for research purposes. In this concept the full-rate data are stored, for a short burst, into an internal buffer memory, in parallel to the normal averaging and other functions of the instrument. The buffered data are subsequently read out at a much lower rate and appended to the normal science data.

The Individual Echoes can only be present in Measurement Mode and IF Mode of the instrument. In this phase only Individual Echoes from measurement mode will be analysed.

In the SODAP plan (AD-10) there is already a function defined to analyse the data in measurement mode with individual echoes during the SODAP phase, the so called function S-H-S-04 of Phase 5 - Measurement Data Acquisition. This function evaluates the Source Packets by comparing the standard deviation of the data parameters to the required standard deviation given by the instrument requirements (see AD-2), as per Section 6.3.

The group will, obviously, benefit from these results, however some further checking can be made.

A very challenging issue with the individual echoes is the precision in the time when the mode is actually taken place, since the maximum time that we can have individual echoes is only one second (see RD-6 for further details). This means that if we are interested in having individual echoes in a very specific geographical area, the instant in which the individual echoes start being acquired shall be very precisely programmed. The operations that take care of this have been defined in AD-12 and AD-14. The checking of the data during the SODAP phase to make sure the required precision is achieved, has to be defined here.

6.4.1 Frequency of Execution and Schedule

Only once.

See AD-11 for schedule.

6.4.2 Data Required

Level 0 data that contain the individual echoes.

6.4.3 MCMD involved and when

INDIVIDUAL ECHOES MCMD (or procedure P-H-N-20 defined AD-3).

6.4.4 IECF functions used and/or procedure

Compute individual echoes datation using the IECF function RA2-01 and RA2-12.

Compare this datation with the scheduled time when individual echoes had to be obtained.

6.4.5 Expected Results

Diff [(dat_IE) - (dat_MCMD)] = MCMD tolerance (~30 microsec, TBC).

6.4.6 Pass/Failure Criteria

Passed when Diff ≤ MCMD tolerance.

6.4.7 Actions

The In-flight Verification team shall investigate together with the RGT team the datation generated in the Individual Echoes MCMD and the RGT files associated.

6.5 Preset_Loop_Output Sub-mode

The Alpha-Beta Tracker is a filter which has two important tasks. First of all it is a Low

Band Pass filter but also it has the function of having to change the rate from the input to the output.

The equations that model the $\alpha-\beta$ tracker are the following:

$$x_c(n) = x_p(n) + \alpha * \varepsilon(n)$$
$$x'_p(n) = x'_p(n\text{-}1) + \beta * \varepsilon(n) \qquad (6.2.3\text{-}1)$$
$$x_p(n+1) = x_c(n) + x'_p(n)$$

The values x_p and x'_p shall be updated at PRF/N_A rate, every time a discriminator output is available. In order to get output values at PRF rate, necessary for the loop closure, a linear interpolator is employed with the following equation:

$$x_o(i) = x_c(n) + n_D * \Delta + i * \Delta \; (i = 1, N_A) \qquad (6.2.3\text{-}2)$$

being $\Delta = x'_p(n) / N_A$. n_D is an integer number representing the time delay in number of PRI required by the discriminator to compute the next value.

In the Level 0 product, both the output of the Alpha branch and the output of the Beta branch are reported. They are called DIST X Corrected and AGC X Corrected for the alpha branch output, which is the equivalent to $x_c(n)$; and DISTX Predicted and AGC X Predicted for the beta branch output, which is the equivalent to $x'_p(n)$.

Note that, from AD-6:

"Chirp_ID, Rx_dist_c, Rx_dist_f, AGC_c and AGC_f are relative to the 17th sweep over the 100 composing a data block.... Similarly, Predicted and Corrected AGC and Distance (output of the Alpha-Beta Tracking Filters) of the data block j, represents the predictions for the data block j+1)"

That means calculated after the 17th receive trigger. Since the first operation done in each sweep is the increment of the interpolating function, this actually means the estimated values which will be used in the 18th.

The aim of the Preset_Loop_Output mode is to maintain the loop open. This means that the error introduced into the filter is always 0, during the duration of the mode ($\varepsilon(n) = 0$, while n within the mode duration). in this way the behaviour of the range window of the altimeter can be programmed. This is of special interest when trying to follow a fixed point of the surface.

Tacking into account all the above explanation, the equations of the Alpha-Beta tracking filter for the Preset_Loop_Output can be re-written in the following way:

$$x_c(n) = \text{DIST X Corrected} + n^*\text{DIST X Predicted}$$
$$x'_p(n) = \text{DIST X Predicted} \qquad (6.2.3\text{-}3)$$

for the Range tracker case, and

$$x_c(n) = \text{AGC X Corrected} + n^*\text{AGC X Predicted}$$
$$x'_p(n) = \text{AGC X Predicted} \qquad (6.2.3\text{-}4)$$

for the AGC tracker case.

The instrument can be switched to Preset_Loop_Output mode both from being in Heater 2 and Measurement mode. The two cases have to be tested.

(Note: it is still TBD that the SODAP plan is updated so that in includes the switching to this mode).

6.5.1 Frequency of Execution and Schedule

Only once.

See AD-11 for schedule.

6.5.2 Data Required

Level 0 data in Preset_Loop_Output mode.

6.5.3 MCMD involved and Sequence

Parameter Setting MCMD: always, because it changes the parameters used from the Dispatch area. The parameters involved are calculated in the FOS, with the algorithm specified in AD-12 and AD-13. This MCMD has to update the following parameters from the CTI table ROP PS&PLO (see Section 4.5.1):

Rx Distance

AGC

First Derv Rx Dist

First Deriv AGC

Chirp Band

Measurement MCMD: only when the instrument is in Heater 2, otherwise it is not necessary.

Preset_loop_Output MCMD: always.

The procedure described in the section below, Section 6.5.4, shall be carried out in two different cases: from the instrument being in Measurement mode and from the instrument being in Heater 2 (see AD-3). Both the procedures and results should be the same in the two cases.

The sequence of MCMD's and its parameters when the instrument is already in measurement mode is: (TBC)

1 PARAMETER SETTING MCMD;

2 PRESET LOOP OUTPUT MCMD.

The sequence of MCMD's and it parameters when the instrument is in heater 2 is: (TBC)

1 PARAMETER SETTING MCMD;

2 PRESET LOOP OUTPUT MCMD;

3 MEASUREMENT MCMD.

Note: the IOM (AD-3) need to be updated to reflect this procedures

6.5.4 IECF functions used and/or procedure

The dispatch area parameters set with the MCMD correspond to the outputs of the Alpha branch and the Beta branch of the Alpha-Beta Tracking filters.

The first data blocks after the execution of the MCMD, should report an alpha and beta branch output equal to the ones have been set through the PS MCMD.

After that and during the time the MCMD specifies, duration of the mode, these output should follow equations (5.2.5-3) and (5.2.5-4).

Data used: Level 0 product.

Parameters: by using IECF reporting functions for data extraction, the following parameters from science data blocks, being j the data block number (1..20), have to be extracted (see AD-6 page 265):

AGC X corrected: 2 words from W:262 + (j-1) 227

AGC X predicted: 2 words from W:264 + (j-1) 227

DIST X corrected: 3 words from W:266 + (j-1) 227

DIST X predicted: 3 words from W:269 + (j-1) 227

Chirp_bandwidth_id: second byte in W: 276 + (j-1) 227

Procedure: The comparison should be done from the first data block after the MCMD to the last one applicable. Let us call the first data block after the MCMD is effective as DataBlock 1_{PLO}. The last data block will then be:

$$DataBlockN_{PLO}TRK = Ceiling\left[DataBlock1_{PLO} - 1 + \frac{OpenTRKLoopDuration}{BataBlockDuration}\right]$$

$$DataBlockN_{PLO}AGC = Ceiling\left[DataBlock1_{PLO} - 1 + \frac{OpenAGCLoopDuration}{BataBlockDuration}\right]$$

Then, for j = DataBlock 1_{PLO}

DIST X corrected(DataBlock 1_{PLO}) = Rx Distance;

DIST X predicted(DataBlock 1_{PLO}) = First Derv Rx Dist;

and for j = DataBlock 1_{PLO}

AGC X corrected(DataBlock 1_{PLO}) = AGC;

AGC X predicted(DataBlock 1_{PLO}) = First Deriv AGC.

For j = DataBlock 1_{PLO} + 1 .. DataBlock N_{PLO}TRK

DIST X corrected(j) = Rx Distance + j*First Derv Rx Dist;

DIST X predicted(j) = First Derv Rx Dist;

and for j = DataBlock 1_{PLO} + 1 .. DataBlock N_{PLO}AGC

AGC X corrected(j) = AGC + j*First Deriv AGC;

AGC X predicted(j) = First Deriv AGC.

Also, for j = DataBlock 1_{PLO} .. max[DataBlock N_{PLO}TRK, DataBlock N_{PLO}AGC]

Chirp Band = Chirp_bandwidth_id

Further more we will prove that the next data block has the corresponding value to the close loop.

Plotting: by using IECF reporting functions (plotting) we will plot all the parameters against time and block number.

Rx Distance and DIST X corrected;

First Derv Rx Dist and DIST X predicted;

AGC and AGC X corrected;

First Deriv AGC and AGC X predicted;

Chirp Band and Chirp_bandwidth_id.

6.5.5 Expected Results

All the equities confirmed during the proper duration.

6.5.6 Pass/Failure Criteria

We can only allow quantification errors (TBCompleted)

6.5.7 Actions

If the values are the same for the first data block, but different after that, it means that the problem is in the mode behaviour:

1 either the MCMD is not been accepted by the instrument, so that the instrument did not actually change mode; or

2 there is a problem with the alpha-beta tracker (not expected due to extensive on-ground testing activity).

6.6 Preset_Tracking Sub-mode

From the measurement mode we need to distinguish two phases: the acquisition phase and the tracking phase.

Knowing how the Alpha-Beta Tracker works from Section 6.5, preset_tracking: skip acquisition; start tracking phase immediately just after the MCMD is effectively implemented.

check both from Heater 2 and from Measurement

(Note: it is still TBD that the SODAP plan is updated so that in includes the switching to this mode)

6.6.1 Frequency of Execution and Schedule

Only once.

See AD-11 for schedule.

6.6.2 Data Required

Level 0 data in Preset_Tracking mode.

6.6.3 MCMD involved and when

Parameter Setting MCMD: always, because it changes the parameters used from the Dispatch area (ROP Table). The parameters involved are calculated in the FOS, with the algorithm specified in xxx.This MCMD has to update the following parameters from the table ROP PS&PLO:

Rx Distance

AGC

First Derv Rx Dist

First Deriv AGC

Chirp Band

Preset_loop_Output MCMD: always, it is needed to specify that the loops are open only for an instant and that afterwards the loops close to the nominal measurement mode behaviour.

Preset_Tracking MCMD: always.

Note: the IOM (AD-3) need to be updated to reflect this procedures

6.6.4 IECF functions used and/or procedure

The dispatch area parameters set with the MCMD correspond to the outputs of the Alpha branch and the Beta branch of the Alpha-Beta Tracking filters.

The first data blocks after the execution of the MCMD, should report an alpha and beta branch output equal to the ones have been set through the PS MCMD.

After that, these output should follow equations the nominal tracking, given by the equations (5.2.3-1) and (5.2.3-2).

Data used: Level 0 product.

Parameters: by using IECF reporting functions for data extraction, the following parameters from science data blocks, being j the data block number (1..20), have to be extracted (see AD-6 page 265):

AGC X corrected: 2 words from W:262 + (j-1) 227

AGC X predicted: 2 words from W:264 + (j-1) 227

DIST X corrected: 3 words from W:266 + (j-1) 227

DIST X predicted: 3 words from W:269 + (j-1) 227

Chirp_bandwidth_id: second byte in W: 276 + (j-1) 227

6.6.5 Expected Results

See Procedure in Section 6.6.4.

6.6.6 Pass/Failure Criteria

See Procedure in Section 6.6.4.

6.6.7 Actions

The generation of the MCMD and the RGT files involved shall be reviewed.

7 IN-FLIGHT INSTRUMENT CALIBRATION - PHASE 1

7.1 Definition and Duration

The high level aim of this first performance checking is getting the quality of the data enough to be used for calibration purposes. This means that the primary functionalities of the instrument have to be checked, but also that a performance evaluation has to be done. In this performance evaluation it is important to ensure that the instrument is fully tested so that in the short term the data used for calibration purposes are completely meaningful from the instrument point of view, and in the long term the data used by the scientist as well. The investigation performed during Phase 2 should only be related to the actual processing of these data, unless something seriously wrong is discovered.

This exercise is planned to have a total duration of 3 months, so be finalised by L+3M.

The tuning of parameters used both on-board, stored in the dispatch area, and on-ground, stored in the auxiliary data files used by the processors algorithms, is an important task. These parameters have to be optimised carefully. However it is also important that some of them are optimised within a reasonable amount of time. The reason is that the data used for the other calibrations (absolute range and sigma-0 and cross-calibration and validation, see RD-4,RD-5, and RD-7) must have been retrieved with the adequate parameter values and those shall not, in principle, be changed after the calibration has started. These parameters, thus, have to be tuned during this period.

Note that some of the instrument parameters are not stored on-board but in an auxiliary file, (so called Characterisation file, see Section 8.1 and Section 8.2). These parameters are used by the on-ground processors. Although they are still instrument parameters, they can be optimised or recalculated during Phase 2.

In the case of the auxiliary data it is also very important to ensure the chain from the acquisition of these data to the final construction of the auxiliary product and the use of these aux data by the products themselves. This phase will be focused in the retrieval of the dynamic auxiliary data. The on-ground algorithms part will be a task of Phase 2.

Primarily the level of the data to be used during this phase will be Level 0. However, also Level 1b and Level 2 data may be used for purposes like surface discrimination, or other purposes of this type that will not affect the results.

The list of the functions to be performed during this period is the following:

Dispatch Area Parameters & Basic Performance:

- Acquisition Parameters and Performance
- Alpha-Beta Tracker Parameters and Performance
- MFT Parameters and Performance
- Resolution Selection Logic (RSL) or Loss-of-Lock logic (LoL) Parameters and Performance
- Noise Power Parameters and Performance
- PTR Parameters
- Acquisition and Tracking Sequences

Auxiliary data Verification:

- IF Mask retrieval approach
- IF Mask variation with Temperature (around the orbit)

Preliminary Datation Verification

Antenna Mispointing Estimation

The required procedures are described in this chapter.

7.2 Tests with Direct Implication into On-board Parameters

The results of the tests proposed in the following sections have a direct implication in to the on-board the dispatch area parameters.

7.2.1 Acquisition Parameters and Performance (Acq)

This function is intended to evaluate the proper value of the parameters from the dispatch area related to Acquisition. These parameters which are in the CTI tables CTI_ACQ_RA and CTI_TRK_RA, are:

PN

PN_MIN

PN_MAX

K_TH_COEF_NPE

TH_MIN

AGC_NPE

TLE_MIN_DET

TLE_MAX_DET

ACG_DET1

ACG_DET2

T'

K_AGC

AGC_SET_MIN

AGC_SET_MAX

NPE phase parameters (both phase 1 and 2 considering that they have the same parameters): Considering that from the ERS-2 Noise experiments we have realized that the noise is constituted of about 80% of instrument noise and only 20% of environmental noise, the tests performed on-ground should be very good representative of the in-flight behaviour and consequently the parameters chosen are likely to be optimised.

Detection 1 Phase parameters: Following the principle used for the on-ground parameters settings, the Detection Phase 1 should be used for detecting signals with high power (Sigma_0 > 10dB), for this reason data recorded over lakes and/or ocean close to the coastline, which have a high probability to be in acquisition mode but have a high backscatter are chosen.

We have pointed to the instrument requirements for which tracking over ocean surfaces should be reached within 1 sec. from the acquisition starting in 95% of cases. We also understand that over high sigma_0 surfaces, Detection Phase 2 will most probably fail if the Detection Phase 1 is fails, since the reason of the failure will probably not be the AGC. Considering all this, we have derived the following objective:

1 over high sigma_0 surfaces (Sigma_0 > 10dB), the Detection Phase 1 should not fail in 95% of cases.

Detection 2 Phase parameters. Following the principle used for the on-ground parameter settings, the Detection Phase 2 should be used for detecting signals with high power (Sigma_0 < 10dB), for this reason the data chosen for this test are data recorded over mountainous and arid regions which have a high probability to be in acquisition mode but have a low backscatter (Takla Makan region).

Considering that there are no requirements on the acquisition performance over land, the Detection Phase 2 not failing percentage allowed is TDB. In any case the same method applied for Detection Phase 1 will be applicable here when changing AGC_DET1 with AGC_DET2.

Note: once the AGC_DET1/2 have been determined basing on the two Detection Phases Failing/not Failing requirements, the position of TLE could be optimised within the allowed range [TLE_MIN_DET, TLE_MAX_DET]. This to avoid the risk to go back directly to Acquisition after getting into Tracking or that the waveform would stay not centred for a too long period. Supposing that the maximum of the Detection Samples time series represents the presence of the signal, we could calculate the statistics, over all the acquisition occurrences, between the position of that maximum and TLE. Then adjust the value of K_TH_COEFF_NPE to force that distance to be of a TBD length and with a TBD probability.

AGC setting Phase parameters. Considering that on AD-15, page 57, the K_AGC is given with a formula which is dependent on the P_REF and supposing that the P_REF is not going to change during flight, the decision taken is that the AGC_SET_MIN and the AGC_SET_MAX will be checked and tuned with reference to statistics of the AGC_SET once calculated.

7.2.1.1 Frequency of Execution and Schedule

These tasks shall be performed at the beginning of the phase 1. It shall be repeated for several days (3, 4) until the results are successful or the pass/fail criteria passed. More details of the frequency are given in the procedure after each single tasks.

7.2.1.2 Data Required

The products to be used are Level 0. This test shall be performed on one day of data, and repeated for several days (3, 4) in order to compare the several results computed.

7.2.1.3 MCMD involved

None.

7.2.1.4 IECF functions used and/or procedure

NPE phase parameters (both phase 1 and 2 considering that they have the same parameters).

The strategy is the following:

- Calculate the normalized histogram of all the PN(1/2) values
- Calculate the integral of this histogram outside the range [PN_min, PN_max], which will be NPE_fail
- If this value > TDB (percentage of failure allowed)
- Evaluate a parameter A=NPE_fail/TBD
- Calculate the new value chosen for AGC as: AGC_NPE_n = AGC_NPE_o - 10*log10(A), where AGC_NPE_n is the new AGC value to be put in memory and AGC_NPE_o is the old one.

Check if the value of PN' matches with the calculated average of PN(1/2), if not define PN' equal to that average.

This test shall be performed on one day of data, and repeated for several days (3, 4) in order to compare the several results computed, which in principle should be very similar.

Detection 1 Phase parameters:

The first step is to check is the percentage of failed cases is > 95%. This can be performed using the fail/notfail flags available in the products, with the following consideration:.

- The parameters TLE_MIN_DET and TLE_MAX_DET, have been determined by considerations related to the position of the satellite in orbit, which will not change in-flight.
- K_TH_COEFF_NPE and AGC_DET1 have been identified as the key parameters of this phase. The important issue, however, is not to consider the two parameters by themselves, but their relation. For this reason we have concentrated on the AGC_DET1 while leaving for the time being, the K_TH_COEFF_NPE as it is.

In case of failure the following procedure has to be followed:

1 Take from all the events (N_acq_events) in acquisition mode the relative Detection Samples in function of the time (index i, from 0 to 192).

2 Choose several multiplicative factors Aj within the step attenuator range converted in linear units ([0, 62] dB with 1dB step, converted in linear units). For each factor Aj perform the following:

  2.1 Multiply all the detection samples for Aj

  2.2 For each index k of the 192 detection samples, evaluate the corresponding index i in the absolute reference system of the 2370 detection samples used on-board with the following algorithm:

  - Using the corresponding T_LE, evaluate the equivalent absolutely referred I index reversing the formula in AD-15, page 54.

- For each of the k indexes, for k=0…191, the corresponding i index in the absolute reference system will be i=I+5-k, for i=I+5…I-186.This considering how the 192 detection samples have been selected to be put in the telemetry, AD-16, page 201.

2.3 For each index i evaluate the corresponding TLE(i) using the formula in AD-15, page 54.

2.4 For each TLE(i) within the range [TLE_MIN_DET, TLE_MAX_DET], over all the acquisition events, calculate the number of Detection Samples are higher than the respective threshold TH which will be N_det_samples_higher(i).

2.5 For each TLE(i) within the range [TLE_MIN_DET, TLE_MAX_DET], evaluate the probability that the corresponding Detections samples are higher than TH as:

- Prob_det_samples_higher(i)=N_det_samples_higher(i)/n_acq_events. Every TLE(i) within the range [TLE_MIN_DET, TLE_MAX_DET] for which Prob_det_samples_higher(i)>0.95 corresponds to a possible good TLE with 95% of probability. Count the number of the indexes I for which this condition is satisfied, this number will be N_TLE_GOOD(j)

- Choose the Aj relative to the highest N_TLE_GOOD(j). This will be the factor with the highest probability of having a good TLE.
- Calculate the new AGC_DET1_n value as: AGC_DET1_n=AGC_DET1_o – 10*log10(Aj) where AGC_DET1_o is the old AGC_DET1 value.

- Check if the minimum value of the threshold TH corresponds to TH_MIN, if not assign TH_MIN the value just calculated.

The test will have to be performed over one day of data and repeated for several (3/4) days in order to compare the results of the AGC_DET1_n found which in principle should be similar.

AGC Setting Phase parameters

As mentioned at the beginning of this procedure, in Section 7.2.1, the AGC_SET_MIN and the AGC_SET_MAX will be checked and tuned with reference to statistics of the AGC_SET once calculated.

7.2.1.5 Expected Results

See procedure described above, Section 7.2.1.4.

7.2.1.6 Pass/Failure Criteria

See procedure described above, Section 7.2.1.4.

7.2.1.7 Actions

If the parameters values or the statistic performed (seeSection 7.2.1.4) are out of range then the on-board parameters will be updated through the Parameter_Setting MCMD.

7.2.2 On-board Alpha-Beta Tracker Parameters

The Alpha-Beta tracker is an on-board filter, with a close loop, which from the previous waveform estimates the on-board parameters (like position and AGC) for the next waveform. An explanation has been given in Section 6.5. For more details refer to RD-9.

The on-board parameter under tests, which are in the CTI Table CTI_ABF_RA, are:

ALPHA_P_FILTER

BETA_P_FILTER

ALPHA_AGC_FILTER

BETA_AGC_FILTER

The Alpha and Beta parameters of the Alpha-Beta Tracker will be obtained on ground. the procedure is described below. In-flight there will only be a quick verification.

7.2.2.1 *Objectives:*

The objective of the Alpha-Beta tuning is to determine the optimum values for the Alpha-beta tracker in light of possible impacts on the RSL. The behaviour of the Alpha-Beta tracker should be such that it does not impede meeting the objectives of the RSL. At the minimum and maximum permitted values of the Alpha-Beta parameters the tracker is likely to exhibit undesirable behaviour leading to un-necessary increases in resolution. The anticipated behaviour at extreme values of the Alpha-Beta tracking constants is as follows:

Maximum values/agility. This will minimise a non-required increase in resolution over rapidly varying topography. It will however increase the likelihood of the tracker "snagging "on bright targets which are passing through the footprint. This will occur for example where the altimeter transits from land to ocean and where a bright target, for example calm water, is present on the coast. A maximum agility tracker will tend to follow such a target as it recedes leading to an increase in resolution and a delay in maximum resolution over the ocean.

Minimum values/agility. This will minimise the succeptibility of the tracker to snagging on bright targets but will increase the likelihood of an un-required increase in resolution over rapidly varying topography, in particular over ice sheet margins. The Alpha-Beta trackers should be tuned to enable the tracker to follow the maximum accelerations likely to be encountered over surfaces where slopes are small enough to produce a reasonable return echo.

7.2.2.2 *Frequency of Execution and Schedule*

Any modification of the Alpha-Beta parameters should take place prior to tuning of the RSL parameters. This is because optimisation of the tracking parameters with regard to the above objectives is largely independent of the RSL. Operation of the RSL is however strongly dependent on the choice of Alpha-Beta parameters. Although the two sets of parameters are coupled simultaneous tuning is probably too complex to be achieved effectively. Updates to the Alpha-Beta parameters should therefore be minimised as far as possible to avoid confusing the effects of any changes to the RSL parameters.

(i) An initial update to the Alpha-Beta parameters will be considered prior to launch to be implemented as soon as possible after switch on of the instrument.

(ii) Tracking performance will be checked following the acquisition of the first complete day of data to check that performance over the ice sheet margins and coastal transitions is as expected. If any serious problems are detected updates to the Alpha-Beta parameters will be considered.

(iii) Further updates will then only be considered where the RSL objectives cannot be met by changes to the RSL parameters alone.

7.2.2.3 Data Required

Level 0, Level 1b and Level 2.

S_0: 1st complete day of data.

7.2.2.4 Procedure

1 The currently implemented values of Alpha-Beta constants will be considered. In particular the rationale behind choosing the current values should be considered in the light of results from the instrument simulations.

2 The minimum acceptable Alpha-Beta values should be determined be examining behaviour over the ice sheet margins. For echoes with a well defined leading edge and shape the tracking window should follow changes in the LEP so as to minimise triggering the RSL counters. Minimum values should be determined by determining the maximum acceleration using ERS ice mode profiles over the ice sheet margin and calculating the minimum values of Alpha-Beta required to follow such accelerations. A first order simulation of the RA-2 tracker should also be used with the ERS height data to determine the probability of triggering an increase in the RSL counters for various Alpha-Beta values.

3 The maximum acceptable Alpha-Beta values should be determined by considering the increasing effect of "snagging" events due to increasing the agility of the tracker. in the limit the trackers should not be so agile as to follow a bright target at a fixed point below the satellite track as it moves to the back of the range window. The acceleration of such a target is equal to the square of the satellite velocity (6.7 kms-1) divided by the orbital height(800km) which for Envisat is approximately 56 m-2 [Rapley, et. al., 1985, ESTEC Contract 5684/83/NL/BI]. Ideally the tracker agility should be significantly below this value to minimise the effect of bright target transitions.

4 Pre-launch values for the Alpha-Beta trackers should be set to the minimum value possible whilst minimising the number of unnecessary switches of resolution do not occur due to the tracker being unable to follow topography. This will be determined by calculating the percentage of echoes over ice sheet margins where the increase resolution counter (C2) is incremented due to the LEP position.

5 Tracking performance on ice sheet margins and over coastal transitions will be checked immediately after acquisitions of the first data and then subsequently following changes to the RSL.

7.2.2.5 IECF/FRAPPE functions:

The following IECF Functions will be used for procedure steps 1) to 4):

- RA-32: Surface Types Discrimination
- RA-10A: World surface plots + statistics generation
- RA-10B: Acquisition Timing

The following FRAPPE functions will be used for procedure steps 5) to 11):

- FRAPPE PDS extract tool will be used to extract subsets of full orbit data for further analysis.
- FRAPPE Dave primary tool will use the Map plotting, XY plotting, histogram and return echo display.
- FRAPPE free format extraction will be used to output time, lat, long and parameters values as ascii text files for subsequent display by external packages (e.g. Generic Mapping Tool - GMT)

7.2.2.6 MCMD involved

None.

7.2.2.7 Expected Results

See objectives.

7.2.2.8 Pass/Failure Criteria

n/a.

7.2.2.9 Actions

See procedure.

7.2.3 On-board Tracking Parameters: MFT & RSL & NPM

The on-board Model Free Tracker (MFT), together with the Resolution Selection Logic (RSL) and the Noise Power Measurement (NPM), are the ones controlling the behaviour of the on-board tracker and the autonomous change of bandwidth or resolution of the instrument. For details of these functionalities please refer to RD-9.

The on-board parameter under tests are in various CTI Tables. We remark that this is the most critical parameter optimisation and that many parameters are all involved at the same time, with no possible de-coupling. These ICT tables and parameters are given in the Table 7.2.3-1 below. The parameters in grey are such that their influence on the subject (MFT, RSL or NPM) is less significant than in the other cases.

Table 7.2.3-1CTI tables and parameters related to the on-board tracking.

CTI Table	MFT Parameters	RSL Parameters	NPM Parameters
CTI_TRK_RA	PREF		
CTI_ABF_RA	DELTA_OFF_TRK		

Table 7.2.3-1CTI tables and parameters related to the on-board tracking.

CTI Table	MFT Parameters	RSL Parameters	NPM Parameters
CTI_MFT_RA	B_MIN B_MAX P_MIN P_MAX SUM_P_MIN SUM_P_MAX K1 K2	B_MIN B_MAX P_MIN P_MAX SUM_P_MIN SUM_P_MAX	
CTI_LOL1RA		SNR_MIN SNR_MAX LOL_P1 LOL_P2 LOL_DELTA LOL_CB1 LOL_CB2 LOL_CBMAX LOL_K	
CTI_LOL2RA		SNR_M1 SNR_M2 DELTA_AGC_1 DELTA_AGC_2 DELTA_AGC_3 DELTA_AGC_4	
CTI_NPM_RA	TS_MIN KS	KS N'_MIN N'_MAX	TS_MIN N' KS N'_MIN N'_MAX AGC_NPM DELTA_N1 DELTA_N2 DELTA_N3

7.2.3.1 Objectives

1 Oceans:

1.1 320 MHz resolution tracking within 14km of a land transition (95%)

1.2 320 MHz tracking over 99% of deep ocean

1.3 320 MHz tracking over TBD% of shallow water

2 Land Ice

2.1 Fixed resolution (320 or 80 MHz) at cross-overs in interior (CryoSat mask)

2.2 90% of tracking over ice sheet margins (accelerations to ± 2.5 ms^{-2}) in any resolution: gives the minimum bandwidth of the α–β tracker (so α and β values).

2.3 2320Mhz tracking over 90% of ice shelves

3 Sea Ice

3.1 320Mhz tracking over 90% of sea ice

4 Land

4.1 80MHz always over certain targets (TBD).

5 Inland water

5.1 320MHz tracking over TBD targets.

7.2.3.2 Frequency of Execution and Schedule

The frequency of execution will depend on the number and severity of problems encountered. As a minimum the procedure will be executed following:

(i) Acquisition of the first complete orbit of data

(ii) Acquisition of the first complete continuous day of data

(iii) Acquisition of the first continuous complete 3 days of data

(iv) Acquisition of the first 35 day repeat cycle

Where generic problems are found, i.e. those where a switch between different surface types occurs on multiple occasions, the procedure will be repeated following the acquisition of the first complete 3 day cycle following any on-board parameter change. The procedure will further be repeated following acquisition of data along the same 35 day ground tracks where problems were previously identified and where a change to the onboard parameters has occurred in the intervening period. The procedure will further be repeated for each complete 3 day cycle following a parameter change until the objectives are fully met.

Where specific problems are identified over a priority target the procedure will be repeated following acquisition of data along the same 35 day ground tracks where problems were previously identified and where a change to the onboard parameters has occurred in the intervening period.

7.2.3.3 Data Required

Level 0 and level 1b

We call S_0 the day in which the switch-on phase is finished and the instrument delivers science data. We will require the following data, linked to a requirement on the instrument mode (see Procedure, Section 7.2.3.5, and MCMD's involved Section 7.2.3.7):

- 1st cycle, from S_0 to S_0 + 5 days: normal tracking
- 1st cycle, from S_0 + 5 days to S_0 + 5 days+ 3 days: 3 days with maximum bandwidth set to 20 MHz (B=20MHz);
- 2nd cycle, from $2S_0$ + 5 days to $2S_0$ + 5 days+ 3 days: 3 days with maximum bandwidth set to 320 MHz, which is to say nominal tracking (B=320MHz).
- 3rd cycle, from $3S_0$ + 5 days to $3S_0$ + 5 days+ 3 days: 3 days with maximum bandwidth set to 80 MHz (B=80MHz) if needed.

7.2.3.4 *Parameters to be extracted*

By using IECF reporting functions for data extraction and FRAPPE tools:

All level 1b

All level 2

7.2.3.5 *Procedure*

1 Generate statistics % tracking data over each surface, % in each resolution.

2 Check land-ocean transitions to ensure that Objective 1.1 is still met following pre-launch update of the αβ parameters.

3 Compare actual resolutions with objectives for each surface type.

4 Identify surface types and specific data sequences where the objectives are not being met.

5 Data will be extracted on either side of an event where the instrument fails to provide tracking data in the desired resolution.

6 Such events will be (i) Data immediately preceding an undesired resolution switch, (ii) Data immediately preceding a transition where a resolution switch was expected but did not occur, will be examined. Type (i) events are identified as those where a resolution switch occurs changes from the desired value (Table 7.2.3-1) over a single surface type. This will require some method / function to identify a switch in resolution which occurs where a change in surface type does not occur (at least within the antenna footprint) (for example the single orbit plots IECF RA2-02)). Type (ii) events are identified by examining transition targets (Table 7.2.3-1) where the resolution did not switches defined (Table 7.2.3-2).

Table 7.2.3-1Desired Resolution for different targets (in MHz)

Target	Resolution
Ocean	320
Sea Ice	320
Ice Shelf	320
Ice Sheet Margin	320/80 but fixed at crossovers
Ice Sheet Interior	320
Land Desert	320
Mountainous	20

Table 7.2.3-2Transition Targets

Transition	Target 1	Target 2	Location
1	Land	Ocean	NE Mediterranean

Table 7.2.3-2Transition Targets

Transition	Target 1	Target 2	Location
2	Land	River	Amazon
3	Ocean	Sea Ice	Southern Ocean
4	Sea Ice	Ice Shelf	Filchner Ronne/Ross
5	Ice Shelf	Ice Sheet Margin	Filchner Ronne/Ross grounding line
6	Ice Sheet Margin	Ice Sheet Interior	Antarctica

7 In particular the value of telemetered parameters (e.g. SNR, C1,C2, etc.) which can affect resolution selection logic will be examined to see which are exceeding on-board parameter thresholds (e.g. LOL-P1, SNR_min, etc.) in such a way to cause a switch. It will then be considered whether changing values of the corresponding on-board thresholds will affect cause the correct behaviour to occur.

8 For the special case of the ice sheets we will compute the percentage of crossovers for which a different resolution is used for the ascending and descending pass. In this case the events will consist of data immediately preceding the cross-over point on both orbits. The optimum resolution for both orbits will then be decided and specified as the desired resolution. In case this objective cannot be met then the possibility of controlling resolution at cross-overs will be considered (2 or 4 MCMD per orbit).

9 Optimum resolution determination. In some cases the optimum resolution over a particular surface type might vary (for example 320 Mhz is desired over the ice sheet interior but 80 or 20MHz may be better over the ice sheet margins). This may only be determined by direct comparison of data acquired over the same groundtracks with a different minimum resolution selected. This is achieved using data from the same 3 day phase of the first 35 day repeats. If the percentage of good data acquired is better with a lower maximum resolution than during normal operation then this will become the desired resolution over that particular area.

10 Where a switch occurs in error data will be extracted prior to the switch over a distance corresponding to the non-nominal values of the RSL counters. Where counters are changing abnormally the waveform position (P) and noise power estimates (SNR)will be compared with current distance (P1,P2) and noise power (SNRm1, SNRm2) thresholds to determine the path followed by the instrument in the RSL logic.

11 Altering the behaviour of the RSL can be achieved either by altering the thresholds in the RSL or by altering the noise power measurement or MFT parameters. However MFT parameters are subject to separate optimisation constraints and will probably not be altered unless they provide the only means to overcome serious problems with the RSL. Any adjustments to thresholds will first be compared with global histograms of the RSL parameters (P, SNR_LOL) to assess the likely general impact on RSL. This will aim to ensure that changes to thresholds do not adversely affect RSL operation in other areas.

7.2.3.6 *IECF/FRAPPE functions:*

The following IECF Functions will be used for procedure steps 1) to 4):

- RA-32 Surface Types Discrimination

- RA-10A World surface plots + statistics generation
- RA-10B Acquisition Timing

The following FRAPPE functions will be used for procedure steps 5) to 11):

- FRAPPE PDS extract tool will be used to extract subsets of full orbit data for further analysis.
- FRAPPE Dave primary tool will use the Map plotting, XY plotting, histogram and return echo display.
- FRAPPE free format extraction will be used to output time, lat, long and parameters values as ascii text files for subsequent display by external packages (e.g. Generic Mapping Tool - GMT)

7.2.3.7 MCMD involved

Parameter_Setting MCMD.

7.2.3.8 Expected Results

See objectives.

7.2.3.9 Pass/Failure Criteria

n/a.

7.2.3.10 Actions

See procedure.

7.2.4 PTR Parameters (CTI_PTR_RA)

This function is intended to test the proper retrieval of the Pulse Target Response (PTR) in its full dynamic range.

The on-board parameter under tests, which are in the CTI Table CTI_PTR_RA, are:

AGC_KU_CAL_IRF

AGC_S_CAL_IRF

Considering the requirements and the results of the on-ground test described in RD-3, the objectives of this test are hereafter summarized:

1 Ratio between max value of PTR within the main lobe and the max value outside the main lobe has to be higher than 27 dBs.

2 The error of the real PTR respect to the theoretical one (sinc2*Hamming Window), within the main lobe, has to be lower than 0.1dB peak to peak.

We will also add the same type of objective as this last one, but comparing the in-flight measurement with respect to the on-ground measurement.

3 The error of the in-flight PTR respect to the on-ground one, within the main lobe, has to be lower than 0.1dB peak to peak.

The main lobe is defined to be ±100KHz around the centre frequency for a certain Chirp ID.

The PTR width at -3dB power will also be measured and compared with the theoretical one and the one measured in ground. The objective is that:

4 PTR -3dB width (in-flight - on-ground) < TBD;

5 PTR -3dB width (in-flight - theory) < TBD.

The -3dB width of an theoretical squared sinc resulting from a Fourier transform of a pulse of unit width, is 2*0,442945 (t= 0,442945 is where the -3dB point is, so the width is twice).

The RA-2 has a pulse length of 20 microsec length, therefore this width becomes:

2*0,442945 / 20*10^-6 = 2*0,442945*50 kHz = 44.294,5 kHz

Due to the Hamming window, the main lobe is widen by 30%, which implies:

44.294,5 kHz * 1,333 = 59059,18 kHz

The factor that multiplies the pulse length is used for retracking purposes in the Level 2 product. Therefore, this value is included in the Level 1b Characterisation file (see Section 8.2). It is compute as follows:

2*0,442945*1,333 = 1.18118.

7.2.4.1 *Frequency of Execution and Schedule*

To be performed every day for several days on all data (both for Ku and S band PTRs) for which the RA-16 is run.

If the actual algorithm implemented in the Level 1b processor is demonstrated to be the one giving more accurate results, this function will be stopped and will have been executed only once.

7.2.4.2 *Data Required*

The products to be used are the Level 0 ones.

7.2.4.3 *MCMD involved*

Neither operations no MCMD involved.

7.2.4.4 *IECF functions used and/or procedure*

The procedure to be followed is described hereafter:

- For each ISP evaluate the PTR, in the frequency domain, using the IECF Function RA2-16. The output will be PTR_NORM(i) samples. See AD-7 page 197
- Evaluate the theoretical PTR shape (sinc2*Hamming Window) in the frequency domain with the same number of samples, and place it at the theoretical position, given in field

#14 of the Characterisation file (see Section 8.2).

- Evaluate error_function(i) using the formula on page 240 of RD-3 properly translated from frequency to filter indexes i.
- Evaluate the main to secondary lobe ratio R as:

$$R = 10.*\log_{10}\left(\frac{\max(PTR\_NORM(i))}{\max(PTR\_NORM(j))}\right)$$

Where:

i: samples inside main lobe

j: samples outside main lobe

- Evaluate the PTR -3 dB width by running the IECF RA2-16 function.

7.2.4.5 *Expected Results*

1 R ≤ 27 dB.

2 Max(error_function(i))-min(error_function(i)) < 0.1 for *i* inside main lobe.

3 (PTR -3 dB width) measured in-flight - (PTR -3 dB width) measured on-ground ≤ 10% (TBC).

4 (PTR -3 dB width) measured in-flight - (PTR -3 dB width) theoretical ≤ 10% (TBC).

7.2.4.6 *Pass/Failure Criteria*

Passed when the expected results are met.

7.2.4.7 *Actions*

If the tests 1 and 2 are not passed a corrective action could be performed by changing the PTR (respectively for Ku and S band) on-board parameters:

- AGC_KU_CAL_IRF
- AGC_S_CAL_IRF

If tests 3 and/or 4 are not passed, field #14 of the characterisation file RA2_CHD_AUX shall be updated with the in-flight measurement result.

7.2.5 IF Auxiliary Data retrieval (CTI_IFC_RA)

This function is intended to test the proper retrieval of the IF calibration data.

The on-board parameter under tests, which are in the CTI Table CTI_IFC_RA, are:

RX_DIST_COARSE_IF_CAL

RX_DIST_FINE_IF_CAL

AGC_IF_CAL

Considering the requirements and the results of the on-ground tests described in RD-3, the objectives of this test are hereafter summarized:

- The error between the actual IF mask and the reference one will have to be lower than 0.05 dB over the whole filter bank, after the launch and under the same testing conditions.

Considering that the calibration site has been chosen to be over the Himalayas, as for ERS, a small check on the ERS RA House Keeping Microwave Receiver temperature, over that region, has been performed. This check showed that temperature is nominally around 5°, which we could assume will be also the temperature of the RA-2 Microwave Receiver.

For this reason the reference IF mask could be chosen as the on-ground test one measured for 0° (or 10°, TBD).

7.2.5.1 *Frequency of Execution and Schedule*

Once, with the first data in IF calibration mode.

7.2.5.2 *Data Required*

The possible products to be used will be the auxiliary files RA2_IFF_AUX, RA2_IFA_AUX and RA2_IFB_AUX, the reference mask from the on-ground tests (RD-3) and Level 0 data in IF Calibration Mode, RA2_CAL__0P.

7.2.5.3 *MCMD involved*

IF_CALIBRATION MCMD

7.2.5.4 *IECF functions used and/or procedure*

The procedure will be the following:

- For each filter bank sample *i*, with $4 < i < 124$, evaluate the following ratio:

$$error\_function(i) = 10.*\log_{10}\left(\frac{IF(i)}{IF\_ref(i)}\right)$$

Where:

IF(*i*): sample of actual IF mask

IF_ref(*i*): sample of reference IF mask

- For each filter bank sample *i*, with $i > 4$ and $i < 124$, error_function(*i*) will have to be lower than 0.05.
- Evaluation of the statistic of these error_function(i): min, max, average and standard deviation.

7.2.5.5 Expected Results

For each filter bank sample i, with $4 < i < 124$, the error_function(i) is expected to be lower than 0.05.

7.2.5.6 Pass/Failure Criteria

Passed if the expected result is achieved: error_function(i) < 0.05, for each i, with $4 < i < 124$.

7.2.5.7 Actions

In case the previous inequality is not fulfilled, implement a corrective action.

Out of the three parameters to be modified we will concentrate in AGC_IF_CAL. The reason is that the other two which are related to the distance from the altimeter to which the measurement is taken (RX_DIST_COARSE_IF_CAL and RX_DIST_FINE_IF_CAL), are set to approximately 752 km. Considering an orbit of a mean altitude of 800 km, this implies almost 50 km above the surface. The height is enough so that no problem is expected.

Therefore, the actions are the following:

- Changing the following on board parameter for IF Calibration mode: AGC_IF_CAL

  A detailed investigation will have to be performed on the single IF Cal Mode waveforms in order to analyse their shape.

  It can be supposed that the problem will come from a too high signal (in this case is only noise) which will make the amplifier work in non-linearity and cause the bad IF mask shape. Supposedly the in-flight noise will be higher than the on-ground one considering that in the first case the environment noise is added to the instrumental one which is the only present during the on-ground tests.

  Considering the experience we have had with ERS, where the environment noise was the 20% of the total, we could think that, in case of problems, the AGC_IF_CAL could be increased of at maximum 1dB.

  Note 1: The parameters RX_DIST_COARSE_IF_CAL and RX_DIST_FINE_IF_CAL are most likely not to be changed because they have been determined, basing on distance considerations, in order not to receive signals from the ground. Those considerations are not going to change if the orbital position of the satellite in not going to change drastically.

- changing the number of seconds used for the "Noise Spectra Accumulation", num_sec_ave_max (AD-7, page 201), in IECF function RA-18
- changing the number of IF masks to be averaged, num_input_IF (AD-7 page 204), for the production of the auxiliary file in the IECF function RA-19

This test will have to be performed over all RA2_IFF_AUX/RA2_IFG_AUX files for several days. In case of problems detailed investigation on a couple of Level 0 files in IF Calibration Mode.

Note: The procedure could be implemented as a modification of the IECF Waveforms Plots reporting function.

7.2.6 Acquisition and Tracking Sequences (CTI_SEQ_RA)

7.2.6.1 Frequency of Execution and Schedule

7.2.6.2 Data Required

7.2.6.3 MCMD involved

7.2.6.4 IECF functions used and/or procedure

7.2.6.5 Expected Results

7.2.6.6 Pass/Failure Criteria

7.2.6.7 Actions

7.3 Tests with No Implication into On-board Parameters

The results of the tests proposed in the following sections do not have a direct implication in to the on-board the dispatch area parameters. However, they are still instrument related parameters.

7.3.1 IF Mask variation with Temperature Around the Orbit

A certain variation of the IF filter mask around the orbit is expected, assuming a certain behaviour of the electronics, as function of the temperature variation, although very little.

This function is intended to check if indeed there is a non-negligible variation and to evaluate it. One should note that despite changes around the orbit are found, no correction can be applied to the products, since only one IF mask (or RA2_IFF_AUX) can be applied per product.

7.3.1.1 Frequency of Execution and Schedule

Once during 1 full orbit.

7.3.1.2 Data Required

RA2_CAL_0P product, which is Level 0 in IF Calibration Mode.

7.3.1.3 MCMD involved

IF_CALIBRATION MCMD (the RA-2 shall be in IF Calibration mode all around the orbit).

7.3.1.4 IECF functions used and approach

Perform an IF mask all around the orbit.

The different masks obtained all around the orbit will be compared by visual inspection using the IECF RA2-18 and IECF RA2-19 and their corresponding reporting functions.

The impact on the data will be evaluated.

7.3.1.5 Expected Results and/or outputs

We expect that, even though there are slight fluctuations around the orbit, the impact on the data is negligible.

7.3.1.6 Pass/Failure Criteria

Maximum % of error in the RA-2 engineering parameters due to IF variations ≤ TBD.

7.3.1.7 Actions

If this variation is proven to have NO effect on the range and sigma-0 measurements performance, the IF filter will be retrieve over one single locations (preferentially over a location where the instrument does not track and consistent with the ERS altimeter, e.g. Himalayas). In case that the variation of the IF filter with the temperature does disturb the range, SWH and sigma-0 measurements performance then a correction file will be evaluated as function of lat and long, for interested users.

7.3.2 Preliminary Datation Verification

The verification of the datation bias is performed by cross-over analysis. The datation is calculated by minimising the Mean Sea Level differences at the cross-overs. For this purpose a complete cycle (35 days[1] of data) are needed, but the more cycles we have the more we can reduce the estimation error.

With only one orbit cycle we attempt for the first datation verification.

The exercise will be repeated for 2 cycles before the end of phase 1.

1. It is not totally essential to have 35 day repeat but very desirable. The function can run with any number of days.

7.3.2.1 Frequency of Execution and Schedule

Only once, 35 days after the first acquired data.

7.3.2.2 Data Required

A full cycle of Level 2 data off-line, so that the best available orbit is processed.

7.3.2.3 MCMD involved

None.

7.3.2.4 IECF functions used and/or procedure

The IECF datation verification functions:

RA2-32: for data preparation and cross-over analysis; and

RA2-24: for the minimisation of the range differences at the cross-overs, and the estimation of the datation bias.

7.3.2.5 Expected Results

Δdat.

7.3.2.6 Pass/Failure Criteria

Passed: Δdat=0;

Otherwise, for any Δdat $\neq$0 a correction shall be applied to the data.

7.3.2.7 Actions

If Δdat$\neq$0, an investigation shall be carried out on 2 different aspects:

- the instrument datation, which is the one considered in the Level 1b datation - the investigation shall be carried out by this group;
- the satellite datation - the investigation shall be carried out by the satellite datation experts.

If it is possible to confirm that the error comes from the instrument datation, then the "Datation Procedure" in the Level 1b, output in field # of the Level 1b product, RA2_MW__1P, shall be modified to account for the datation error.

Note that there is no implication in the RA-2 on-board dispatch parameters.

7.3.3 Antenna Mispointing Estimation

7.3.3.1 Frequency of Execution and Schedule

The test will have to be repeated for several days

7.3.3.2 Data Required

The data to be used will be the Level 1b products.

7.3.3.3 MCMD involved

None.

7.3.3.4 IECF functions used and/or procedure

IECF function RA-20, with the data discriminated by surface, and with difference averaging times.

7.3.3.5 Expected Results

Considering the ERS experience a mispointing squared value < 0.04° is expected.

7.3.3.6 Pass/Failure Criteria

Mispointing squared angle < Max squared mispointing allowed = 0.04°

7.3.3.7 Actions

IF Squared mispointing angle > Max squared mispointing allowed an action will be passed to the satellite pointing group in order to consider the satellite pointing.

8 IN-FLIGHT LEVEL 1B PERFORMANCE VERIFICATION - PHASE 2

8.1 Definition and Duration

Verification that the parameter setting done in the lab on-ground prior to the launch are optimal can only be done in-flight, once the instrument is acquiring scientifically meaningful data. This is an important objective of the in-flight verification, and is required for any calibration to be accurate. As stated in Chapter 7, the instrument related parameters have already been optimised during the first phase of the verification. The algorithm related parameters will be verified in this second phase, with only a couple of exceptions in which a preliminary check has been performed in Phase1.

Algorithms are applied to the raw data to permit their use by the scientists. From the Level 0 data (which are basically telemetry data) the Level 1b processor is applied to create the Level 1b product. In doing this auxiliary data is used. Some parameter used in this process may also be tuned, for both the processor itself and the retrieval and construction of the auxiliary data.

The Level 1B processor performs the following functions:

- *Level 0 Data Decoding Function*
- *Orbit Data Generation and Datation Correction Function:* provides latitude and longitude data for each generated DSR starting from the preliminary datation information created by the Level 0 data Decoding function. It also corrects the UTC datation measurement of the Level 0 Data Decoding Function for the radar height over the reference ellipsoid.
- *PTR Data Processing Function:* processes PTR calibration data found in the instrument source packet and provides either smoothed or single measurement corrections for the Window Time Reference Extraction and AGC calibration functions (see below) for both the Ku and S band data.
- *Window Time Reference Extraction Function:* combines the input Rx distance coarse and fine information with the ground characterisation data, and the calibration data provided from the PTR processing function. Then it corrects by the Doppler effect through Doppler information coming from the orbit propagator.
- *AGC Calibration Function:* corrects the Ku band AGC by ground characterisation data and calibration data derived from the PTR processing function; retrieves S band AGC from corrected Ku band AGC and evaluates the Ku and S band Power Scaling factors.
- *IF Shape Correction Function:* corrects the Ku and S band waveform samples by the IF filter shape mask.
- *Output Data Packaging.*

To do that auxiliary data are required. There are 2 types of auxiliary data, the static one and the dynamic one. The static auxiliary data files are:

1 **Characterisation file:**

instrument parameters used in the Level 1b processing. They have either been obtained by testing in ground, mathematically, or they are nominal values. Some of them can be re-calculated / re-measured in-flight and some other can not.

Examples: antenna gains; AGC characterisation table; bandwidths and chirps slopes; PRF, PTR width.

2 **Configuration file:**

Level 1b parameters used in the Level 1b processor. They have been set with test data on-ground, but more optimised values can be derived in-flight.

Examples: zero padding factor; minimum number of IF noise spectra to be averaged.

3 **Constant file:**

numerical values used in the Level 1b processor.

Examples: semi-major and minor axis of the used ellipsoid; speed of light.

The dynamic auxiliary data files are:

1 **IF auxiliary file (RA2_IFF_AX):**

contains the IF mask to be applied to the Level 0 data to create the Level 1b products, plus the datation, number of averages spectra, etc.

2 **USO auxiliary file (RA2_USO_AX):**

it contains the Tx/Rx clock period, used in the Level 1b processor, plus datation, quality flags, etc.

The static files have been generated on-ground, and they will only be modified when a parameter is found not to be optimum. However, the dynamic files are constantly being regenerated during the satellite life time. They are produced by the IECF using specific Level 0 data.

In the case of the static auxiliary data, a study has to be performed to understand which parameters are likely to be non-optimum, and how this influences the data. After that, the strategies and procedures to actually optimise them have to be defined in the following sections.

The need for the dynamic data optimisation is, however, totally different. The first thing to check is weather the auxiliary file that has been created by the IECF is correct. No problem is expected. After that, the important issue here is to ensure the correct used of this auxiliary data.

In the case of the IF mask, the behaviour around the orbit, due to temperature variations is also of a great importance.

The algorithms used in the Level 1b processor may have to be check and/or optimised. Examples of this would be the doppler correction, the datation algorithm, the way in which the PTR is processed.

All sorts of data will be used during the in-flight verification, depending on the purpose of the specific verification and its status.

The duration of this Phase 2 will be 3 months, starting at the end of Phase 1 and until the end of the Commissioning Phase.

8.2 Static Auxiliary Data - Instrument parameters

After analysing the Characterisation file, where the instrument parameters are contained, only few parameters can be recalculated. In the Table below there is the description of each of the Characterisation parameters in the RA2_CHD_AUX file, weather they can be recalculated in-flight and by which means.

Table 8.2-1 RA2_CHD_AUX parameters summary table.

Field	Contents	Values	Verified In-flight?	Where/ How?
1	Characterisation file creation time (MJD) (not used)		NA	_
2	Length of DSR in byte	2512	NA	_
3	Spare		_	_
4	Ku antenna gain in [10 -2 dB] units.	4200	NO	_
5	S antenna gain in [10 -2 dB] units.	2930	NO	_
6	Ku band antenna beamwidth (-3dB value) in [10 -6 deg] units.	1300000	NO	_
7	S band antenna beamwidth (-3dB value) in [10 -6 deg] units.	5210000	NO	_
8	Effective Tx-Rx Gain for Ku channel in [10 -2 dB] units. 4 values (positive real) defined, according to HPA and RF subsystems crosstrapping: Tx-A/RFSS-A, Tx-A/RFSS-B, Tx-B/RFSS-B, Tx-B/RFSS-A.	16042.0 15844.7 15843.5 16007.3	NO	-
9	Effective Tx-Rx Gain for S channel in [10 -2 dB] units. 2 values (positive real) defined, one for RFSS-A and one for RFSS-B chains, according to RF subsystem crosstrapping.	15370.1 15221.0	NO	-
10	Ku band PTR Reference Power value in [10 -2 dB] units at Microwave Receiver Output. Four values are defined according to HPA and RF subsystems crosstrapping: Tx-A/RFSS-A, Tx-A/RFSS-B, Tx-B/RFSS-B, Tx-B/RFSS-A	-3015.92 -3191.97 -3193.14 -3050.67	NO	-
11	S band PTR Reference Power value in [10 -2 dB] units at Microwave Receiver Output. Two values are defined, one for RFSS-A and one for RFSS-B, according to RF subsystem crosstrapping.	-2900.32 -2968.18	NO	-
12	Reference AGC in [10 -2 dB] units used for PTR Reference Power value measurement at Ku band. Two real values are defined, one for RFSS-A and one for RFSS-B, according to RF subsystem crosstrapping.	5485.1 5454.3	NO	-
13	Reference AGC in [10 -2 dB] units used for PTR Reference Power value measurement at S band. Two values (non negative real) are defined, one for RFSS-A and one for RFSS-B, according to RF subsystem crosstrapping.	5280.1 5249.8	NO	-
14	Default Ku band time delay calibration factor in [ps] derived from PTR measurement. Four values are defined according to HPA and RF subsystems crosstrapping: Tx-A/RFSS-A, Tx-A/RFSS-B, Tx-B/RFSS-B, Tx-B/RFSS-A	18329.6 18894.6 20885.5 20149.1	NO, In-flight measured	Level 1b processor

Field	Contents	Values	Verified In-flight?	Where/ How?
15	Default S band time delay calibration factor in [ps] derived from PTR measurement. Two values are defined according to RF subsystems crosstrapping: RFSS-A, RFSS-B	19904.9 29225.9	NO, In-flight measured	Level 1b processor
16	Default Ku band amplitude calibration factor derived from on ground PTR measurement in [10 -2 dB] units. Four values are defined according to HPA and RF subsystems crosstrapping: Tx-A/RFSS-A, Tx-A/RFSS-B, Tx-B/RFSS-B, Tx-B/RFSS-A	9899.5 9909.0 9909.0 9899.5	NO, In-flight measured	Level 1b processor
17	Default S band amplitude calibration factor derived from on ground PTR measurement in [10 -2 dB] units. Two values are defined according to RF subsystems crosstrapping: RFSS-A, RFSS-B	9917 9866	NO, In-flight measured	Level 1b processor
18	AGC characterization table for AGC signal conversion in [10 -2 dB] units. Each table in characterized by two entries (one for each RF attenuator) in the range 0-31 dB with 1 dB step resolution. Two Tables are defined, one for RFSS-A and one for RFSS-B, according to RF subsystem crosstrapping.	see "AGC_Char _Tables.xls" RD-3	NO	_
19	Correction table for AGC fine conversion in [10 -2 dB] units defined as 301 entries in the range 0..3 dB with 0.01 dB step resolution. A unique conversion table is defined for both SPSA-A and SPSA-B units. Non linearities of on board AGC loop can be compensated through this table.	Sequence of 301 values from 0 to 300 step 1	NO	_
20	AGC characterization table for NPM calibration in [10 -2 dB] units. The table is characterized by 64 floating point values. Two Tables are defined, one for RFSS-A and one for RFSS-B, according to RF subsystem crosstrapping.	see "NPM_Char _Tables.xls" RD-3	NO	_
21	Differential Delay calibration factor in [ps] for the time delay measurement of the Ku channel defined during ground test activity. It includes FEE Tx/Rx vs calibration paths differential delay, equiphase antenna plane - antenna flange path, antenna flange - panel flange path. Two values (non negative real) are defined, one for RFSS-A and one for RFSS-B, according to RF subsystem crosstrapping.	21617.0 21546.5	YES	Abs Range Cal
22	Differential Delay calibration factor in [ps] for the time delay measurement of the S channel defined during ground test activity. It includes FEE Tx/Rx vs calibration paths differential delay, equiphase antenna plane - antenna flange path, antenna flange - panel flange path. Two values (non negative real) are defined, one for RFSS-A and one for RFSS-B, according to RF subsystem crosstrapping.	29169.6 29180.5	YES	Abs Range Cal
23	Loss Calibration factor in [10 -2 dB] units for the Ku channel defined during ground test activity. Four real values are defined according to HPA RF subsystem crosstrapping: Tx-A/RFSS-A, Tx-A/RFSS-B, Tx-B/RFSS-B, Tx-B/RFSS-A.	170.5 TBD 147.6 147.6 170.5 TBD	YES	Abs Sigma-0 Cal
24	Loss Calibration factor in [10 -2 dB] units for the S channel defined during ground test activity. Two real values are defined, one for RFSS-A and one for RFSS-B, according to RF subsystem crosstrapping.	236.68 234.48	NO	_
25	Nominal Tx pulse length (20 msec) in [ps]	20000000	NO	_
26	first Ku nominal chirp bandwidth (20 Mhz) in [Khz]	20000	NO	_
27	second Ku nominal chirp bandwidth (80 Mhz) in [Khz]	80000	NO	_

Field	Contents	Values	Verified In-flight?	Where/ How?
28	third Ku nominal chirp bandwidth (320 Mhz) in [Khz]	320000	NO	_
29	S nominal chirp bandwidth (160 Mhz) in [Khz]	160000	NO	_
30	Chirp Slope of first Ku chirp. Two values in [Khz/µs] units are defined, one for RFSS-A and one for RFSS-B, according to RF subsystem crosstrapping.	1000.6 998.8	NO	–
31	Chirp Slope of second Ku chirp. Two values in [Khz/µs] units are defined, one for RFSS-A and one for RFSS-B, according to RF subsystem crosstrapping.	3997.6 3997.0	NO	–
32	Chirp Slope of third Ku chirp. Two values in [Khz/µs] units are defined, one for RFSS-A and one for RFSS-B, according to RF subsystem crosstrapping.	15994.0 15991.2	NO	–
33	Chirp Slope of S chirp. Two values in [Khz/µs] units are defined, one for RFSS-A and one for RFSS-B, according to RF subsystem crosstrapping.	-7997.0 -7995.6	NO	–
34	Tx/Rx Clock period in [ps] derived from USO frequency calibration. Two values (non negative real) are defined, one for RFSS-A and one for RFSS-B, according to RF subsystem crosstrapping.	12500 12501	NO, In-flight measured	Generated in IECF RA2-25
35	Ku Pulse Repetition Interval defined as a positive integer in multiples of fundamental Tx/Rx clock periods	44560	NO	_
36	Ambiguity Order for Ku band: 9 (positive integer)	9	NO	_
37	Ku radar wavelength. Two values in multiples of [10 -6 m] are defined, one for RFSS-A and one for RFSS-B, according to RF subsystem crosstrapping.	22090 22100	NO	–
38	S radar wavelength. Two values in multiples of [10 -6 m] are defined, one for RFSS-A and one for RFSS-B, according to RF subsystem crosstrapping.	93750 93760	NO	–
39	Factor for PTR width computation	118118000	YES	In-flight Verif. Section 7.2.4
40	spare		_	_

A part from the parameters measured in-flight by the instrument and processed in the Level 1b, and the ones that will be calibrated by the Absolute Range and Sigma-0 Calibrations, only the PTR width parameters is subject of this verification. This parameters has already been measured during the PTR Parameters analysis in Chapter 7, Section 7.2.4, and it will be measured once more in the Performance Verification, Section 8.5.3.

8.3 Static Auxiliary Data - Level 1b parameters

An analysis of the Configuration file, where the parameters used in the Level 1b processor are contained, has been performed to understand which parameters are likely to be non-optimum and need to be optimised. In Table 8.3-1 below there is the description of each of the Configuration parameters in the RA2_CON_AUX file, weather they need to be re-computed in-flight and by which means.

Table 8.3-1 RA2_CON_AUX parameters summary table.

Field	Contents	Value	Verified In-flight?	Where/ How?
1	Configuration file creation time (not used)		NA	_
2	Length of DSR in byte	176	NA	_
3	spare		_	_
4	Flag for selection of specific IF filter mask correction processing	3	NO	_
5	Flag for selection of specific USO calibration value	3	NO	_
6	Two non negative values in [μs] representing the reference values for computed Rx delay test.	5090 5500	Monitored	In-flight Verif
7	Two non negative values in [10^{-2} dB] representing the reference values for AGC test.	0 6300	Monitored	In-flight Verif
8	Zero padding factor used for PTR evaluation. It must be an integer power of 2.	16	YES	In-flight Verif Section 8.5.3
9	Two values in multiples of 10^{-2} FFT filter units representing the reference values for PTR shift test.	-1000 1000	Monitored	In-flight Verif
10	Two values in [10 -2 dB] representing the reference values for PTR power test.	-800 800	Monitored	In-flight Verif
11	Positive integer representing the maximum number of measures derived from single PTR measurements to be averaged to get Flight Calibration Correction Parameters for the Ku band.	5	YES	In-flight Verif. Section 8.3.1
12	Positive integer representing the maximum number of measures derived from single PTR measurements to be averaged to get Flight Calibration Correction Parameters for the S band.	5	YES	In-flight Verif. Section 8.3.1
13	Positive integer representing the minimum number of calibration data from single Ku PTR measurements required for evaluation of smoothed flight calibration parameters.	3	YES	In-flight Verif. Section 8.3.1
14	Positive integer representing the minimum number of calibration data from single S PTR measurements required for evaluation of smoothed flight calibration parameters.	3	YES	In-flight Verif. Section 8.3.1
15	Positive integer defining the maximum time lug in SP multiples between two Ku PTR measurements.	30	NO	_
16	Positive integer defining the maximum time lug in SP multiples between two S PTR measurements.	30	NO	_
17	Positive number in multiples of [10^{-2}] defining the scaling multiplicative factor for NPM measurement - defined in multiples of 10^{-2}.	40000	NO	_

Table 8.3-1 RA2_CON_AUX parameters summary table.

Field	Contents	Value	Verified In-flight?	Where/ How?
18	Default reference value for redundancy flag of HPA subsystem required to manage event of unknown decoded value in "Red_vec_HPA" flag.	3	NO	–
19	Default reference value for redundancy flag of RFSS subsystem required to manage event of unknown decoded value in "Red_vec_RFSS" flag.	3	NO	–
20	Number of OBDH clocks between two consecutive source packets.	584056	Monitored	In-flight Verif.
21	Tolerance on number of OBDH clocks between two consecutive source packets	400	Monitored	In-flight Verif.
22	Number of USO counter clocks between two consecutive source packets	111400	Monitored	In-flight Verif., IECF RA2-25
23	Tolerance on number of USO counter clocks between two consecutive source packets	100	Monitored	In-flight Verif.
24	Offset in multiples of [10^{-2}] for Data Blocks Datation Calculation.	4950	Verified	In-flight Verif. Section 7.3.2& Section 8.5.2
25	Offset in multiples of [10^{-2}] for waveform delay rate compensation.	1700	Verified	In-flight Verif. Section 7.3.2& Section 8.5.2
26	Time Lug in seconds to compare Level 0 product UTC Datation and IF Mask Flight Calibration Datation for IF Mask selection	86400	NO	–
27	Time Lug in seconds to compare Level 0 product UTC Datation and USO Calibration Datation for IF Mask selection	86400	NO	–
28	Two non negative values in multiples of [10^{-4}] representing the reference values for IF mask quality check.	5000 15000	Verified	In-flight Verif. Section 7.2.5
29	Minimum number of IF Noise spectra to be averaged	20	YES	In-flight Verif Section 8.3.2
30	Number of noise samples skipped at edges of FFT filter bank in IF Mask retrieval processing	5	NO	–
31	Number of packets skipped at the beginning of Level 0 Product for IF Mask retrieval processing	5	NO	–
32	Two non negative values in [ps] representing the reference values for Tx/Rx clock quality check	12400 12600	Verified	In-flight Verif. Section 8.4.3
33	SP number in the first Level 0 Product selected for the USO Calibration processing	5	NO	–
34	SP number in the second Level 0 Product selected for the USO Calibration processing	40	NO	–
35	Minimum time lug between USO datation measurements needed for USO calibration processing in seconds	86400	NO	–

Table 8.3-1 RA2_CON_AUX parameters summary table.

Field	Contents	Value	Verified In-flight?	Where/ How?
36	Threshold for Level 1 B SPH field (RA2_PROC_THRESH)	8000	NO	_
37	Threshold for Level 1 B SPH field (RA2_HEADER_THRESH)	8000	NO	_
38	Spare		_	_

Fields # 6,7,9 and10: these fields are lower and upper bounds of Level-1B outputs, they are needed to define the values of some RA2_MW__1P MCDs. These values can be calculated theoretically. They have also been validated exhaustively during the on-ground test activities. However, statistic of MCDs set to "error" in different geographical area and/or surface type, will be performed in-flight in order confirm these values. The Rx delay, and AGC will also be monitors by plotting the data with the IECF generic reporting function (one orbit per day) in order to see if the range of these quantities is within the range defined by the configuration file thresholds.

Field#20 and 22: they will be monitored (shall only be changed if the clock period of the onboard clock changes dramatically).

Fields#21 and 23 (OBDH and USO tolerances between SP): will be monitored.

Note that the USO clock period, is computed within the IECF function RA2-25 and an auxiliary file is generated (RA2_USO_AUX). This auxiliary file is used in the Level 1b processor.

Fields# 24 and 25: are part of the datation verification carried out in Section 7.3.2 of Chapter 7 and Section 8.5.2.

Field# 26: only in case of a serious problem with the in-flight measured IF mask this flag shall be modified. Otherwise it remains equal 2.

Field# 28 (lower bound and upper bound for IF mask consistency checks): is used by IECF function RA-18 that builds the auxiliary file that contains the in-flight IF mask (RA2_IFF_AUX), therefore it is indirectly checked within the procedure shown in Section 7.2.5.

Field# 30 (number of noise samples skipped at edges of FFT filter bank in IF mask retrieval processing): parameter that depends on aliasing effects. It has been already checked during RA-2 on-ground testing activities, no further checks and tests are needed.

Field# 32: verified in the procedure defined in Section 8.4.3.

Fields# 33, 34 and 35 are never used within Level-1B processor or within IECF functions RA-25 and RA-26, responsible for generating the USO auxiliary file. Therefore, they not need to be checked.

8.3.1 Number of PTR's to be averaged - Fields # 11, 12, 13 and 14

(RA2_CON_AUX)

This procedure is intended to analyse the optimum number of measures derived from single PTR measurements to be averaged to get Flight Calibration Correction Parameters for the Ku and S bands.

8.3.1.1 *Frequency of Execution and Schedule*

Once, at the beginning of the In-flight Verification Phase 2.

8.3.1.2 *Data Required*

Level 1b data.

8.3.1.3 *MCMD involved*

None.

8.3.1.4 *IECF functions used and/or procedure*

The Level-1b prototype processor shall be run with different values of this parameter (e.g. 5, 10, 20). As a consequence, for each setting of this parameter a RA2_MW__1P shall be generated.

The data shall be filtered according to the values of the following flags (contained in the same MDSR):

- PTR calibration band ID
- Ku calibration corrections identifier (it has to be set to 0!).

For each of the generated RA2_MW__1P, using the IECF generic reporting function, plot the following data extracted from the Level 1b PTR data MDSRs

- Time delay calibration correction (Ku band)
- Gain calibration correction (Ku band)

as a function of data record time.

One plot should be generated for each generated RA2_MW__1P.

The IECF PTR reporting function that uses the output of the PTR function, RA2-16, includes a running window for the average of the outputs. This running window can be set to different averaging values. This function will also be used for this study, in order to compute and visualise the best number of PTR to be averaged.

REMARK: same procedure should be applied for S band

8.3.1.5 *Expected Results*

Optimum number of PTR averaged equal 4.

8.3.1.6 Pass/Failure Criteria

NA.

8.3.1.7 Actions

According to the trend that can be analysed by the plots relative to the different RA2_MW__1P products, and the output of the PTR behaviour with different averaging, the value of field# of the RA2_CON_AX ADF shall be set.

8.3.2 Number of IF Noise Spectra to be averaged - Fields # 29 (RA2_CON_AUX)

The aim of this procedure is to retrieve the minimum number of IF noise spectra to be averaged.

This parameter has been superseded by an APT of function RA-18 (see AD-7, section 6.14). However, the setting of this APT shall be calculated.

8.3.2.1 Frequency of Execution and Schedule

Only once.

8.3.2.2 Data Required

RA2_CAL__0P.

8.3.2.3 MCMD involved

IF_CALIBRATION MCMD is necessary to put the instrument in IF Calibration mode. However, this procedure will run with previous retrieved data, so that no specific operations request shall be added.

8.3.2.4 IECF functions used and/or procedure

The procedure is the following:

- Generate different IF masks (store in IECF RA-18 output) with different values of this APT.
- For each of the generated IF masks, evaluate the error w.r.t. the reference IF mask according to a procedure similar to the one described in Section 7.2.5.
- Compare the evaluated errors and obtain the minimum number of averaged IF noise spectra for which the error is lower than a threshold (TBD).

8.3.2.5 Expected Results

Around 20 IF noise spectra.

8.3.2.6 Pass/Failure Criteria

NA.

8.3.2.7 Actions

The APT will be set to the obtained value.

If the value obtained is very different from 20, the field # of the configuration file might be modified.

8.4 Dynamic Auxiliary data

8.4.1 IF Auxiliary Data - Use of Aux file (RA2_IFF_AX)

This function is intended to check the correct use of the IF auxiliary file (RA2_IFF_AX) when it is applied to the Level 0 waveforms to produce the Level 1b.

We will also ensure that the right IF auxiliary file (RA2_IFF_AX) corresponding to the Level 1b product, has been used.

8.4.1.1 Frequency of Execution and Schedule

8.4.1.2 Data Required

RA2_MW__1P relative to the selected orbit.

8.4.1.3 Operations and MCMD involved

None.

8.4.1.4 IECF functions used and/or procedure

The procedure to be implemented is hereafter described:

First step is a quality inspection in order to ensure that the correct auxiliary file has been used:

1 Check that the time range defined by the RA2_IFA_AX/RA2_IFB_AX/RA2_IFF_AX validity start/stop time contains the time range defined by first/last UTC of RA2_MW__1P MDSRs. This information is contained in the products/ADFs header, that are ASCII

2 Using the IECF reporting functions, analyse the plot of the IF mask in order to check if it is, from the qualitative point of view, as expected (a more quantitative analysis of the IF mask is performed in another RA-2 verification task).

The second step is a more close evaluation in order to ensure that the way in which the auxiliary file has been used in the Level 1b processor is correct:

- Consider a segment of data over Ocean and close to the Equator, ten minutes long. All the Source packets have to be characterized by the same Chirp ID=0 (bandwidth equal to 320 MHz).
- Evaluate the Level 1b Waveforms average over 15, 30, 60 and 120 seconds (TBC).
- For each of the previous cases evaluate the standard deviation of the filter samples on the trailing edge, finding std_15, std_30, std_60, std_120.
- Consider the following inequality

$$std\_15 > std\_30 > std\_60 > std\_120$$

If the IF mask has been applied in the proper way, the left ripple over the trailing edge will be only due to incoherent contribution of the speckle noise. The incoherent contribution becomes lower when averaging.

This procedure will implemented using IECF reporting function and FRAPPE.

8.4.1.5 *Expected Results*

The IF mask validity time range shall contain the Level 1b time range.

The above inequality shall be fulfilled.

8.4.1.6 *Pass/Failure Criteria*

Passed: when the above inequality is fulfilled, which means that the IF mask has been applied in the proper way.

Failed: when any part of the above inequality is not fulfilled.

8.4.1.7 *Actions*

If the previous inequality is not fulfilled most probably the problem has been caused by either:

wrong implementation of the fine shift to be applied on the waveforms before applying the IF mask correction; or

wrong implementation of the waveforms reversion before applying the IF mask correction.

The problem has to be investigated in more detail making use of the IECF function RA-13 to be run on Level 0 data corresponding to the just processed Level 1b ones.

8.4.2 USO - Production of a new Aux file (RA2_USO_AX)

The IECF function RA-25 is triggered with the arrival at the IECF of a RA2_ME__0P product in visibility of Kiruna. A new Tx/Rx clock period is computed every time. However, only when the difference between the new computed value and the current one in the auxiliary file exceeds a certain threshold, a new auxiliary file is produced.

This function is intended to test that the auxiliary file (RA2_USO_AX) is produced at the correct time, and correctly used by the Level 1b processor. The process of creating the auxiliary file is automatised. At the beginning of the mission and during the commissioning the process shall be carefully monitored by visual inspection of each of the auxiliary files produced and when, and their use in the Level 1b.

8.4.2.1 Frequency of Execution and Schedule

Every time there is a RA2_ME__0P product in visibility of Kiruna, which is approximately 10 per day.

8.4.2.2 Data Required

Level 0 (RA2_ME__0P), on Kiruna visibility; the corresponding Level 1b (RA_MW__1P); and the last USO aux file (RA2_USO_AX).

8.4.2.3 Operations and MCMD involved

None.

8.4.2.4 IECF functions used and/or procedure

RA2-25 and RA2-26.

8.4.2.5 Expected Results

N/A.

8.4.2.6 Pass/Failure Criteria

N/A.

8.4.2.7 Actions

If problems are spotted the functions that produce the USO auxiliary file (RA2_USO_AUX), RA2-25 and RA2-26 shall be reviewed accordingly.

8.4.3 USO Clock Period or Frequency Monitoring

This procedure is intended to monitor the USO frequency all throughout the mission.

8.4.3.1 Frequency of Execution and Schedule

Every time a RA2_ME__0P in visibility of Kiruna is received at IECF: IECF RA-25 shall be executed, so that 10 results will be collected daily.

Once a day run IECF RA-26 with those 10 results, and produce a daily output Tx/Rx clock period.

Collect the daily Tx/Rx clock period (stored in output of RA-26) throughout the mission life time.

8.4.3.2 Data Required

All RA2_ME__0P in visibility of Kiruna and the corresponding AUX_TIM_AX (time correlation tables).

8.4.3.3 Operations and MCMD involved

None.

8.4.3.4 IECF functions used and/or procedure

IECF functions: RA2-25 and RA2-26 from AD-7.

See also above Section 8.4.3.1.

We remark that in order to run RA-25, the IECF function RA-1, has been already run using as input the currently analysed RA2_ME__0P in order to generate the corresponding RA2_001_1R.

After that the results of RA-26 have been collected over one/two months the IECF reporting function that ingests output of RA-26 has to be used in order to plot the Tx/Rx clock period data as a function of time.

The Tx/Rx clock period since the beginning of the EnviSat-1 mission (i.e. historical data + sequence of the last one/two months) in order to perform a long term trend analysis.

8.4.3.5 Expected Results

The trend of ENVISAT Tx-Rx clock period collected should be similar to the trend that was found for ERS-1/2 Tx-Rx clock period: this can be checked by visual inspection using the IECF reporting function (see Section 8.4.3.4 above).

8.4.3.6 Pass/Failure Criteria

The pass/failure criteria are qualitative: they are based on visual inspection (see Section 8.4.3.5 above).

8.4.3.7 Actions

If the Tx/Rx clock period has a dramatic change, the following RA2_CON_AX fields should be updated:

1. Number of USO counter clocks between two consecutive source packets

2. Tolerance on number of USO counter clocks between two consecutive source packets

3. Reference values for Tx/Rx clock quality check

8.5 Level 1b Performance Verification

8.5.1 Comparison between RA2_MW__1P and IECF RA-13

The aim of this function is an initial check on the RA2_MW__1P main computations by comparing its results with the results of the IECF RA-13 which produces the same outputs as the Level 1b processor. This will allow us to spot problems of either the Level 1b processor or the IECF RA-13. Later a more detailed analysis of where the spotted differences are will be performed.

Note: this function has not been yet developed. It will be developed during Phase 1 of the commissioning, time permitting.

8.5.1.1 *Frequency of Execution and Schedule*

One product per day.

8.5.1.2 *Data Required*

All the input data needed in order to run IECF function RA-13 (see R- 1, section 6.11). The main inputs needed are:

- RA2_MW__1P
- RA2_ME__0P from which RA2_MW__1P was generated (name of product contained in the RA2_MW__1P SPH)
- Level-1B ADFs: RA2_CON_AX, RA2_CHD_AX, RA2_USO_AX; RA2_CST_AX, RA2_IFx_AX [where x=A,B.F] (name of ADFs contained in the RA2_MW__1P SPH)

8.5.1.3 *Operations and MCMD involved*

None.

8.5.1.4 *IECF functions used and/or procedure*

This procedure should involve 2 functions:

- IECF function RA-13;
- a new function that performs the collocation of MDSRs contained in RA_013_xR (x=1,2,3,4), output of RA-13, and the RA-2 MDSRs contained in RA2_MW__1P.

First RA-13 has to be invoked, then the new function should be invoked. The inputs of the new functions should be:

- RA_013_xR (x=1,2,3,4), output of RA-13 (generated with the input described in Section 8.5.1.2)
- RA2_MW__1P

This new function shall perform the following steps:

1 one to one matching (where possible) between RA_013_xR and RA2_MW__1P: the

matching shall be done according to the UTC time stamp contained in RA_013_xR MDSR and in and RA2_MW__1P

2 All the matched MDSRs are analysed in order to compute the differences between fields that in principle should have the same value. A draft list of the fields to be compared is below (see section below list of RA2_013_xR/ RA2_MW__1P fields to be compared)

3 The differences relative to the same field are collected in order to perform some statistics on them; for instance it could be useful to evaluate the mean difference and its r.m.s.; moreover it could be interesting to have, for each of the fields to be compared, a "maximum allowed difference" threshold, in order to evaluate the percentage of differences that overcome this threshold. The differences that overcome the threshold could be annotated into an output together with more details:

- the MDSR # of RA2_013_xR
- the MDSR # of RA2_MW__1P;
- the value of the field contained in RA2_013_xR;
- the value of the field contained in RA2_MW__1P;
- the difference between RA2_013_xR field value and RA2_MW__1P field value.

in order to analyse in more detail what is the source of the difference: this could be done re-running RA-13 focusing the attention on that MDSR (by an IECF debug session?).

What written above could be applied not only to the fields but also to the flags contained in both RA2_013_xR and RA2_MW__1P

List of RA2_013_xR/ RA2_MW__1P fields to be compared:

Average Ku-band waveform corrected for IF transfer function

Average S-band waveform corrected for IF transfer function

Ku-band window delay

S-band window delay

Ku-band AGC

S-band AGC

Ku time delay flight calibration factor

S time delay flight calibration factor

Ku sigma-0 flight calibration factor

S sigma-0 flight calibration factor

From MCD: OBDH validity flag

From MCD: AGC fault ID

From MCD: RX fault ID

From MCD: Waveform samples fault ID

It is to be noted that the Ku Doppler correction is checked within another calibration task (see Section 8.5.4).

8.5.1.5 Expected Results

The results of RA-13 should be in agreement with RA2_MW_1P content.

8.5.1.6 Pass/Failure Criteria

Percentage of differences between RA-13 output and RA2_MW__1P for each compared parameter shall be less that a percentage threshold (TBD).

8.5.1.7 Actions

If the checks fail, the MDSRs and the fields where there is a relevant difference shall be further investigated. A possibility is by a debug session of RA-13.

8.5.2 Datation Verification

The verification of the datation bias is performed by cross-over analysis. The datation is calculated by minimising the Mean Sea Level differences at the cross-overs. For this purpose a complete cycle (35 days[1] of data) are needed, but the more cycles we have the more we can reduce the estimation error.

This exercise can be performed repeatedly with 35 days of data, by the use of a running window. Results stored in a file.

Note that a first attempt with preliminary data has already been performed using the same method, in Phase 1.

8.5.2.1 Frequency of Execution and Schedule

Weekly execution, with a weekly running window of 35 days.

8.5.2.2 Data Required

All Level 2 data (computation is done cycle per cycle).

8.5.2.3 Operations and MCMD involved

None.

8.5.2.4 IECF functions used and/or procedure

The IECF datation verification functions:

RA2-32: for data preparation and cross-over analysis; and

RA2-24: for the minimisation of the range differences at the cross-overs, and the estimation of the datation bias.

1. It is not totally essential to have 35 day repeat but very desirable. The function can run with any number of days.

8.5.2.5 *Expected Results*

Δdat.

8.5.2.6 *Pass/Failure Criteria*

Passed: Δdat=0;

Otherwise, for any Δdat $\neq 0$ a correction shall be applied to the data.

8.5.2.7 *Actions*

If the criteria has not been passed, the algorithm used in the Level 1b to calculate the datation has to be analysed in detailed, as a first step.

If still no problem is found, presumably the error will come from the satellite datation. Investigation on this side will have to be carried out. The expertise of the satellite datation specialist (D. Peakover) will be required.

8.5.3 PTR Performance Verification

The parameters used on-board by the instrument at the time that collects the PTR data (AGC for Ku and S bands) have been discussed in Section 7.2.4. Here, on the contrary, the objective of this function is to be able to obtain the best estimation of the position of the PTR and it power value, since they are of a great importance in the Level 1b processor.

The Level 1b processor has implemented an certain algorithm for the retrieval of these parameters. This algorithm will be compared with another two algorithms.

The PTR -3dB width will be computed again since it is a result of the IECF function RA-16.

The PTR round the orbit will also be monitored.

8.5.3.1 *Frequency of Execution and Schedule*

One orbit per day.

8.5.3.2 *Data Required*

All the data needed to run IECF function RA-16 (main input: RA2_ME__0P) relative to the selected orbit.

8.5.3.3 *Operations MCMD involved*

None.

8.5.3.4 *IECF functions used and/or procedure*

IECF function: RA-16.

Procedure: it is composed of the following main steps:

1. Determination of the best zero-padding factor

2. Determination of the best PTR modelisation

The first main step (Determination of the best zero-padding factor) is split into the following sub-steps:

1 Run RA-16 setting the zero padding factor to 2n, n=0

2 Extract the 128*n PTR samples as stored in every MDSR of output of RA-16: PTRn

3 Run RA-16 (using exactly the same input files) setting the zero padding factor to 2n+1

4 Extract the 128*(n+1) PTR samples as stored in every MDSR of output of RA-16: PTRn+1

5 Collocate the MDSRs output of the first run (with zero padding factor set to n) with the ones output of the second run (with zero padding factor set to n+1)

6 For each collocated MDSR perform the following operations:

7 Compute, for each of the 128*n bins (resampled for PTRn+1), the error according to the following formula (see R- 2, section 5.2.1)

Err_fun_PTR(i) = 10 log10 [1+ (PTR n(i) – PTRn+1(2*i)/max(PTRn)]i=0,….,128*n-1

8 Compute the mean squared error err(n, MDSR) as the sum over i of [Err_fun_PTR(i)]2 divided by 128*n

9 Compute the mean error over all the collocated MDSRs: err(n)

10 This step cannot be performed the first time (i.e. if n=0). Compare err(n) with err(n-1): if the difference is less that a threshold equal 0.01 dB (TBC) then the "best" zero padding factor has been selected: it is n. If the difference is greater that the threshold, set n to n+1 and re-start form step 1

I understand the procedure, but I don't understand what do we gain by doing this. Aren't we going to get always that the greater the zero padding is the better?

Well I see, what you determine is from which moment the improvement is not significant, right?

REMARK: We would expect that err(n) is decreasing as function of n.

The second main step (Determination of the best PTR modelisation) can be performed only once that the "best" zero-padding factor n_{zpadd} has been already selected. It consists of the following sub-steps:

1 Run RA-16 setting the PTR model to "no model"

2 Run RA-16 (using exactly the same input files) setting the PTR model to "Centre of Gravity" (CoG)

3 Run RA-16 (using exactly the same input files) setting the PTR model to "gaussian fit" (i.e. fitting with 3 gaussians is performed)

4 Collocate the 3 outputs of the 3 different runs so that for each MDSR we have the 3 different modelisations; in particular we have 3 different estimations of:

- Time calibration factor
- PTR width

together with the zero-padded PTR (PTRzpadd(i) i=0,….,128*nzpadd-1). We remark that in case of gaussian fit we have a triplet of time calibration factor and PTR width.

5 The following steps have to be performed on all the collocated MDSRs:

5.1 For each of the 3 different modelisations regenerate:

- one gaussian function if the PTR model is "no model" or "CoG"
- 3 gaussian functions if the PTR model is "gaussian fit"

using the data (time calibration factor, PTR width) as derived from the RA2-16 output MDSR.

Store the re-simulated PTR into PTR model(i) i=0,....,128*nzpadd,-1, model=1,2,3

5.2 Compute the error according to the formula:

Err_fun_PTR(model, i) = 10 log10 [1+ (PTR model(i) – PTRzpadd(i) / max(PTRzpadd)] i=0,....,128*nzpadd-1, model=1,2,3.

We remark that if model=1,3 (i.e. "no modelisation" or "CoG") then the error function Err_fun_PTR has to be computed at 3 dB i.e. Err_fun_PTR(model, i) has to be evaluated only on the bins "i" corresponding to a power greater than half the maximum power. If the model is 2 (i.e. "gaussian") then Err_fun_PTR has to be computed on all the 128*n_{zpadd} bins.

5.3 Compute the mean squared error err(model, MDSR) as the sum over i of [Err_fun_PTR(i)]2 divided by the number of bins summed up (taking into account that, as written i the previous steps the range of i changes according to the PTR. modelisation).

6 Compute the mean error over all the collocated MDSRs: err(model).

7 Select the model as the one with the lowest value of err(model).

The PTR round the orbit will also be monitored using the outputs of the IECF function RA-16 together with reporting functions.

8.5.3.5 Expected Results

1. Best zero-padding factor: 16 (according to ALS settings in RA2_CON_AX).

2. Best PTR modelisation: 3 gaussians. The problem is that 3 gaussian modelisation is much more CPU expensive (i.e. it is more expensive from the performances point of view) than the other 2 modelisations; the best trade-off is expected to be CoG (that should give better results than "no modelisation").

8.5.3.6 Pass/Failure Criteria

NA

8.5.3.7 Actions

After a long term analysis of the best parameters

1. Update the file RA2_CON_AX with the best zero-padding factor n_{zpadd}

2. Update the absolute calibration algorithm in Level-1B processor if the best model is dif-

ferent from "no modelisation"

8.5.4 Doppler Correction verification

8.5.4.1 *Frequency of Execution and Schedule*

Once, with the first complete cycle of data.

8.5.4.2 *Data Required*

The products to be used are the Level 2 products.

The method will be implemented using 35 days data.

8.5.4.3 *Operations and MCMD involved*

None.

8.5.4.4 *IECF functions used and/or procedure*

Compute the delta elevation versus the delta height rate from the Level 1b output, for each cross over.

Cross over analysis from the IECF.

The procedure to be followed is described hereafter:

- Take all the Cross Over points related to the highest resolution, that is B=320 MHz
- For each Cross Over i evaluate the R(i) ratio:

$$R(i) = \frac{R_1(i) - R_2(i)}{v_1(i) - v_2(i)}$$

  Where R1(i)=Corrected Range of the first point, R2(i)=Corrected Range of the second point, v1(i)=Range rate of the first point, v2(i)=Range rate of the second point.

- Evaluate the histogram of the just calculated ratio over all the Cross Overs.
- If the histogram is centred on the value fT/B then the Doppler correction has been implemented with the right sign. If the histogram is centred on the value -fT/B then the Doppler Correction has been implemented with the wrong sign.

  Where f= centre frequency(13.6 GHz), T=length of the real pulse(20ms), B=Bandwidth(320MHz)

  Note that with reference to the symbols used in AD-7 on page 247 the ratio R(i) is equivalent to:

$$R(i) = \frac{\Delta SSH(i)}{\Delta SSH'(i)}$$

Once the R(i) variable has been evaluated in this way, the rest of the procedure can be implemented as previously described.

The data used for RA-24 are not selected basing on the Bandwidth B, but on the surface type. This means that the procedure, as previously described will be applied using data over "Ocean". Assuming that in the most of the cases RA-2 will track ocean surfaces with B=320 MHz, and considering that our conclusion are made on a statistical base, the procedure can be applied.

Therefore, the method will be implemented using the IECF RA2-24 function, over 35 days data. The FRAPPE tool Cross Over facility will be used as well, in particular for redundancy of the results.

8.5.4.5 Expected Results

The expected result is that the Level 1b applies the doppler correction in the right way and therefore, the histogram of the differences in the cross-overs shall be centred around 0.

8.5.4.6 Pass/Failure Criteria

Passed: when the histogram of the differences in the cross-overs is centred around fT/B.

Failed: when the histogram of the differences in the cross-overs is centred around -fT/B.

8.5.4.7 Actions

If the histogram of the differences in the cross-overs is centred around fT/B no action will be taken.

If the histogram of the differences in the cross-overs is centred around -fT/B, then the sign of the Level 1b Doppler correction shall be changed.

8.5.5 Quality check of L1B tracked range (engineering corrections applied)

This function is intended to roughly evaluate the Level 1b range window computation.

Note: this function has not been yet developed. It will be developed during Phase 1 of the commissioning, time permitting.

8.5.5.1 Frequency of Execution and Schedule

Once, on 1 full cycle of data.

8.5.5.2 Data Required

- The RA2_MW__1P products off-line version over the selected cycle. The highest consolidation level is required because the best available orbit has to be used for the generation of the products in order to extract a precise altitudes of CoG above reference ellipsoid
- The output of IECF RA-31 relative to the selected RA2_MW__1P products (RA2_031_1R)
- Mean Sea Surface ADF: RA2_MSS_AX
- Platform Data file: RA2_PLA_AX
- Constant file: RA2_CT_AX

8.5.5.3 Operations and MCMD involved

None.

8.5.5.4 IECF functions used and/or procedure

A new functions should be implemented: this function should perform the following steps:

1. Extract from RA2_MW_1P (using the surface information contained in RA2_031_1R) all the MDSRs flagged as ocean data.

2. For each of the selected MDSRs compute the tracked height h_tracked, which is defined as,

h_tracked = h_orb – [c*(time_ku + dopp_corr_ku)/2 + CoG_corr]

where

h_orb: altitude of CoG above reference ellipsoid (from L1B MDSR);

c: light speed (from RA2_CST_AX);

time_Ku: Ku-band window delay (from L1B MDSR);

dopp_corr_ku: Ku-band Doppler compensation (from L1B MDSR);

CoG_corr: centre of mass correction (from RA2_PLA_AX).

3. Compute the average tracked height summing up all the contributions of the data located in the same MSS (Mean Sea Surface) grid (grid size: 0,0625 deg * 0,0625 deg).

4. Compute, for all the evaluated average tracked heights, the difference

DIFF = h_tracked_ave – MSS

5. Evaluate the minimum and the maximum value of DIFF: DIFF_min and DIFF_max.

6. Perform the following check:

| DIFF_max – DIFF_min | < diff_threshold

where diff_threshold is TBD (of the order of magnitude of the error associated to h_orb).

7. If the check fails the quantities time_Ku contained in RA2_MW__1P MDSRs should be

further analysed. One possible way to analyse them is to re-process the corresponding RA2_ME__0P data by IECF function RA-13

8.5.5.5 Expected Results

See above, Section 8.5.5.4.

8.5.5.6 Pass/Failure Criteria

See above, Section 8.5.5.4.

8.5.5.7 Actions

See above, Section 8.5.5.4.

8.6 Parameters Monitoring

The aim of the set of procedures is the checking of several parameters that help to a better understanding of the correct functionality of the instrument and the Level 1b processor. They will be carried out by means of IECF reporting functions on filtered data.

8.6.1 AGC Monitoring

The aim of this function is the monitoring of the AGC over different type of surfaces.

In the following we will refer to Ku-band data. However, the same procedure could on S-band data.

8.6.1.1 Frequency of Execution and Schedule

One cycle of data.

8.6.1.2 Data Required

The RA2_MW__1P products (all with the same consolidation level) over the selected cycle.

The output of IECF RA-31 relative to the selected RA2_MW__1P products (RA2_031_1R)

8.6.1.3 Operations and MCMD involved

None.

8.6.1.4 IECF functions used and/or procedure

The procedure shall be the following:

1 Rank the Ku AGC according to the surface type and/or geographical areas in order to generate different Ku AGC subsets where the expected backscattering coefficient is supposed to have a constant value
2 Compute the average AGC of the generated subsets
3 Compare these average AGC values: in principle we should know a-priory what is the AGC mean difference (e.g. the difference of AGC over ocean w.r.t. AGC over Antarctica): these differences should not be very far form the differences that were retrieved in ERS-1/ERS-2 sigma-0 data relative to different surfaces/targets
4 If the differences are very different w.r.t. what expected there could be problems related to the gain that should be further analysed

The definition of the expected average AGC differences over different geographical areas/surfaces is TBD.

This will be performed by using the FRAPPE tool.

8.6.1.5 *Expected Results*

See above Section 8.6.1.4.

8.6.1.6 *Pass/Failure Criteria*

If AGC differences are very far from what expected the test is not passed.

8.6.1.7 *Actions*

See above Section 8.6.1.4.

8.6.2 Peakness monitoring

The aim of this function is the monitoring of the peakness over different type of surfaces.

In the following we will refer to Ku-band data. However, the same procedure shall be done on S-band data and the differences computed and monitored.

8.6.2.1 *Frequency of Execution and Schedule*

One cycle of data.

8.6.2.2 *Data Required*

The RA2_MW__1P products (all with the same consolidation level) over the selected cycle.

The output of IECF RA-31 relative to the selected RA2_MW__1P products (RA2_031_1R)

8.6.2.3 *Operations and MCMD involved*

None.

8.6.2.4 IECF functions used and/or procedure

The procedure shall be the following:

1 Rank the peakness, obtained from the IECF function RA2-10, according to the surface type and/or geographical areas in order to generate different peakness subsets where the peakness is expected to have almost a constant value.

2 Compute the average peakness of the generated subsets.

3 Check the average peakness values: it is expected, for instance, that over open ocean the peakness is small, while it should be larger over sea-ice or over ice. In other words we should know a priory what is the average peakness value over a selected geographical area. So the comparison of computed averages w.r.t. the expected ones should be done.

4 If the mean values are very different w.r.t. what expected there could be problems related to the echo waveform on-board processing or to the IF mask correction (i.e. the IF mask was not able to reduce the thermal noise).

The definition of the expected peakness average values over different geographical areas/ surfaces is TBD (a first guess could be provided by A.Martini, who has a large experience in ERS-1/ERS-2 products analysis).

8.6.2.5 Expected Results

See above Section 8.6.2.4.

8.6.2.6 Pass/Failure Criteria

If peakness values are very far from what expected the test is not passed.

8.6.2.7 Actions

See above Section 8.6.2.4.

8.7 New Types of Processing

8.7.1 Burst Mode Data Processing

For details on how the individual echoes are acquired and reported in the Source Packets see RD-6.

An algorithm has been defined the process the individual echoes as they would be processed on board in case they would be treated as nominal waveforms. The function also generate a Level 0 like product (see RD-6 for the algorithm and RA2-12 of AD-7 for the function itself).

Another function has been defined that compensates the individual echoes by the IF filter (see RA2-13 of AD-7).

8.7.1.1 Frequency of Execution and Schedule

Every time the Level 0 data contains Individual Echoes.

8.7.1.2 Data Required

Level 0 product with Individual Echoes.

8.7.1.3 Operations and MCMD involved

INDIVIDUAL ECHOES MCMD (or procedure P-H-N-20 defined in AD-3).

8.7.1.4 IECF functions used and/or procedure

RA2-12 and RA2-13.

8.7.1.5 Expected Results

The individual Echoes are also processed as nominal Level 0 data, in order to be able to compare the two sources of echoes over the same spot in the surface. The expected result is that these two data match exactly, with a tolerance of TBD in the Rx_dist and a tolerance TBD in the AGC.

8.7.1.6 Pass/Failure Criteria

Passed: if differences in the comparison lower than the tolerances.

8.7.1.7 Actions

If the pass/failure criteria is not passed the IECF function RA2-12 shall be reviewed.

9 SPECIFIC COMMISSIONING PHASE OPERATIONS

Several specific operations of the instrument are planned during the commissioning phase. They are specific operations because the instrument has to be set to a specific mode or sub-mode of the measurement mode, by means of a MCMD. These modes require the intervention of the operations teams.

The list of modes or sub-modes in which the altimeter will be set, a part from the nominal measurement mode, is the following:

- IF Calibration mode
- Preset_Loop_Output sub-mode;
- Preset_Tracking sub-mode;
- Burst Mode (measurement mode with Individual Echoes).

The transition of the instrument to these modes has to be planned, as explained in "RA-2 Operations", Section 4.5, and the data processing has to be defined. In Chapter 7 and Chapter 8, most of the procedures for these data processing have been defined. However, for some other specific operations which are not only for verification purposes but also for ABsolute calibrations, the procedures are yet to be defined in this document. This is the case of the satellite overflying a transponder, for which the instrument has to be set to Preset_Loop_Output sub-mode. In this case the operations have already been planned within the RGT (see AD-4, AD-12 and AD-13) and the data processing defined within the IECF (see AD-7 and RD-6), and therefore a simple reference to these files or functions will be enough.

In other cases, however, the operations have been defined but the targets over which these operations have to be performed not. This would be the case of the Burst mode or Preset_Tracking sub-mode over specific regions. In this case these document not only has to refer to files and functions used but also it has to identify the locations over which the satellite has to be set to Burst mode or in Preset_Tracking.

9.1 Category A: Calibration & Verification Purposes

The operations required during the Commissioning Phase that aim to the verification of the on-board parameters are given in Table 9.1-1 below. The description of the procedures to be followed in order to process the data are given throughout Chapter 7 and Chapter 8. This table is only intended to summarise the operations required in order to obtain the necessary data for these on-board parameter optimisation.

Table 9.1-1 Operations required during the Commissioning Phase for instrument optimisation purposes.

Purpose	Duration	Target/Orbits	IECF/RGT	Table	Product	Comments
IF mask	full orbit	any	RGT	MPL_MAI_RA	RA2_CAL_0P	See Section 7.3.1
IF Mask	7 min	Himalayas	RGT	MPL_MAI_RA	RA2_CAL_0P	See Section 7.2.5

Table 9.1-1 Operations required during the Commissioning Phase for instrument optimisation purposes.

Purpose	Duration	Target/Orbits	IECF/RGT	Table	Product	Comments
RSL	3 days	1st cycle	IECF	CTI_LOL1RA	RA_ME_0P/ RA_MW_1P	B max = 20 MHz
RSL	3 days	3rd cycle	IECF	CTI_LOL1RA	RA_ME_0P/ RA_MW_1P	B max = 80 MHz
RSL	1 sec	Antarctica (all)	RGT	MPL_IEZ_RA	RA_ME_0P/ RA_MW_1P	IE analysed at the boundaries
RSL	1 sec	Antartica1	RGT	MPL_IEZ_RA	RA_ME_0P/ RA_MW_1P	IE analysed in area of particular reflections
RSL	1 sec	Uyuni Salar (Bol.)	RGT	MPL_IEZ_RA	RA_ME_0P/ RA_MW_1P	IE analysed in area of particular reflections
RSL	1 sec	Sea-Ice	RGT	MPL_IEZ_RA	RA_ME_0P/ RA_MW_1P	IE analysed in area of particular reflections
RSL	1 sec	Land/Sea Boundary	RGT	MPL_IEZ_RA	A_ME_0P/ RA_MW_1P	IE analysed at the boundaries
RSL	1 sec	Land/Sea Boundary	RGT	MPL_IEZ_RA	A_ME_0P/ RA_MW_1P	IE analysed at the boundaries

9.2 Category B: Calibration & Long Term Monitoring

The following procedures are related to Absolute calibration purposes. It is important to understand that the following functions are not supposed to check neither mode changes nor instrument performance since this would be of the scope of Chapter 7 and Chapter 8.

ESA has developed a transponder in order to obtain the RA-2 Sigma-0 bias. For further details on the transponder and its location see the "Absolute Sigma-0 Calibration Plan" (RD-5). The procedure to process the altimeter data to retrieve the Sigma-0 bias is described below in Section 9.2.2.

On the other hand, for Absolute Range calibration, ESA has not developed a dedicated transponder. However, the intention is to use the old transponder built for ERS. The results are to be taken only as an indication of the absolute range bias, because the transponder has not been calibrated for years and therefore they will not be accurate. There is a full campaign dedicated to Absolute Range Calibration in the NW Mediterranean sea, from which the absolute range bias will be obtained.

Table 9.2-1 Operations required during the Commissioning Phase for absolute calibration purposes (LT stands for Long Term).

Purpose	Duration	Target/ Orbits	IECF /RGT	Table	Product	Comments	LT?
Abs Sigma-0 Cal	5 sec	Sigma-0 Transp.	RGT	MPL_PLT_RA/ MPL_PLO_RA	A_ME_0P/ RA_MW_1P	P_L_O mode over the Sigma-0 transponder (see Section 9.2.2)	yes
Abs Range Ca	5 sec	Range Transp.	RGT	MPL_PLT_RA/ MPL_PLO_RA	A_ME_0P/ RA_MW_1P	P_L_O mode over the Range transponder (see Section 9.2.1)	no
Abs Range Cal	1 sec	Casa-blanca	RGT	MPL_IEZ_RA	A_ME_0P/ RA_MW_1P/ RA_MWG_2P	IE at Abs Range Cal sites are use for Abs Range Bias determination (see Section 8.7.1)	yes
Abs Range Cal	1 sec	GPS Buoys x-over	RGT	MPL_IEZ_RA	A_ME_0P/ RA_MW_1P/ RA_MWG_2P	IE at Abs Range Cal sites are use for Abs Range Bias determination (see Section 8.7.1)	no
Abs Range Cal	1 sec	Eivissa site	RGT	MPL_IEZ_RA	A_ME_0P/ RA_MW_1P/ RA_MWG_2P	IE at Abs Range Cal sites are use for Abs Range Bias determination (see Section 8.7.1)	no
Abs Range Cal	1 sec	Capraia	RGT	MPL_IEZ_RA	A_ME_0P/ RA_MW_1P/ RA_MWG_2P	IE at Abs Range Cal sites are use for Abs Range Bias determination (see Section 8.7.1)	no
Abs Range Cal	1 sec	Ajaccio	RGT	MPL_IEZ_RA	A_ME_0P/ RA_MW_1P/ RA_MWG_2P	IE at Abs Range Cal sites are use for Abs Range Bias determination (see Section 8.7.1)	no
Passive Sigma0 Cal	2 min	Ocean	RGT	MPL_PLT_RA/ MPL_PLO_RA	A_ME_0P/ RA_MW_1P/	The instrument is measuring noise at a pre-defined range window position (Section 9.2.3)	no
Passive Sigma0 Cal	2 min	Amazon Rainforest	RGT	MPL_PLT_RA/ MPL_PLO_RA	A_ME_0P/ RA_MW_1P/	The instrument is measuring noise at a pre-defined range window position (Section 9.2.3)	no
Passive Sigma0 Cal	2 min	Antarctica	RGT	MPL_PLT_RA/ MPL_PLO_RA	A_ME_0P/ RA_MW_1P/	The instrument is measuring noise at a pre-defined range window position (Section 9.2.3)	no
Passive Sigma0 Cal	2 min	Sahara desert	RGT	MPL_PLT_RA/ MPL_PLO_RA	A_ME_0P/ RA_MW_1P/	The instrument is measuring noise at a pre-defined range window position (Section 9.2.3)	no

9.2.1 Range Transponder Overflight

This is intended to describe the procedure for operations of the altimeter when flies over the Range Transponder and its data processing.

9.2.1.1 *Frequency of Execution and Schedule*

Every time the satellite overflies the Range transponder: once every 35 days (repeat cycle).

9.2.1.2 *Data Required*

Level 0 product over transponder location.

9.2.1.3 *Operations and MCMD involved*

The RGT files involved are:

- MPL_PLO_RA for Preset_Loop_Output planning: specification of the file to provide planning information for the PLO activities for a specified planning period
- MPL_PLT_RA RA-2 for Preset-Loop Output Transponder Definition: specification of the file to transfer the Transponder parameters.

Both the MPL_PLO_RA and MPL_PLT_RA are given in the Annex. For further details see AD-12 and AD-13.

Using the parameters of the RGT file the following results will be computed:

Alpha_TRK [s]: It is computed as follows:

- when the best predicted orbit is available, compute the closest point of the satellite to the coordinates given in the file ($\Delta r_{T\text{-}S}$ [m]);
- translate this distance into time by multiplying the above by the factor 2/c and corrected for the ambiguity, which is 9 pulses:

$$\Delta t_{T-S} = \Delta r_{T-S} \cdot \frac{2}{c} - 9PRI \quad [s] \qquad (8.1.1.3.\text{-}1)$$

where c = 299.792.458 m/s and PRI = 557 e-6 s;

- add the Internal Delay given in the file (Δt_{ID} [s]);
- add the Tropospheric Delay given in the file (Δt_{TD} [s]);
- translate the minimum range into time by multiplying it by the factor 1/ChirpBandwidth:

$$\Delta t_{min} = (n/(ChirpBandwidth)) \quad [s] \qquad (8.1.1.3\text{-}2)$$

being n the minimum range in number of filters);

- subtract the above computed time delay;
- subtract the height in time due to the rate given by the Beta branch of the Alpha-Beta Tracker:

$$\Delta t_\beta = \frac{TRKModeDuration}{2} \cdot Beta\_TRK \quad [s] \qquad (8.1.1.3\text{-}3)$$

So that,

$$Alpha\_TRK = \Delta t_{T-S} + \Delta t_{ID} + \Delta t_{TD} - \Delta t_{min} - \Delta t_\beta \; [s] \quad (8.1.1.3\text{-}4)$$

Beta_TRK [s/s]: It is computed using both the information of the altitude rate from the orbit propagator and the Surface_Slope given in the Target file. Note that the doppler correction due to the orbit rate will not be applied.

Preset_loop_Output PROCEDURE for MCMD generation: With the parameters generated in the RGT plus the outputs, the sequence of commands is ready to be built. In general we shall distinguish two cases depending on the actual status of the instrument at the time we want to switch it to Preset_Loop_Output mode, either already in measurement mode or in Heater 2. For the purpose of this plan, we are only interested in the first case. The reason is that in the second case we cannot be precise with the actual time in which the mode effectively takes place. Therefore, the procedure is:

PARAMETER SETTING MCMD
PRESET LOOP OUTPUT MCMD

The Parameter_Setting MCMD has to be sent first to set the following four parameters of the dispatch area (see AD-3):

Rx Distance [μs] (offset 207)

AGC [dB] (offset 209)

First Deriv Rx Dist [μs/100PRI] (offset 211)

First Deriv AGC [dB/100PRI] (offset 213)

Chirp Band (offset 215)

The relationship between the parameters of the Parameter_Setting MCMD (see AD-3) and the ones described above in the previous section are the following:

TIME TAG = (see below in this section)

PARAMETER IDENTIFIER = Rx Distance
PARAMETER's VALUES = Alpha_TRK * 10^6

PARAMETER IDENTIFIER = AGC
PARAMETER's VALUES = Alpha_AGC

PARAMETER IDENTIFIER = First Deriv Rx Dist
PARAMETER's VALUES = Beta_TRK * 10^6 * 100 PRI

PARAMETER IDENTIFIER = First Deriv AGC
PARAMETER's VALUES = Beta_AGC * 100 PRI

PARAMETER IDENTIFIER = Chirp Band
PARAMETER's VALUES = Chirp Bandwidth (0-1-2)

Immediately after having sent the Parameter_Setting MCMD, the Preset_Loop_Output MCMD has to be sent. This MCMD will allow the instrument to actually switch to Preset_Loop_Output Mode using the new parameters of the dispatch area. The Preset_Loop_Output CMD also gives the information of the mode duration. The relationship between the parameters of the MCMD (see AD-3) and the ones described above in the previous section are the following:

TIME TAG [μs] = (Time Target - TRK Mode Duration/2) * 10^6
OP_AGC_LP = F
OP_TRK_LP = F
AGC_LP_OU = F
TRK_LP_OU = F
OPEN AGC_LOOP DURATION [μs] = AGC Mode Duration * 10^6
OPEN TRK_LOOP DURATION [μs] = TRK Mode Duration * 10^6

The Parameter_Setting MCMD has to be sent just before the Preset_Loop_Output MCMD. Therefore, the time tag of the first has to be calculated accounting for the duration of the MCMD, so that when the Preset_Loop_Output MCMD is sent, the Parameter_Setting MCMD has already finished. If the duration of the Parameter_Setting MCMD is given by Δt(P_S), the two time tag relationship will be:

TIME TAG (P_S) = TIME TAG (P_L_O) - Δt(P_S)

where TIME TAG (P_S) is the Parameter_Setting MCMD time tag and TIME TAG (P_L_O) is the Preset_Loop_Output MCMD time tag.

9.2.1.4 *IECF functions used and/or procedure*

RA-2 Range Transponder function: RA2-33 of AD-7.

9.2.1.5 *Expected Results*

Assuming mode change performed correctly and instrument in new mode with no anomaly, we expect a certain shape/behaviour of the function that describes the distance between the altimeter and the transponder antennas as a function of time or satellite position, as given in AD-7).

The result is the retrieval of the altimeter range bias.

This result might not be complete and shall be passed to the RA-2 Absolute Range calibration group (see RD-4).

9.2.1.6 *Pass/Failure Criteria*

The data have to be analysed in first place to make sure that no satellite or instrument failure has occurred and therefore the data is usable.

The pass criteria is based on the flags from RA2-33 in AD-7.

9.2.1.7 *Actions*

A full traceability of the results obtained shall be possible.

The results shall be passed to the RA-2 Absolute Range Calibration team, for them to be assimilated in to the complete campaign.

9.2.2 Sigma-0 Transponder Overflight

This is intended to describe the procedure for operations of the altimeter when flies over the Sigma-0 Transponder and its data processing.

9.2.2.1 *Frequency of Execution and Schedule*

Every time the satellite overflies the Sigma-0 transponder: twice every 35 days (repeat cycle), since the transponder is located on a cross-over.

9.2.2.2 *Data Required*

Level 0 and Level 1b data over the transponder.

9.2.2.3 *Operations and MCMD involved*

The RGT files used are as for Section 9.2.1.3, MPL_PLO_RA and MPL_PLT_RA. Both the MPL_PLO_RA and MPL_PLT_RA are given in the Annex. For further details see AD-12 and AD-13.

Using the parameters of the RGT file the results:

Alpha_TRK [s]:

Beta_TRK [s/s]:

are computed exactly in the same way than Section 9.2.1.3 for the range transponder case.

Preset_loop_Output PROCEDURE for MCMD generation: With the parameters generated in the RGT plus the outputs, the sequence of commands is ready to be built. In general we shall also distinguish the two cases described in Section 9.2.1.3, but for the purpose of this plan we are only interested in the first case. Therefore, the procedure is:

PARAMETER SETTING MCMD
PRESET LOOP OUTPUT MCMD

The Parameter_Setting MCMD has to be sent first to set the following four parameters of the dispatch area (see AD-3):

Rx Distance [μs] (offset 207)

AGC [dB] (offset 209)

First Deriv Rx Dist [μs/100PRI] (offset 211)

First Deriv AGC [dB/100PRI] (offset 213)

Chirp Band (offset 215)

The relationship between the parameters of the Parameter_Setting MCMD (see AD-3) and the ones described above in the previous section are the following:

TIME TAG = (see below in this section)

PARAMETER IDENTIFIER = Rx Distance
PARAMETER's VALUES = Alpha_TRK * 10^6

PARAMETER IDENTIFIER = AGC
PARAMETER's VALUES = Alpha_AGC

PARAMETER IDENTIFIER = First Deriv Rx Dist
PARAMETER's VALUES = Beta_TRK * 10^6 * 100 PRI

PARAMETER IDENTIFIER = First Deriv AGC
PARAMETER's VALUES = Beta_AGC * 100 PRI

PARAMETER IDENTIFIER = Chirp Band
PARAMETER's VALUES = Chirp Bandwidth (0-1-2)

The relationship between the parameters of the MCMD (see AD-3) and the ones described above in the previous section are the following:

TIME TAG [μs] = (Time Target - TRK Mode Duration/2) * 10^6
OP_AGC_LP = F
OP_TRK_LP = F
AGC_LP_OU = F
TRK_LP_OU = F
OPEN AGC_LOOP DURATION [μs] = AGC Mode Duration * 10^6
OPEN TRK_LOOP DURATION [μs] = TRK Mode Duration * 10^6

The Parameter_Setting MCMD has to be sent just before the Preset_Loop_Output MCMD. If the duration of the Parameter_Setting MCMD is given by Δt(P_S), the two time tag relationship will be:

TIME TAG (P_S) = TIME TAG (P_L_O) - Δt(P_S)

where TIME TAG (P_S) is the Parameter_Setting MCMD time tag and TIME TAG (P_L_O) is the Preset_Loop_Output MCMD time tag.

9.2.2.4 IECF functions used and/or procedure

RA-2 Sigma-0 Transponder Function: IECF RA-34 of AD-7. Also IECF RA2-33 has to be run since the output is needed as input of RA2-34.

9.2.2.5 Expected Results

Assuming mode change performed correctly and instrument in new mode with no anomaly, we expect a specific shape/behaviour of the function that describes the RA-2 received power as a function of time or satellite position, as given in AD-7).

The result is the retrieval of the altimeter sigma-0 bias.

This result shall be passed to the RA-2 Absolute Sigma-0 calibration group (see RD-5).

9.2.2.6 Pass/Failure Criteria

The data have to be analysed in first place to make sure that no satellite or instrument failure has occurred and therefore the data is usable. The pass/fail criteria in this case is not related to the mode but whether the data is usable for calibration purposes or not.

The pass criteria is based on the flags from RA2-34 in AD-7.

9.2.2.7 Actions

A full traceability of the results obtained shall be possible.

As this will be the only way of calibration the RA-2 Sigma-0, the results shall be passed to the RA-2 Absolute Sigma-0 Calibration team, for them to make the proper use. This result can either be inserted in the Level 1b Characterisation file (RA2_CHR_AUX) field # 23, or can be provided to the users as a *Sigma-0 Bias*.

9.2.3 Passive Sigma-0 Calibration

This procedure is TBD. It will use a IECF function that is still under development.

9.3 Category C: Areas of Scientific Interest

Certain areas of interest for different group of scientist with different applications, as land and in-land waters, require special instrument operations in order to track the data, since the altimeter has not been designed to track those surfaces. These areas have been compiled and operations have been programmed so that those special instrument operations or modes are possible. The project can not commit to these special operation but it will try to satisfy these scientific requests time and mission requirements permitting.

These areas and the required operations are given in Table 9.3-1 below.

The files associated can be found in the Annex.

Table 9.3-1 Operations required during the Commissioning Phase for operations over specific areas of scientific interest.

Function/ Parameter	Duration	Target/ Orbits	IECF /RGT	Table	Product	Comments
Land Applic.	2 min	TaklaMaka Dessert	IECF	CTI_LOL1RA	RA_MW_1P/ RA_MWG_2P	B max = 80 MHZ
Land Applic.	2 min	Sympson Desert	IECF	CTI_LOL1RA	RA_MW_1P/ RA_MWG_2P	B max = 80 MHZ
Lake Applic.	N/A	Missouri River	RGT	MPL_PLT_RA	RA_MW_1P/ RA_MWG_2P	Preset Tracking Mode to the given height
Lake Applic.	N/A	Rukwa Lake	RGT	MPL_PLT_RA	RA_MW_1P/ RA_MWG_2P	Preset Tracking Mode to the given height
Lake Applic.	N/A	Iliamna Lake	RGT	MPL_PLT_RA	RA_MW_1P/ RA_MWG_2P	Preset Tracking Mode to the given height
Lake Applic.	N/A	Nicaragua Lake	RGT	MPL_PLT_RA	RA_MW_1P/ RA_MWG_2P	Preset Tracking Mode to the given height
Lake Applic.	N/A	Chapala Lake	RGT	MPL_PLT_RA	RA_MW_1P/ RA_MWG_2P	Preset Tracking Mode to the given height
Lake Applic.	N/A	Toledo Bend Reservoire	RGT	MPL_PLT_RA	RA_MW_1P/ RA_MWG_2P	Preset Tracking Mode to the given height

ANNEX

This Annex gives the RGT operation files as they are implemented in the RGT, only for the cases of MPL_PLT_RA and MPL_IEZ_RA.

MPL_PLT_RA (description of target for PLO and PST).

```
FILE ; RA-2 Targets File
;-----------------------
RECORD fhr
FILENAME="MPL_PLT_RAVRGT20000523_121422_00000000_00000121_20000619_135929_20
781231_2359591.N1"
DESTINATION="FOS "
PHASE_START=+001
CYCLE_START=+001
REL_START_ORBIT=+00???
ABS_START_ORBIT=+00???
ENDRECORD fhr
;-----------------------
RECORD rtf_vhr ; Variable Header
NB_TRANS=+008
RA2_X_POS=+01.000<m>
RA2_Y_POS=+02.000<m>
RA2_Z_POS=+03.000<m>
CHIRP_HIGH=+320.000<MHz>
CHIRP_MEDIUM=+080.000<MHz>
CHIRP_LOW=+020.000<MHz>
PRI=+557.000000<10-6s>
ENDRECORD rtf_vhr
;-----------------------
LIST num_trans=016 ; List of Num_Trans Target Records
;
RECORD trans
TARGET_ID="TRP_asc"
RECORD location: LAT=+036.665937<deg> LONG=-004.527799<deg>
HEIGHT=+???.???<m> ENDRECORD
RECORD pass: PASS_FLAG="Asc" MAX_SEP=+1000<m> ENDRECORD
RECORD range_rate_correction: SLOPE=+00.000<percentage> ORBIT_RATE="Yes"
ENDRECORD
CHIRP_RESOLUTION="High"
RECORD properties: TROP_DELAY=+000.008<10E-6sec>
INT_DELAY=+055.000<10E-6sec> ENDRECORD
RECORD params: MIN_RANGE=-55 A_AGC=+12.000<dB> B_AGC=+0.000<dB/s> ENDRECORD
UNION mode=Preset_loop_output
RECORD duration: TRK_DUR=+05.000<sec> AGC_DUR=+05.000<sec> ENDRECORD
RECORD flags: OP_TRK_LP="Yes" OP_AGC_LP="Yes" TRK_LP_OU="Yes"
AGC_LP_OU="Yes" ENDRECORD
ENDUNION mode
ENDRECORD trans
;
RECORD trans
TARGET_ID="TRP_Desc"
```

```
RECORD location: LAT=+036.665937<deg> LONG=+355.47220<deg>
HEIGHT=+???.???<m> ENDRECORD
RECORD pass: PASS_FLAG="Desc" MAX_SEP=+1000<m> ENDRECORD
RECORD range_rate_correction: SLOPE=+00.000<percentage> ORBIT_RATE="Yes"
ENDRECORD
CHIRP_RESOLUTION="High"
RECORD properties: TROP_DELAY=+000.008<10E-6sec>
INT_DELAY=+055.000<10E-6sec> ENDRECORD
RECORD params: MIN_RANGE=-55 A_AGC=+12.000<dB> B_AGC=+0.000<dB/s> ENDRECORD
UNION mode=Preset_loop_output
RECORD duration: TRK_DUR=+05.000<sec> AGC_DUR=+05.000<sec> ENDRECORD
RECORD flags: OP_TRK_LP="Yes" OP_AGC_LP="Yes" TRK_LP_OU="Yes"
AGC_LP_OU="Yes" ENDRECORD
ENDUNION mode
ENDRECORD trans

RECORD trans
TARGET_ID="Ocean_PLO_asc"
RECORD location: LAT=+???.??????<deg> LONG=+???.??????<deg>
HEIGHT=+???.???<m> ENDRECORD
RECORD pass: PASS_FLAG="Asc" MAX_SEP=+10000<m> ENDRECORD
RECORD range_rate_correction: SLOPE=+00.000<percentage> ORBIT_RATE="Yes"
ENDRECORD
CHIRP_RESOLUTION="High"
RECORD properties: TROP_DELAY=+000.000<10E-6sec>
INT_DELAY=+000.000<10E-6sec> ENDRECORD
RECORD params: MIN_RANGE=-55 A_AGC=+12.000<dB> B_AGC=+0.000<dB/s> ENDRECORD
UNION mode=Preset_loop_output
RECORD duration: TRK_DUR=+120.000<sec> AGC_DUR=+120.000<sec> ENDRECORD
RECORD flags: OP_TRK_LP="Yes" OP_AGC_LP="Yes" TRK_LP_OU="Yes"
AGC_LP_OU="Yes" ENDRECORD
ENDUNION mode
ENDRECORD trans

RECORD trans
TARGET_ID="Ocean_PLO_desc"
RECORD location: LAT=+???.??????<deg> LONG=+???.??????<deg>
HEIGHT=+???.???<m> ENDRECORD
RECORD pass: PASS_FLAG="Desc" MAX_SEP=+10000<m> ENDRECORD
RECORD range_rate_correction: SLOPE=+00.000<percentage> ORBIT_RATE="Yes"
ENDRECORD
CHIRP_RESOLUTION="High"
RECORD properties: TROP_DELAY=+000.000<10E-6sec>
INT_DELAY=+000.000<10E-6sec> ENDRECORD
RECORD params: MIN_RANGE=-55 A_AGC=+12.000<dB> B_AGC=+0.000<dB/s> ENDRECORD
UNION mode=Preset_loop_output
RECORD duration: TRK_DUR=+120.000<sec> AGC_DUR=+120.000<sec> ENDRECORD
RECORD flags: OP_TRK_LP="Yes" OP_AGC_LP="Yes" TRK_LP_OU="Yes"
AGC_LP_OU="Yes" ENDRECORD
ENDUNION mode
ENDRECORD trans

RECORD trans
TARGET_ID="Amazon_RF_PLO_asc"
RECORD location: LAT=+???.??????<deg> LONG=+???.??????<deg>
HEIGHT=+???.???<m> ENDRECORD
RECORD pass: PASS_FLAG="Asc" MAX_SEP=+10000<m> ENDRECORD
RECORD range_rate_correction: SLOPE=+00.000<percentage> ORBIT_RATE="Yes"
```

```
ENDRECORD
CHIRP_RESOLUTION="High"
RECORD properties: TROP_DELAY=+000.000<10E-6sec>
INT_DELAY=+000.000<10E-6sec> ENDRECORD
RECORD params: MIN_RANGE=-55 A_AGC=+12.000<dB> B_AGC=+0.000<dB/s> ENDRECORD
UNION mode=Preset_loop_output
RECORD duration: TRK_DUR=+120.000<sec> AGC_DUR=+120.000<sec> ENDRECORD
RECORD flags: OP_TRK_LP="Yes" OP_AGC_LP="Yes" TRK_LP_OU="Yes"
AGC_LP_OU="Yes" ENDRECORD
ENDUNION mode
ENDRECORD trans

RECORD trans
TARGET_ID="Amazon_RF_PLO_desc"
RECORD location: LAT=+???.??????<deg> LONG=+???.??????<deg>
HEIGHT=+???.???<m> ENDRECORD
RECORD pass: PASS_FLAG="Desc" MAX_SEP=+10000<m> ENDRECORD
RECORD range_rate_correction: SLOPE=+00.000<percentage> ORBIT_RATE="Yes"
ENDRECORD
CHIRP_RESOLUTION="High"
RECORD properties: TROP_DELAY=+000.000<10E-6sec>
INT_DELAY=+000.000<10E-6sec> ENDRECORD
RECORD params: MIN_RANGE=-55 A_AGC=+12.000<dB> B_AGC=+0.000<dB/s> ENDRECORD
UNION mode=Preset_loop_output
RECORD duration: TRK_DUR=+120.000<sec> AGC_DUR=+120.000<sec> ENDRECORD
RECORD flags: OP_TRK_LP="Yes" OP_AGC_LP="Yes" TRK_LP_OU="Yes"
AGC_LP_OU="Yes" ENDRECORD
ENDUNION mode
ENDRECORD trans

RECORD trans
TARGET_ID="Antarctica_PLO_asc"
RECORD location: LAT=+???.??????<deg> LONG=+???.??????<deg>
HEIGHT=+???.???<m> ENDRECORD
RECORD pass: PASS_FLAG="Asc" MAX_SEP=+10000<m> ENDRECORD
RECORD range_rate_correction: SLOPE=+00.000<percentage> ORBIT_RATE="Yes"
ENDRECORD
CHIRP_RESOLUTION="High"
RECORD properties: TROP_DELAY=+000.000<10E-6sec>
INT_DELAY=+000.000<10E-6sec> ENDRECORD
RECORD params: MIN_RANGE=-55 A_AGC=+12.000<dB> B_AGC=+0.000<dB/s> ENDRECORD
UNION mode=Preset_loop_output
RECORD duration: TRK_DUR=+120.000<sec> AGC_DUR=+120.000<sec> ENDRECORD
RECORD flags: OP_TRK_LP="Yes" OP_AGC_LP="Yes" TRK_LP_OU="Yes"
AGC_LP_OU="Yes" ENDRECORD
ENDUNION mode
ENDRECORD trans

RECORD trans
TARGET_ID="Antarctica_PLO_desc"
RECORD location: LAT=+???.??????<deg> LONG=+???.??????<deg>
HEIGHT=+???.???<m> ENDRECORD
RECORD pass: PASS_FLAG="Desc" MAX_SEP=+10000<m> ENDRECORD
RECORD range_rate_correction: SLOPE=+00.000<percentage> ORBIT_RATE="Yes"
ENDRECORD
CHIRP_RESOLUTION="High"
RECORD properties: TROP_DELAY=+000.000<10E-6sec>
INT_DELAY=+000.000<10E-6sec> ENDRECORD
```

```
RECORD params: MIN_RANGE=-55 A_AGC=+12.000<dB> B_AGC=+0.000<dB/s> ENDRECORD
UNION mode=Preset_loop_output
RECORD duration: TRK_DUR=+120.000<sec> AGC_DUR=+120.000<sec> ENDRECORD
RECORD flags: OP_TRK_LP="Yes" OP_AGC_LP="Yes" TRK_LP_OU="Yes"
AGC_LP_OU="Yes" ENDRECORD
ENDUNION mode
ENDRECORD trans

RECORD trans
TARGET_ID="SaharaD_PLO"
RECORD location: LAT=+???.??????<deg> LONG=+???.??????<deg>
HEIGHT=+???.???<m> ENDRECORD
RECORD pass: PASS_FLAG="Asc" MAX_SEP=+10000<m> ENDRECORD
RECORD range_rate_correction: SLOPE=+00.000<percentage> ORBIT_RATE="Yes"
ENDRECORD
CHIRP_RESOLUTION="High"
RECORD properties: TROP_DELAY=+000.000<10E-6sec>
INT_DELAY=+000.000<10E-6sec> ENDRECORD
RECORD params: MIN_RANGE=-55 A_AGC=+12.000<dB> B_AGC=+0.000<dB/s> ENDRECORD
UNION mode=Preset_loop_output
RECORD duration: TRK_DUR=+120.000<sec> AGC_DUR=+120.000<sec> ENDRECORD
RECORD flags: OP_TRK_LP="Yes" OP_AGC_LP="Yes" TRK_LP_OU="Yes"
AGC_LP_OU="Yes" ENDRECORD
ENDUNION mode
ENDRECORD trans

RECORD trans
TARGET_ID="SaharaD_PLO"
RECORD location: LAT=+???.??????<deg> LONG=+???.??????<deg>
HEIGHT=+???.???<m> ENDRECORD
RECORD pass: PASS_FLAG="Desc" MAX_SEP=+10000<m> ENDRECORD
RECORD range_rate_correction: SLOPE=+00.000<percentage> ORBIT_RATE="Yes"
ENDRECORD
CHIRP_RESOLUTION="High"
RECORD properties: TROP_DELAY=+000.000<10E-6sec>
INT_DELAY=+000.000<10E-6sec> ENDRECORD
RECORD params: MIN_RANGE=-55 A_AGC=+12.000<dB> B_AGC=+0.000<dB/s> ENDRECORD
UNION mode=Preset_loop_output
RECORD duration: TRK_DUR=+120.000<sec> AGC_DUR=+120.000<sec> ENDRECORD
RECORD flags: OP_TRK_LP="Yes" OP_AGC_LP="Yes" TRK_LP_OU="Yes"
AGC_LP_OU="Yes" ENDRECORD
ENDUNION mode
ENDRECORD trans


RECORD trans
TARGET_ID="MissouriRiver"
RECORD location: LAT=+043.150000<deg> LONG=-098.900000<deg>
HEIGHT=+450.000<m> ENDRECORD
RECORD pass: PASS_FLAG="Desc" MAX_SEP=+1000<m> ENDRECORD
RECORD range_rate_correction: SLOPE=+00.000<percentage> ORBIT_RATE="Yes"
ENDRECORD
CHIRP_RESOLUTION="High"
RECORD properties: TROP_DELAY=+???.???<10E-6sec>
INT_DELAY=+000.000<10E-6sec> ENDRECORD
RECORD params: MIN_RANGE=-18 A_AGC=+12.000<dB> B_AGC=+0.000<dB/s> ENDRECORD
UNION mode=Preset_Tracking
ENDUNION mode
```

```
ENDRECORD trans

RECORD trans
TARGET_ID="RukwaLake"
RECORD location: LAT=-007.830000<deg> LONG=+32.000000<deg>
HEIGHT=+867.000<m> ENDRECORD
RECORD pass: PASS_FLAG="Desc" MAX_SEP=+1000<m> ENDRECORD
RECORD range_rate_correction: SLOPE=+00.000<percentage> ORBIT_RATE="Yes"
ENDRECORD
CHIRP_RESOLUTION="High"
RECORD properties: TROP_DELAY=+???.???<10E-6sec>
INT_DELAY=+000.000<10E-6sec> ENDRECORD
RECORD params: MIN_RANGE=-18 A_AGC=+12.000<dB> B_AGC=+0.000<dB/s> ENDRECORD
UNION mode=Preset_Tracking
ENDUNION mode
ENDRECORD trans

RECORD trans
TARGET_ID="IliamnaLake"
RECORD location: LAT=+059.500000<deg> LONG=-155.000000<deg>
HEIGHT=+015.600<m> ENDRECORD
RECORD pass: PASS_FLAG="Desc" MAX_SEP=+1000<m> ENDRECORD
RECORD range_rate_correction: SLOPE=+00.000<percentage> ORBIT_RATE="Yes"
ENDRECORD
CHIRP_RESOLUTION="High"
RECORD properties: TROP_DELAY=+???.???<10E-6sec>
INT_DELAY=+000.000<10E-6sec> ENDRECORD
RECORD params: MIN_RANGE=-18 A_AGC=+12.000<dB> B_AGC=+0.000<dB/s> ENDRECORD
UNION mode=Preset_Tracking
ENDUNION mode
ENDRECORD trans

RECORD trans
TARGET_ID="NicaraguaLake"
RECORD location: LAT=+011.5000000<deg> LONG=-085.500000<deg>
HEIGHT=+034.000<m> ENDRECORD
RECORD pass: PASS_FLAG="Desc" MAX_SEP=+1000<m> ENDRECORD
RECORD range_rate_correction: SLOPE=+00.000<percentage> ORBIT_RATE="Yes"
ENDRECORD
CHIRP_RESOLUTION="High"
RECORD properties: TROP_DELAY=+???.???<10E-6sec>
INT_DELAY=+000.000<10E-6sec> ENDRECORD
RECORD params: MIN_RANGE=-18 A_AGC=+12.000<dB> B_AGC=+0.000<dB/s> ENDRECORD
UNION mode=Preset_Tracking
ENDUNION mode
ENDRECORD trans

RECORD trans
TARGET_ID="ChapalaLake"
RECORD location: LAT=+020.2300000<deg> LONG=-103.000000<deg>
HEIGHT=+1641.000<m> ENDRECORD
RECORD pass: PASS_FLAG="Desc" MAX_SEP=+1000<m> ENDRECORD
RECORD range_rate_correction: SLOPE=+00.000<percentage> ORBIT_RATE="Yes"
ENDRECORD
CHIRP_RESOLUTION="High"
RECORD properties: TROP_DELAY=+???.???<10E-6sec>
INT_DELAY=+000.000<10E-6sec> ENDRECORD
RECORD params: MIN_RANGE=-18 A_AGC=+12.000<dB> B_AGC=+0.000<dB/s> ENDRECORD
```

```
UNION mode=Preset_Tracking
ENDUNION mode
ENDRECORD trans

RECORD trans
TARGET_ID="ToledoBendReservoire"
RECORD location: LAT=+031.5000000<deg> LONG=-093.670000<deg>
HEIGHT=+057.000<m> ENDRECORD
RECORD pass: PASS_FLAG="Desc" MAX_SEP=+1000<m> ENDRECORD
RECORD range_rate_correction: SLOPE=+00.000<percentage> ORBIT_RATE="Yes"
ENDRECORD
CHIRP_RESOLUTION="High"
RECORD properties: TROP_DELAY=+???.???<10E-6sec>
INT_DELAY=+000.000<10E-6sec> ENDRECORD
RECORD params: MIN_RANGE=-18 A_AGC=+12.000<dB> B_AGC=+0.000<dB/s> ENDRECORD
UNION mode=Preset_Tracking
ENDUNION mode
ENDRECORD trans
;
ENDLIST num_trans
;
ENDFILE
```

MPL_IEZ_RA

```
FILE ; RA-2 Individual Echoes Zone Definitions File
;---------------------------------------------------
;
RECORD fhr
FILENAME="MPL_IEZ_RAVRGT20000523_132326_00000000_00000121_20000619_170141_20
781231_2359591.N1"
DESTINATION="FOS "
PHASE_START=+001
CYCLE_START=+001
REL_START_ORBIT=+00168
ABS_START_ORBIT=+00165
ENDRECORD fhr
;
RECORD zdf_vhr ; Variable Header
TABLE_DESC="List of Zones for the Individual Echoes mode of the RA-2"
NB_ZONES=0002 ; Number of zones
PRI=+557.000<10-6sec>
ENDRECORD zdf_vhr
;
LIST num_zones=0010 ; List of num_zones zone records
;
RECORD zone
ZONE_ID="Antartica"
RECORD params: DELTA=0.500<sec> PACKETS=+20<blocks> REPEAT=+00001<times>
PASS_FLAG="Asc" ENDRECORD
PROJECTION="                "
LIST num_polygon_pt=152 ; polygon definition (if 1 pt, use also diametre below
    RECORD polygon_pt: LONG=+000.000000<deg> LAT=-090.000000<deg> ENDRECORD
```

```
RECORD polygon_pt: LONG=+000.000000<deg> LAT=-069.800000<deg> ENDRECORD
RECORD polygon_pt: LONG=+002.500000<deg> LAT=-070.150000<deg> ENDRECORD
RECORD polygon_pt: LONG=+005.000000<deg> LAT=-070.200000<deg> ENDRECORD
RECORD polygon_pt: LONG=+007.000000<deg> LAT=-070.000000<deg> ENDRECORD
RECORD polygon_pt: LONG=+007.500000<deg> LAT=-070.150000<deg> ENDRECORD
RECORD polygon_pt: LONG=+008.500000<deg> LAT=-069.900000<deg> ENDRECORD
RECORD polygon_pt: LONG=+009.200000<deg> LAT=-070.000000<deg> ENDRECORD
RECORD polygon_pt: LONG=+010.100000<deg> LAT=-069.800000<deg> ENDRECORD
RECORD polygon_pt: LONG=+012.800000<deg> LAT=-070.000000<deg> ENDRECORD
RECORD polygon_pt: LONG=+014.000000<deg> LAT=-069.450000<deg> ENDRECORD
RECORD polygon_pt: LONG=+015.400000<deg> LAT=-069.450000<deg> ENDRECORD
RECORD polygon_pt: LONG=+015.600000<deg> LAT=-069.800000<deg> ENDRECORD
RECORD polygon_pt: LONG=+017.700000<deg> LAT=-069.650000<deg> ENDRECORD
RECORD polygon_pt: LONG=+019.000000<deg> LAT=-069.900000<deg> ENDRECORD
RECORD polygon_pt: LONG=+020.600000<deg> LAT=-069.900000<deg> ENDRECORD
RECORD polygon_pt: LONG=+021.600000<deg> LAT=-070.150000<deg> ENDRECORD
RECORD polygon_pt: LONG=+023.800000<deg> LAT=-070.350000<deg> ENDRECORD
RECORD polygon_pt: LONG=+027.000000<deg> LAT=-070.000000<deg> ENDRECORD
RECORD polygon_pt: LONG=+027.600000<deg> LAT=-070.000000<deg> ENDRECORD
RECORD polygon_pt: LONG=+029.400000<deg> LAT=-069.700000<deg> ENDRECORD
RECORD polygon_pt: LONG=+031.000000<deg> LAT=-069.000000<deg> ENDRECORD
RECORD polygon_pt: LONG=+032.900000<deg> LAT=-069.300000<deg> ENDRECORD
RECORD polygon_pt: LONG=+034.000000<deg> LAT=-068.600000<deg> ENDRECORD
RECORD polygon_pt: LONG=+034.800000<deg> LAT=-068.520000<deg> ENDRECORD
RECORD polygon_pt: LONG=+035.000000<deg> LAT=-068.940000<deg> ENDRECORD
RECORD polygon_pt: LONG=+040.000000<deg> LAT=-068.940000<deg> ENDRECORD
RECORD polygon_pt: LONG=+043.300000<deg> LAT=-068.160000<deg> ENDRECORD
RECORD polygon_pt: LONG=+046.400000<deg> LAT=-067.320000<deg> ENDRECORD
RECORD polygon_pt: LONG=+051.700000<deg> LAT=-066.060000<deg> ENDRECORD
RECORD polygon_pt: LONG=+055.000000<deg> LAT=-065.850000<deg> ENDRECORD
RECORD polygon_pt: LONG=+060.000000<deg> LAT=-067.400000<deg> ENDRECORD
RECORD polygon_pt: LONG=+069.500000<deg> LAT=-067.800000<deg> ENDRECORD
RECORD polygon_pt: LONG=+070.000000<deg> LAT=-068.600000<deg> ENDRECORD
RECORD polygon_pt: LONG=+072.690000<deg> LAT=-069.080000<deg> ENDRECORD
RECORD polygon_pt: LONG=+074.000000<deg> LAT=-069.800000<deg> ENDRECORD
RECORD polygon_pt: LONG=+078.000000<deg> LAT=-069.100000<deg> ENDRECORD
RECORD polygon_pt: LONG=+078.000000<deg> LAT=-068.500000<deg> ENDRECORD
RECORD polygon_pt: LONG=+081.800000<deg> LAT=-067.700000<deg> ENDRECORD
RECORD polygon_pt: LONG=+081.700000<deg> LAT=-066.270000<deg> ENDRECORD
RECORD polygon_pt: LONG=+082.250000<deg> LAT=-066.200000<deg> ENDRECORD
RECORD polygon_pt: LONG=+083.000000<deg> LAT=-066.760000<deg> ENDRECORD
RECORD polygon_pt: LONG=+088.300000<deg> LAT=-066.060000<deg> ENDRECORD
RECORD polygon_pt: LONG=+089.100000<deg> LAT=-066.760000<deg> ENDRECORD
RECORD polygon_pt: LONG=+090.000000<deg> LAT=-066.700000<deg> ENDRECORD
RECORD polygon_pt: LONG=+090.000000<deg> LAT=-090.000000<deg> ENDRECORD
RECORD polygon_pt: LONG=+090.000000<deg> LAT=-090.000000<deg> ENDRECORD
RECORD polygon_pt: LONG=+090.000000<deg> LAT=-066.700000<deg> ENDRECORD
RECORD polygon_pt: LONG=+094.660000<deg> LAT=-066.550000<deg> ENDRECORD
RECORD polygon_pt: LONG=+095.650000<deg> LAT=-065.150000<deg> ENDRECORD
RECORD polygon_pt: LONG=+098.440000<deg> LAT=-064.720000<deg> ENDRECORD
RECORD polygon_pt: LONG=+099.330000<deg> LAT=-065.750000<deg> ENDRECORD
RECORD polygon_pt: LONG=+101.170000<deg> LAT=-065.350000<deg> ENDRECORD
RECORD polygon_pt: LONG=+102.000000<deg> LAT=-065.700000<deg> ENDRECORD
RECORD polygon_pt: LONG=+103.070000<deg> LAT=-065.150000<deg> ENDRECORD
RECORD polygon_pt: LONG=+104.170000<deg> LAT=-065.990000<deg> ENDRECORD
RECORD polygon_pt: LONG=+108.100000<deg> LAT=-066.480000<deg> ENDRECORD
RECORD polygon_pt: LONG=+108.790000<deg> LAT=-066.900000<deg> ENDRECORD
RECORD polygon_pt: LONG=+110.700000<deg> LAT=-066.130000<deg> ENDRECORD
```

```
RECORD polygon_pt: LONG=+113.300000<deg> LAT=-065.700000<deg> ENDRECORD
RECORD polygon_pt: LONG=+116.550000<deg> LAT=-066.480000<deg> ENDRECORD
RECORD polygon_pt: LONG=+116.790000<deg> LAT=-066.900000<deg> ENDRECORD
RECORD polygon_pt: LONG=+120.860000<deg> LAT=-066.480000<deg> ENDRECORD
RECORD polygon_pt: LONG=+123.970000<deg> LAT=-066.200000<deg> ENDRECORD
RECORD polygon_pt: LONG=+129.830000<deg> LAT=-066.200000<deg> ENDRECORD
RECORD polygon_pt: LONG=+133.830000<deg> LAT=-066.060000<deg> ENDRECORD
RECORD polygon_pt: LONG=+134.330000<deg> LAT=-065.000000<deg> ENDRECORD
RECORD polygon_pt: LONG=+135.000000<deg> LAT=-065.000000<deg> ENDRECORD
RECORD polygon_pt: LONG=+135.330000<deg> LAT=-066.060000<deg> ENDRECORD
RECORD polygon_pt: LONG=+145.690000<deg> LAT=-067.110000<deg> ENDRECORD
RECORD polygon_pt: LONG=+145.340000<deg> LAT=-067.540000<deg> ENDRECORD
RECORD polygon_pt: LONG=+151.110000<deg> LAT=-068.520000<deg> ENDRECORD
RECORD polygon_pt: LONG=+153.700000<deg> LAT=-068.310000<deg> ENDRECORD
RECORD polygon_pt: LONG=+155.380000<deg> LAT=-069.000000<deg> ENDRECORD
RECORD polygon_pt: LONG=+156.300000<deg> LAT=-068.940000<deg> ENDRECORD
RECORD polygon_pt: LONG=+158.650000<deg> LAT=-069.440000<deg> ENDRECORD
RECORD polygon_pt: LONG=+162.600000<deg> LAT=-070.280000<deg> ENDRECORD
RECORD polygon_pt: LONG=+167.700000<deg> LAT=-070.990000<deg> ENDRECORD
RECORD polygon_pt: LONG=+170.650000<deg> LAT=-071.860000<deg> ENDRECORD
RECORD polygon_pt: LONG=+168.330000<deg> LAT=-073.590000<deg> ENDRECORD
RECORD polygon_pt: LONG=+180.000000<deg> LAT=-073.380000<deg> ENDRECORD
RECORD polygon_pt: LONG=+180.000000<deg> LAT=-090.000000<deg> ENDRECORD
RECORD polygon_pt: LONG=+180.000000<deg> LAT=-090.000000<deg> ENDRECORD
RECORD polygon_pt: LONG=+180.000000<deg> LAT=-073.380000<deg> ENDRECORD
RECORD polygon_pt: LONG=-150.000000<deg> LAT=-073.380000<deg> ENDRECORD
RECORD polygon_pt: LONG=-145.530000<deg> LAT=-075.420000<deg> ENDRECORD
RECORD polygon_pt: LONG=-140.280000<deg> LAT=-075.490000<deg> ENDRECORD
RECORD polygon_pt: LONG=-139.470000<deg> LAT=-074.930000<deg> ENDRECORD
RECORD polygon_pt: LONG=-135.000000<deg> LAT=-074.580000<deg> ENDRECORD
RECORD polygon_pt: LONG=-130.000000<deg> LAT=-074.230000<deg> ENDRECORD
RECORD polygon_pt: LONG=-128.500000<deg> LAT=-074.300000<deg> ENDRECORD
RECORD polygon_pt: LONG=-127.380000<deg> LAT=-073.310000<deg> ENDRECORD
RECORD polygon_pt: LONG=-114.000000<deg> LAT=-073.870000<deg> ENDRECORD
RECORD polygon_pt: LONG=-110.330000<deg> LAT=-074.300000<deg> ENDRECORD
RECORD polygon_pt: LONG=-108.160000<deg> LAT=-075.070000<deg> ENDRECORD
RECORD polygon_pt: LONG=-108.250000<deg> LAT=-074.440000<deg> ENDRECORD
RECORD polygon_pt: LONG=-106.750000<deg> LAT=-074.370000<deg> ENDRECORD
RECORD polygon_pt: LONG=-103.680000<deg> LAT=-075.070000<deg> ENDRECORD
RECORD polygon_pt: LONG=-101.940000<deg> LAT=-075.070000<deg> ENDRECORD
RECORD polygon_pt: LONG=-103.640000<deg> LAT=-072.390000<deg> ENDRECORD
RECORD polygon_pt: LONG=-101.740000<deg> LAT=-071.970000<deg> ENDRECORD
RECORD polygon_pt: LONG=-098.910000<deg> LAT=-071.760000<deg> ENDRECORD
RECORD polygon_pt: LONG=-095.830000<deg> LAT=-071.900000<deg> ENDRECORD
RECORD polygon_pt: LONG=-095.000000<deg> LAT=-072.540000<deg> ENDRECORD
RECORD polygon_pt: LONG=-090.000000<deg> LAT=-072.540000<deg> ENDRECORD
RECORD polygon_pt: LONG=-090.000000<deg> LAT=-090.000000<deg> ENDRECORD
RECORD polygon_pt: LONG=-090.000000<deg> LAT=-090.000000<deg> ENDRECORD
RECORD polygon_pt: LONG=-090.000000<deg> LAT=-072.540000<deg> ENDRECORD
RECORD polygon_pt: LONG=-083.000000<deg> LAT=-073.590000<deg> ENDRECORD
RECORD polygon_pt: LONG=-082.120000<deg> LAT=-073.870000<deg> ENDRECORD
RECORD polygon_pt: LONG=-081.250000<deg> LAT=-073.870000<deg> ENDRECORD
RECORD polygon_pt: LONG=-081.190000<deg> LAT=-073.030000<deg> ENDRECORD
RECORD polygon_pt: LONG=-078.860000<deg> LAT=-072.320000<deg> ENDRECORD
RECORD polygon_pt: LONG=-073.810000<deg> LAT=-073.100000<deg> ENDRECORD
RECORD polygon_pt: LONG=-072.500000<deg> LAT=-072.750000<deg> ENDRECORD
RECORD polygon_pt: LONG=-075.430000<deg> LAT=-071.760000<deg> ENDRECORD
RECORD polygon_pt: LONG=-073.330000<deg> LAT=-071.200000<deg> ENDRECORD
```

```
        RECORD polygon_pt: LONG=-075.000000<deg> LAT=-070.000000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-072.120000<deg> LAT=-069.370000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-071.920000<deg> LAT=-069.080000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-070.370000<deg> LAT=-068.730000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-068.650000<deg> LAT=-069.370000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-067.140000<deg> LAT=-067.990000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-067.590000<deg> LAT=-067.250000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-063.870000<deg> LAT=-065.350000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-059.850000<deg> LAT=-063.730000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-057.210000<deg> LAT=-063.170000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-056.890000<deg> LAT=-063.380000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-057.030000<deg> LAT=-064.210000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-059.040000<deg> LAT=-065.250000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-060.740000<deg> LAT=-067.750000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-059.630000<deg> LAT=-067.960000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-059.760000<deg> LAT=-073.030000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-061.840000<deg> LAT=-074.390000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-033.660000<deg> LAT=-077.680000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-026.470000<deg> LAT=-076.340000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-026.470000<deg> LAT=-076.770000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-023.750000<deg> LAT=-075.530000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-024.340000<deg> LAT=-074.790000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-022.500000<deg> LAT=-074.300000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-020.250000<deg> LAT=-074.080000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-018.690000<deg> LAT=-072.680000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-017.140000<deg> LAT=-072.890000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-011.820000<deg> LAT=-071.690000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-012.170000<deg> LAT=-071.340000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-009.680000<deg> LAT=-070.850000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-009.360000<deg> LAT=-070.560000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-003.200000<deg> LAT=-070.280000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-001.100000<deg> LAT=-070.000000<deg> ENDRECORD
        RECORD polygon_pt: LONG=-000.700000<deg> LAT=-069.790000<deg> ENDRECORD
        RECORD polygon_pt: LONG=+000.000000<deg> LAT=-069.800000<deg> ENDRECORD
        RECORD polygon_pt: LONG=+000.000000<deg> LAT=-090.000000<deg> ENDRECORD
    ENDLIST num_polygon_pt
    DIAM=+0000000.000<m> ; diameter if circle zone (1 pt)
    ENDRECORD zone

    RECORD zone
    ZONE_ID="Antartica1"
    RECORD params: DELTA=0.500<sec> PACKETS=+20<blocks> REPEAT=+00001<times>
    PASS_FLAG="Asc" ENDRECORD
    PROJECTION="CIRCLE "
    LIST num_polygon_pt=0001
    RECORD polygon_pt: LONG=-176.877622<deg> LAT=-078.036701<deg> ENDRECORD
    ENDLIST num_polygon_pt
    DIAM=+0001000.000<m> ; diameter if circle zone (1 pt)
    ENDRECORD zone

    RECORD zone
    ZONE_ID="UyuniSalar"
    RECORD params: DELTA=0.000<sec> PACKETS=+20<blocks> REPEAT=+00001<times>
    PASS_FLAG="Asc" ENDRECORD
    PROJECTION="CIRCLE "
    LIST num_polygon_pt=0001
    RECORD polygon_pt: LONG=-67.642200<deg> LAT=-20.179600<deg> ENDRECORD
    ENDLIST num_polygon_pt
```

```
DIAM=+0001000.000<m> ; diameter if circle zone (1 pt)
ENDRECORD zone

RECORD zone
ZONE_ID="Sea-Ice"
RECORD params: DELTA=0.500<sec> PACKETS=+20<blocks> REPEAT=+00001<times>
PASS_FLAG="Asc" ENDRECORD
PROJECTION="CIRCLE "
LIST num_polygon_pt=0001
RECORD polygon_pt: LONG=+000.000000<deg> LAT=+090.000000<deg> ENDRECORD
ENDLIST num_polygon_pt
DIAM=+2000000.000<m> ; diameter if circle zone (1 pt)
ENDRECORD zone

RECORD zone
ZONE_ID="Land/Sea"
RECORD params: DELTA=0.500<sec> PACKETS=+20<blocks> REPEAT=+00001<times>
PASS_FLAG="Asc" ENDRECORD
PROJECTION="CIRCLE "
LIST num_polygon_pt=0001
RECORD polygon_pt: LONG=-176.877622<deg> LAT=-078.036701<deg> ENDRECORD
ENDLIST num_polygon_pt
DIAM=+0001000.000<m> ; diameter if circle zone (1 pt)
ENDRECORD zone

RECORD zone
ZONE_ID="Sea/Land"
RECORD params: DELTA=0.500<sec> PACKETS=+20<blocks> REPEAT=+00001<times>
PASS_FLAG="Asc" ENDRECORD
PROJECTION="CIRCLE "
LIST num_polygon_pt=0001
RECORD polygon_pt: LONG=-176.877622<deg> LAT=-078.036701<deg> ENDRECORD
ENDLIST num_polygon_pt
DIAM=+0001000.000<m> ; diameter if circle zone (1 pt)
ENDRECORD zone

RECORD zone
ZONE_ID="GPS_Buoys_x-over"
RECORD params: DELTA=0.500<sec> PACKETS=+20<blocks> REPEAT=+00001<times>
PASS_FLAG="Asc" ENDRECORD
PROJECTION="CIRCLE "
LIST num_polygon_pt=0001
RECORD polygon_pt: LONG=+3.735674<deg> LAT=+40.075154<deg> ENDRECORD
ENDLIST num_polygon_pt
DIAM=+0001000.000<m> ; diameter if circle zone (1 pt)
ENDRECORD zone

RECORD zone
ZONE_ID="Eivissa"
RECORD params: DELTA=0.500<sec> PACKETS=+20<blocks> REPEAT=+00001<times>
PASS_FLAG="Asc" ENDRECORD
PROJECTION="CIRCLE "
LIST num_polygon_pt=0001
RECORD polygon_pt: LONG=+1.220704<deg> LAT=+38.967149<deg> ENDRECORD
ENDLIST num_polygon_pt
DIAM=+0001000.000<m> ; diameter if circle zone (1 pt)
ENDRECORD zone
```

```
RECORD zone
ZONE_ID="Capraia"
RECORD params: DELTA=0.500<sec> PACKETS=+20<blocks> REPEAT=+00001<times>
PASS_FLAG="Asc" ENDRECORD
PROJECTION="CIRCLE "
LIST num_polygon_pt=0001
RECORD polygon_pt: LONG=+???.??????<deg> LAT=+???.??????<deg> ENDRECORD
ENDLIST num_polygon_pt
DIAM=+0001000.000<m> ; diameter if circle zone (1 pt)
ENDRECORD zone

RECORD zone
ZONE_ID="Ajaccio"
RECORD params: DELTA=0.500<sec> PACKETS=+20<blocks> REPEAT=+00001<times>
PASS_FLAG="Asc" ENDRECORD
PROJECTION="CIRCLE "
LIST num_polygon_pt=0001
RECORD polygon_pt: LONG=+???.??????<deg> LAT=+???.??????<deg> ENDRECORD
ENDLIST num_polygon_pt
DIAM=+0001000.000<m> ; diameter if circle zone (1 pt)
ENDRECORD zone
ENDLIST num_zones

ENDFILE
```