In-Flight Test Plan

PAZ Mission CALVAL Centre

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INTRODUCTION

PNOTS
SPANISH NATIONAL PLAN FOR EARTH OBSERVATION

INGENIO
OPTICAL
SATELLITE

PAZ
RADAR SATELLITE

Responsible for coordinated development of both systems
Ground Segment location at INTA Torrejón headquarters
PAZ Ground Segment Developer
PAZ Calibration and Validation Centre
PAZ PROGRAM

HISDESA T
Space Segment

PAZ

INTA
Ground Segment

INSA
G/S

DLR
PSP
CalVal Tools
IO

INTA
CalVal
Centre

Spanish
Companies
INDRA - GMV -
DEIMOS - INSA

INTA - Acceptation
The test plan deals with characterization, calibration, configuration and validation of a complete E2E SAR system.

At the end of the tests system shall be ready to provide products according to the product tree for all the nominal modes and to determine if specified performances are met.

Groups of tasks have been identified and broken down to derivate required processes, tested/no tested features and data requirements at different levels.

Software developments and test procedures have been tested with SVT1B and TDX-PAZGS test data sets.
APPROACH

Plan development
Pre-launch checkpoint
Launch
In-Flight Tests
First System Validation
Product Definition
The main plan is the source of a group of plans intended to cover all the tasks to be accomplished.
APPROACH

Plan development
Pre-launch checkpoint
Launch
In-Flight Tests
First System Validation
Product Definition

- E2E Configuration
- Characterization Calibration Status
- Performance Assessment
- Product Definition
- Risks Analysis

To check the status of the system and analyse key points to define the approach for next steps.

E2E system configuration:

- Systematic Item identification
- Data and coherence review
- List of possible updates over CALVAL plan execution and possible side effects

Characterization, calibration report

- List of characterization analysis: tested / no tested features
- List of calibration parameters: tested / no tested

Performance assessment / product definition / validation report

- Instrument performance assessment (IRF, amplitude and phase drifts, NESZ, ambiguities, TX/Rx Gain, internal calibration processes, stability)
- Product tree and beam / mode parameters per product establishment
- Requirement Validation matrix

Risk identification
SAR System Operation focuses on processes that shall be carried out in PAZ operation phase:

- Provide requested products to users
- Monitoring the status of the system
- Generation and distribution of a new system configuration
- Provide data for characterization, calibration and validation to CALVAL users.

These shall be considered under different scenarios:

- **Commercial Operation**
  - Operation from data take request to product delivery including verification tasks.

- **CALVAL Centre operation.**
  - Operation from campaign definition to data analysis considered.

Configuration of the E2E system.
Signal conditioning and characterization shall assure that the signal is good enough to be used in subsequent stages or may drive to an optimizations, establishes expected operation limits and define the actual behavior of the complete system.
INTERNAL CALIBRATION

Intended to correct instrument effects on image products, excluding antenna pattern.

- TRM analysis to control the effect of antenna feed.
- Gains (amplitude and phase) in signal paths: RxGain validation
- System noise
- Calibration strategy
  - Chirp reference and azimuth drifts
- Internal calibration processes
INTERNAL CALIBRATION

TRM Reference Generation
PN_Gating Accuracy Evaluation
Temp. Limits Verification
Temp. Drifts Verification
CAL Pulses Analysis
Cal Strategy Analysis
Replica Analysis
Absolute Azimuth Drift Extraction
Residual Drift Calculation
NESZ Estimation
Temperature Analysis
Cal. Network Signal and Noise Analysis
System NESZ
Drift in Azimuth
Internal Calibrator Accuracy
PN_Gating Accuracy Evaluation
TRM Monitoring
RX Gain Calibration Validation
TRM Reference Generation

Approach Refinements

Features to be Tested

Status of Antenna TRM
TRM shift w.r.t. TRM Reference Status
RX Gain Actual Values
System Noise Power
Warm up Effects over CN Signals
Prolog TX Behavior
Chirp Reference
Replica IRF Degradation Performances
Internal Delays
Internal Calibration Accuracy

Design of Test Cases

Procedures

Internal Calibration
EXTERNAL CALIBRATION

In-Flight Tests

SAR System Operation

Conditioning and Characterization

Internal Calibration

External Calibration

Intended to estimate and compensate error contributions to the complete SAR System.

Activities shall analyze antenna pattern effects on the images, transform digital numbers into physical units and assure the location accuracy of the generated products.
EXTERNAL CALIBRATION

Test Procedures

External Calibration

Features to be Tested

Geometric Calibration
- Antenna Pointing
- Antenna Pattern Verification
- Radiometric Calibration
- Polarimetric Calibration

Design of Test Cases

Geometric Calibration
- Elevation Pointing via Rain Forest DTs
- Azimuth Pointing via Transponder
- Elevation Pattern verification
- Azimuth Pattern verification
- Absolute Calibration Factor
- Absolute Radiometric Accuracy
- Relative Radioimetric Accuracy
- Radiometric Stability
- Polarimetry

Antenna Beam to Beam gain Verification

Internal Delay Calibration

Abs. Cal. Factor

Channel Imbalance

Channel Cross Talk

Antenna Pattern Estimation

DT Start Time Characterization

Systematic Azimuth Shift

Abs. and Relative Radiometric Accuracy

Antenna Pattern Verification

Antenna Elevation Pointing

Radiometric Stability

Antenna Phase Pattern Validation

Abs. Cal. Factor

Absolute Radiometric Accuracy

Radiometric Stability

Radiometric Stabilty

Polarimetry
DATA TAKE PLANNING

A 10 cycles plan is defined:

- 3 cycles for nominal chain,
- 2 cycles for redundant chain and
- 2 cycles main chain mainly intended to system validation based on stripmap mode.
- 3 cycles main chain intended to system validation and product definition for SL, HS and SC modes.

Two point target deployments have been designed. The first one for stripmap analysis, and the second one for spotlight and scansar modes.

- 21 CR with 2 deployments with reorientations
- Max 60DT per day / 33 up to L1b
- 10 Orbit cycles
- 2-4 system configuration changes
- RX Transponder

![DEPLOYMENT PLAN](image-url)
**ORBIT CYCLES AND STAGES**

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SUMMARY

The objective of this plan is to identify, define and carry out the activities required to the first E2E validation of the complete PAZ SAR system and the initial product definition for all imaging modes.

Software developments and test procedures mostly completed
Software tested with TDS from SBT1B and TDX-PAZGS campaigns
Data take plan completed for cycles 1, 3, 4, 5, 6, 7, 8, 9 and 10
Data take plan for cycle 2 (hot/cold) on progress
Calibration Sites defined. Contractual agreements to be signed.
21 Ground corner reflectors defined:
   6 ready
   15 on progress
1 transponder on development