**Project: Solar Orbiter SWA**

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# Introduction

This document describes the procedure to carry out the short functional test (SFT) of the flight model of the SO-SWA suite (SWA-FM).

# Scope and applicability

## Scope

This test procedure defines the instructions for conducting the SFT on the flight model (FM) of the Solar Wind Analyser (SWA-FM) of the SO-SWA project. This test procedure is based on the requirements found in NR1 and NR2.

## Purpose

The purpose of the SFT is to verify the health of the instrument and to ensure that all nominal mode and state transitions are performed correctly. This is achieved by monitoring certain housekeeping parameters in order to verify that power consumption and configuration of the sensors is correct. The SWA-FM sensor units **do have** functioning detector systems, therefore, this test procedure is applicable for an airside set-up or environment only if the required Air safety plugs are inserted correctly. See NR4 for details

# References

## Normative references

This document incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at appropriate places in the text and publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these apply to this document only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

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| --- | --- | --- |
| **Ref.** | **No** | **Title** |
| NR1 | SOL-EST-RCD-0050 | Solar Orbiter Experiment Interface Document Part A |
| NR2 | SOL.S.ASTR.TN.00235 | Input Format Required for Spacecraft Level Instrument Test Procedures |
| NR3 | SO-SWA-MSSL-PR-029 | SWA Power Up & Power Down procedure |
| NR4 | SO-SWA-MSSL-PR-031 | SWA PFM Red/Green Tag Items Procedure |

# Abbreviations

|  |  |
| --- | --- |
| **Abbreviation** | **Meaning** |
| ACK / NACK | Acknowledge / Not-Acknowledge |
| AIT | Assembly Integration and Test |
| DPU | Data Processing Unit |
| EAS | Electron Analyser System |
| EGSE | Electrical Ground Support Equipment |
| EID | Experiment Interface Document |
| EM | Engineering Model |
| ESA | European Space Agency |
| ETB | Electrical Test Bench |
| FFT | Full Functional Test |
| HIS | Heavy Ion System |
| HK | House Keeping |
| HPC | High Power Command |
| HV | High Voltage |
| MSSL | Mullard Space Science Laboratory |
| N/A | Not Applicable |
| OTB | Operational Test Bench |
| PAS | Proton Alpha System |
| POST | Power On System-Test |
| PSU | Power Supply Unit |
| SC | SpaceCraft |
| SFT | Short Functional Test |
| SIIS | Spacecraft Instrument Interface System |
| SO | Solar Orbiter |
| SpW | Space Wire |
| SWA | Solar Wind Analyser |
| TBC | To Be Confirmed |
| TBD | To Be Defined |
| TC | Tele-command |
| TM | Telemetry Packet |

# Requirements to be verified

The EID-A document makes the following statements:

1. SFTs will be used to provide diagnostic tests after major SC test steps. **They will serve for verifying the command and telemetry paths** during overall spacecraft functional tests. They should typically last no more than 1 hour. EIDA-3851.
2. The instrument FFTs, SFTs will be conducted in normal cleanroom conditions, as foreseen during the spacecraft AIV-program. They will not rely on any specific constraints on the spacecraft (such as spacecraft orientation, temperature, access by personnel, or stimuli (open loop). EIDA-3855.
3. Potential constraints on what can be done within these tests might depend on the SC AIT sequence. Ideally, the tests should not be dependent on any particular orientation of the spacecraft and should not require any breaking of electrical or mechanical connections (i.e. be non-invasive) and should not require the use of any optical or mechanical I-EGSE. EIDA-3855.

Further, NR11 makes the following statement. The short functional test (SFT) is used to provide a basic health check of the instrument. The SFT should exercise the interface and the main elements of the instrument. The SFT is not a performance test.

# Test Setup

The SFT for the SWA units described in this document will be performed by Airbus. It is therefore assumed that the SWA is electrically integrated to the control system in the correct manner.

The units under test will remain purged throughout the test. The usual electrical discharge safe environment practices must be obeyed along with the usual clean room practices.

**The SWA sensor units are ESD sensitive and appropriate caution must be taken.**

The SWA sensor units must be correctly grounded.

The SWA must have SWA DPU software (vers 3.3.2) including ASW (vers 3.0.2) and ExOS (vers 3.1.2), or above.

The controlling system must have IDB version 4.1.0 or above.

All numbers quoted in the procedure below are decimal unless preceded by 0x to indicate hex.

**All HIS, EAS 1&2 and PAS HV Disable or Airsafe plugs must be installed in the correct configuration for the appropriate, following test.**

**The HIS entrance aperture cover shall be INSTALLED when using the DISABLE PLUG.**

**The HIS entrance aperture cover shall be REMOVED when using the AIRSAFE PLUG.**

See NR4 for details of the safety plug configuration.

# Test constraints and operations

## TRR

Before a test can proceed, a test readiness review (TRR), shall be convened by the test manager. All the relevant test and facility documentation will be made available. The TRR must give approval before the test can commence.

## TRB

At the end of the test a Test Review Board (TRB) shall be convened and approve the dismantling of the test setup.

If a non-conformance report (NCR) is raised during a test the TRB will decide the next steps.

## Rejection and retest

In the event of any HK checks being out of limits or the TM checks being incorrect, the procedure should be halted immediately and advice sought from the SWA team.

If a failure, malfunction, or out of tolerance occurs during or after test as appropriate the test shall be halted and an NCR shall be issued.

A test report shall be produced logging all events and the results of the visual inspections. The test report shall also contain the environmental measurement data (taken during the test) and the calibration/qualification certificates of the test facility.

# Test Flow

It is assumed that the SWA and sensors have been powered on and are configured ready for testing.

The procedure detailed in NR3 provides full details on how to get to that state.

The test can be run on the nominal side or the redundant side. A full power down should take place between testing on these sides. See NR3 for details on how to power down SWA.

# SWA SFT Procedure

## HIS

|  |  |  |
| --- | --- | --- |
| **Step N°** | **FFT Commanding Flow** | **Checks and PASS/FAIL Criteria** |
|  | ; Put HIS into science mode  **TC,** **ZIA58917, PIA59011, EQUAL, NORMAL\_SCI** | ; Reception of:  **TM,YIA58602** ; (5,1) SID=43802 SWA\_E\_HIS\_MODE\_CHANGE |
|  | ; Wait 00:05:00 (5 minute) |  |
|  | ; Put HIS into standby mode  **TC,** **ZIA58917, PIA59011, EQUAL, HVSTDBY** | ; Reception of:  **TM,YIA58602** ; (5,1) SID=43802 SWA\_E\_HIS\_MODE\_CHANGE |

## PAS

If this SFT is being performed during the ESA TVac test where the vacuum pressure is too low. This section MUST NOT be run.

|  |  |  |
| --- | --- | --- |
| **Step N°** | **FFT Commanding Flow** | **Checks and PASS/FAIL Criteria** |
|  | ~~; Run the HV Ramp Macro~~  **~~TM, ZIA58856, PIA60791,EQUAL,0~~**  **~~TM,,PIA60790,EQUAL,0xCCC~~**  **~~TM,,PIA60792,EQUAL,0x1FD~~**  **~~TM,,PIA60793,EQUAL,0x1E~~** | This call shall be in ON Procedure |
|  | ; Wait 00:05:00 (5 minutes) |  |
|  | ; Put PAS into normal mode via the mailbox  **TC,ZIA58873,PIA60347,EQUAL,0x1** | **THIS COMMAND CAN BE EXECUTED IF AIRSAFE PLUG IS INSTALLED**  **IF DISABLE PLUG IS INSTASLLED, DO NOT EXECUTE THIS COMMAND**  ; Reception of  **TM,YIA58729** ; (21,3) SSID=215 SWA\_TM\_SCI\_PAS\_MOMENTS\_RAW\_DATA  **TM,YIA58700** ; (21,3) SSID=192 SWA\_TM\_SCI\_PAS\_FULL3D\_RAW\_HEAD  **TM,YIA58705** ; (21,6) SSID=193 SWA\_TM\_SCI\_PAS\_FULL3D\_RAW\_DATA |
|  | ; Upload the PAS pulse table #5  **TC,ZIA58878,PIA60719,EQUAL,0x0F1A6E**  **TC,,PIA60433,EQUAL,0x28**  **TC,,PIA60672,EQUAL,0x4**  **TC,,PIA60717,EQUAL,0x5**  **TC,,PIA60718,EQUAL,0x14** |  |
|  | ; Wait 00:05:00 (5 minute) |  |
|  | ; Put PAS into no science mode  **TC**,**ZIA58944** |  |
|  | ~~; Ramp PAS HV down~~  **~~TC, ZIA58857, PIA60790,EQUAL,0~~**  **~~TC,,PIA60791,EQUAL,0xCCC~~**  **~~TC,,PIA60792,EQUAL,0x1FD~~**  **~~TC,,PIA60793,EQUAL,0x1E~~** | This call shall be in OFF Procedure |
|  | ; Wait 00:03:20 (200 seconds) |  |

## EAS 1

|  |  |  |
| --- | --- | --- |
| **Step N°** | **FFT Commanding Flow** | **Checks and PASS/FAIL Criteria** |
|  | Start Normal Mode on EAS1  **TC,ZIA58771,PIA60031,EQUAL, MBOX1**  **TC,ZIA58771,PIA60446,EQUAL, 0**  **TC,ZIA58771,PIA60447,EQUAL, 0**  **TC,ZIA58771,PIA60448,EQUAL, 0xC2** | ; Reception of  **TM,YIA58727**;TM(21,3) SSID=20 SWA\_TM\_SCI\_EAS\_PARTIAL\_MOMENTS\_RAW\_DATA  **TM,YIA58703** ; TM(21,3) SSID=0 SWA\_TM\_SCI\_EAS1\_FULL3D\_RAW\_HEAD  **TM,YIA58704** ; TM(21,6) SSID=1 SWA\_TM\_SCI\_EAS1\_FULL3D\_RAW\_DATA  **TM,YIA58713** ; TM(21,6) SSID=9 SWA\_TM\_SCI\_EAS1\_STRAHL\_RAW\_DATA |
|  | ; Wait 00:05:00 (5 minute) |  |
|  | ; Stop normal mode on EAS1  **TC, ZIA58771, PIA60031, EQUAL, MBOX1**  **TC,, PIA60446, EQUAL, 0**  **TC,, PIA60447, EQUAL, 0**  **TC,, PIA60448, EQUAL, 0** |  |

## EAS 2

|  |  |  |
| --- | --- | --- |
| **Step N°** | **FFT Commanding Flow** | **Checks and PASS/FAIL Criteria** |
|  | ; Start normal mode on EAS2  **TC, ZIA58819, PIA60031, EQUAL, MBOX1**  **TC,, PIA60446, EQUAL, 0**  **TC,, PIA60447, EQUAL, 0**  **TC,, PIA60448, EQUAL, 0xC2** | ; Reception of  **TM,YIA58727**;TM(21,3) SSID=20 SWA\_TM\_SCI\_EAS\_PARTIAL\_MOMENTS\_RAW\_DATA  **TM,YIA58701** ; TM(21,3) SSID=30 SWA\_TM\_SCI\_EAS2\_FULL3D\_RAW\_HEAD  **TM,YIA58702** ; TM(21,6) SSID=31 SWA\_TM\_SCI\_EAS2\_FULL3D\_RAW\_DATA  **TM,YIA58711** ; TM(21,6) SSID=39 SWA\_TM\_SCI\_EAS2\_STRAHL\_RAW\_DATA |
|  | ; Wait 00:05:00 (5 minute) |  |
|  | ; Stop normal mode on EAS2  **TC, ZIA58819, PIA60031, EQUAL, MBOX1**  **TC,, PIA60446, EQUAL, 0**  **TC,, PIA60447, EQUAL, 0**  **TC,, PIA60448, EQUAL, 0** |  |

# Power Down Sensors

Once the test is completed the SWA unit is left in its standby state. It can be left in this state for further operation or it can be powered down. See NR3 for details on how to power down SWA.

# Procedure variations and justifications

The FDIR monitoring HK is not currently tested as this functionality is not available.

# End of test

Once all SWA sensors and DPU have been powered down, the SFT is completed. The science data collected during the SFT can be processed post-test to verify instrument functionality.