**Project: Solar Orbiter SWA**

**Author:** **Gethyn Lewis**

**TITLE: SWA Instrument Commissioning Plan**

**Document Number: SO-SWA-MSSL-PL-024 Iss. B Date: 14th Sep, 2018**

**Distribution:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Mullard Space Science | C J Owen | X | SwRI | S Livi |  |
| Laboratory | C Brockley-Blatt | X |  | M Phillips |  |
|  | B Hancock | X |  | S Persyn |  |
|  | D Kataria | X |  | E Edlund |  |
|  | A Spencer | X | University of Michigan | M Panning |  |
|  | A. Rousseau | x |  | S Lepri |  |
|  |  |  |  |  |  |
| LPP | M Berthomier |  | IRAP | P Louarn |  |
|  | J-D Techer |  |  | A Fedorov |  |
|  |  |  |  | C Amoros |  |
| IAPS | R Bruno |  |  | H Seran |  |
|  | F Marcucci |  |  | S Bordon |  |
| TSD | G Capuano |  |  |  | X |
|  | R Lirato | X | ESA | A Pacros |  |
| SSI | A Alapide |  |  | K. Wirth |  |
| Sitael | V Arciuli |  |  | S. Fahmy |  |
| Planetek | M Tragni |  |  | F Marliani |  |
|  |  | X |  | Joe Cerullo |  |
| UNH | S Myers |  | NASA | J. Cerullo |  |
|  | M Popecki |  |  | M. Reden |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Author: |  | Date: |  |
| Manager/Project Office |  | Date: |  |
| PA: |  | Date: |  |

**CHANGE RECORD**

|  |  |  |  |
| --- | --- | --- | --- |
| **ISSUE** | **DATE** | **PAGES CHANGED** | **COMMENTS** |
| A | 17/05/2018 |  | All new |
| B | 24/09/2018 | Section 5.3 | Added details from DOK |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**CONTENTS**

[1 Introduction 4](#_Toc514338058)

[2 Normative and Informative Documents 4](#_Toc514338059)

[2.1 Normative Documents 4](#_Toc514338060)

[2.2 Informative Documents 4](#_Toc514338061)

[3 Acronym and Abbreviation List 5](#_Toc514338062)

[4 General requirements 5](#_Toc514338063)

[4.1 Spacecraft Location and Plasma Environment 5](#_Toc514338064)

[4.2 Required Configuration of the Spacecraft 5](#_Toc514338065)

[4.2.1 Spacecraft Pointing 5](#_Toc514338066)

[4.2.2 Spacecraft-generated Gases 5](#_Toc514338067)

[4.2.3 Telemetry 5](#_Toc514338068)

[4.3 Required Configuration of Other Instruments 5](#_Toc514338069)

[4.4 Inter-Experiment Links - Service 20 6](#_Toc514338070)

[4.5 Verification process during commissioning 6](#_Toc514338071)

[4.5.1 Performance Verification 6](#_Toc514338072)

[4.5.2 Spacecraft EGSE Real-time Housekeeping Parameters 6](#_Toc514338073)

[4.5.3 Real-time SWA Housekeeping Parameters 6](#_Toc514338074)

[4.5.4 Spacecraft OBDH Checking of Housekeeping Parameters 6](#_Toc514338075)

[4.5.5 Real-time SWA Science Data 6](#_Toc514338076)

[4.6 Order of commissioning of the DPU and SWA sensors 7](#_Toc514338077)

[5 SWA Commissioning 7](#_Toc514338078)

[5.1 DPU 7](#_Toc514338079)

[5.2 PAS 7](#_Toc514338080)

[5.3 EAS 8](#_Toc514338081)

[5.4 HIS 8](#_Toc514338082)

[6 Near Earth Suite commissioning – realtime contact 8](#_Toc514338083)

[6.1 Normal mode operation demonstration 8](#_Toc514338084)

[6.2 Burst, triggered. MAG and RPW (can be faked) on 8](#_Toc514338085)

[6.3 Normal mode operation 8](#_Toc514338086)

[Possible in parallel with other instruments being commissioned 8](#_Toc514338087)

[7 Inter-instrument campaign 8](#_Toc514338088)

[8 Interference campaign 8](#_Toc514338089)

# Introduction

The primary objective of this document is to describe the in-flight commissioning plan of the SWA flight instrument. The proposed tests will demonstrate that the performance of the instrument meets the operational requirements. The aim is to define activities with an emphasis on performing tests that require real time contact with the spacecraft.

# Normative and Informative Documents

## Normative Documents

The documents listed below form a part of this document, to the extent specified and described herein.

|  |  |  |
| --- | --- | --- |
| Ref. | No | Title |
| NR1 | SOL-EST-IF-0050 | Solar Orbiter Experiment Interface Document Part A |
| NR2 | SOL-EST-RS-1937 | Solar Orbiter Product Assurance Requirements for Instruments |
| NR3 | SO-SWA-MSSL-SP-006 | SWA Instrument Scientific Requirements Report |
| NR4 | SO-SWA-MSSL-PL-006 | SWA Product Assurance Plan |
| NR5 | MSSL-SO-SWA-EID-B | SWA EID-B |
| NR6 | SO-SWA-LPP-LP-039\_MCP Acceptance Test | LPP MCP Acceptance and characterisation Plan |
| NR7 | SO-SWA-LPP-RP-078\_1\_1-MCP\_test\_report\_PartI | MCP detector characterisation test report |
| NR8 | SO-SWA-LPP-RP-092 EAS Det FM1 Test Report rev 1-4.pdf | LPP detector sub-system test report FM1 |
| NR9 | SO-SWA-LPP-RP-093 EAS Det FM2 Test Report rev 1-2.pdf | LPP detector sub-system test report FM2 |
| NR10 | SO-SWA-MSSL-SP-012\_EAS-DPU\_Interface\_Specification\_Issue\_2.pdf | EAS-DPU Interface Specification |
| NR11 | SO-SWA-MSSL-PL-013 | SWA EAS Calibration Plan |
| NR12 | SO-SWA-MSSL-UM-002 | SWA Instrument User manual |

## Informative Documents

The following documents are called up in this plan and are used for guidance and information only.

|  |  |  |
| --- | --- | --- |
| Ref. | No | Title |
| IR1 |  |  |
| IR2 |  |  |
| IR3 |  |  |

# Acronym and Abbreviation List

|  |  |
| --- | --- |
| Abbreviation | Meaning |
| AD | Applicable Document |
| EAS | Electron Analyser System |
| EID | Experiment Interface Document |
| FMECA | Failure Modes, Effects and Criticality Analysis |
| ESA | European Space Agency |
| MSSL | Mullard Space Science Laboratory |
| N/A | Not Applicable |
| PA | Product Assurance |
| SWA | Solar Wind Analyser |
| TBC | To Be Confirmed |
| TBD | To Be Defined |

# General requirements

## Spacecraft Location and Plasma Environment

To be included

## Required Configuration of the Spacecraft

### Spacecraft Pointing

To be included

### Spacecraft-generated Gases

SWA commissioning, particularly involving high voltages, should not begin until sufficient time has elapsed for spacecraft outgassing to be essentially complete. It has been estimated that at least 20 days are required after launch, following assessment of data from TQCM.

No thruster firing should occur during SWA commissioning, and a sufficient time should be allowed between any thruster firing and the start of commissioning.

### Telemetry

A telemetry requirement of xxx will be required for SWA commissioning

## Required Configuration of Other Instruments

It is requested that ALL other instruments are in ‘Standby’ or are not powered during SWA commissioning periods.

## Inter-Experiment Links - Service 20

The IEL inputs to SWA are from

* MAG
* RPW

Until completion of commissioning of each sensor, IEL inputs will be disabled at the DPU.

## Verification process during commissioning

### Performance Verification

Following each command in the commissioning sequence the experimenter will either confirm that the command was executed as expected or recommend that a contingency plan is executed.

### Spacecraft EGSE Real-time Housekeeping Parameters

Checking of the housekeeping parameters will be performed using the spacecraft EGSE. Visual checking of the real time housekeeping by a SWA team member viewing the ESOC video display.  **Unless otherwise stated, each command in the commissioning sequences given should be followed by inspection of the housekeeping by an SWA team member before the next command in the sequence is sent.**

### Real-time SWA Housekeeping Parameters

Visual checking of the near-real time housekeeping data by an SWA team member viewing the SWA EGSE display. Data will be acquired via tbd mechanism. The EGSE provides a range of graphical displays for the interpretation of the housekeeping and science data and will have limit checking similar to that used for ground testing. Specific parameters which will be checked in this way are listed in the detailed procedures in this document.

### Spacecraft OBDH Checking of Housekeeping Parameters

None (tbc)

### Real-time SWA Science Data

Real-time assessment of science data from the SWA sensors will be required during commissioning. Interpretation and visualisation of the data will use a dedicated EGSE, both for engineering and science assessments.

## Order of commissioning of the DPU and SWA sensors

The order of commissioning of the different SWA units is as follows (tbc):

* DPU
* PAS
* EAS
* HIS

# SWA Commissioning

The overall commissioning flow for the SWA instrument is as follows:

* In the first instance, the DPU will be commissioned to the extent that the unit is powered, service 20 response is verified and relevant tests required prior to sensor turn-on are carried out
* The next step will be to turn on the individual sensors and commission them, one at a time. This will include performing sensor functional tests, commissioning of high voltages, performing engineering mode tests as required and carrying out optimisation of instrument performance, with the emphasis on tests requiring real time contact with the spacecraft
* Following completion of commissioning of each of the three sensors, the DPU will be commissioned for operation of all three sensors and step through the suite level commissioning process. This process will
  + Demonstrate Normal Mode operation
  + Demonstrate Burst and Triggered mode operation. MAG and RPW will require to be commissioned and operational for this step
  + Perform suite level performance optimisation, particularly carrying out tests where real time contact is required
* Following demonstration of suite level operation, the instrument suite will be operated for a period of time, possibly in parallel with other instruments being commissioned.
* Finally, the Suite will participate in inter-instrument operations and interference campaigns

The rest of the section details the commissioning plan for the DPU and each individual sensor.

## DPU

## PAS

## EAS Commissioning step by step procedure

Send this Tc, wait some time, check some value, if/else, send next Tc.

### General details

|  |  |
| --- | --- |
| **Date:** | Oct. 2020 |
| **MSSL Personnel:** | Malpuss, Kataria, Gethyn, Adam, Barry |
| **ESA Personnel:** | ?? |
| **Sensor name:** | EAS |
| **Sub-system name:** | Head 1 |
|  |  |

### Initial Commissioning preparation

Commissioning to be scheduled xx days after launch.

| Test Title: **Initial preparation** | | | | |
| --- | --- | --- | --- | --- |
| Step No. | Description | Value | Conductor sign and date | Comments |
|  | Record the time and date |  |  |  |
|  | Has sufficient time elapsed since launch (more than xx days)  (Yes) Proceed (No) Wait |  |  |  |
|  | Log spacecraft pressure readings |  |  |  |
|  | Is pressure better than xx? (Yes) Proceed (No) Consult commissioning team lead |  |  |  |
|  | Log spacecraft temperature |  |  |  |
|  | Log EAS temperature |  |  |  |
|  | Is EAS temperature less than xx? (Yes) Proceed to step 8. (No) Consult commissioning team lead |  |  | The spacecraft should not allow commissioning if temp is out of range |
|  | Other steps before going to section 5.3.2? |  |  |  |
|  | Commissioning team lead confirmation to proceed to section 5.3.2. (Yes) Proceed. (No) EAS PI input required |  |  |  |

### MCP turn on

| Title: **MCP turn on** | | | | |
| --- | --- | --- | --- | --- |
| Step No. | Description | Value | Confirmation to proceed | Comments |
|  | Record the FPGA sequence version |  |  | Sequence update expected? |
|  | Prepare in-flight equivalent of Run macros with appropriate values for commissioning.  Have this double checked by an instrument scientist. | Hem max: 800V  Hem Ratio: 1  Upper def: 0  Lower def: 0  VGF: 0  Threshold: tbc |  | Suggested values. Need further discussion |
|  | Power either EAS Head 1 or 2. |  |  |  |
|  | Input required from Adam/Gethyn/Barry for electronics commissioning steps (in-flight version of low voltage FFT suggested) |  |  |  |
|  | Is the EAS current draw(s) in DPU HK between xx mA and yy mA (YES-PASS / NO-FAIL)? Record their values. | current:\_\_\_\_\_\_\_\_\_mA |  | Not sure DPU provides anything relevant |
|  | Demand HK? |  |  |  |
|  | Run in-flight equivalent EAS\_POST\_MemoryTest\_Macro.txt |  |  |  |
|  | Run in-flight equivalent EAS\_to\_Idle\_Trans\_Macro.txt or in-  Change in DPU HK?  (YES-PASS / NO-FAIL) | current:\_\_\_\_\_\_\_\_\_mA |  | Not sure DPU provides anything relevant |
|  | Run in-flight equivalent  EAS\_to\_Run\_Trans\_Macro.txt  EAS HK should start being returned.  Are HK parameters within an acceptable range?  (YES-PASS / NO-FAIL) | current:\_\_\_\_\_\_\_\_\_mA |  |  |
|  | FPGA self-test, EMs? |  |  |  |
|  | Stim EMs? |  |  |  |
|  | Run in-flight equivalent of EAS\_to\_Normal\_Mode\_Command  .txt  Science packets should start being returned.  (YES-PASS / NO-FAIL) |  |  |  |
|  | Verify data. No counts expected. If counts appear, consult commissioning lead |  |  | Details tbd |
|  | MCP ramp macro. Step up 100V, wait 5 seconds, step down 50V (tbd). |  |  |  |
|  | Verify data. No counts expected up to 2200V. If counts appear, consult commissioning lead |  |  |  |
|  | Repeat steps 14 and 15 up to 2200V (tbd) |  |  |  |
|  | Verify data. No counts expected. If counts appear, consult commissioning lead |  |  |  |
|  | Run in-flight version of EAS\_to\_no\_science.txt |  |  | Check if needed |
|  | Prepare Run macro with appropriate values for transmitting plasma particles.  Have this double checked by an instrument scientist. | Hem max: 800V  Hem Ratio: 0.83  Upper def: 0  Lower def: 0  VGF: 0  Threshold: tbc |  | Suggested values. Need further discussion |
|  | Run in-flight equivalent of EAS\_to\_Normal\_Mode\_Command  .txt  Science packets should start being returned.  (YES-PASS / NO-FAIL) |  |  |  |
|  | Verify data. No counts expected. If counts appear, consult commissioning lead |  |  |  |
|  | MCP ramp macro. Step up 50V, wait 5 seconds, step down 25V (tbd). |  |  |  |
|  | Verify data. Record counts. Consult commissioning lead to continue |  |  |  |
|  | Repeat steps 22 and 23 to 2500 (tbd) voltage |  |  |  |
|  | Run in-flight version of EAS\_to\_no\_science.txt |  |  |  |
|  | Prepare Run macro with appropriate values for stopping transmission of plasma particles.  Have this double checked by an instrument scientist. | Hem max: 800V  Hem Ratio: 1  Upper def: 0  Lower def: 0  VGF: 0  Threshold: tbc |  | Suggested values. Need further discussion. Once agreed, replace with named macro |
|  | Run in-flight equivalent of EAS\_to\_Normal\_Mode\_Command  .txt  Science packets should start being returned.  (YES-PASS / NO-FAIL) |  |  |  |
|  | Verify data. Record counts. Consult commissioning lead to continue |  |  |  |
|  | MCP ramp macro. Step up 30V, wait 5 seconds, step down 15V (tbd). |  |  |  |
|  | Verify data. Record counts. Consult commissioning lead to continue |  |  |  |
|  | Repeat steps 22 and 23 to 2710 (tbd) voltage |  |  |  |
|  | Acquire data for 15 minutes at 2695V (tbd) |  |  |  |
|  | Run in-flight version of EAS\_to\_no\_science.txt |  |  |  |
|  | Prepare Run macro with appropriate values for stopping transmission of plasma particles.  Have this double checked by an instrument scientist. | Hem max: 800V  Hem Ratio: 0.83  Upper def: 0  Lower def: 0  VGF: 0  Threshold: tbc |  | Suggested values. Need further discussion. Once agreed, replace with named macro |
|  | Run in-flight equivalent of EAS\_to\_Normal\_Mode\_Command  .txt  Science packets should start being returned.  (YES-PASS / NO-FAIL) |  |  |  |
|  | Verify data. Record counts. Consult commissioning lead to continue |  |  |  |
|  | Acquire data for 15 minutes at 2695V (tbd) |  |  |  |
|  | Record peak MCP voltage that was tested. | MCP:\_\_\_\_\_\_\_\_\_\_\_\_\_V |  |  |
|  | Run rest of EMs |  |  | Details tbd |
|  | EAS in-flight parameter optimisation |  |  | Details tbd |
|  | Copy data for analysis | File path: |  |  |

## HIS

# Near Earth Suite commissioning – realtime contact

## Normal mode operation demonstration

## Burst, triggered. MAG and RPW (can be faked) on

## Normal mode operation

## Possible in parallel with other instruments being commissioned

# Inter-instrument campaign

# Interference campaign