**Project: Solar Orbiter SWA**

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# 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.

# Reference 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 |

# Acronym and Abbreviation List

|  |  |
| --- | --- |
| **Abbreviation** | **Meaning** |
| PDOR | Payload Direct Operations Request |
| MDOR | Memory Direct Operations Request |
| IA-FCP | Instrument (SWA) – Flight Control Procedure |
| TC | TeleCommand |
| IIC | Inter Instrument Check |
|  |  |
|  |  |

# General requirements

## Spacecraft Location and Plasma Environment

To be included

## Required Configuration of the Spacecraft

There is no particular spacecraft configuration required during SWA commission.

## Spacecraft Pointing

There is no designated pointing required during the SWA commission phase.

## 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 accepted by SWA that some other instruments are powered on during the SWA commission. However if SWA feel that the other instruments are causing interference to SWA commission, then SWA will request that those instruments be powered down. It is also expected that no other instrument commanding will take place during SWA commission 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.

### 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 SWA provided EGSE, both for engineering and science assessments.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **NECP Phase** | **NECP number** | **Date** | **Day** | **Start Time** | **End Time** | **Duration** | **One Way Light Time (Seconds)** | **Comments** |
| SWA-6 |  | 08-May | Fri | 06:22 | 14:22 | 08:00 | 146-147 | SWA |
| SWA-6 |  | 11-May | Mon | 06:07 | 14:07 | 08:00 | 177-203 | SWA |
| IIC |  | 20-May | Wed | 15:00 | 18:00 | 03:00 | 215-248 | IIC |
| EMC |  | 02-Jun | Tue | 01:00 | 10:17 | 09:17 | 319-362 | EMC |

Table 4.1 MOC Timeline for each SWA commission phase (version 5.6). All times are in UTC.

# 8th &11th May. SWA-6 (IA-6) SWA

## Configure SWA from MTL

The **PDOR\_SSWA\_SWA\_MTL\_8thMay\_00001.SOL** has been sent to the MTL and will run automatically. It contains the following TCs.

| **Step N°** | **Commanding Flow** | **FCP ID or PDOR title & contents** | **Comments** |
| --- | --- | --- | --- |
|  | Power DPU on into OPS | **AIAF011A**  **AIAF030A** | Starts at 06:00 |
|  | Power up & configure HIS with ramped-up High Voltage ready to sweep. | **ANEF800A (Manually loaded by MOC)**  **ZIA58913** | Starts at 06:10 |
|  | Power up & configure PAS in No science. | **ZIA58050**  **ZIA58064**  **ZIA58706**  **ZIA58708**  **ZIA58707**  **ZIA58858**  **ZIA58863**  **ZIA58063**  **ZIA58063**  **ZIA58064**  **ZIA58063**  **ZIA58947**  **ZIA58863**  **ZIA58853**  **ZIA58063**  **ZIA58863**  **ZIA58863**  **ZIA58863**  **ZIA58862**  **ZIA58876**  **ZIA58873**  **ZIA58873**  **ZIA58856**  **ZIA58063** | Starts at 07:38 |
|  | Power up & configure EAS 1 in No science. | **ZIA58050**  **ZIA58064**  **ZIA58760**  **ZIA58934**  **ZIA58753**  **ZIA58782**  **ZIA58758**  **ZIA58776**  **ZIA58757**  **ZIA58765**  **ZIA58769**  **ZIA58766**  **ZIA58767**  **ZIA58771**  **ZIA58797**  **ZIA58784**  **ZIA58706**  **ZIA58708** | Starts at 08:09 |
|  | Power up & configure EAS 2 in No science. | **ZIA58050**  **ZIA58064**  **ZIA58808**  **ZIA58936**  **ZIA58801**  **ZIA58830**  **ZIA58806**  **ZIA58824**  **ZIA58805**  **ZIA58813**  **ZIA58817**  **ZIA58814**  **ZIA58815**  **ZIA58819**  **ZIA58845**  **ZIA58832**  **ZIA58706**  **ZIA58708** | Starts at 08:12 |
|  | Modify EAS Tau value | **ZIA58054**  **ZIA58054**  **ZIA58054**  **ZIA58054**  **ZIA58053**  **ZIA58053**  **ZIA58053**  **ZIA58053**  **ZIA58054**  **ZIA58054**  **ZIA58054**  **ZIA58054**  **ZIA58737** | Starts at 08:14 |
|  | Enable DPU Diagnostic HK | **ZIA58050**  **ZIA58050** | Starts at 08:15 |

At 08:16 all SWA sensors are powered on and configured ready for science. We then proceed to send the following PDORs interactively.

## EAS FDIR

|  |  |  |  |
| --- | --- | --- | --- |
| **Step N°** | **Commanding Flow** | **FCP ID or PDOR title & contents** | **Comments** |
|  | Enable EAS FDIR | **PDOR\_SSWA\_EAS1\_ENABLE\_FDIR\_00002.SOL**  **PDOR\_SSWA\_EAS2\_ENABLE\_FDIR\_00002.SOL** |  |

## SWA Normal mode (No Compression)

|  |  |  |  |
| --- | --- | --- | --- |
| **Step N°** | **Commanding Flow** | **FCP ID or PDOR title & contents** | **Comments** |
|  | Puts HIS into NM | **PDOR\_SSWA\_HIS\_NORMSCI\_00001.SOL** |  |
|  |  | Wait 00:10:00 (600 seconds) |  |
|  | Put PAS into NM | **PDOR\_SSWA\_PAS\_NM\_00001.SOL** |  |
|  |  | Wait 00:10:00 (600 seconds) |  |
|  | HIS to HVSTBY | **PDOR\_SSWA\_HIS\_HVSTBY\_00001.SOL** |  |
|  | EAS 1&2 into NM | **PDOR\_SSWA\_EAS1\_NormalMode\_00001.SOL**  **PDOR\_SSWA\_EAS2\_NormalMode\_00001.SOL** |  |
|  |  | Wait 00:10:00 (600 seconds) |  |
|  | PAS into No Science | **PDOR\_SSWA\_PAS\_NoScience\_00001.SOL** |  |
|  | Puts HIS into NM | **PDOR\_SSWA\_HIS\_NORMSCI\_00001.SOL** |  |
|  |  | Wait 00:10:00 (600 seconds) |  |
|  |  | **PDOR\_SSWA\_PAS\_NM\_00001.SOL** |  |
|  |  | Wait 00:10:00 (600 seconds) |  |
|  | Enable Compression | IA-FCP-101 |  |

## SWA Normal mode (No Compression)

|  |  |  |  |
| --- | --- | --- | --- |
| **Step N°** | **Commanding Flow** | **FCP ID or PDOR title & contents** | **Comments** |
|  | Puts HIS into NM | **PDOR\_SSWA\_HIS\_NORMSCI\_00001.SOL** |  |
|  |  | Wait 00:10:00 (600 seconds) |  |
|  | Put PAS into NM | **PDOR\_SSWA\_PAS\_NM\_00001.SOL** |  |
|  |  | Wait 00:10:00 (600 seconds) |  |
|  | HIS to HVSTBY | **PDOR\_SSWA\_HIS\_HVSTBY\_00001.SOL** |  |
|  | EAS 1&2 into NM | **PDOR\_SSWA\_EAS1\_NormalMode\_00001.SOL**  **PDOR\_SSWA\_EAS2\_NormalMode\_00001.SOL** |  |
|  |  | Wait 00:10:00 (600 seconds) |  |
|  | PAS into No Science | **PDOR\_SSWA\_PAS\_NoScience\_00001.SOL** |  |
|  | Puts HIS into NM | **PDOR\_SSWA\_HIS\_NORMSCI\_00001.SOL** |  |
|  |  | Wait 00:10:00 (600 seconds) |  |
|  |  | **PDOR\_SSWA\_PAS\_NM\_00001.SOL** |  |
|  |  | Wait 00:10:00 (600 seconds) |  |
|  | Enable Compression | IA-FCP-101 |  |

## SWA Burst mode (No Compression)

|  |  |  |  |
| --- | --- | --- | --- |
| **Step N°** | **Commanding Flow** | **FCP ID or PDOR title & contents** | **Comments** |
|  | Test Burst Mode  All sensors into BM for 5 mins  5m = 300s / 8 = 2400 | **PDOR\_SSWA\_SWA\_BM\_00001.SOL**  ZIA58726, PIA60157 = 2400  PIA60158 = 0  PIA60159 = 2400  PIA60160 = 0  PIA60163 = 2400  PIA60164 = 0  PIA60170 = DYNAMIC  PIA60161 = 2400  PIA60162 = 0  Wait 00:20:00 (1200 seconds) |  |

All sensors return to Normal Mode.

## PAS Calibration

|  |  |  |  |
| --- | --- | --- | --- |
| **Step N°** | **Commanding Flow** | **FCP ID or PDOR title & contents** | **Comments** |
|  |  | **PDOR\_SSWA\_EAS1\_NoScience\_00001.SOL**  **PDOR\_SSWA\_EAS2\_NoScience\_00001.SOL** |  |
|  |  | **PDOR\_SSWA\_HIS\_HVSTBY\_00001.SOL** |  |
|  |  | **PDOR\_SSWA\_PAS\_NoScience\_00001.SOL** |  |
|  |  | Wait at least 10 seconds |  |
|  |  | **PDOR\_SSWA\_PAS\_Calibration\_00006.SOL** |  |

## Compression On

|  |  |  |  |
| --- | --- | --- | --- |
| **Step N°** | **Commanding Flow** | **FCP ID or PDOR title & contents** | **Comments** |
|  | Turn compression on | **PDOR\_SSWA\_SWA\_CompressOn\_00001.SOL** |  |

## SWA Normal mode (With Compression)

|  |  |  |  |
| --- | --- | --- | --- |
| **Step N°** | **Commanding Flow** | **FCP ID or PDOR title & contents** | **Comments** |
|  | Puts HIS into NM | **PDOR\_SSWA\_HIS\_NORMSCI\_00001.SOL** |  |
|  |  | Wait 00:10:00 (600 seconds) |  |
|  | Put PAS into NM | **PDOR\_SSWA\_PAS\_NM\_00001.SOL** |  |
|  |  | Wait 00:10:00 (600 seconds) |  |
|  | EAS 1&2 into NM | **PDOR\_SSWA\_EAS1\_NormalMode\_00001.SOL**  **PDOR\_SSWA\_EAS2\_NormalMode\_00001.SOL** |  |

## SWA Burst mode (With Compression)

|  |  |  |  |
| --- | --- | --- | --- |
| **Step N°** | **Commanding Flow** | **FCP ID or PDOR title & contents** | **Comments** |
|  | Test Burst Mode  All sensors into BM for 5 mins  5m = 300s / 8 = 2400 | **PDOR\_SSWA\_SWA\_BM\_00001.SOL**  Wait 00:10:00 (600 seconds)  ZIA58726, PIA60157 = 2400  PIA60158 = 0  PIA60159 = 2400  PIA60160 = 0  PIA60163 = 2400  PIA60164 = 0  PIA60170 = DYNAMIC  PIA60161 = 2400  PIA60162 = 0  Wait 00:20:00 (1200 seconds) |  |

All sensors return to Normal Mode.

## SWA Cadence test

|  |  |  |  |
| --- | --- | --- | --- |
| **Step N°** | **Commanding Flow** | **FCP ID or PDOR title & contents** | **Comments** |
|  | Test SWA Cadences  Decrease All SWA cadence  Increase EAS cadence  All SWA at nominal cadence | **PDOR\_SSWA\_Suite\_Comm\_Cadence\_00002.SOL**  ZIA58728, PIA60096 = 2  PIA60097 = 2  PIA60099 = 2  PIA60098 = 2  Wait 00:10:00 (600 seconds)  ZIA58728, PIA60096 = 0  PIA60097 = 0  PIA60099 = 1  PIA60098 = 1  Wait 00:10:00 (600 seconds)  ZIA58728, PIA60096 = 1  PIA60097 = 1  PIA60099 = 1  PIA60098 = 1  Wait 00:10:00 (600 seconds) |  |
|  | Enter Low Cadence Mode  Select Product Configuration Table 3 for Max Res  VDF  Select "SWA\_HIS\_LOW\_1TENTH" PHA  Select "SWA\_HIS\_LOW\_1TENTH" VDF  Select "SWA\_HIS\_LOW\_QUARTER" PHA  Select "SWA\_HIS\_LOW\_QUARTER" VDF  Select "SWA\_HIS\_LOW\_HALF" PHA  Select "SWA\_HIS\_LOW\_HALF" VDF  Select "SWA\_HIS\_LOW\_2THIRDS" PHA  Select "SWA\_HIS\_LOW\_2THIRDS" VDF  Enter Normal Cadence Mode  Select "SWA\_HIS\_NORMAL\_5X" PHA  Select "SWA\_HIS\_NORMAL\_5X" VDF  Select "SWA\_HIS\_NORMAL\_3X" PHA  Select "SWA\_HIS\_NORMAL\_3X" VDF  Select "SWA\_HIS\_NORMAL\_2X" PHA  Select "SWA\_HIS\_NORMAL\_2X" VDF  Select Product Configuration Table 0 for Half  Res VDF  Select "SWA\_HIS\_NORMAL" PHA  Select "SWA\_HIS\_NORMAL" VDF  Select Burst PHA  Select Burst PHA  Select Burst VDF  Select Burst VDF  Setup DPU for 5-minute HIS core burst  Setup DPU for 5-minute HIS optional burst  Command NOP to hold wait time | **PDOR\_SSWA\_HIS\_DATA\_RATE\_CADENCES\_00002.SOL**  Wait 0:00:01 (1 seconds)  ZIA58913, PIA60001 = 8  Wait 0:01:00 (60 seconds)  ZIA58919, PIA60356 = PR\_CONF\_TAB\_NO  PIA60352 = 3  Wait 0:00:01 (1 seconds)  ZIA58919, PIA60356 = PHA\_MAX\_NORMAL  PIA60352 = 5654  Wait 0:00:01 (1 seconds)  ZIA58919, PIA60356 = VDF\_EN\_NORM  PIA60352 = 0  Wait 0:22:00 (1320 seconds)  ZIA58919, PIA60356 = PHA\_MAX\_NORMAL  PIA60352 = 8928  Wait 0:00:01 (1 seconds)  ZIA58919, PIA60356 = VDF\_EN\_NORM  PIA60352 = 1  Wait 0:22:00 (1320 seconds)  ZIA58919, PIA60356 = PHA\_MAX\_NORMAL  PIA60352 = 11904  Wait 0:00:01 (1 seconds)  ZIA58919, PIA60356 = VDF\_EN\_NORM  PIA60352 = 1  Wait 0:22:00 (1320 seconds)  ZIA58919, PIA60356 = PHA\_MAX\_NORMAL  PIA60352 = 23808  Wait 0:00:01 (1 seconds)  ZIA58919, PIA60356 = VDF\_EN\_NORM  PIA60352 = 7  Wait 0:22:00 (1320 seconds)  ZIA58913, PIA60001 = 15  Wait 0:00:10 (10 seconds)  ZIA58919, PIA60356 = PHA\_MAX\_NORMAL  PIA60352 = 11904  Wait 0:00:01 (1 seconds)  ZIA58919, PIA60356 = VDF\_EN\_NORM  PIA60352 = 7  Wait 0:17:00 (1020 seconds)  ZIA58919, PIA60356 = PHA\_MAX\_NORMAL  PIA60352 = 13094  Wait 0:00:01 (1 seconds)  ZIA58919, PIA60356 = VDF\_EN\_NORM  PIA60352 = 1  Wait 0:12:00 (720 seconds)  ZIA58919, PIA60356 = PHA\_MAX\_NORMAL  PIA60352 = 5654  Wait 0:00:01 (1 seconds)  ZIA58919, PIA60356 = VDF\_EN\_NORM  PIA60352 = 1  Wait 0:12:00 (720 seconds)  ZIA58919, PIA60356 = PR\_CONF\_TAB\_NO  PIA60352 = 0  Wait 0:00:01 (1 seconds)  ZIA58919, PIA60356 = PHA\_MAX\_NORMAL  PIA60352 = 5357  Wait 0:00:01 (1 seconds)  ZIA58919, PIA60356 = VDF\_EN\_NORM  PIA60352 = 1  Wait 0:12:00 (720 seconds)  ZIA58919, PIA60356 = PHA\_MAX\_BURST\_1  PIA60352 = 4000  Wait 0:00:01 (1 seconds)  ZIA58919, PIA60356 = PHA\_TLM\_MAX\_B2  PIA60352 = 4000  Wait 0:00:01 (1 seconds)  ZIA58919, PIA60356 = VDF\_EN\_BURST\_1  PIA60352 = 0x3F  Wait 0:00:01 (1 seconds)  ZIA58919, PIA60356 = VDF\_EN\_B2  PIA60352 = 0x3F  Wait 0:00:01 (1 seconds)  ZIA58726, PIA60157 = 0  PIA60158 = 0  PIA60159 = 0  PIA60160 = 0  PIA60163 = 0  PIA60164 = 0  PIA60170 = DYNAMIC  PIA60161 = 2400  PIA60162 = 0  Wait 0:10:00 (600 seconds)  ZIA58726, PIA60157 = 0  PIA60158 = 0  PIA60159 = 0  PIA60160 = 0  PIA60163 = 0  PIA60164 = 0  PIA60170 = DYNAMIC  PIA60161 = 0  PIA60162 = 2400  Wait 0:10:00 (600 seconds)  ZIA58915 |  |

## SWA Cadence test

The **PDOR\_SSWA\_SWA\_MTL\_8thMay\_00001.SOL** has been sent to the MTL and will run automatically. This contains the Power off sequence for SWA. It will start at 13:47 UTC and complete at 14:43 UTC.

# SWA Commission conclusion

At this point, SWA is fully commissioned.