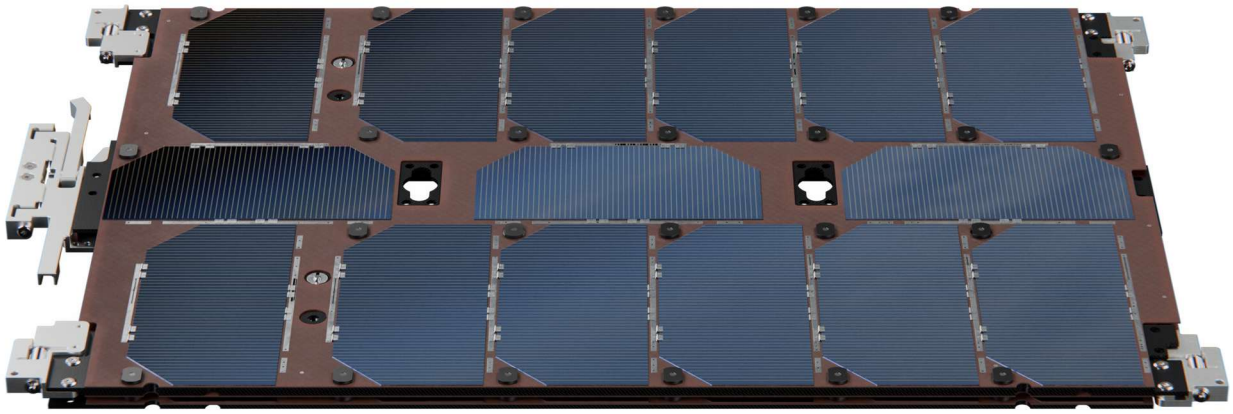


NanoPower TSP 45W
Tracking Solar Panel

Manual
Tracking solar panels

GomSpace A/S | Langagervej 6 | DK-9220 Aalborg East | Denmark
gomspace.com | sales@gomspace.com | T: +45 71 741 741

1 Table of Contents

3 Changelog

Date	Revision	Author	Description
	0.1	RABN	First draft
29-09-2022	1.0	FARA	First Release
08-02-2023	2.0	RABN, FCO	Major document revision
22-10-2025	3.0	FJVO	Updated HDRM
23-03-2026	4.0	JMB	Updated section 9.3 *Installation of the HDRM* Update in section 9.6. Change of screw length

Document name: NanoPower TSP-45W User Manual

Document No.: 1044358

Revision: 4.0

Author: FJVO;JMB

Verified by: SBJE

Verification date: 05-05-2026

Confidentiality Notice

4 Introduction

This document gives a description on how to mount your GomSpace TSP 45W on your structure and prepare it for flight.

4.1 Unpacking and Handling Precautions

Handling

This product uses advanced solar cells that are fragile. Wear gloves when handling. Do not touch solar cell surface.

Only handle solar panels with great care.

Never place anything on solar cells!

For handling of the solar array it is recommended to avoid touching the cells, and instead touch the black nuts at the outer edge as shown in Figure 4-1.

The TSP 45W requires anti-static handling precautions to be observed. Do not touch or handle the product without proper grounding.
The solar cells and particular their interconnect tabs are fragile entities and should not be touched.

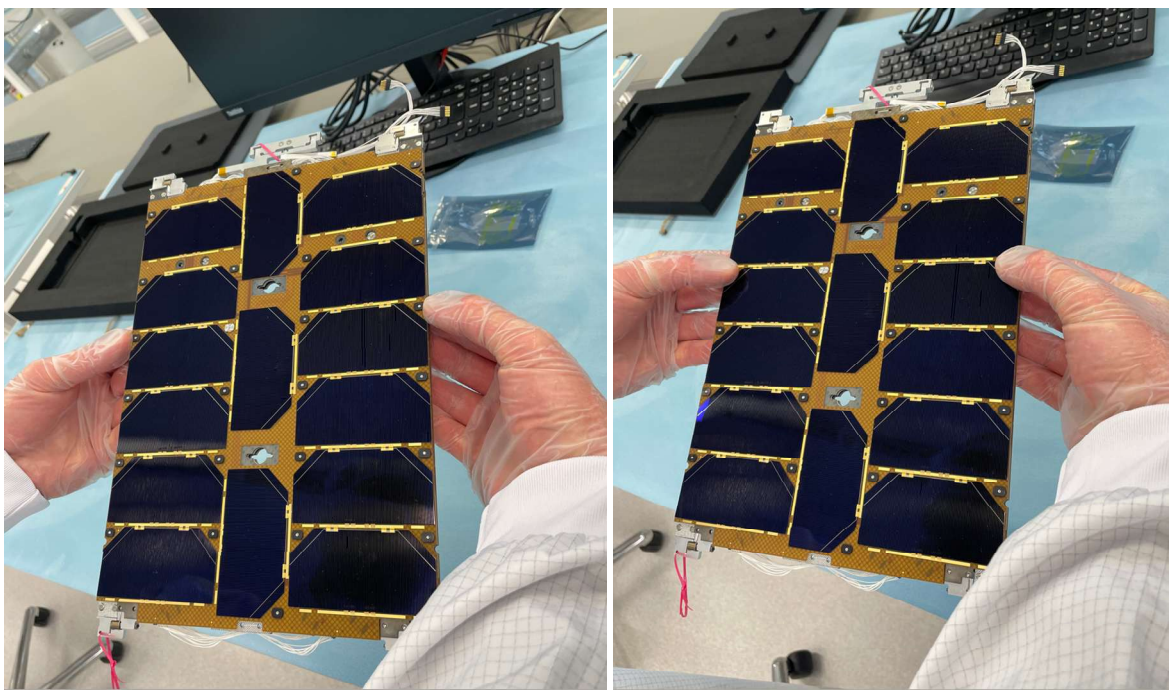


Figure 4-1: Safe handling of solar array.

5 Integration and verification overview

GomSpace recommends to following the integration and verification process depicted in Figure 5-1. This shall be regarded as sufficient verification of the TSP 45W. The product may be a part of a larger spacecraft verification campaign, however, be aware the product is qualified for a maximum of 8 on ground release and deploy events.

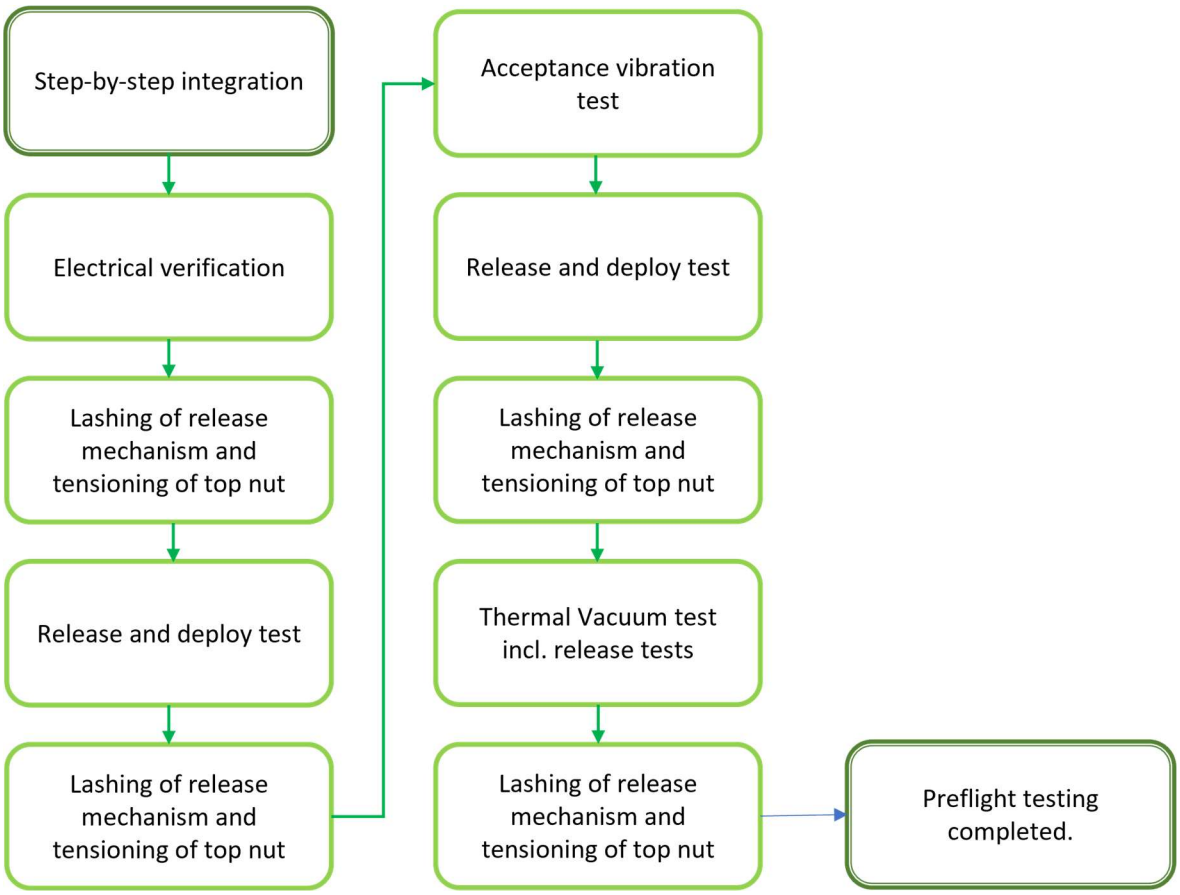


Figure 5-1 Recommended verification tests

The steps are described in more detail in the following chapters.

6 Supporting documentation

The following documentation is available to the support the integration and verification of the TSP 45W:

- NanoPower SADA-50 Datasheet (Document ID: 1027859)
- NanoPower SADA-50 Manual (Document ID:1028361)
- NanoPower TSP 45W Datasheet (Document ID: 1038993)
- NanoUtil AR6 SW Manual (Document ID:1013944)
- NanoSoft Product Interface Application (Document ID:1018560)

7 Unpacking

The TSP 45W is shipped in a pelicase 1560. In the first layer 2 cardboard boxes are found. Box 1 contains: the SADA-50, Mechanical release devices, and various mounting screws, Box 2 contains the Release controller PCBs, and the Z-close out assembly.

Figure 7-1: Unpackaging.

The second layer contains the solar array stored in a cleanroom safe foam box, and the cover plate if this has been ordered. To take out the solar array from the foam box first remove it from the ESD bag and remove the tape which secures the lid of the foam box.

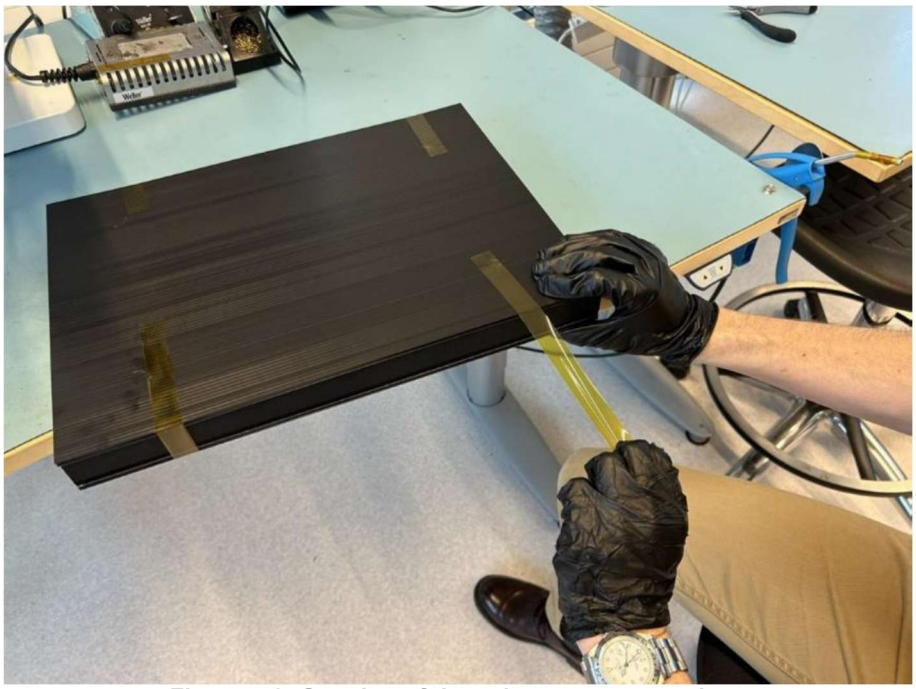


Figure 7-2: Opening of the solar array storage box.

Now take off the lid of the foam box and notice that the solar array is stored inside a pocket with a tight fit, and is prepared with lifting strings, to safely remove it from the pocket.

IMPORTANT: The solar panels are not mutually locked to prevent deployment. So, when removed from the packaging material be sure to not accidentally open/deploy the solar array.

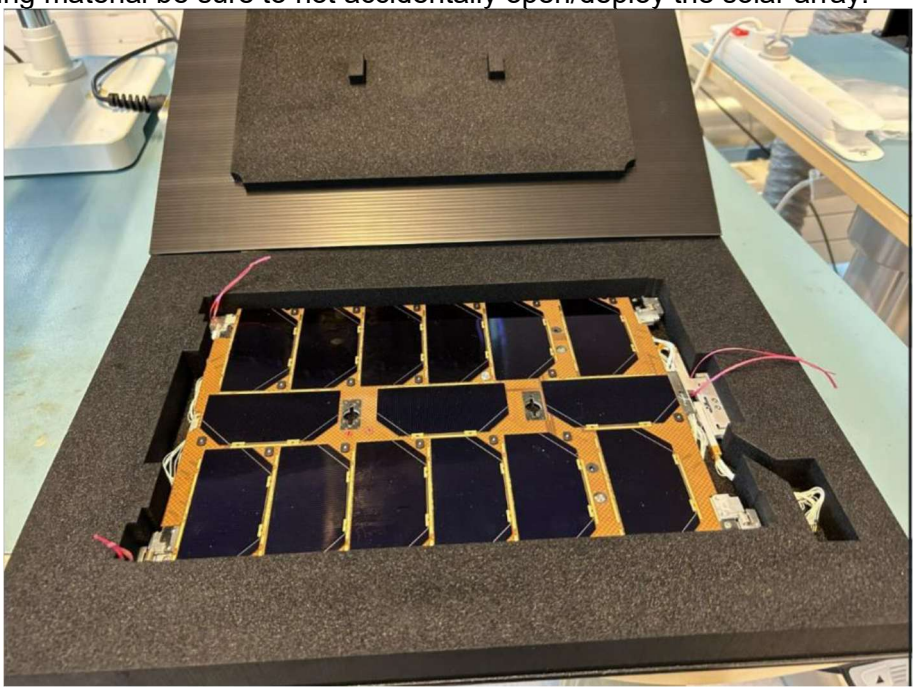


Figure 7-3: Opened solar array storage box. Lifting strings shown.

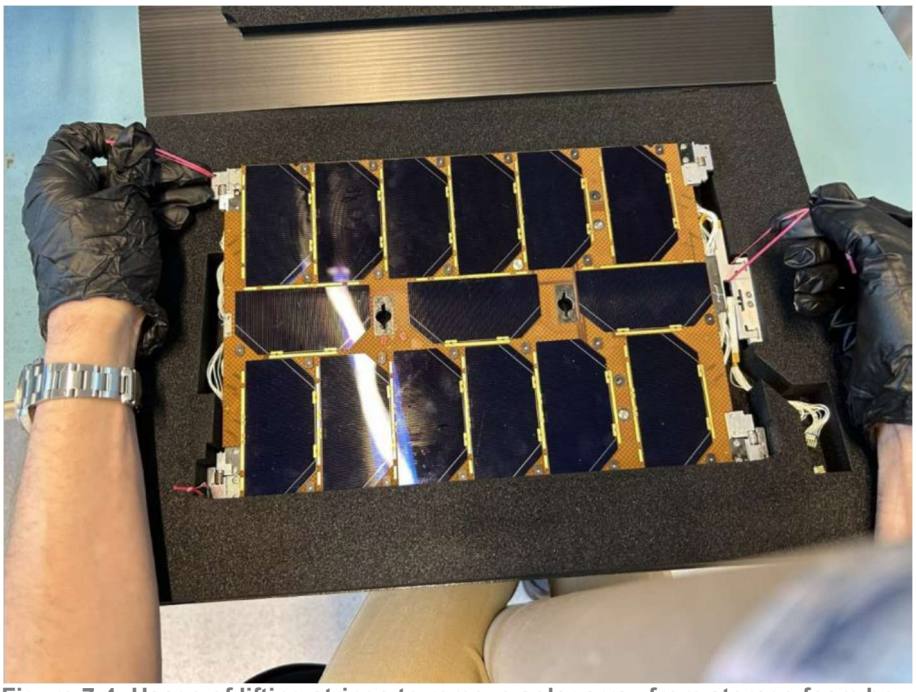


Figure 7-4: Usage of lifting strings to remove solar array from storage foam box.

The solar array can safely be stored laying on flat surface, but GomSpace recommends keeping it in the storage box for as long as possible.

The lifting strings shall be cut off when the solar array is removed from the storage box.

8 Pre-integration activities

GomSpace recommends that the SADA-50 and release controller PCBs are configured before integrated for easier access to the PCB connectors. This is done by modifying the parameter system of the unit.

8.1 Addressing, routing and configuration of NanoPower SADA-50

The NanoPower SADA-50 supports two physical communication interfaces: CAN and I2C. The details to configure the unit are contained in the NanoPower SADA-50 manual, including a list of the mission-specific parameters to configure.

GomSpace recommend setting the CAN and I2C addresses of the NanoPower SADA-50 before integrating into a spacecraft. This is the simplest approach to avoid the risk of conflicting addresses in the spacecraft internal network, which would require further troubleshooting once the spacecraft is assembled and integrated.

8.2 Addressing and configuration of release controller PCBs.

The release controller PCB is a GomSpace Sensor Bus device (GSSB), which is based on I2C as physical communication interface. The details to configure the unit is contained in the NanoSoft Product Interface Application manual (see libgssb_client).

The units are usually configured with a separate subsystem supporting the GSSB library, which acts as a proxy server for the GSSB devices connected to the I2C lines. GomSpace GSSB library provide both drivers for all its GSSB devices and a CSP service handler.
If a separate device supporting the GSSB library is not available, the NanoUtil AR6 manual contains a description of the AR6 Client API.

To configure the units using the GSSB library, these are connected to the addressing device one at a time and the address is set though the *gssb addr* and *gssb setaddr* commands.
The *gssb scanbus* command can be handy to identify the original address of the board before the configuration and to validate the result of the configuration afterwards.

8.3 Release controller boards harnessing

The release controller PCBs are interfaced to the rest of the system though a GomSpace Release Bus (GSRB), which is a typically daisy-chained bus connected directly to the device controlling the release. The bus lines include the I2C clock and data, the logic Vcc and return lines (3.3V) and the release power and return lines (5V or 32V).
If several NanoPower TSP-45 release controller boards are daisy-chained together or with other GSRB devices, the voltage drop along the bus needs to be considered to ensure the release can occur without risks. If necessary, the release voltage can be brought directly to each unit instead of daisy chained. In this case, extra precaution is necessary for units that are cross-strapped together to avoid the risk of shorting lines at different voltage levels (e.g. if the release voltage coming from different regulators is short together during the burn).

8.4 Control of release PCBs

The user is encouraged to study the options for using the release controller PCBs described in the AR6 software manual. It is generally recommended to use the option for manual deploying the solar arrays, to simultaneous deployment with eg. TMTC antennas, which could lead to collisions during the deployment motion. It is furthermore advised to always burn on both release controller boards at the same time, since both need to release for the solar array to deploy.

Under nominal conditions (supply voltage and temperature) a burn time of 5 seconds is typically sufficient. In a few cases it is necessary to send a second burn command in case the first did not result in a successful release. If the deployment is done under more extreme conditions (i.e. low temperatures and low supply voltages) a burn time of up to 20s may be necessary.

9 Integration step-by-step

This section demonstrates how the TSP 45W product is integrated. The procedure assumes integrated on a GomSpace cubesat structure.

Before the user gets started with the step-by-step procedure for integrating the product it is recommended to read section 8.

9.1 Use of thread locker

GomSpace recommends that all threads are secured using a suited thread locker, such as Loctite 243, when these are installed without screw lock helicoils.

9.2 Tightening torques

For bolt assemblies with screw lock helicoils GomSpace recommends tightening torques according to table Table 9-1, unless otherwise stated throughout the step-by-step integration procedure.

Table 9-1: Tightening torques for assemblies with screw lock helicoils.

Standard Bolt Assembly with Screw lock Helicoils			
Thread	**First-time on nom. (min/max) [Nm]**	**First-time off nom. (min/max) [Nm]**	**Fifth-time off nom. (min/max) [Nm]**
M2	0.51 (0.44/0.57)	0.38 (0.31/0.44)	0.37 (0.30/0.43)
M2.5	0.97 (0.83/1.11)	0.75 (0.61/0.89)	0.72 (0.58/0.86)
M3	1.69 (1.41/1.90)	1.34 (1.10/1.59)	1.30 (1.06/1.55)
M4	3.68 (3.12/4.24)	2.96 (2.40/3.52)	2.90 (2.34/3.46)
M5	7.19 (6.07/8.31)	5.88 (4.76/7.00)	5.79 (4.67/6.91)
M6	12.42 (10.53/14.3)	9.87 (7.98/11.75)	9.72 (7.83/11.60)

9.3 Installation of the HDRM

The hold-down release mechanism (HDRM) is made of two subassemblies:

- A *release controller PCB* which contains a hold down bar, two burn resistors, and a spring for release detection.
- A *mechanical release device* consisting of a hold down, a sleigh, HDRM bolt, pin bracket and two actuating springs.

It is recommended that the various parts are installed as in the order presented below.

9.3.1 Installation of Release Controller PCBs

The *release controller PCB* is mounted on the inside of the structure wall as shown in the Figure 9-1. Some GomSpace structures use screwlock coil inserts in these screw holes while other structures do not. If screwlock coil inserts are not used, it is recommended securing these screws with Loctite 243. The manual for the GomSpace structure will specify if these screw holes are equipped with screw-locking coil inserts.

Recommended mounting hardware and torque per release controller PCB:

- 4 pcs M2x4mm Torx medium socket head ISO 14580 (part number: 102283)
- 4 pcs M2x0.1 washer (part number: 108103)
- Torque: 0.3Nm both in case of screwlocking coil inserts and without.

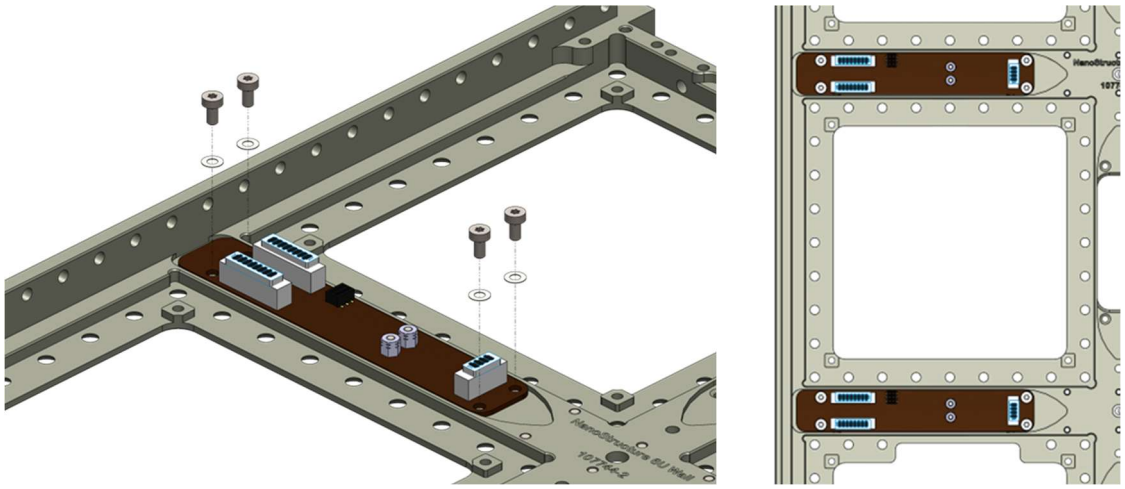


Figure 9-1: Mounting of a Release controller PCB on a GomSpace 6U structure.

Remark that the release boards shall be electrically connected before internal integration is completed. To make use of the optional cross burn functionality, J103 on one Release Control board must be connected with J103 on the other Release Control board on the same face.

9.3.2 Installation of Mechanical Release Device

The Mechanical Release Device is installed as shown in Figure 9-2.

Mounting hardware and torque per each:

- 4 pcs M2x4 CSK screws (part number 102401)
- 2 pcs M2x5 CSK screws (part number 102402)
- 2 pcs Release assist spring, (part number 113378)
- Torque: See Table 9-1

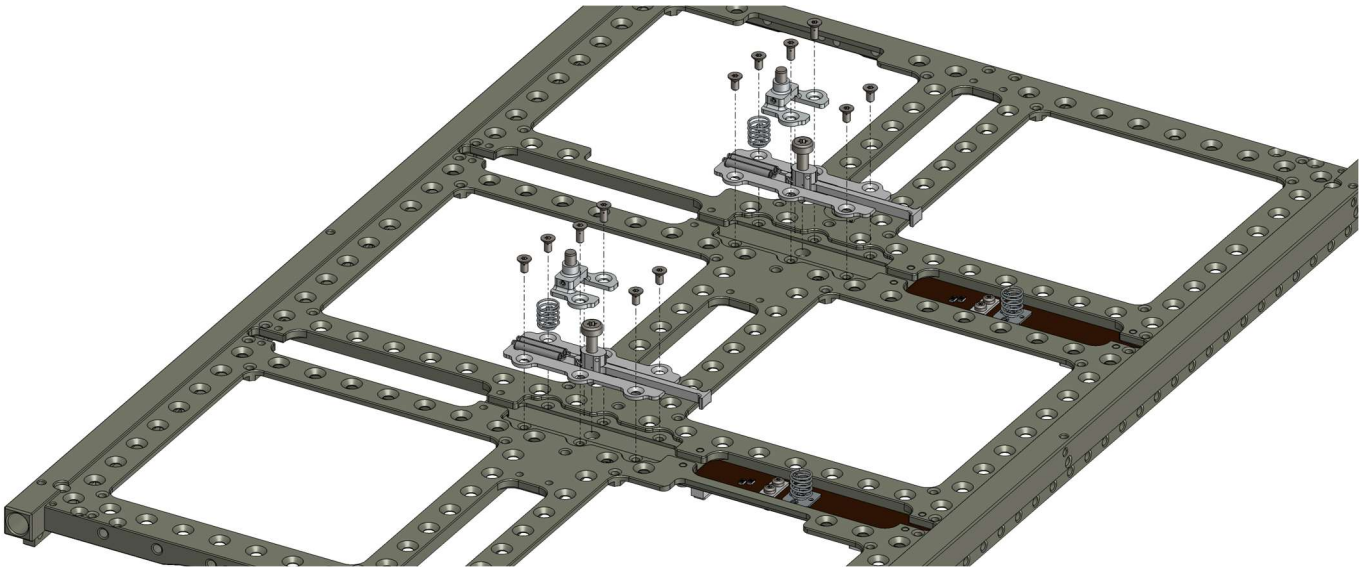


Figure 9-2: Mounting of Mechanical Release Device.

9.4 Installation of cover plate

When the structure is closed, and the external integration is started, the cover plate may be mounted as shown in Figure 9-3. Mounting hardware and torque:
pcs of

- 14 pcs M2x3 Ultra Low Head screws (part number: 101710)
- Torque: 0.18Nm

For alignment of the coverplate it is expedient to use the Ø1.5mm found at each corner of the cover plate. These should align to the Ø1.5mm holes in the 6U GomSpace structure – see Figure 9-4. Typically, visual inspection suffices, but it is also possible to align the holes using guide pins. If guide pins are used it is recommended to remove them after the alignment, to avoid the risk of loose debris.

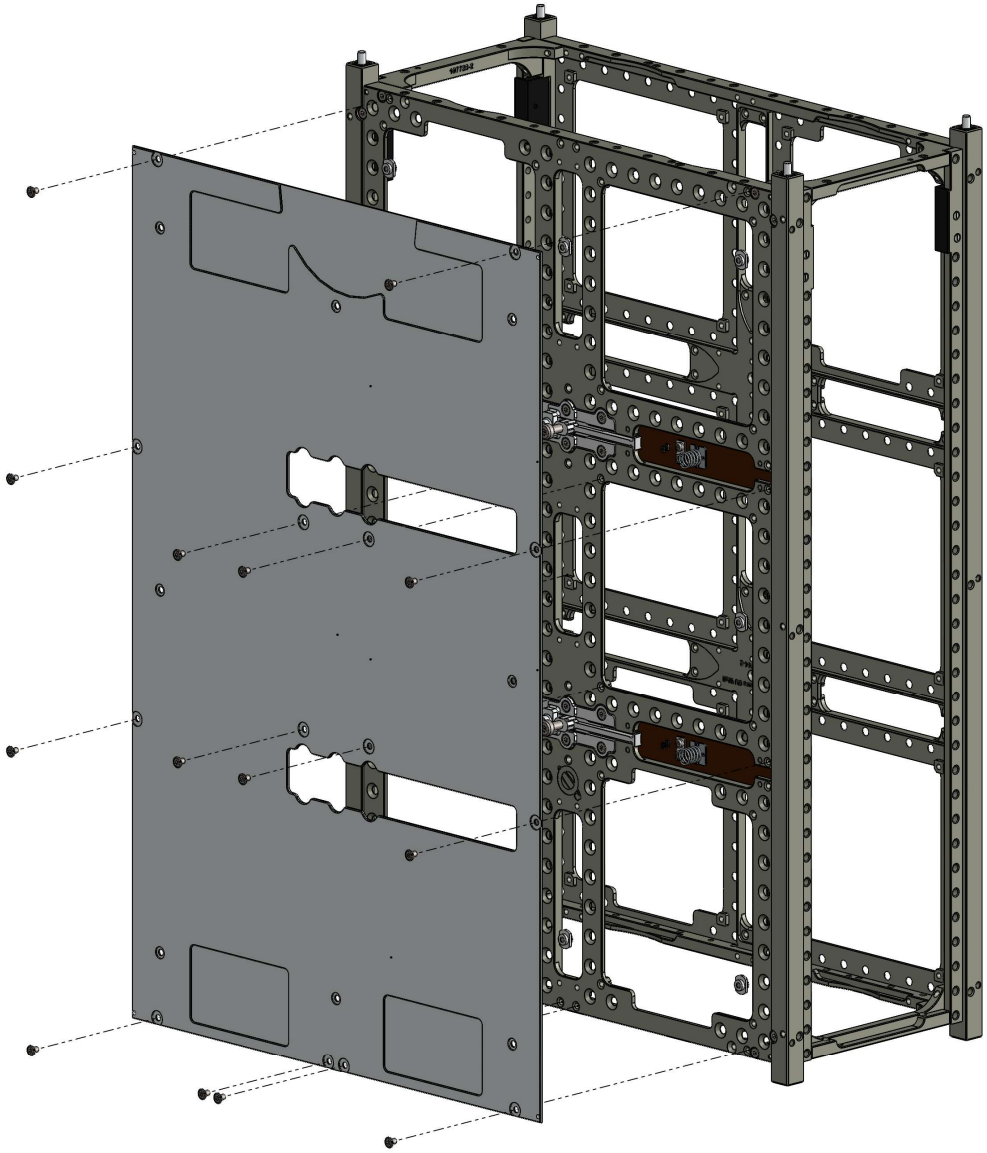


Figure 9-3: Mounting of coverplate.

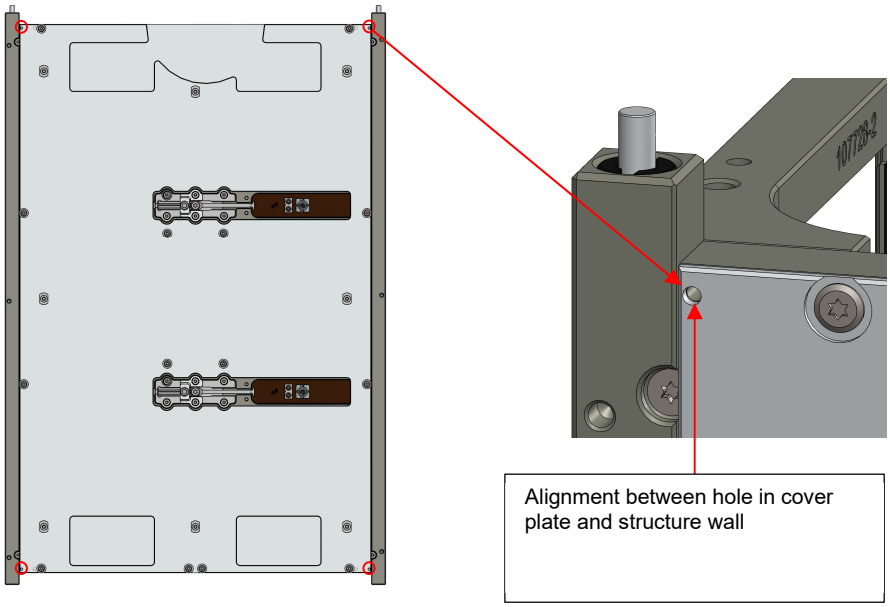


Figure 9-4: Alignment of coverplate.

9.5 Installation of SADA-50

The SADA-50 can now be installed – see Figure 9-5.

Mounting hardware:

- 3pcs M2x10 CSK screws (part number 102405)
- Torque: See Table 9-1

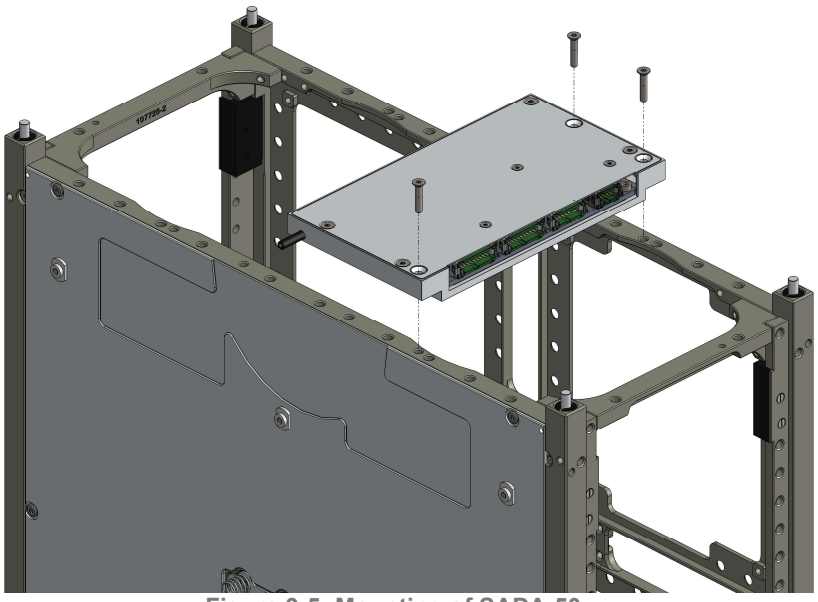


Figure 9-5: Mounting of SADA-50.

It is expedient to insert the harness to the SADA-50 before advancing to next step. The harness from the SADA includes 4 separate harnesses for each connector. J1 and J2 are identical and J2 can be used as backup. J3 is a power connector for 5V and 3.3V, J6 is for the connection of 3.3V power and GomSpace protocol. For details on the SADA-50 connector pin out, please see the SADA-50 manual.

9.6 Installation of Z cover close out

The Z cover shall now be installed. Before this is mounted, the harness from the EPS shall be connected to the 26pin connector (J110) on the bottom of the *TSP connect PCB* (the PCB built into the Z cover close out). Likewise, shall the I^2C harness between the SADA-50 and the *TSP connect PCB*. For detailed connector pin out please see the TSP-45W datasheet.

The Z cover close out is mounted as shown in Figure 9-6.

Mounting hardware:

- 6pcs M2.5x5 Socket head screws (part number 102299)
- Torque: See Table 9-1

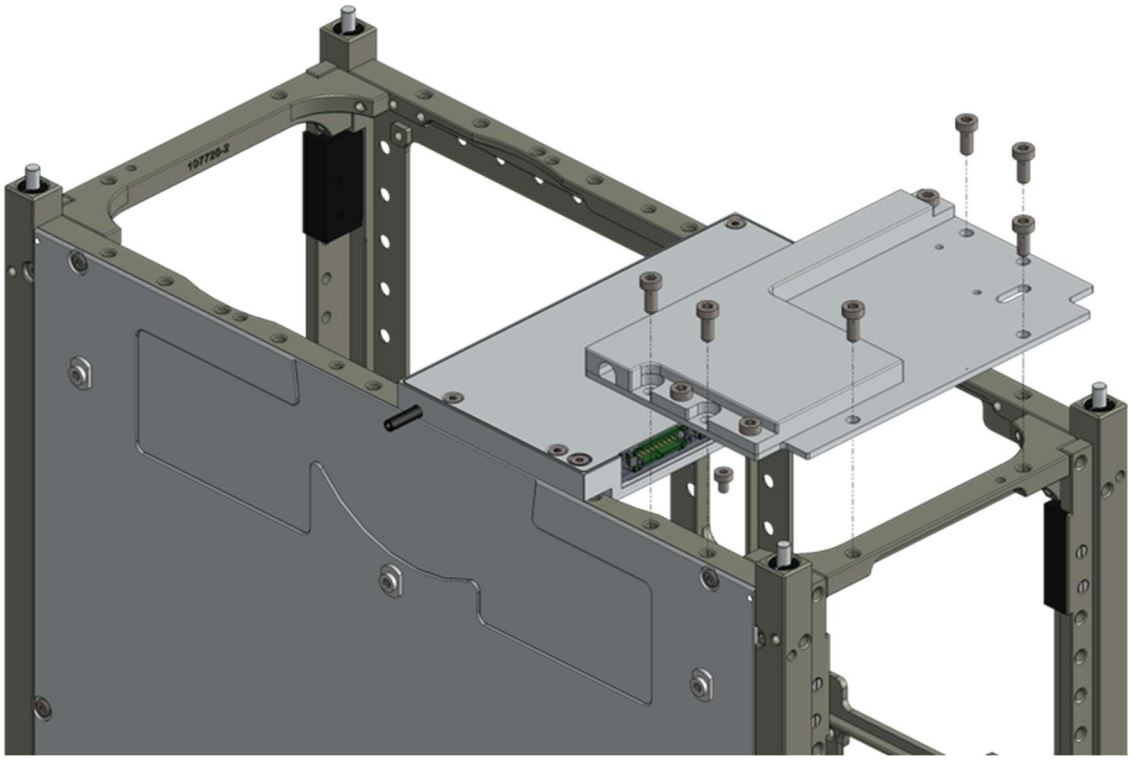


Figure 9-6: Mounting of Z cover close out.

This concludes the installation of the TSP 45W product except for the solar array itself and the harness.

9.7 HDRM-Panel part installation on Solar array

Depending on whether a left or right configuration is selected, the orientation of the HDRM-Panel part is determined accordingly to the specific configuration.

The correct orientation can be identified by the direction in which the mechanical release device operates. The table below indicates the direction with a red arrow, showing the mechanism's movement corresponding to the direction of which the latching takes place.

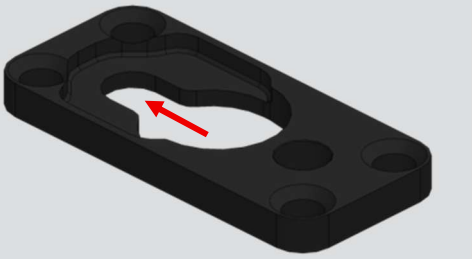
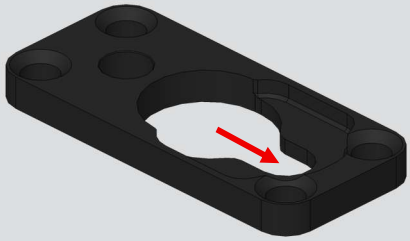
Left Configuration	Right Configuration
	

Table 9-2: Panel Mounted HDRM Oriented accordingly to specific configuration.

HDRM-Panel parts are installed as illustrated in Figure 9-7.

Mounting hardware and torque per each:

- 4pcs M2x5mm CSK screws (part number 102402)
- Torque: Do not fully tighten or apply thread locker at this stage yet

It is important not to fully tighten the screws or use thread locker at this point, as further adjustments will be necessary during the integration of the solar array.

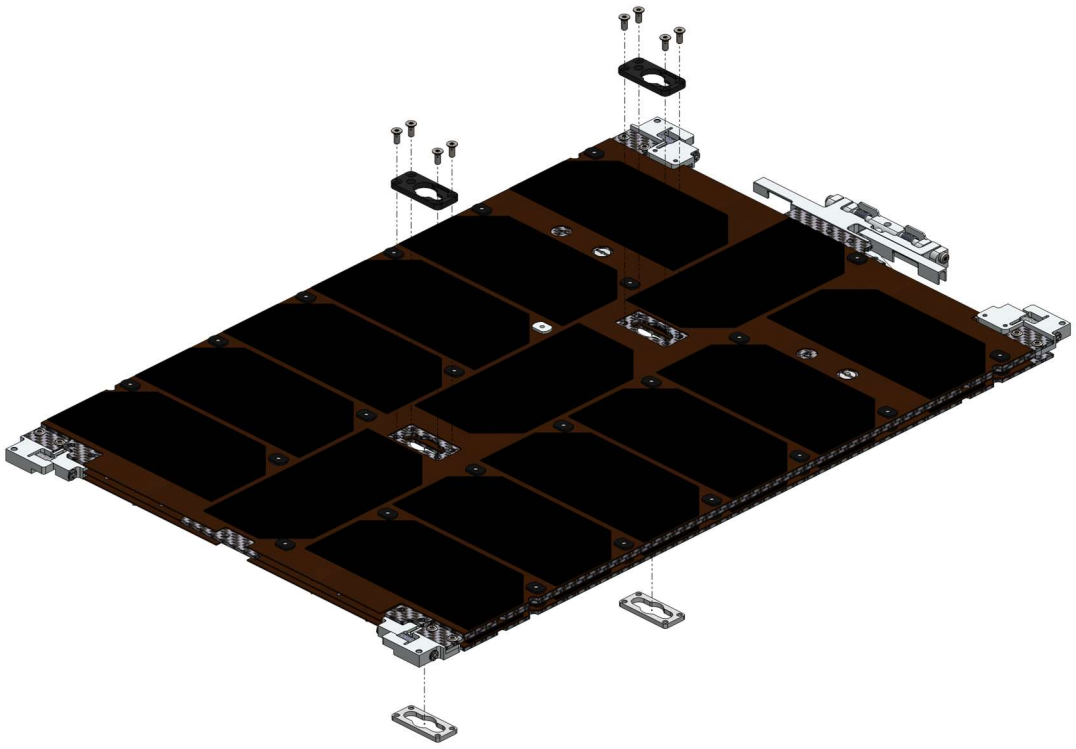


Figure 9-7: Mounting of HDRM on Solar Array.

9.8 Installation of the solar array

This section describes how to correctly mount and secure the solar array. Before the solar array is mounted it is recommended to lash the release devices, see section 9.10.1, so the solar array can be secured after the installation.

- Place the spacecraft laying down with the output shaft of the SADA-50 pointing upwards.

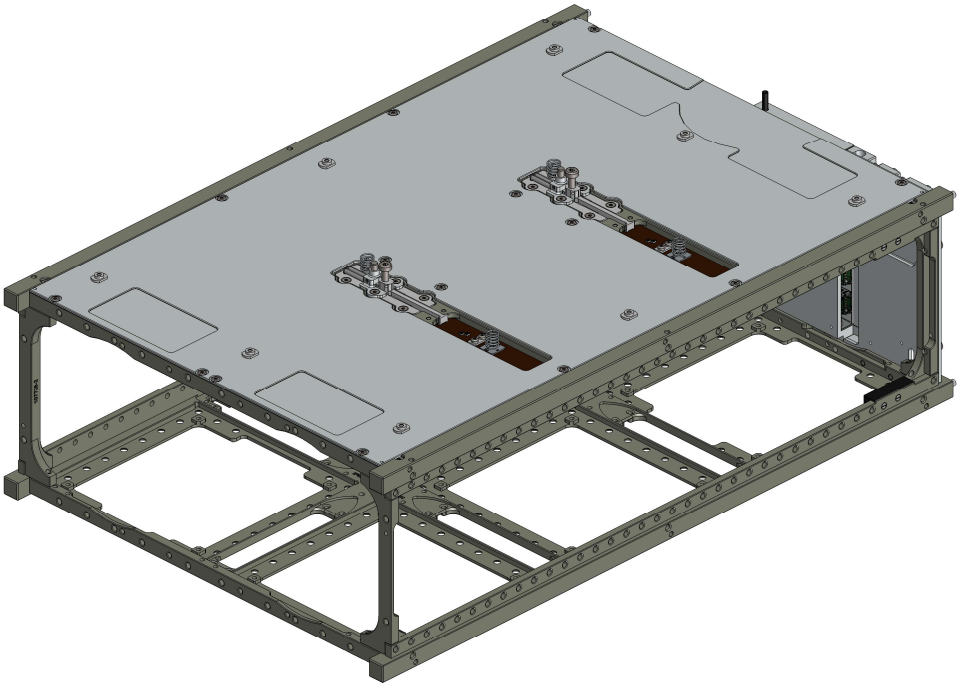


Figure 9-8: Correct Orientation for Spacecraft.

- The two screws in the primary hinge shall be loosened to ensure that the output shaft of the SADA-50 can slide into the hole in the primary hinge.

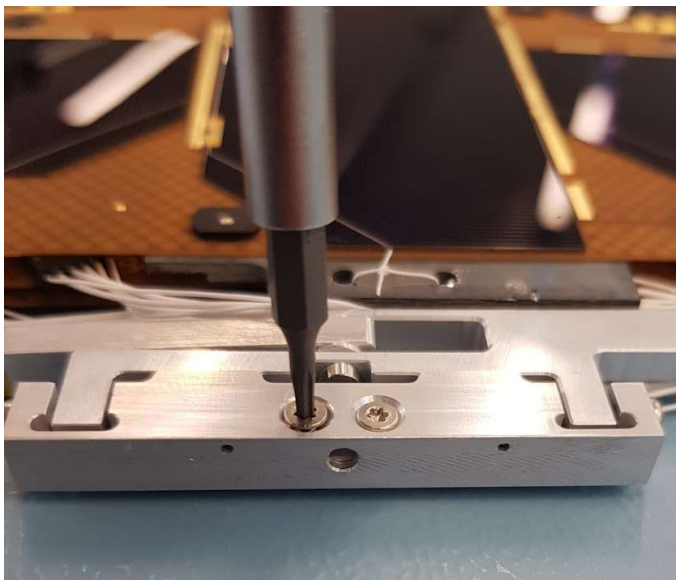


Figure 9-9: Screws in the Primary Hinge loosened.

- (Optional) Temporarily tape the Primary harness to the hinge to ensure it does not get in the way when mounting the solar array.

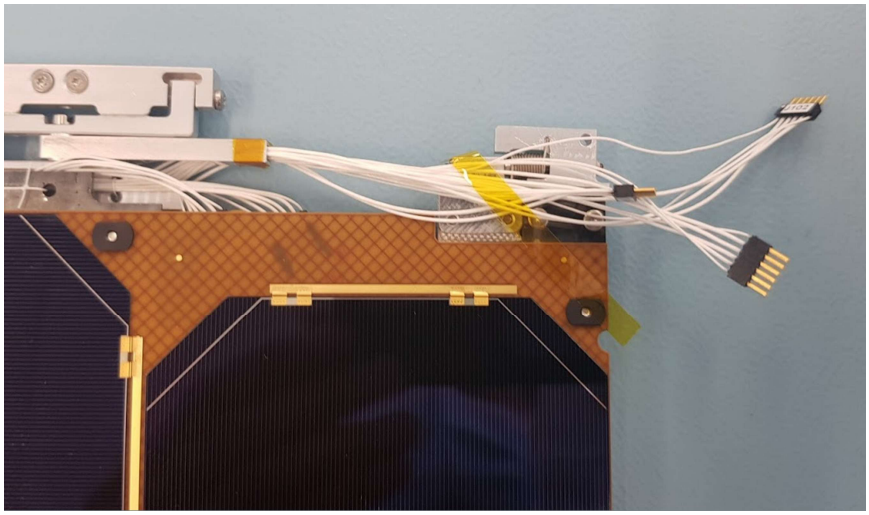


Figure 9-10: Harness Taped when solar array is mounted.

- Carefully slide the stowed solar array onto the output shaft and fold it down on the cover plate so the fixation pins on the cover plate engage with the holes in the backplate of the first panel (see section 9.10.3 for more details).

Figure 9-11: Solar Array slides onto the output shaft.

- Ensure that the tip of the output shaft is flush to the top face of the primary hinge and clamp the primary hinge to the output shaft using the 2 screws in the hinge.
    - Remember thread locker
    - Torque: 0.09Nm

Figure 9-12: Solar array Correctly mounted onto the Output shaft and clamped from the screw interface.

WARNING: At this stage the solar array is not secured and therefore the spacecraft may not be lifted or rotated. See section 9.10 for information on how to correctly arm the HDRMs, solar array stowage and pretension of top nut.

9.9 Mounting of solar array harness

This section describes how to integrate the solar array harness correctly.

- Unmount the cover part of the Z bracket to access the *TSP connect PCB*.

Figure 9-13: Z bracket cover part being dismounted.

- Insert add a piece of Kapton tape (or similar) to the harness where it will enter through the hole in the Z bracket cover part:

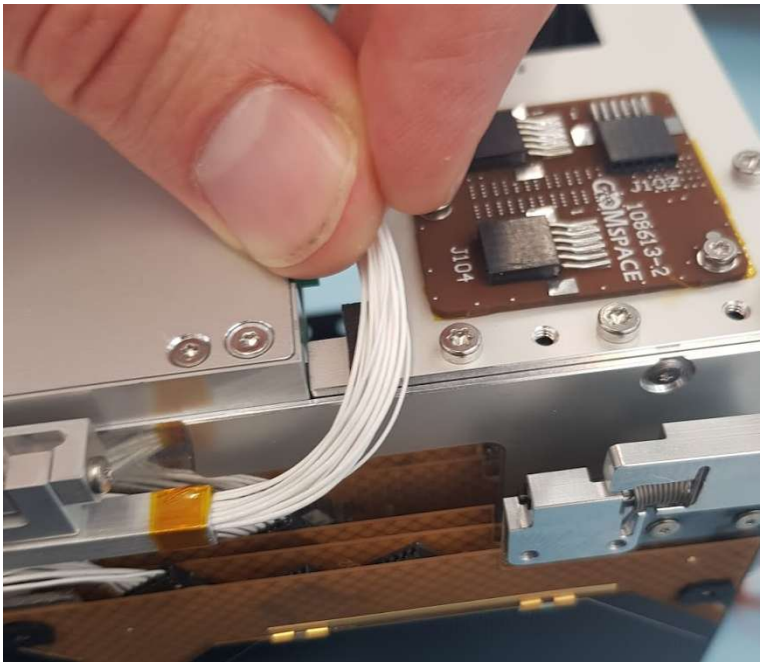


Figure 9-14: Harness Aligned properly with hole in Z bracket cover part

- Insert the connectors so the tags (J102, J104, and J106) matches the designations on the connect PCB.

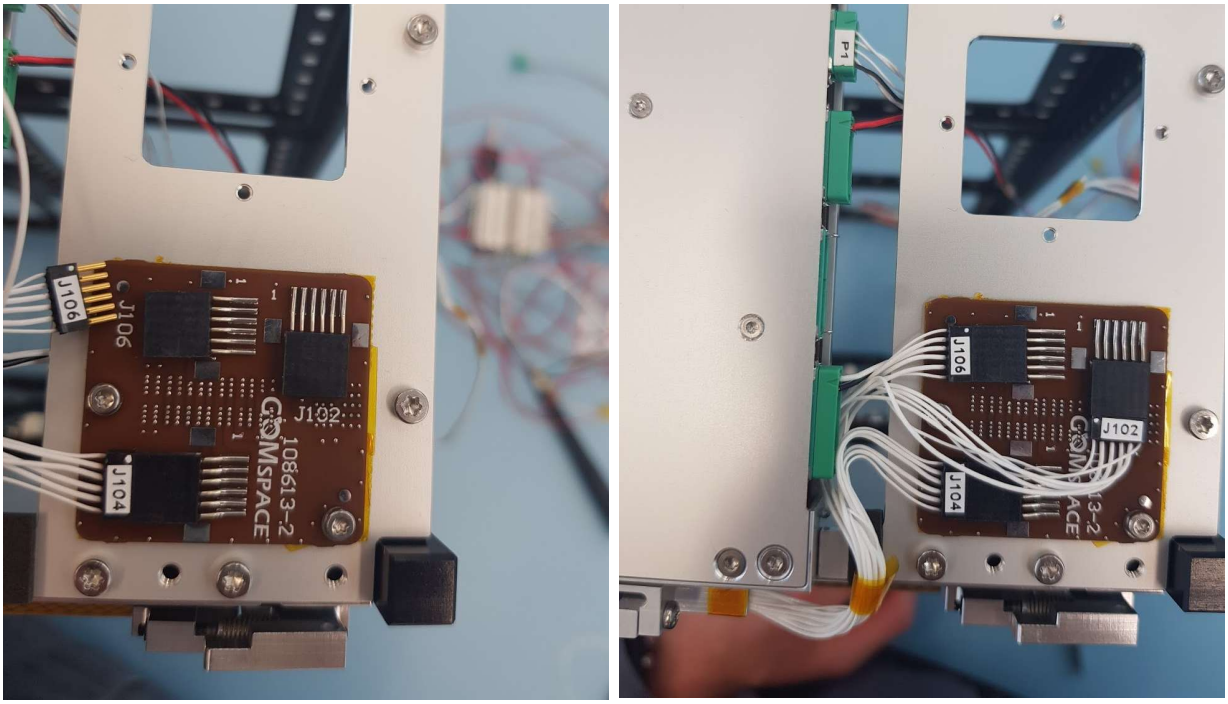


Figure 9-15: Harness connected with the designated connectors.

- Re-mount the cover part of the Z- bracket. The segment of the harness with Kapton shall lay in the channel in the cover part.
    - Remember thread locker
    - Torque: 0.3Nm

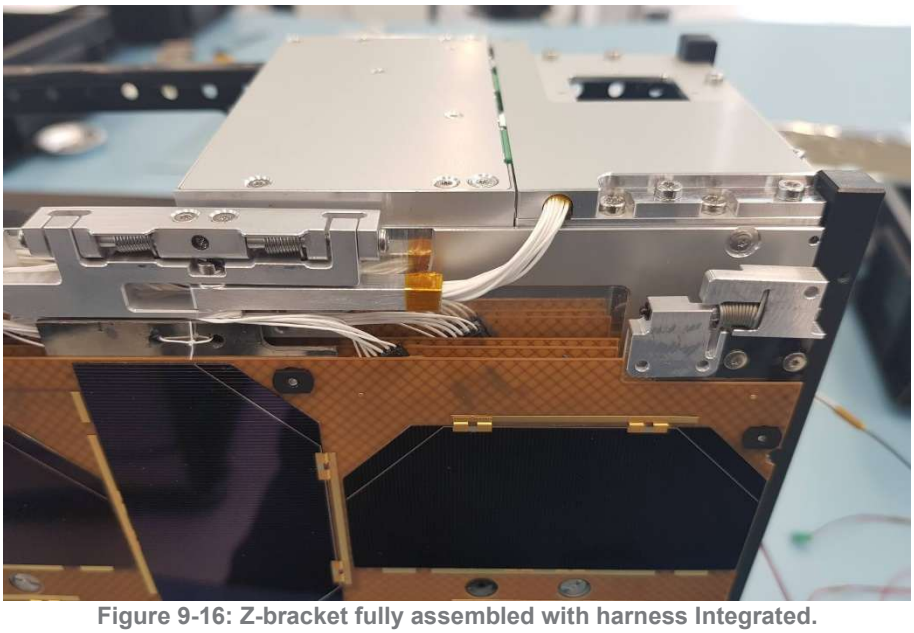


Figure 9-16: Z-bracket fully assembled with harness Integrated.

CHECK: The harness shall be well stuck in the channel below the Z-bracket. If the harness bundle can easily be pulled in and out it may be necessary to add more Kapton.

This completes the mounting of the main harness.

9.10 Prepare Release Device for testing and launch.

9.10.1 Lashing of the Release device

This section describes how to prepare the release device for launch or testing.

Hardware needed:

- Burn wire (about 25 cm) (Part number: 106262)
- Thread locker
- M4 Hex Standoff
- Tweezer with ESD safe tips
- TX5 bit

The lashing procedure is explained in the steps below, but beforehand it is expedient to repeat the part annotations also mentioned in the datasheet – see Figure 9-17.

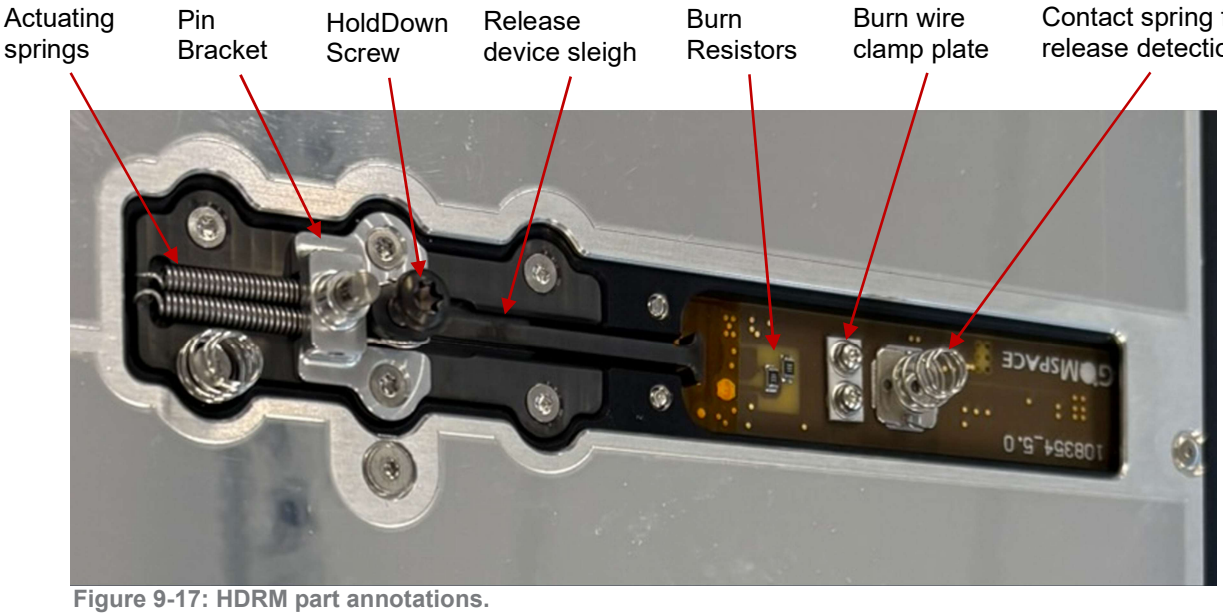


Figure 9-17: HDRM part annotations.

The HDRM are lashed correctly by the following steps:

- Slide the release device sideways to its latched position with an insertion of the M4 Standoff between the Pin bracket and the sleigh.

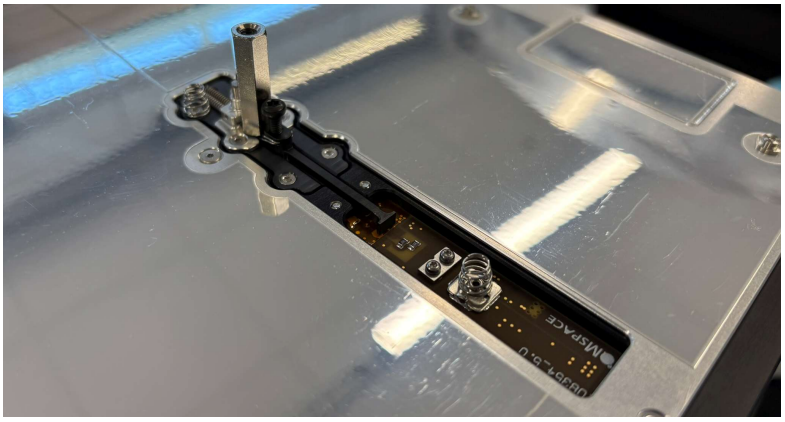


Figure 9-18: M4 Standoff Inserted to hold the HDRM device in an armed position.

- Prepare the two screws holding the clamp plate, with thread locker and insert the screws again by using the TX5 bit for a few revolutions into the threads in the PCB.

  The Burn wire is folded in the middle, creating a bonded pair of wires that are tucked underneath the clamp plate and wounded around the handle part of the sleigh as shown in the picture below. Tip: A tweezer with ESD safe polymer tips is practical to use.

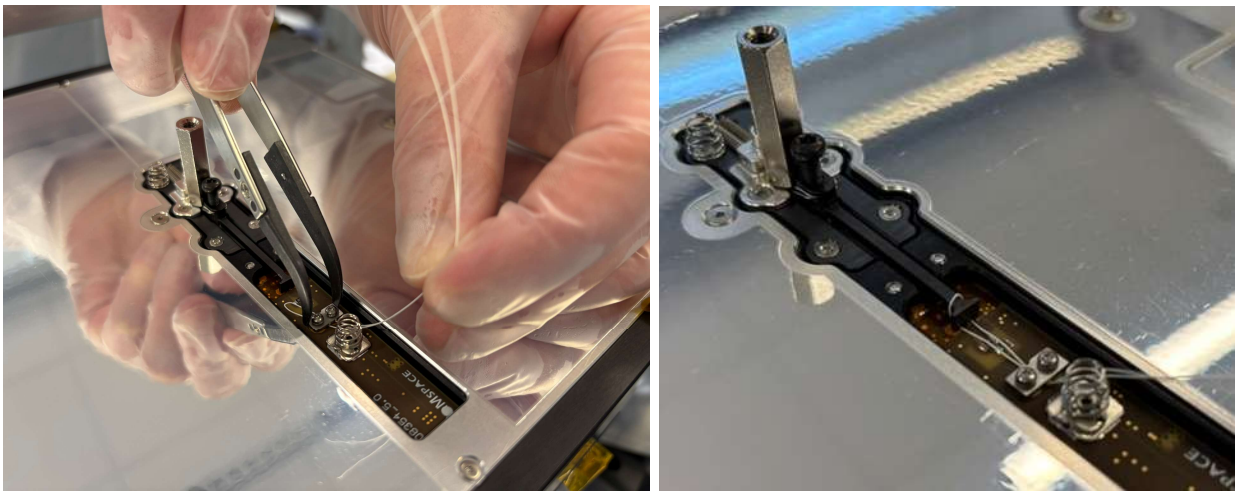


Figure 9-19: Burn Wire tucked through Clamp and HDRM PCB and mounted around Sleigh's handle.

- Tighten up the burn wire while sliding wires sideways to ensure that it is positioned correctly on the burn resistors. This means that the black part of the burn resistor shall be visible on each side of the burn wire. Tighten the two screws in clamp plate.
  - Torque: 0.16Nm

  Beware to ensure that both segments of the burn wire lie over the corresponding burn resistor. It's important that the black part of the resistor housing shall be seen on both sides of the string over the full width of the resistor.

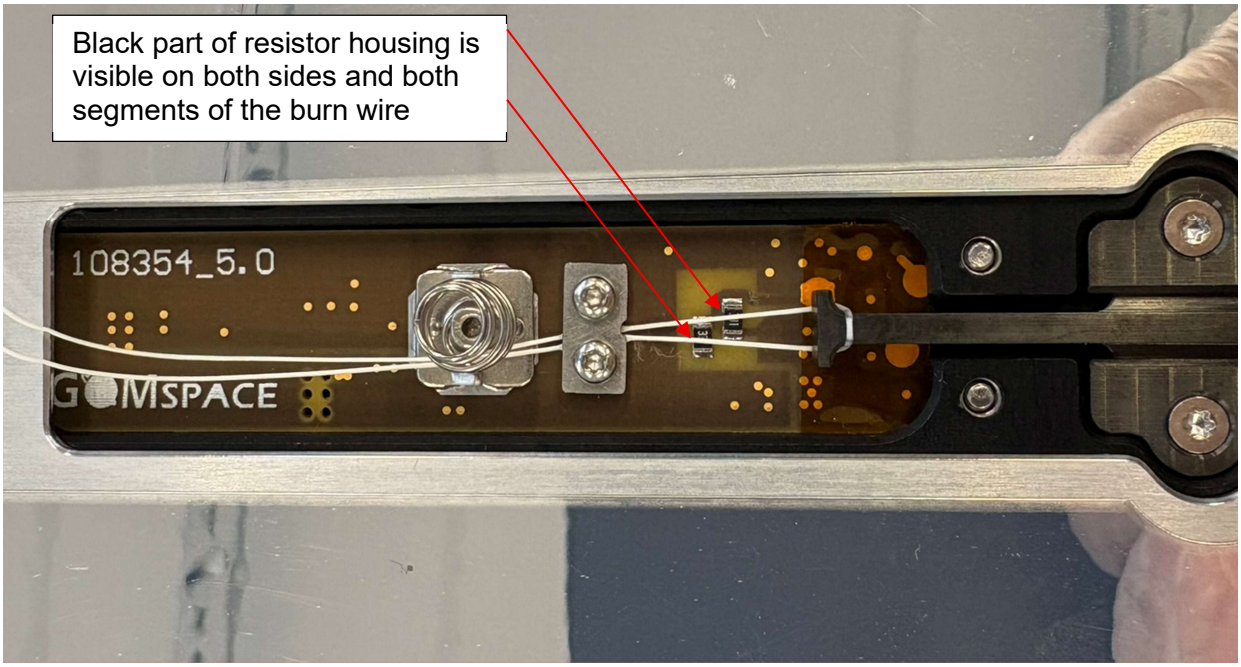


Figure 9-20: Burn Wire Tighten and adjusted to be above the resistors and Final torqued.

- Remove the Hex Standoff and cut off the excess burn wire between the clamp plate and the contact spring for release detection.

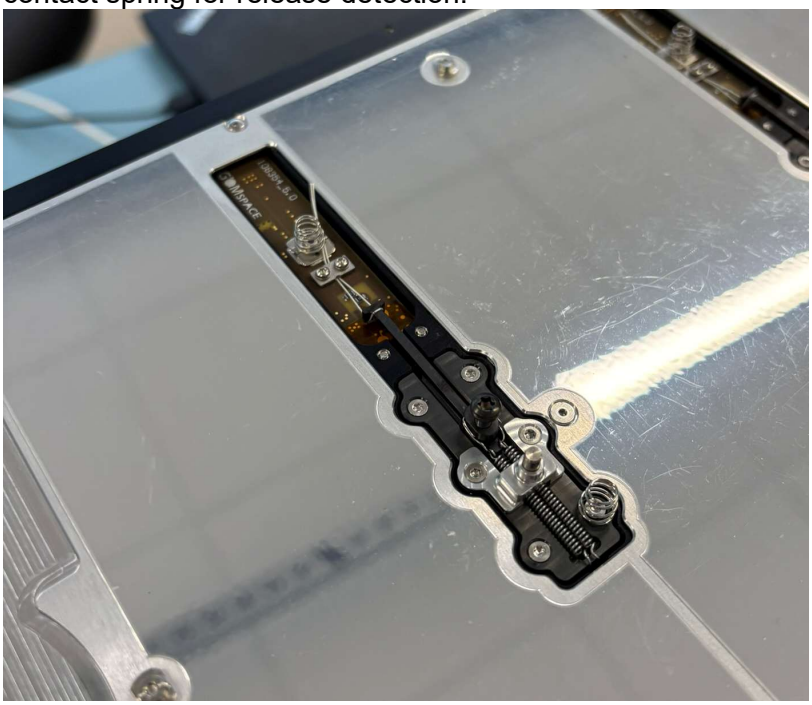


Figure 9-21: Completed lashing of the Mechanical Release Device.

This completes lashing of the Mechanical Release Device.

9.10.2 Pretension of HDRM Bolt

In this section it is demonstrated how the HDRM bolt shall be mounted.

Hardware needed:

- Thread locker
- TX10 bit
- Bolt tensioning spacer - MGSE Tool 01

Pretension of HDRM bolt is done by the following steps:

- First ensure that the HDRM Bolt is unscrewed, as this would prevent the panels from resting on the coverplate.
- Then snap the Bolt tensioning spacer - MGSE Tool 01, onto the pin bracket, as shown below:

Figure 9-22: HDRM Bolt is unscrewed and Bolt tensioning spacer - MGSE Tool 01 installed.

- Gently rest the Solar Array onto the coverplate and ensure visually that the panels engage correctly to the fixation pins in the cover plate (More details are provided in section 9.10.3).

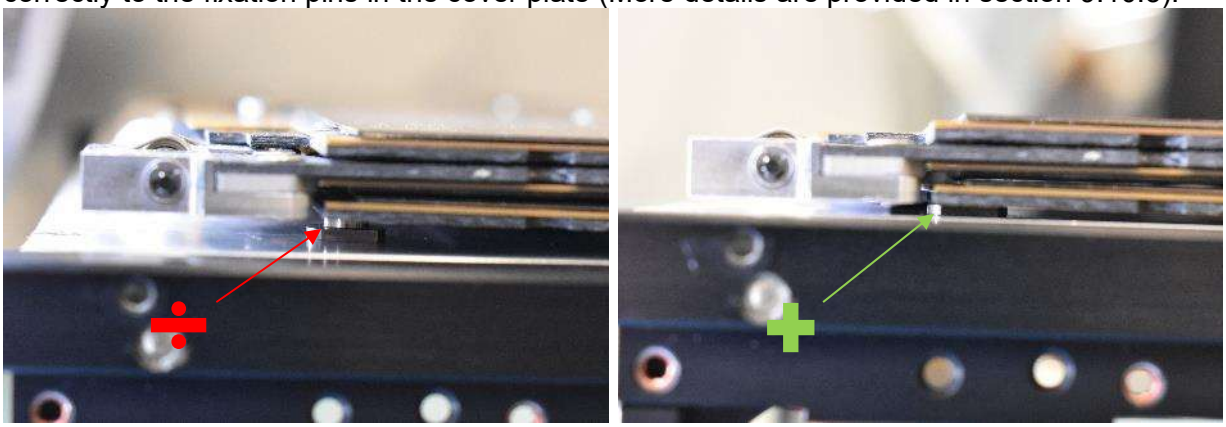


Figure 9-23: Correct alignment of Solar Array and Fixation Pins.

- Apply a small pressure on the HDRM-Panel part to check for alignment with Pin bracket. It's important not to apply any pressure on other parts besides the HDRM-panel as solar cells are very fragile and can easily be damaged.

  A sufficient alignment is achieved when an air-gab between the pin bracket and HDRM-Panel part is seen, please consider Figure 9-24.

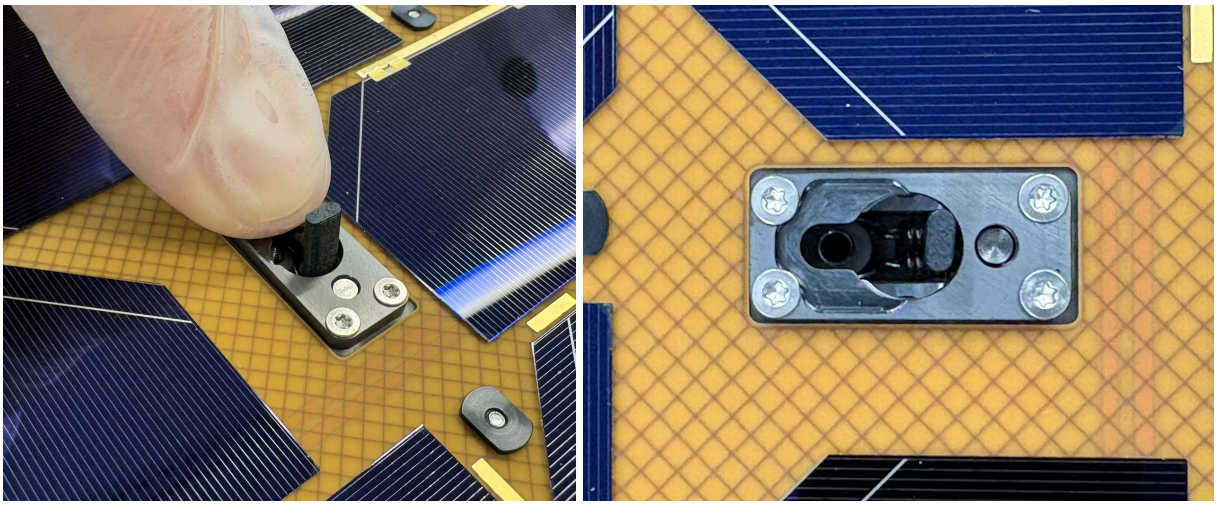


Figure 9-24: Proper Alignment between Pin Bracket and HDRM-Panel part.

- When proper alignment is achieved, apply a torque of 0.2 Nm to all four screws without any thread locker, then unscrew two screws diagonally as shown in Figure 9-25.

  This method will ensure proper alignment while thread locking can be applied, and the screws can be mounted once again to be final torqued with the levels stated in Table 9-1.
  Now untighten the opposite two screws and perform the above-mentioned.

  Now that all four screws are torqued and thread locked properly, a check whether alignment is still sufficient is recommended to perform, as final adjustment is still achievable, when working within the timeframe of curing time of the thread locking is still applicable.

  Note: This step shall be performed for both HDRM-Panel parts located on the Solar Array.

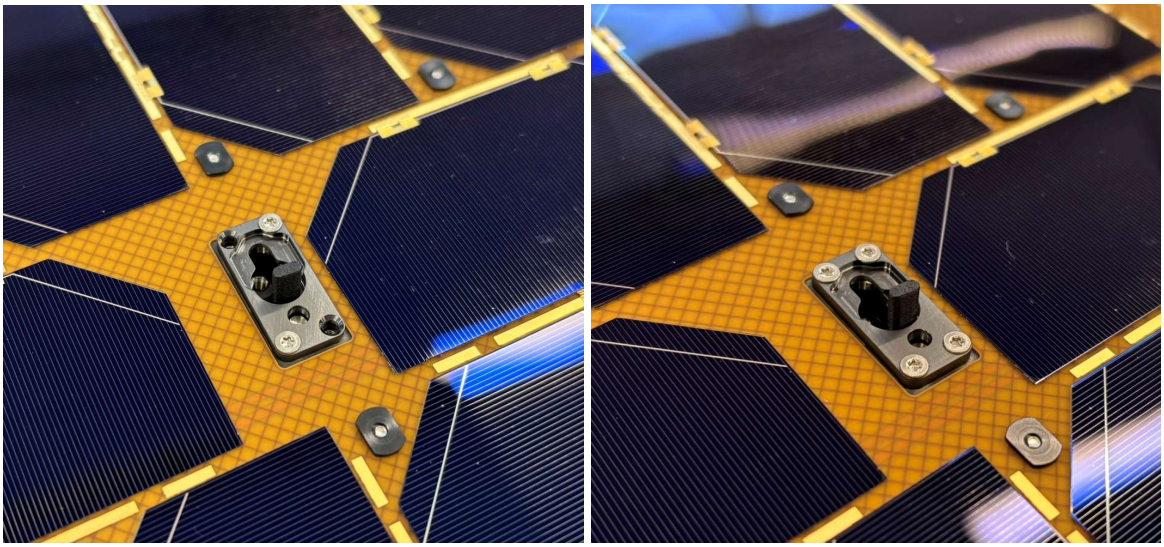


Figure 9-25: Thread locker and final torque applied to HDRM-Panel part.

- Apply thread locker to the HDRM Bolt and Insert the hold down screw.

  Now push on Panel Bracket with a finger until it touches the Bolt tensioning spacer underneath and turn the screw until it is flush with the panel bracket. This can be tested by releasing the finger and pushing down again while adjusting until the play is gone.

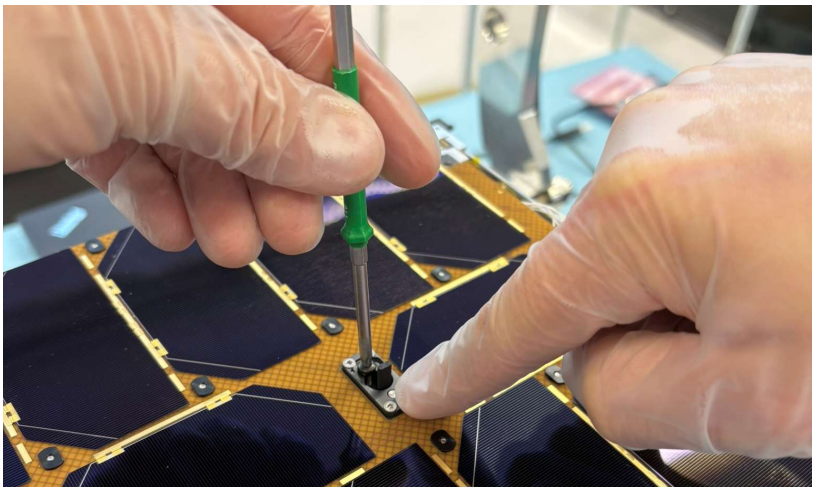


Figure 9-26:

- The Bolt tensioning spacer can now be removed, and the HDRM bolt is turned a single full revolution clockwise.

  This should leave the HDRM-Panel part flush with the pin in the Pin Bracket assembly or slightly above the surface.

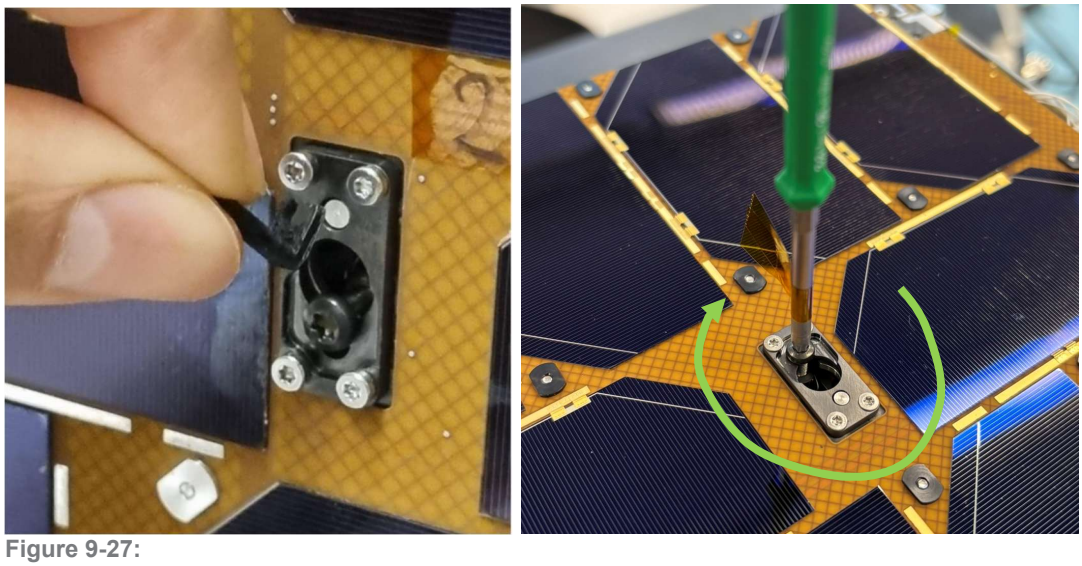


Figure 9-27:

Note: This step shall be performed for both HDRM Bolts located on the Solar Array.

GomSpace recommends to always check that the thread locker has cured before eg. vibration tests or launch. This may be done using a handheld TX10 bit and testing that the bolt cannot be turned with minimal resistance.

This completes the tightening procedure of the HDRM bolt.

9.10.3 How to ensure correct solar array stowage

While the HDRM devices fixes the solar array in terms of out-of-plane motion, the TSP-45W build in features to prevent the in-plane motion between the solar array and the spacecraft. This feature is achieved by the support pins found on the cover plate and a hole pattern on the back side of the backplate of the first panel. This is illustrated in Figure 9-28, in which the engagement between support pins and the panel backplate is encircled. At the green encirclements a gap of 0.15mm is present, and at the red encirclements have larger clearances. Thus, the support pins at the two green encirclements are the primary in plane support, and the rest are effectively only out-of-plane supports locally around the hole. Nevertheless, the engagement/disengagement at all supports shall be with no or minimal resistance. It is recommended to test the engagement in the following way: Gently push out (eg. with a tweezer or similar) the panel locally at each support and observe that the panel bends back and engages with the support pin when the panel is no longer pushed out. This is illustrated in Figure 9-29. If this pin-to-hole interface does not engage/disengage freely this way, the panel or cover plate is not aligned properly.

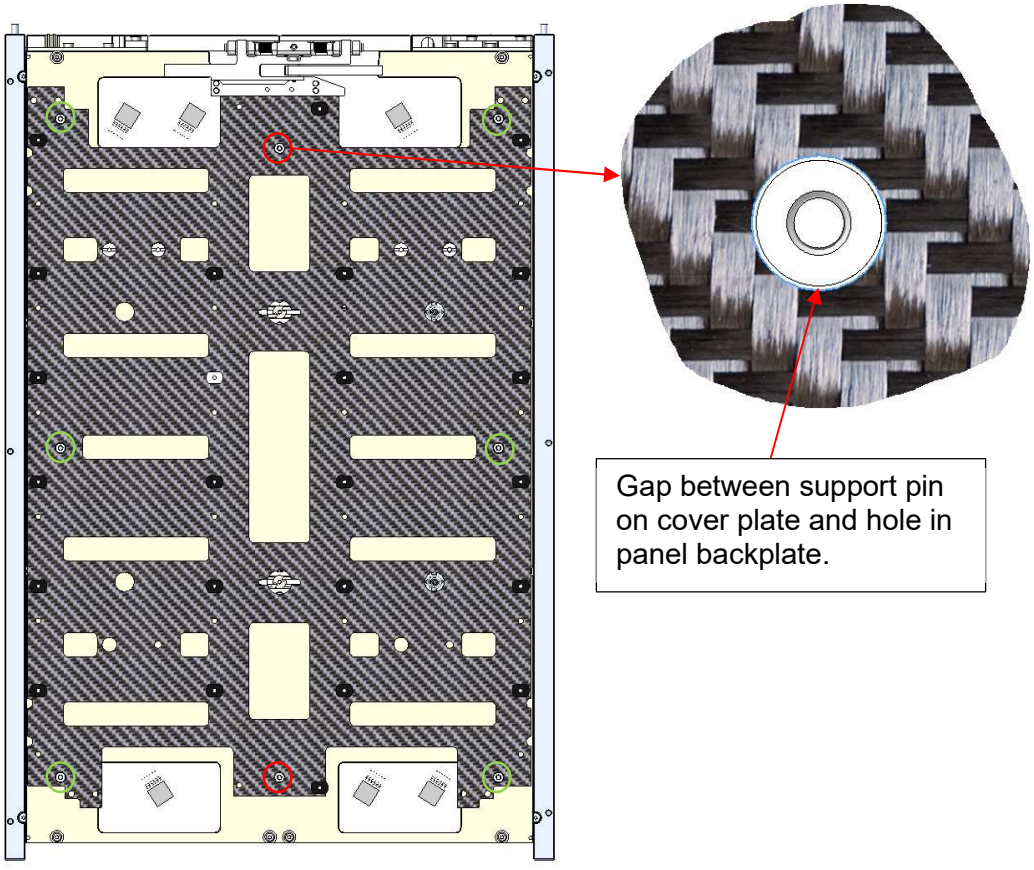


Figure 9-28: Engagement between support pin on cover plate and hole in panel backplate.

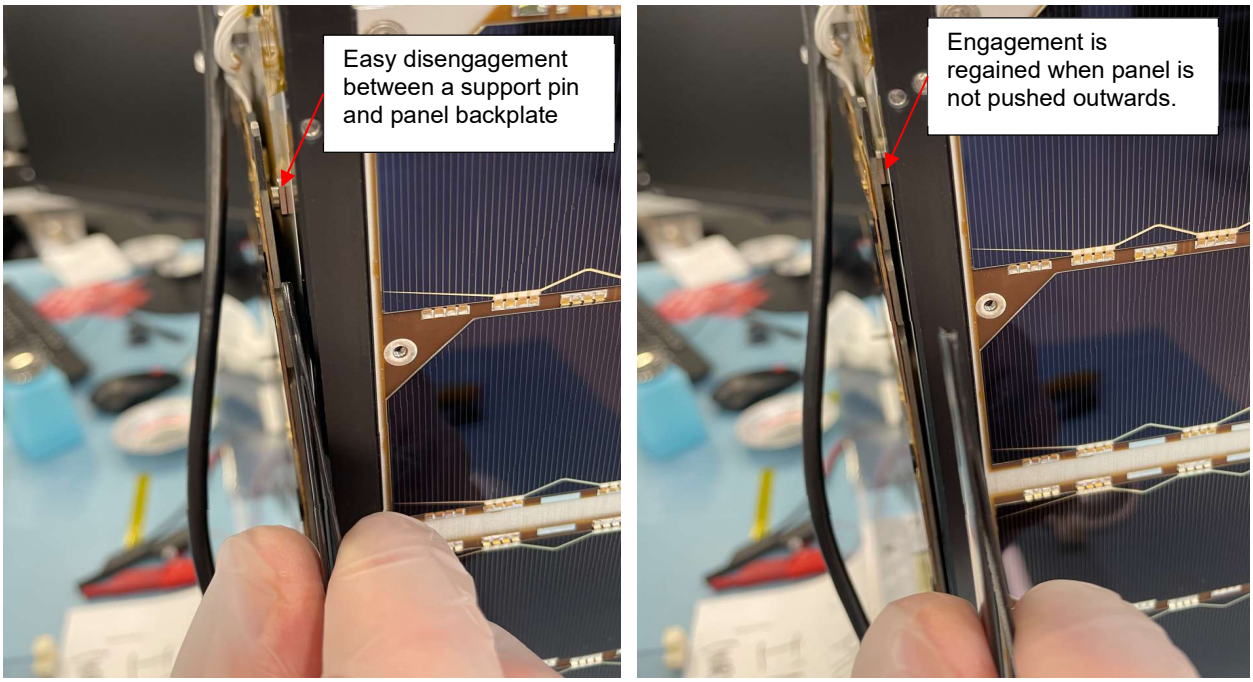


Figure 9-29: Test of correct stowage of solar array.

10 Verification tests

This section presents a short description of the GomSpace recommended test sequence for the TSP-45W when integrating them on a spacecraft. The sequence is intended to be used as a starting template to plan the overall spacecraft AIV/AIT phase and should be tailored to the specific needs of the project.

10.1 Electrical Tests

The main purpose of the electrical tests is to verify that all the panel electrical connections of the TSP-45W are connected as intended. The test should be designed to be as simple and quick as possible, in order to be repeatable throughout the satellite AIV phase. In particular, the tests should be designed as much as possible to be carried out with a fully integrated spacecraft in flight ready configuration (stowed and/or deployed).

It is recommended to include the Electrical Tests as part of the spacecraft FFT (Full Functional Tests) and RFT (Reduced Functional Tests) procedures. For the RFT, it is recommended to avoid Electrical Tests that require a fully deployed TSP-45W to simplify the RFT procedure.
As part of either the FFT or RFT, it is recommended to carry out the Electrical Tests after each major milestone of the AIV process including, as a minimum, Vibration Test, TVAC Test and LEOP rehearsal, as well as after any spacecraft rework(s) that requires the temporary removal or electrical disassembly of the TSP-45W.

As part of the Electrical Tests, the following connections should be verified:

- Power generation and delivery from each of the three panels of the TSP-45W
- Power delivery to the SADA sub-assembly
- TT&C to and from the SADA sub-assembly
- Power delivery to the release devices
- TT&C to and from the release devices
- TT&C to and from the temperature sensor on the solar array (if connected)

10.2 Release and Deploy Tests

The main purpose of the Release and Deploy Tests is to confirm that the TSP-45W is capable of transitioning from the stowed to deployed configuration once in orbit. If possible, it is recommended to use the same procedure that will be used in orbit for the Release and Deploy Tests performed on ground, including commanding routine, deploy sequence, timers and burn time.

WARNING: To perform a deployment test involving the full range of motion, an appropriate offloading device, which fully compensates for gravity, is required. **Do not** attempt to release and deploy the solar array without an off-loading device.

It is recommended to include the Electrical Tests as part of the spacecraft FFT and to repeat the test after each major milestone of the AIV process. However, the TSP-45W are qualified for a maximum of 8 on ground release and deploy events. This limitation should be considered when planning the number of Release and Deploy Tests, taking into account the possibility of repeating the test.

As part of the Release and Deploy Test, the following is validated:

- Mechanical integrity and functionality of the deploy hinge.
- Mechanical integrity and functionality of the release devices.
- Software interface between the unit commanding the deployment and the release devices.
- Deploy timers and burn times.

10.3 Sun tracking test

The main purpose of a sun tracking test is to verify the functionality of the SADA-50 and, if possible, to ensure that the main harness of the wing does not entangle with other components of the integrated space craft. A sun tracking test may be performed either before the solar array is integrated, or after the solar array is integrated. In the latter case the solar array must be deployed and supported by an appropriate off-loading device.

WARNING: Do not perform a sun tracking test while the solar array is stowed.

10.4 Acceptance Level System Vibration Test

The main purpose of the Acceptance Level System Vibration Test is to validate the mechanical integration, the structural coupling, and the mechanical simulations of the TSP-45W with the hosting spacecraft.

As part of the preparation for the Vibration Test, it is important to ensure that the TSP-45W is properly stowed according to this manual, all cables are properly connected, and all RBFs are removed.
It is also recommended to verify the clearance between the stowed solar panels and the vibration test equipment during the test. If possible, the clearance should match the clearance of the Launch Deployer selected for the mission, or in any case exceed this value.

10.5 Acceptance Level System Thermal Vacuum Test

The main purpose of the TVAC Test is to validate the thermal integration and the thermal simulations of the TSP-45W with the hosting spacecraft.

As part of the TVAC test, it is moreover recommended to validate the release timers and burn time of the system in the most extreme thermal condition (worst hot and cold cases). The system shall be able to deploy the TSP-45W in the worst cold case conditions and lowest allowed battery voltage, as well as in the worst hot case conditions and highest allowed battery voltage. The test shall be performed using the same configuration for timers and burn times. The release devices shall be carefully inspected and photographed before and after the test to ensure they were not affected during the test.

10.6 LEOP Rehearsal

The main purpose of the LEOP Rehearsal is to perform a dry-run of the Launch and Early Operation phase of the mission. The test is aimed at validating the expected sequence of events (automatically or manually triggered) after the release of the spacecraft in orbit.

10.7 Antenna radiation test

In case the space craft verification campaign involves antenna radiation tests, it shall be considered if the solar arrays shall be deployed or stowed during such a test, as this may affect the radiation pattern. In case the solar arrays must be deployed for such a test, an appropriate fixture shall be prepared to off-load the solar arrays.