The University of Sydney

School of Aerospace, Mechanical and Mechatronic Engineering

AERO4701 Space Engineering 3

LUNATICS

Assembly, Integration and Testing Plan

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1 Scope

The Assembly, Integration and Testing Plan (AIT) outlines the important considerations and processes involved in the practical design and assembly of LUNATICS-0. The Tools section includes information about the equipment required to assemble LUNATICS-0 and the Layout section provides an overview of the final design of the CubeSat. The Assembly section then explains each step necessary to put together each of the sub-systems and components such to produce the final product.

2 Tools

2.1 Assembly Tools

- Slotted head screwdriver;
- Philips head screwdriver;
- Hex driver;
- Fine tip soldering iron and stand; 60/40 solder;
- Fine bristled paintbrush;
- Kapton thermal tape;
- 5-minute Epoxy;
- Superglue;
- Electrical Tape;
- 3.5 mm Drill Bit;
- M3 tap and die;
- Electric drill;
- 0.5 mm Enamel Copper Wire.

Note: All screwdriver heads should be appropriately sized to match required fasteners.

2.2 Fasteners

Table 1: Fasteners required for overall assembly

Fastener	Quantity
M2x4mm Flat Head Socket (Countersunk) Machine Screw	4
M3x4mm Flat Head Socket (Countersunk) Machine Screw	56
M3x8mm Flat Head Socket (Countersunk) Machine Screw	24
M3x10mm Flat Head Socket (Countersunk) Machine Screw	4
M3x12mm Flat Head Socket (Countersunk) Machine Screw	4
M3x20mm Flat Head Socket (Countersunk) Machine Screw	2

Table 2: Breakdown of fasteners per sub-assembly

Sub-assembly	Fastener	Quantity
ADCS	M3x8mm Flat Head Socket (Countersunk) Machine Screw	18
	M3x20mm Flat Head Socket (Countersunk) Machine Screw	2
	M3x4mm Flat Head Socket (Countersunk) Machine Screw	8
	M3x12mm Flat Head Socket (Countersunk) Machine Screw	4
Payload	M3x10mm Flat Head Socket (Countersunk) Machine Screw	4
PCB Stack	M3x4mm Flat Head Socket (Countersunk) Machine Screw	8
	M2x4mm Flat Head Socket (Countersunk) Machine Screw	4
Top End Plate	M3x4mm Flat Head Socket (Countersunk) Machine Screw	18
Bottom End Plate	M3x4mm Flat Head Socket (Countersunk) Machine Screw	18
EPS	M3x4mm Flat Head Socket (Countersunk) Machine Screw	4
	M3x8mm Flat Head Socket (Countersunk) Machine Screw	4
Deployer	M3x8mm Flat Head Socket (Countersunk) Machine Screw	2
Total	-	94

2.3 Operational Equipment

- Computer with WIFI
- 3D Printer
- Multimeter
- Power Source
- CNC Automatic Coil Winder

3 Layout

3.1 Overall Layout

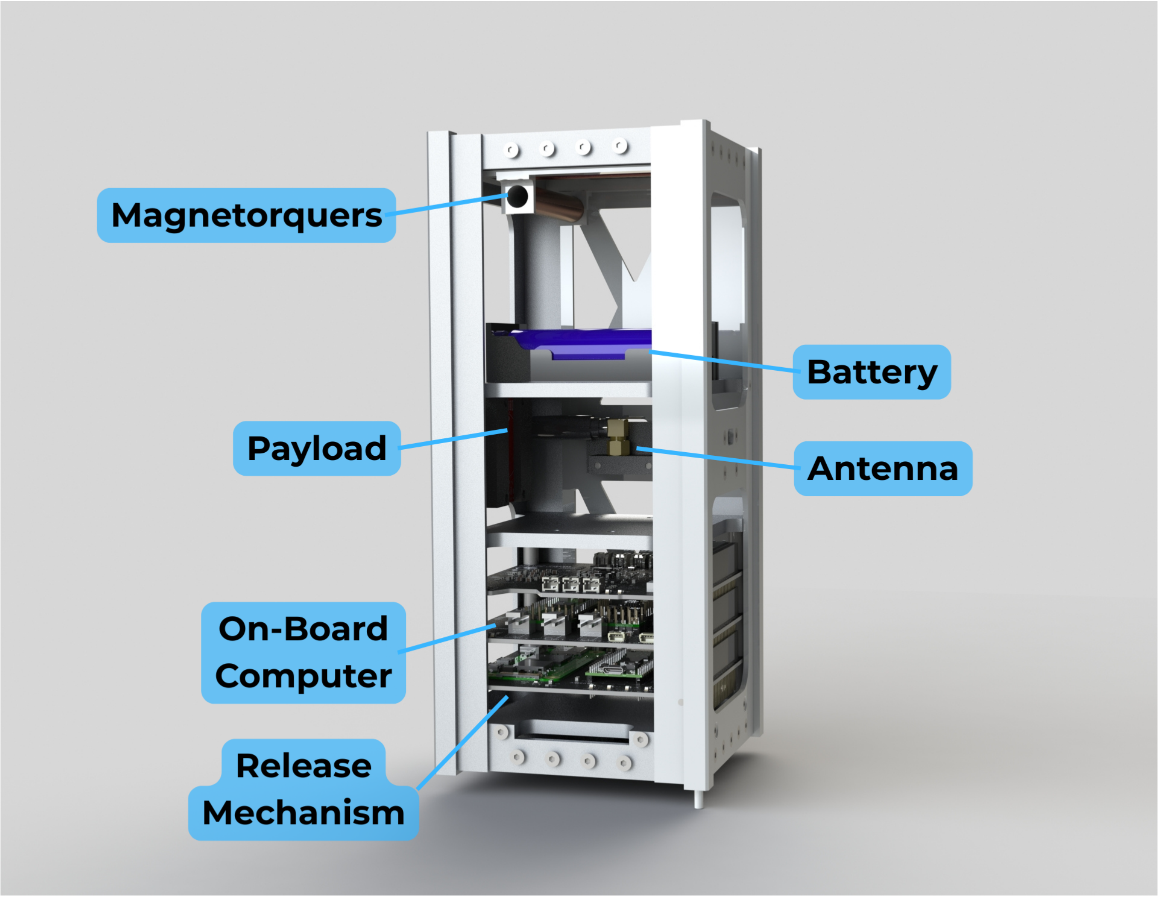


Figure 1: Overall Layout of CubeSat

3.2 Subsystem Layout

3.2.1 Bottom Plate Layout

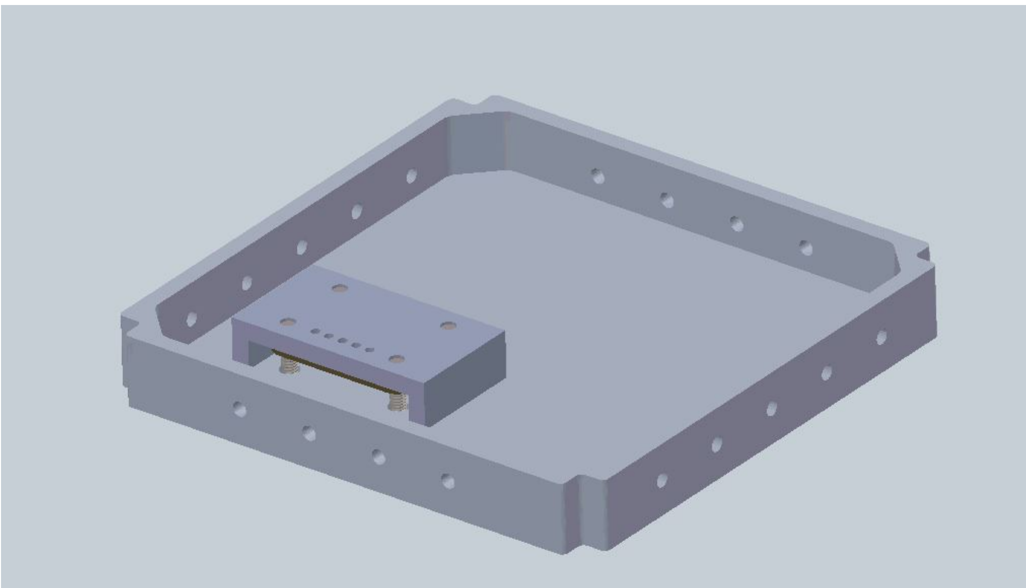
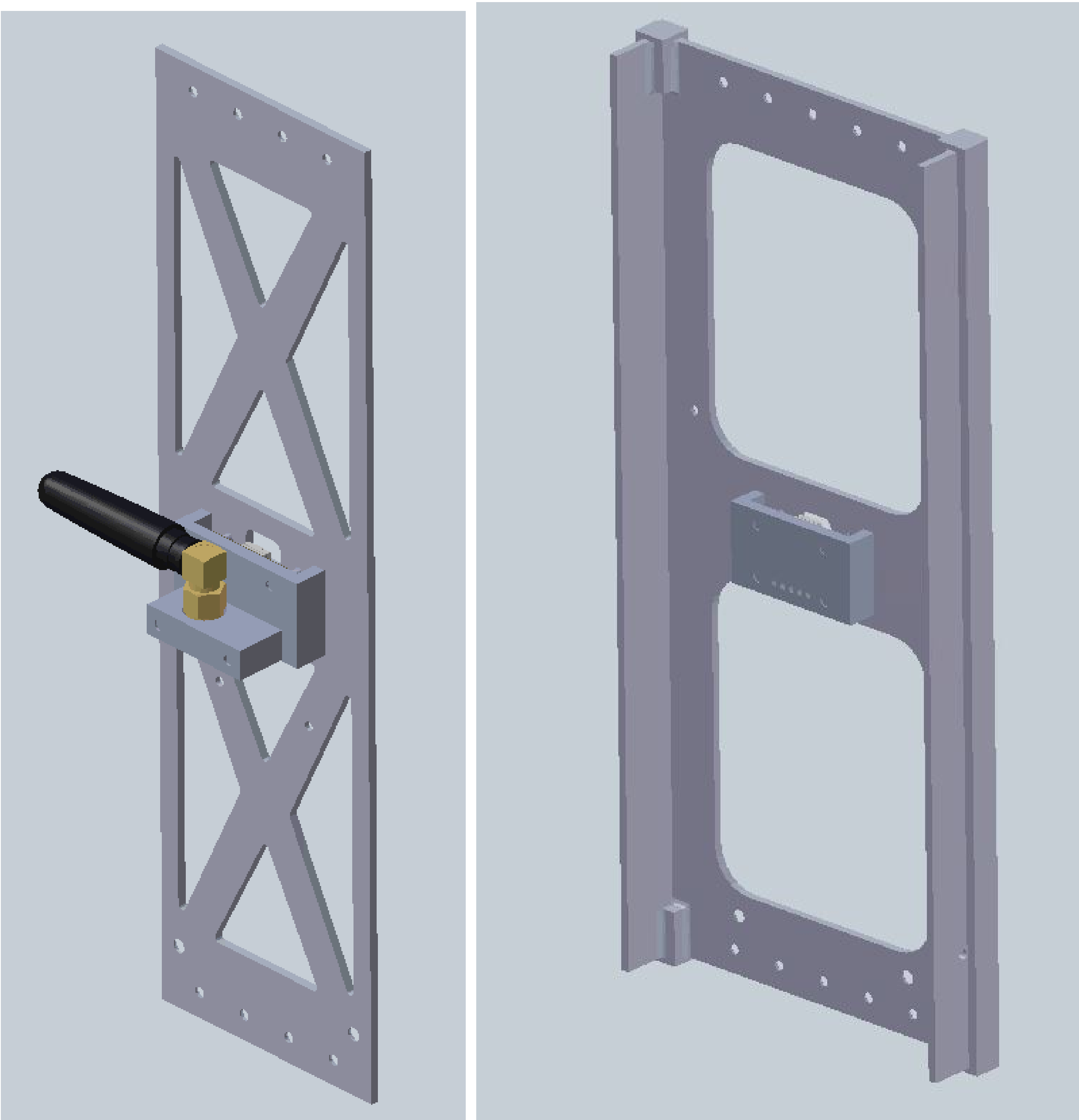


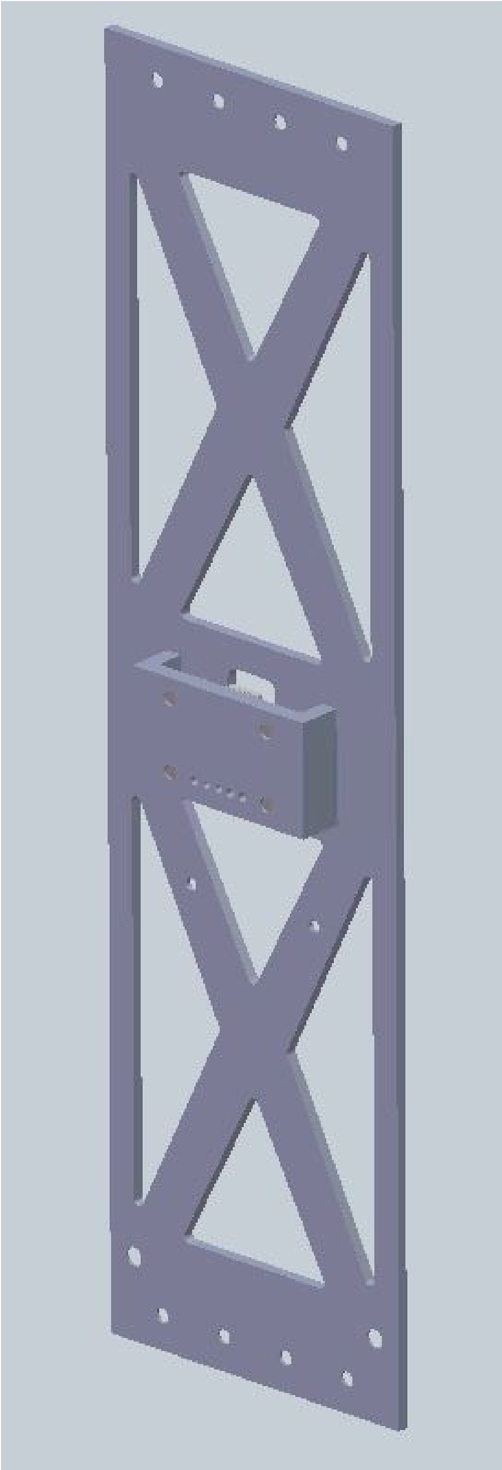
Figure 2: Bottom End Completed Subassembly

3.2.2 Side Plates Layout

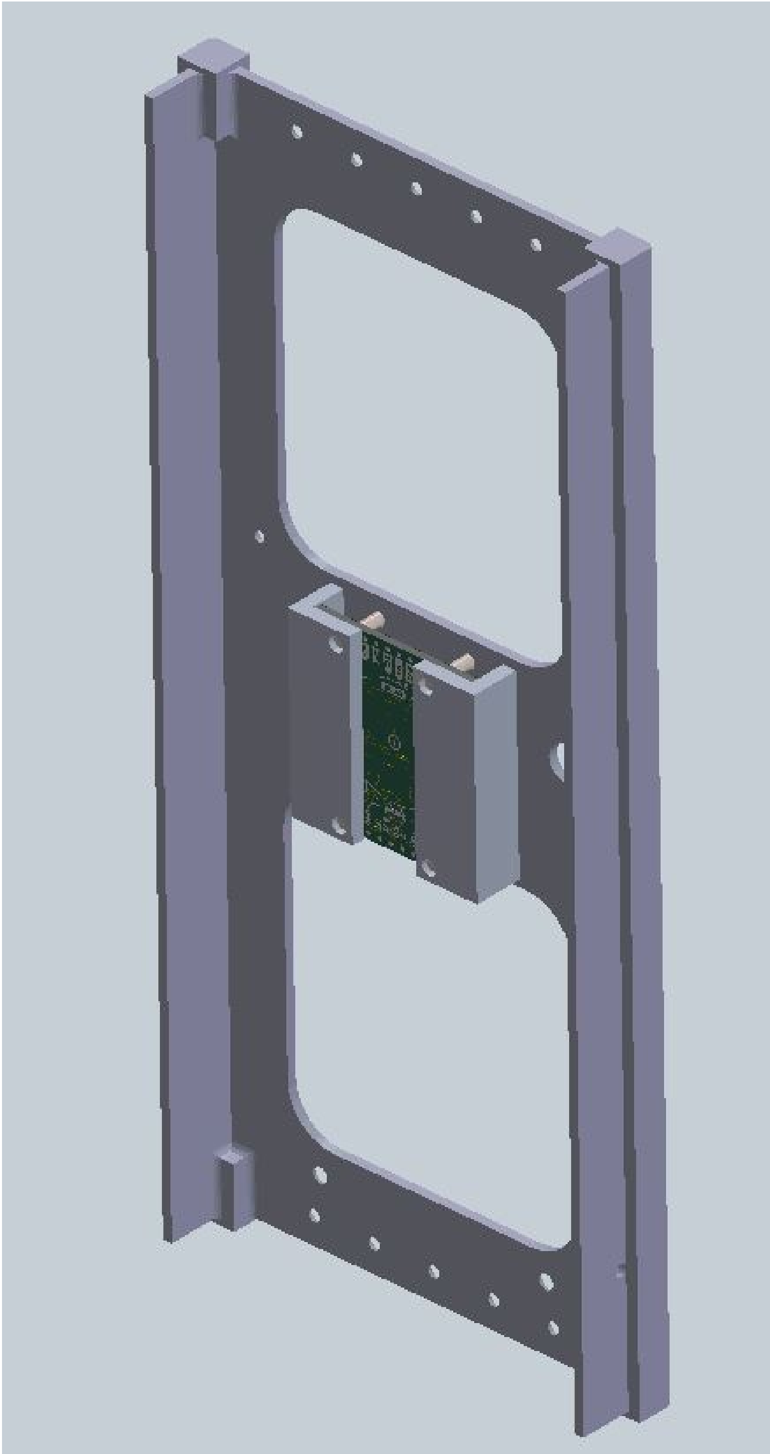


(a) Side 1 (b) Side 2

Figure 3: Side Plate Layout



(a) Side 3



(b) Side Plate Layout Continued

Figure 4: Side 4

3.2.3 PCB Stack Layout

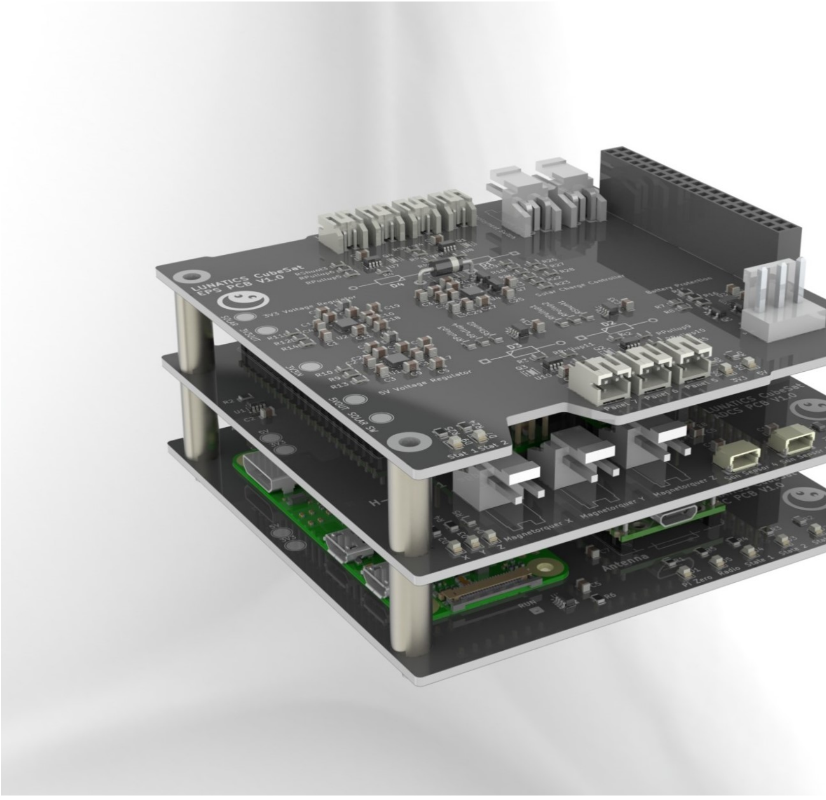


Figure 5: PCB Stack Render

3.2.4 Power System Layout

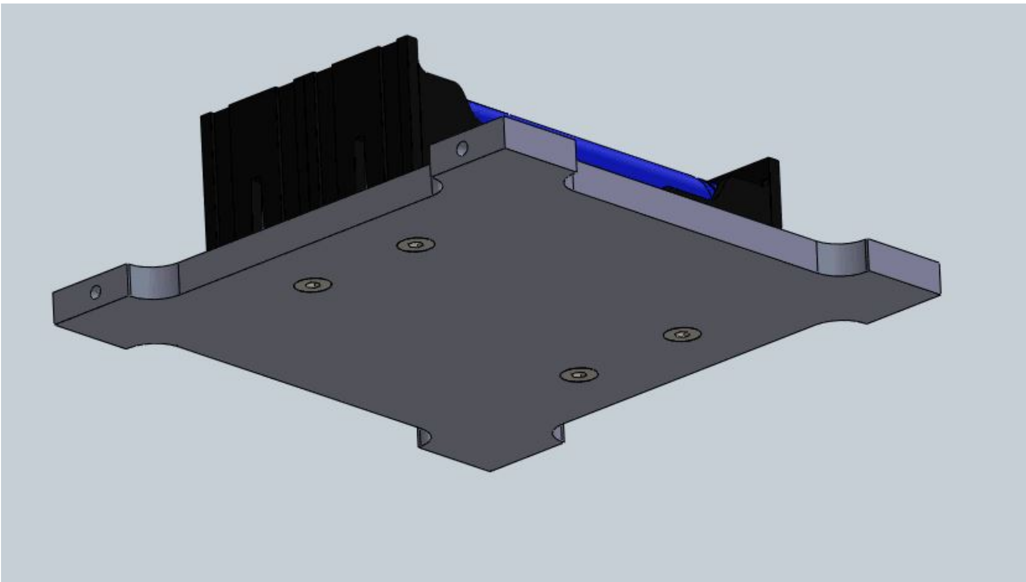


Figure 6: Power System Completed Subassembly

3.2.5 Magnetorquer Layout

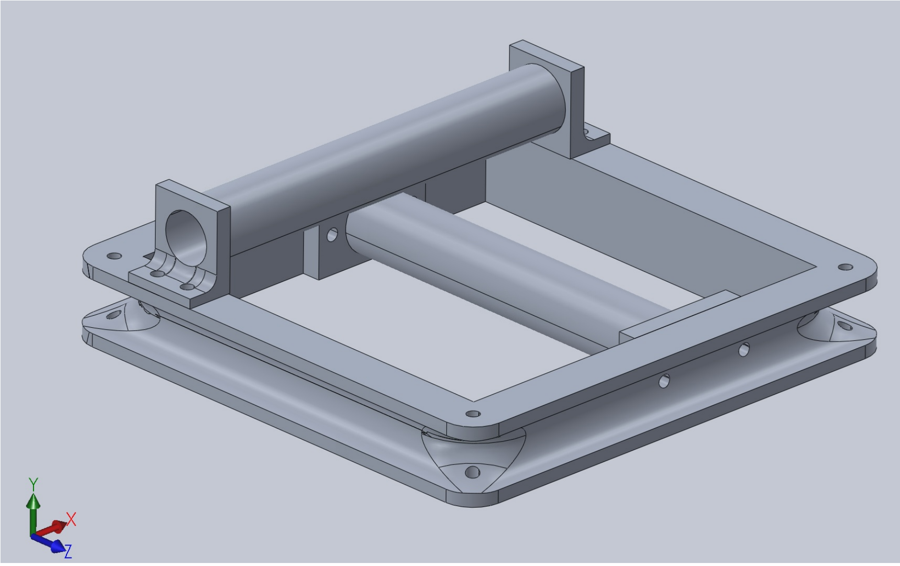


Figure 7: Magnetorquer Assembly

3.2.6 Top Plate Layout

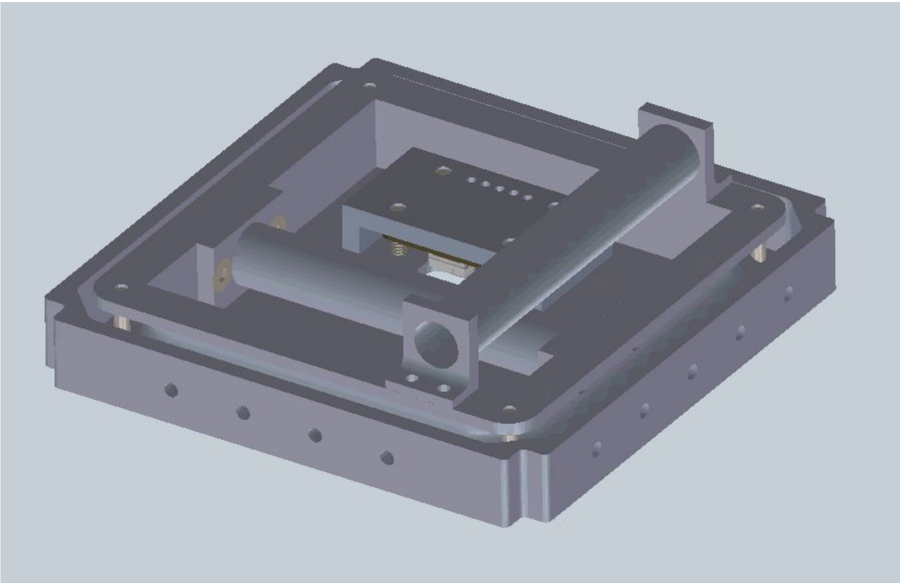


Figure 8: Top End Plate

4 Assembly

4.1 Parts

All 3D printing will be done using carbon fiber nylon as the filament. The parts that need to be 3D printed include.

- 5x Sun Sensor Mounts
- 1x Antenna Mount
- 1x Spectrometer Mount
- 1x X-Axis Magnetorquer Mount
- 1x Y-Axis Magnetorquer Mount
- 1x Rod Magnetorquer Winding Attachment
- 1x Z-Axis Magnetorquer Mount
- 1x Square Magnetorquer Winding Attachment

CNC'd Aluminium parts will be ordered using a third party provider for the following parts.

- 2x Cross Shaped Side Frame (Sides 1 and 3)
- 2x Hollow Side Frame (Sides 2 and 4)
- 1x Top End Plate
- 1x Bottom End Plate

Note that these sections are sun-facing surfaces and a uniform coverage of Titanium Dioxide White Paint will be applied as a thermal control method.

Each of these stages within the assembly process are explained in further detail in the coming section.

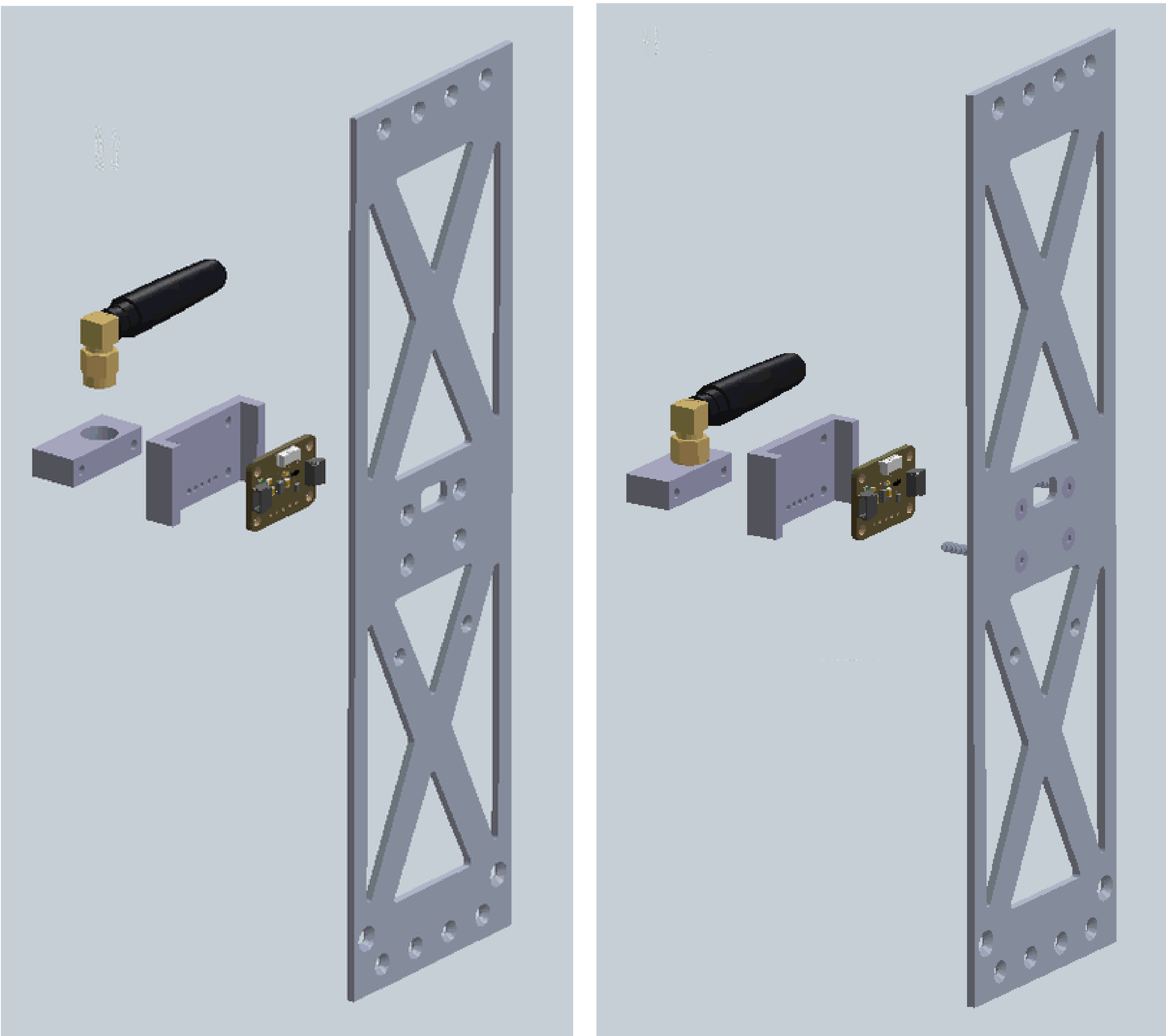
The assembly of the LUNATICS-0 CubeSat is split into the following key steps.

- Attach the appropriate components (i.e Sun Sensor, Spectrometer or Antenna) to each of the 4 side plates and bottom end plate
- Assemble three of the side plates with the bottom end assebly to produce a C-Shaped housing
- Assemble the PCB stack with the power source
- Insert this sub-assembly into the C-Shaped housing
- Assemble the magnetorquers
- Insert the magnetorquers and sun sensor into the top end assembly
- Assemble the top end assembly with the C-shaped Housing
- Attach the final side plate
- Attach the Solar Panels to the CubeSat

4.2 Side Plate Assembly

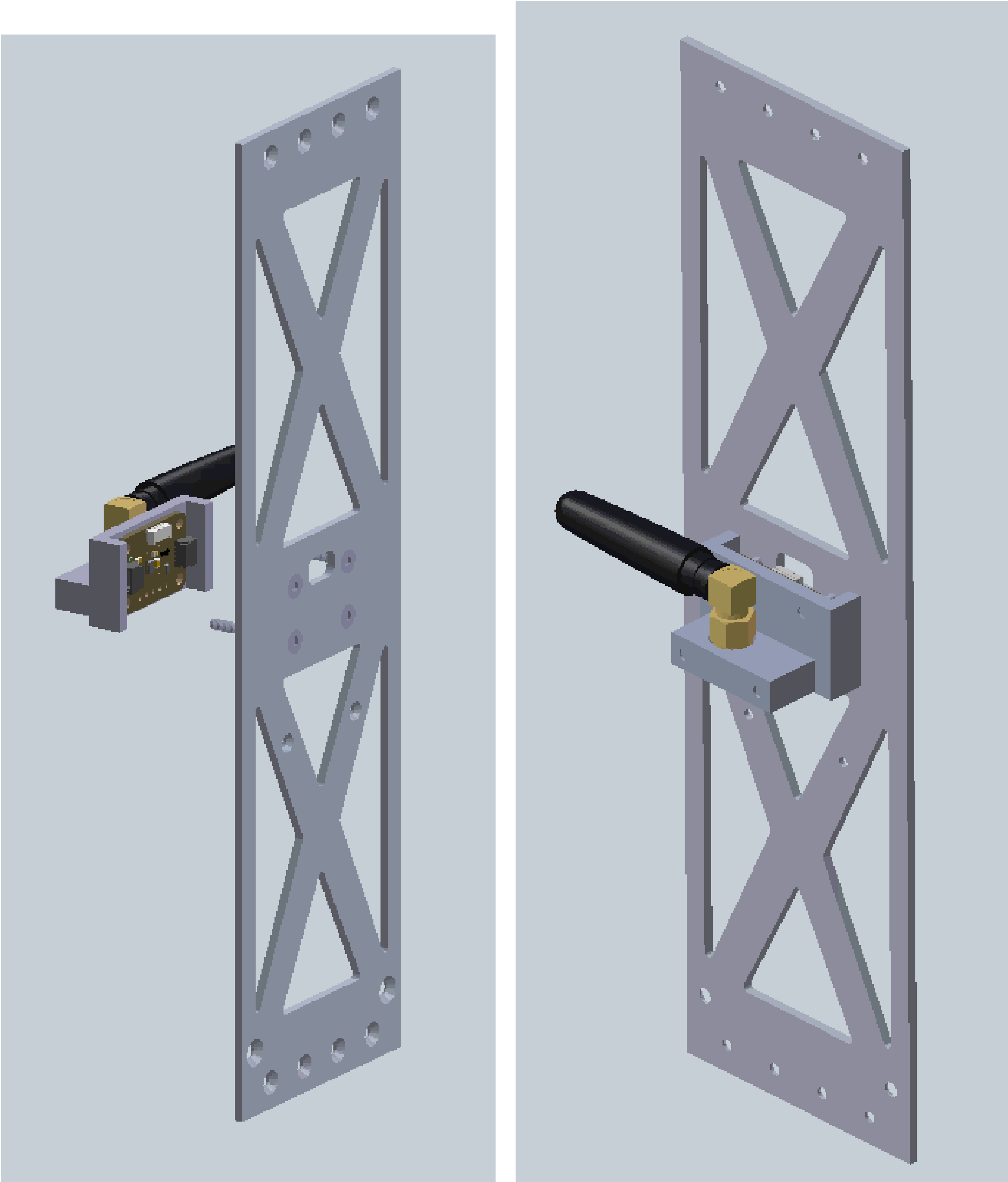
4.2.1 Side Plate 1

The assembly of Side Plate 1 comprises of the plate itself, a sun sensor, sun sensor mount, an antenna and the antenna mount as shown in Figure 9a. Side Plate 1 will be constructed out of CNC'd Aluminum. The Sun Sensor mount and Antenna mount will be 3D printed with Carbon Fiber Nylon Filament. The Antenna is then friction fit to the Antenna mount. The Sun Sensor can then be placed on top of the Side Plate, followed by the Sun Sensor Mount and finally the antenna mount on top. Four 20mm M3 Countersunk screws are then drilled into the holes such that it holds the four components together, while sitting flush with the outside of the plate. Note that for every screw used blue thread locker will be applied to the threaded fasteners to prevent loosening while allowing for disassembly with standard tools. This process is seen in Figure 10



(a) Component overview (b) Screw Positioning

Figure 9: Side Plate 1 Subassembly

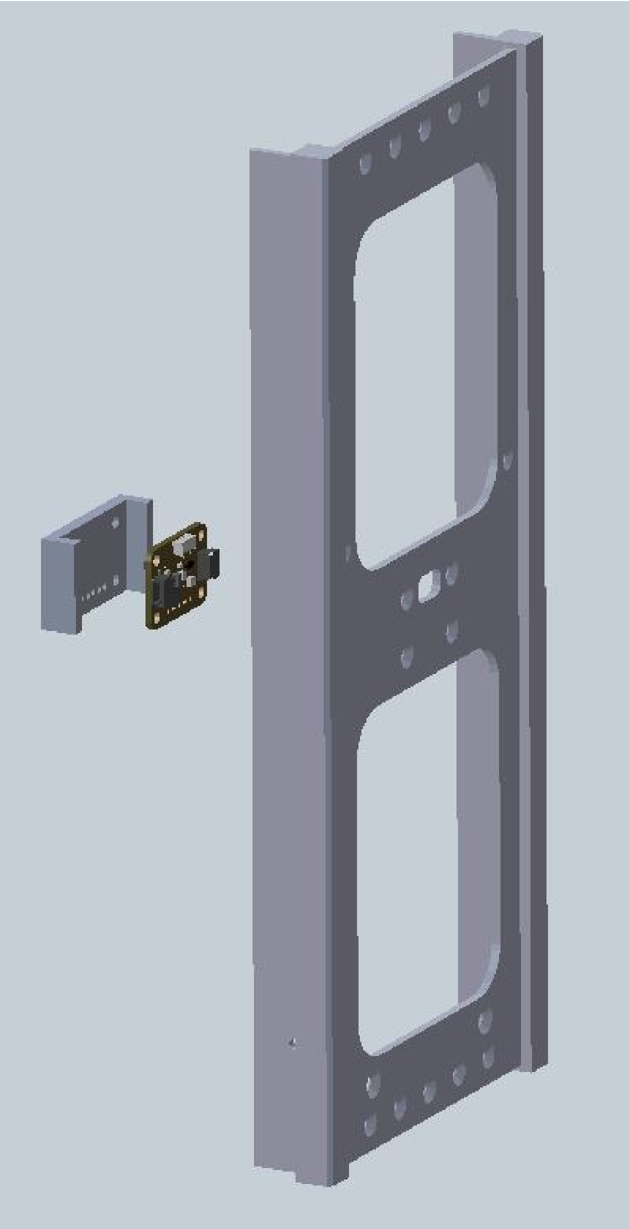


(a) Component Integration (b) Completed Subassembly

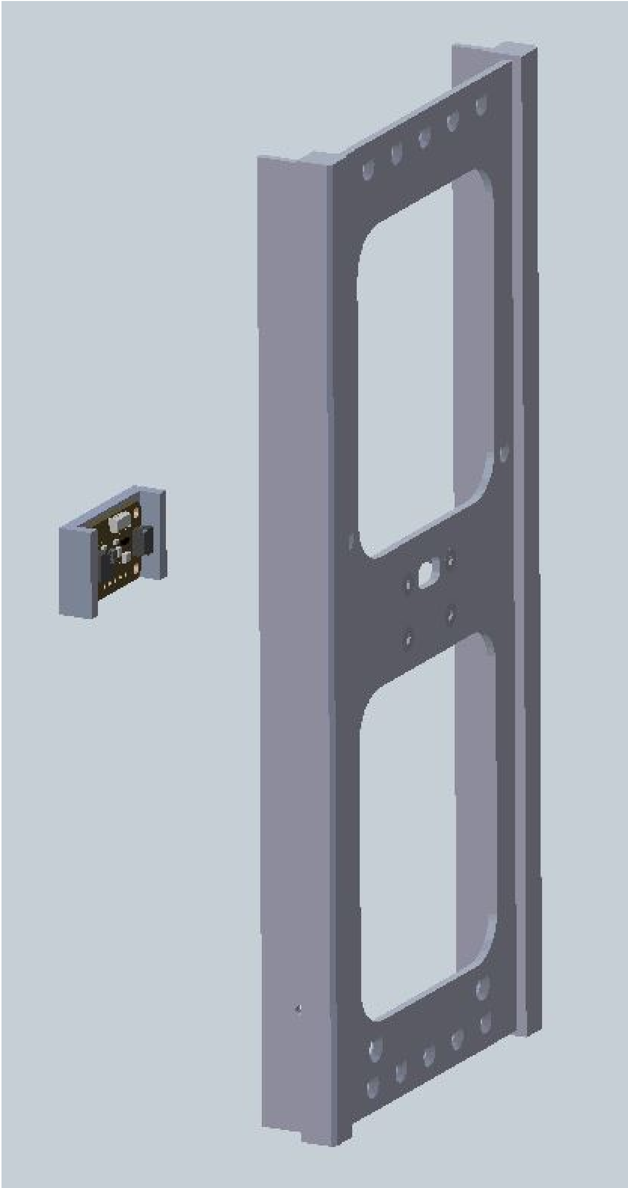
Figure 10: Side Plate 1 Subassembly Continued

4.2.2 Side Plate 2

The assembly of Side Plate 2 comprises of the plate itself, a sun sensor and a sun sensor mount as shown in Figure 11. Similar to Side Plate 1, Side Plate 2 will be constructed out of CNC'd Aluminum. The Sun Sensor mount will be 3D printed with Carbon Fiber Nylon Filament. The Sun Sensor can then be placed on top of the Side Plate, followed by the Sun Sensor Mount on top. Four 8mm M3 Countersunk screw are then drilled into the holes such that they hold the three components together, as seen in Figure 12.



(a) Component overview



(b) Component Integration

Figure 11: Side Plate 2 Subassembly

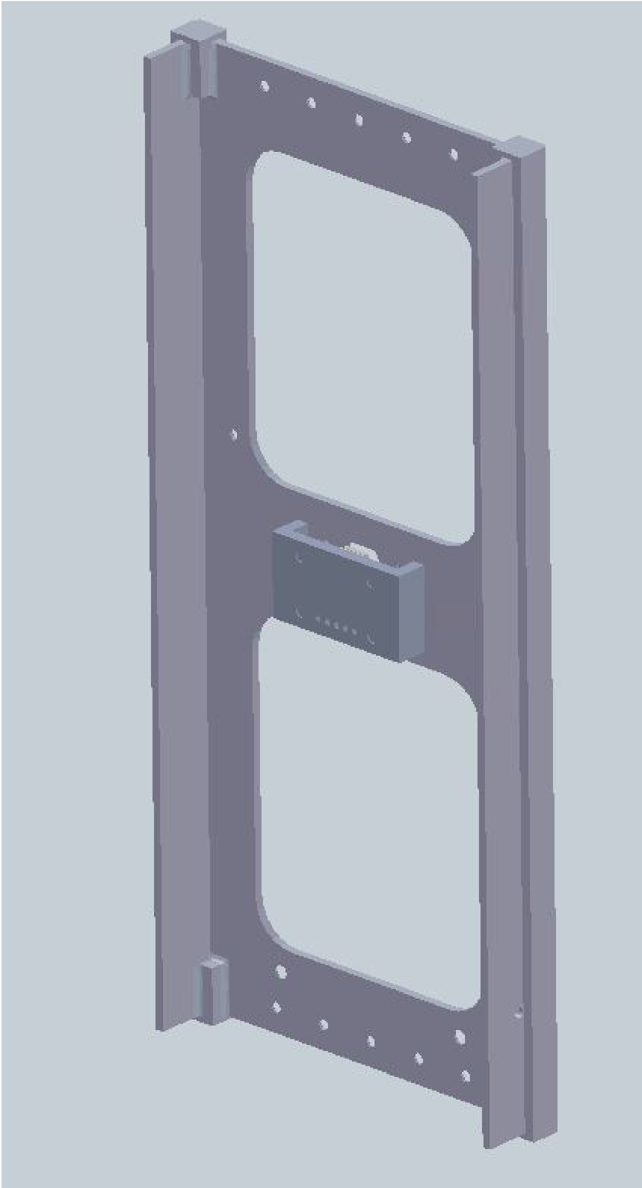
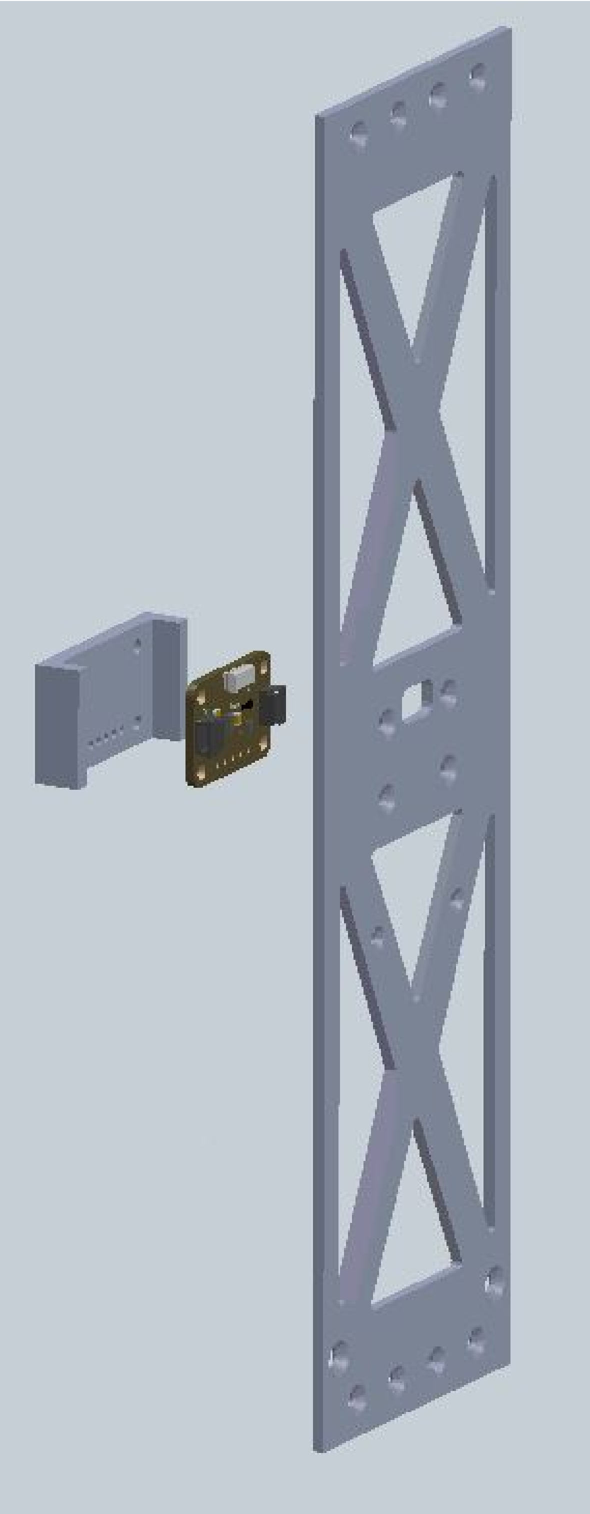


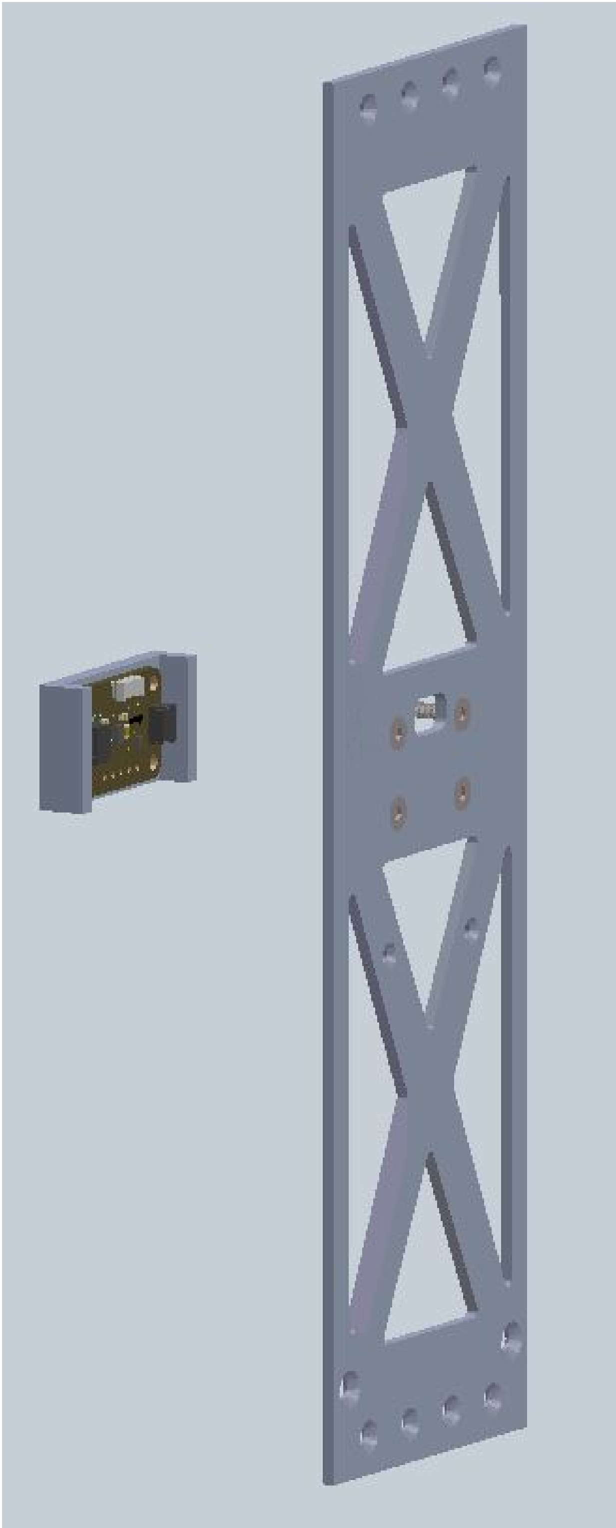
Figure 12: Side Plate 2 Completed Subassembly

4.2.3 Side Plate 3

Similar to Side Plate 2, the assembly of Side Plate 3 comprises of the plate itself, a sun sensor and a sun sensor mount as seen in Figure 13a. The assembly process is identical to that of Side Plate 2, with the only exception being the plate has a different design. The assembled side plate can be seen in Figure 14.



(a) Component overview



(b) Component Integration

Figure 13: Side Plate 3 Subassembly

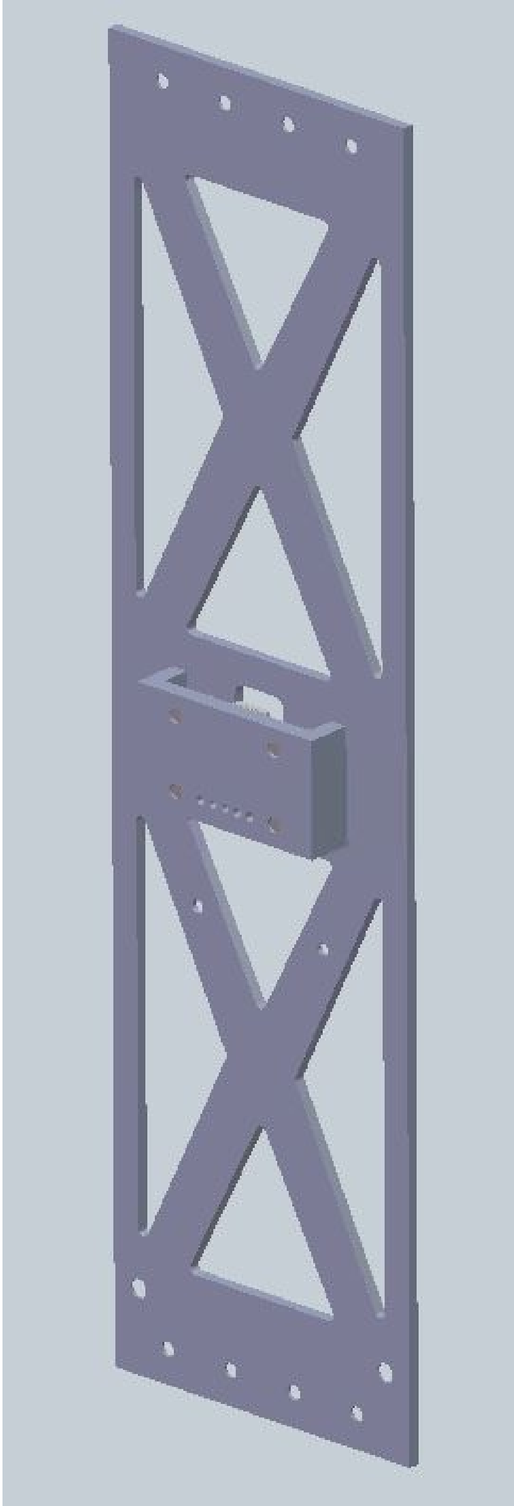
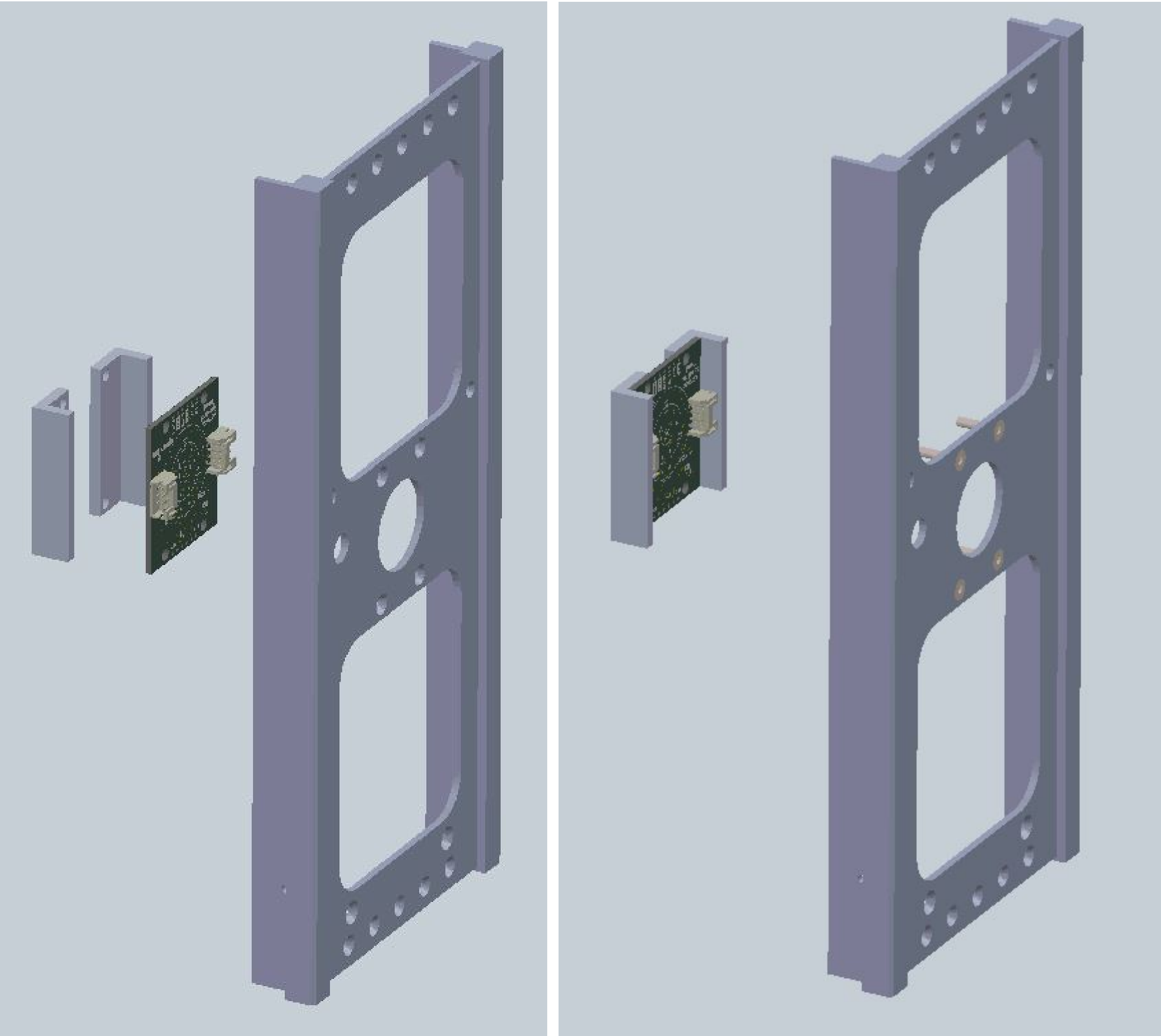


Figure 14: Side Plate 3 Completed Subassembly

4.2.4 Side plate 4

Attach spectrometer to hollow plate The assembly of Side Plate 4 comprises of the plate itself, the spectrometer and the two spectrometer mount pieces as seen in Figure 15. The Side Plate itself will again be constructed out of CNC'd Aluminum. The spectrometer mount pieces will be 3D printed with Carbon Fiber Nylon Filament. The Spectrometer can then be placed on top of the Side Plate, followed by the two Mount pieces with one on each side on top. Four 10mm M3 Countersunk screw are then drilled into the holes such that they hold the three components together, as seen in Figure 16.



(a) Component overview (b) Component Integration

Figure 15: Side Plate 4 Subassembly

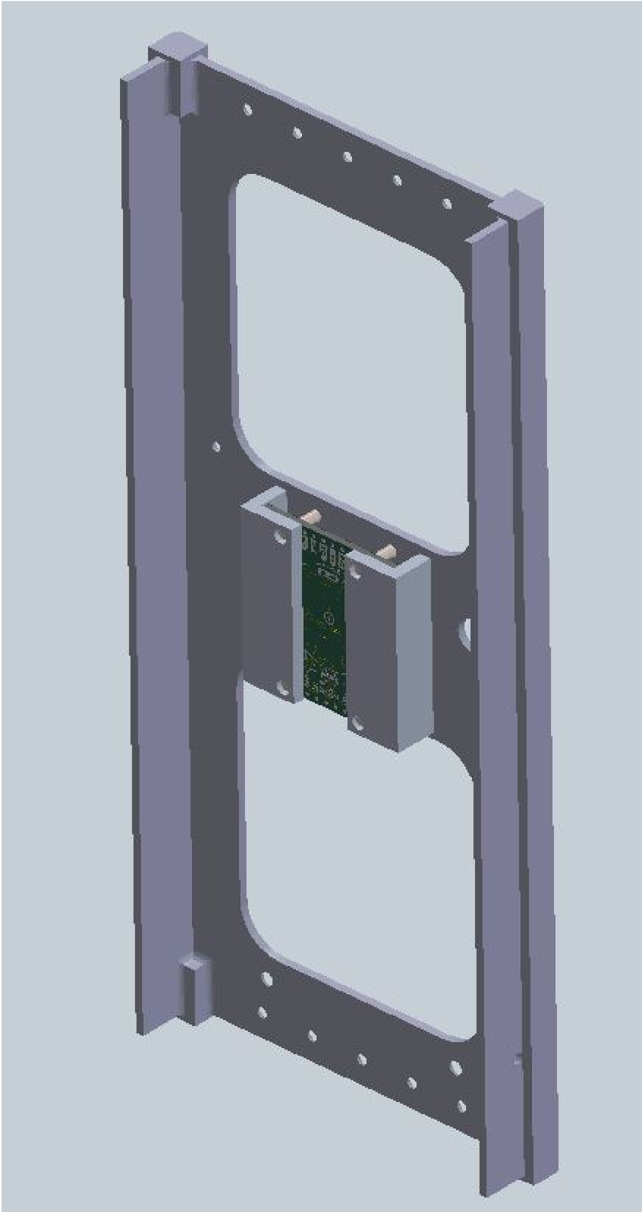
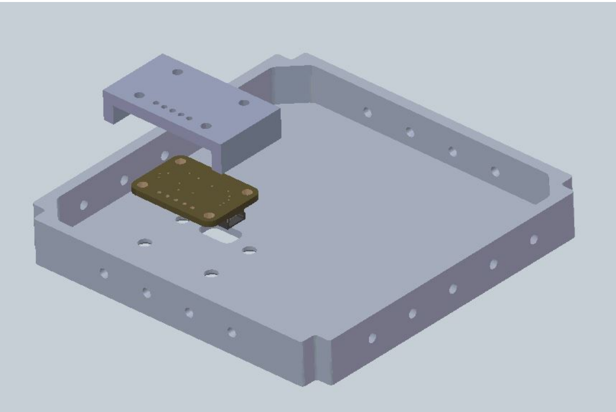


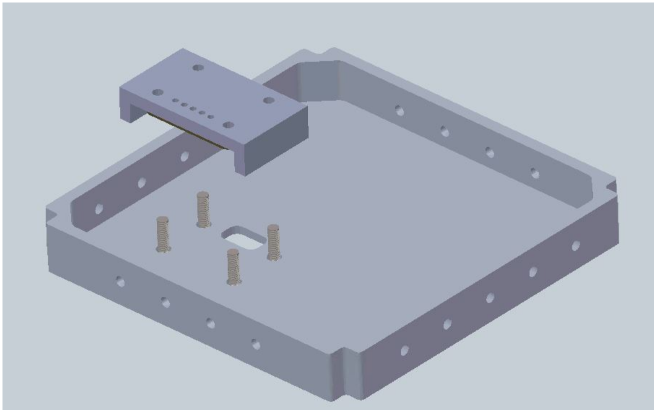
Figure 16: Side Plate 4 Completed Subassembly

4.2.5 Bottom End Assembly

The subassembly of the bottom end comprises of the base plate, a sun sensor and a sun sensor mount as seen in Figure 17a. The main base plate will be constructed using CNC'd aluminum, while the sun sensor mount will be 3D printed with Carbon Fiber Nylon. The Sun Sensor can then be placed on top of the Base Plate, followed by the Sun Sensor Mount on top. Four 8mm M3 Countersunk screw are then drilled into the holes such that they hold the three components together, as seen in Figure 18.



(a) Component overview



(b) Component Integration

Figure 17: Bottom End Subassembly

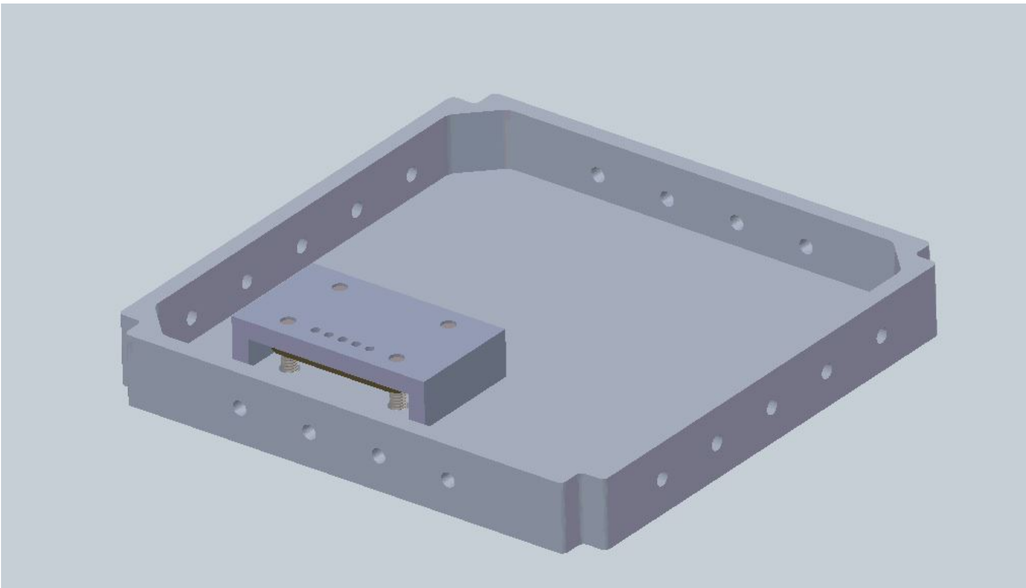
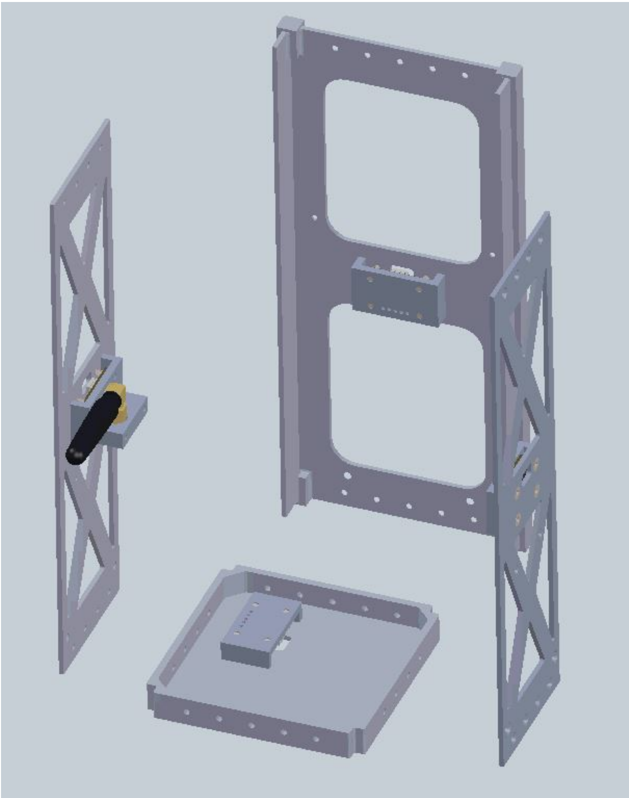


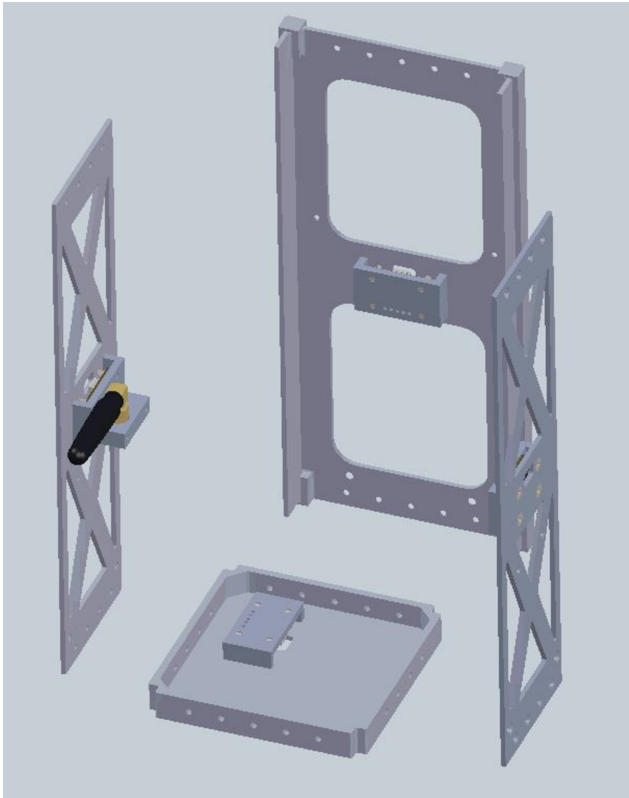
Figure 18: Bottom End Completed Subassembly

4.3 C-Shaped Housing Assembly

Attach the sub assemblies for sides 1, 2 and 3 to the Bottom End assembly. Sides 1 and 3 are each attached with 4 M3 Countersunk 4mm screws to the base plate. Side 2 is attached to the bottom end assembly using 5 M3 Countersunk 4 mm screws to complete this sub assembly. This assembly can be seen in Figure 20 shall be referred to as the C-Shaped Housing Assembly going forward and will serve as the main housing for the rest of the components.

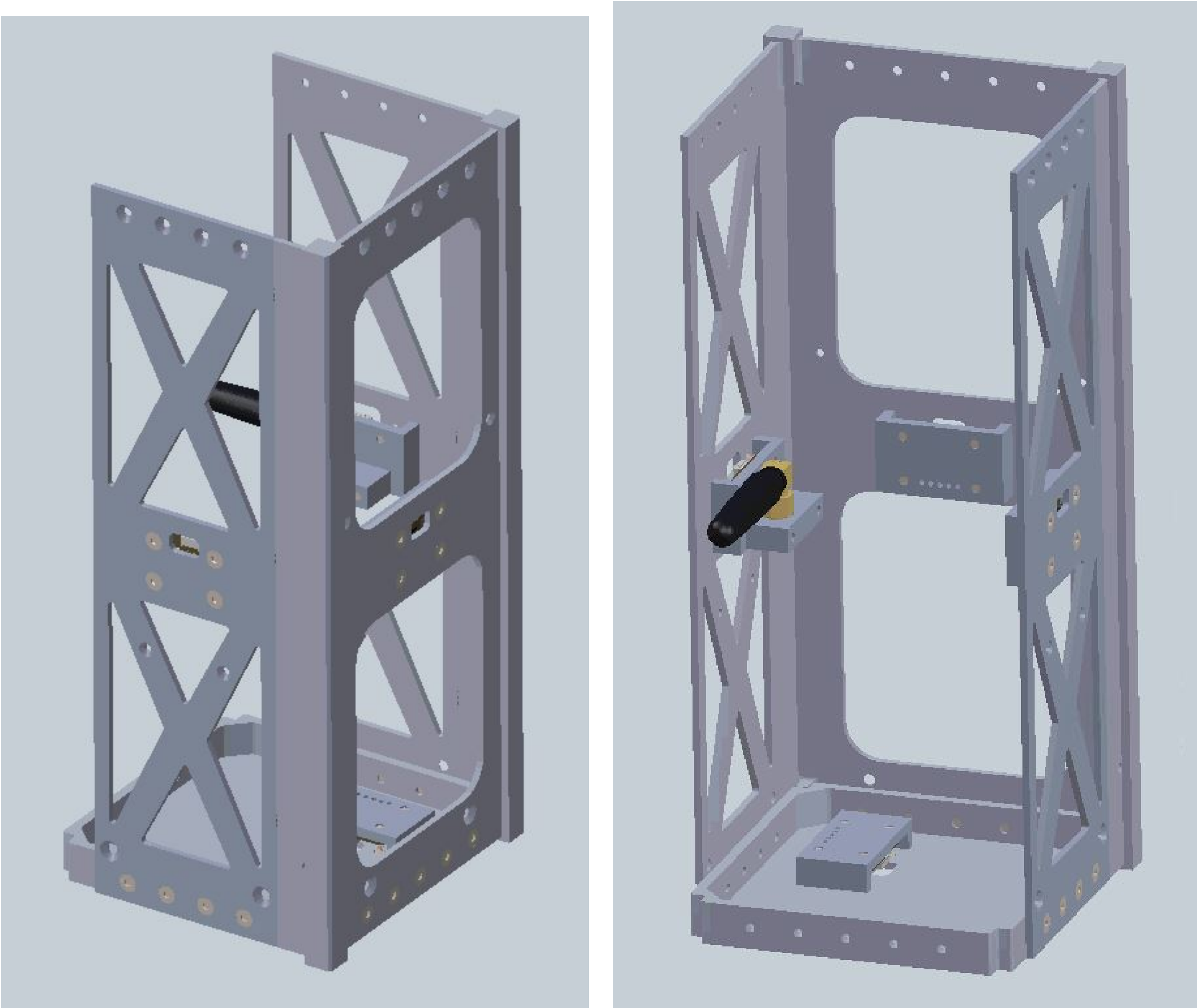


(a) Component overview



(b) Screw Positioning

Figure 19: C-Shaped Housing Subassembly



(a) Exterior View (b) Interior View

Figure 20: C-Shaped Housing Completed Subassembly

4.4 Deployment Switch

The end of the deployment switch lever is epoxied onto a small mounting block, which is rectangular in shape with one curved side. This can be seen in Figure 21. The rod is inserted through the bottom holes located on the feet of the structure. The rod and the mounting block are then bonded together using epoxy.

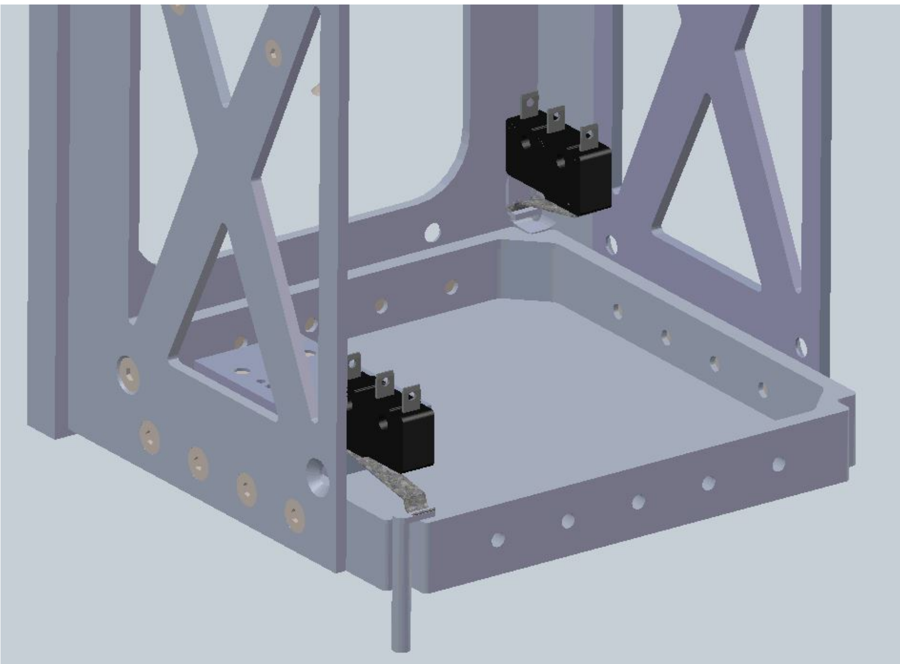
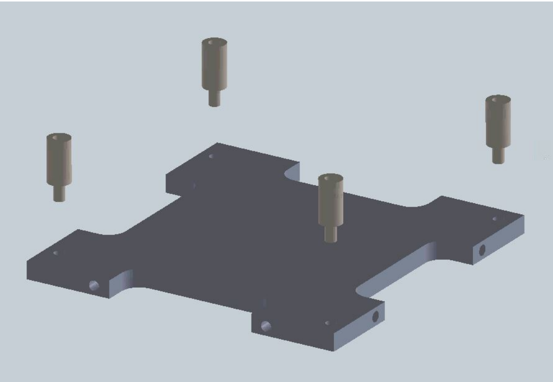


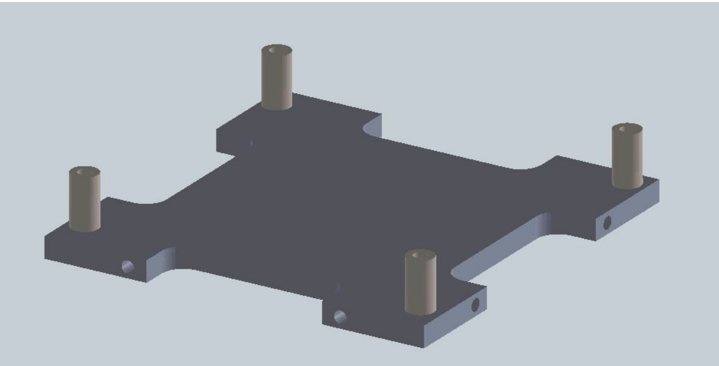
Figure 21: Deployment Switch

4.5 PCB Stack Assembly

Kapton tape is applied over any exposed pin or soldered connection. The printed circuit boards (PCBs) are then assembled in a stacked configuration using precision-machined stack separators. These separators ensure consistent spacing between each PCB, allowing for both mechanical support and component clearance. Once the PCBs are aligned and stacked, a bottom plate and a top plate are installed to sandwich the stack securely. This configuration provides structural rigidity and protection to the assembly, facilitating easy handling and integration into the enclosure. The base plate is first attached to stack separators as seen in Figure 22. The OBC PCB layer is then mounted as seen in Figure 23, after this the ADCS PCB layer is mounted as seen in Figure 24, from here the EPS PCB layer is mounted as shown in Figure 26.

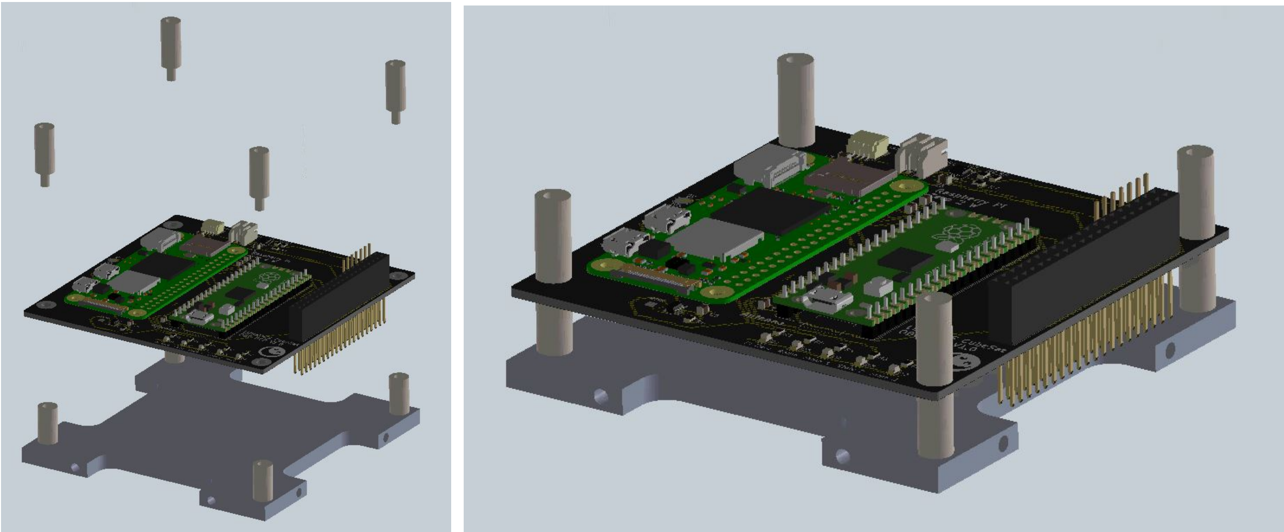


(a) Base Plate and Stack Separator



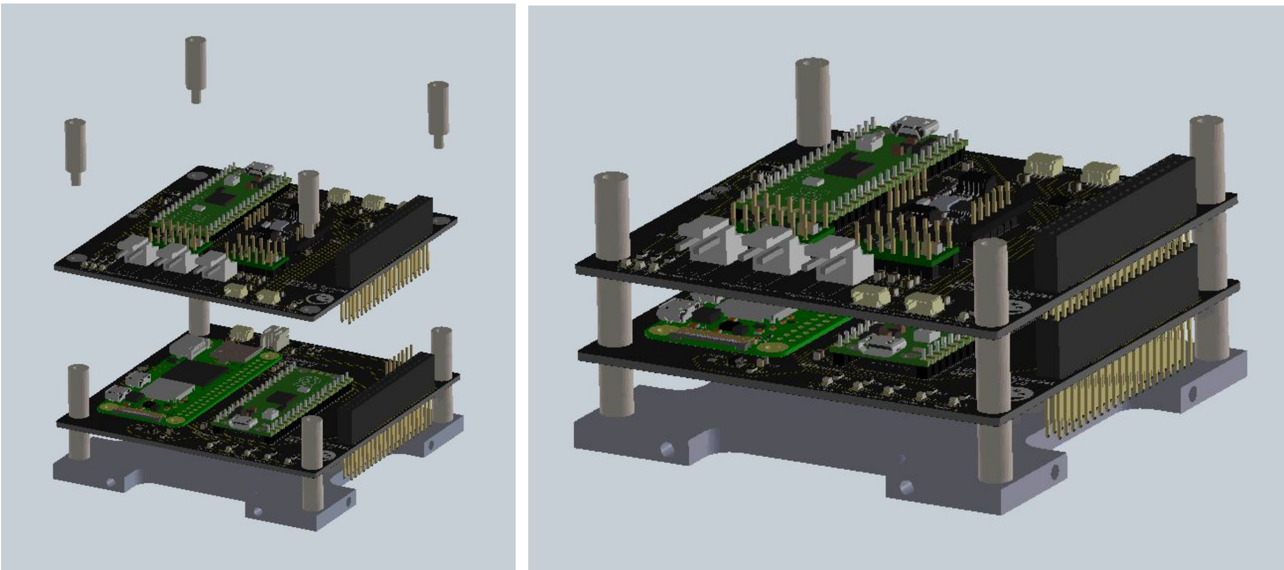
(b) PCB Stack Bottom Layer

Figure 22: PCB Stack Subassembly



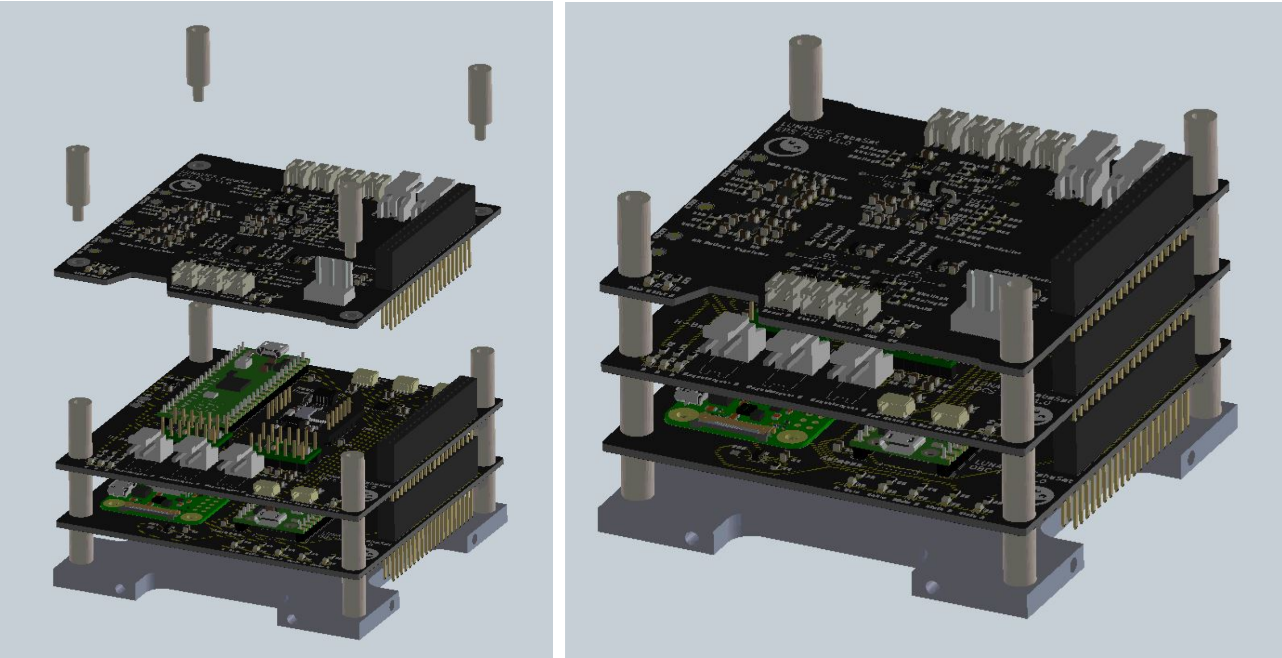
(a) Unassembled (b) Assembled

Figure 23: PCB Stack OBC Layer



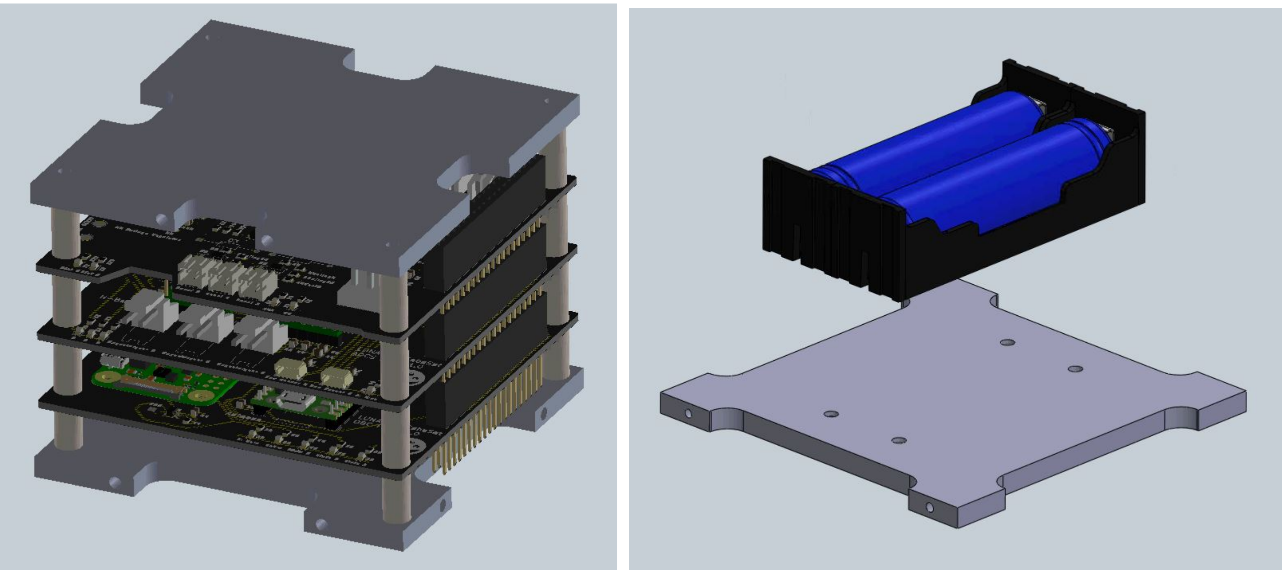
(a) Unassembled (b) Assembled

Figure 24: PCB Stack ADCS Layer



(a) Unassembled (b) Assembled

Figure 25: PCB Stack EPS Layer



(a) PCB Stack Completed (b) Power System Subassembly

Figure 26: PCB Stack Continued

The power system is put together with the power supply screwed into the base plate as seen in Figure 27.

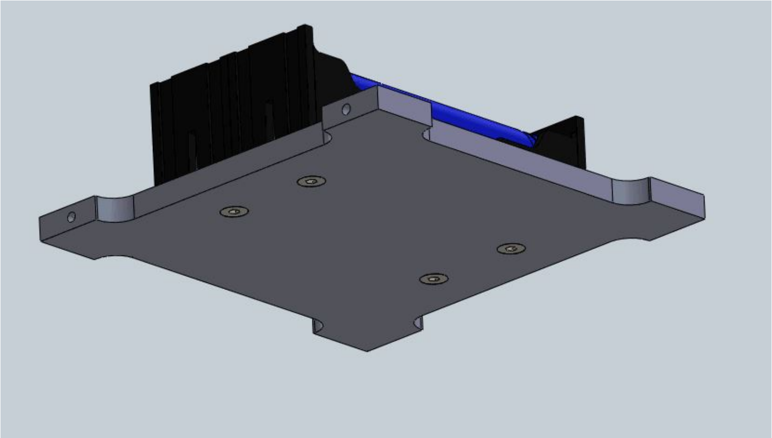
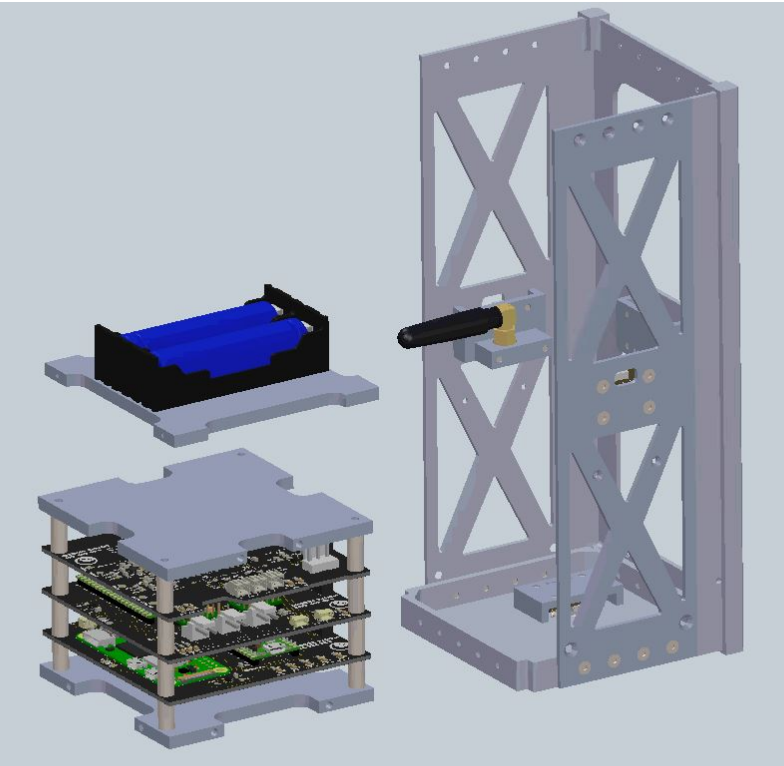


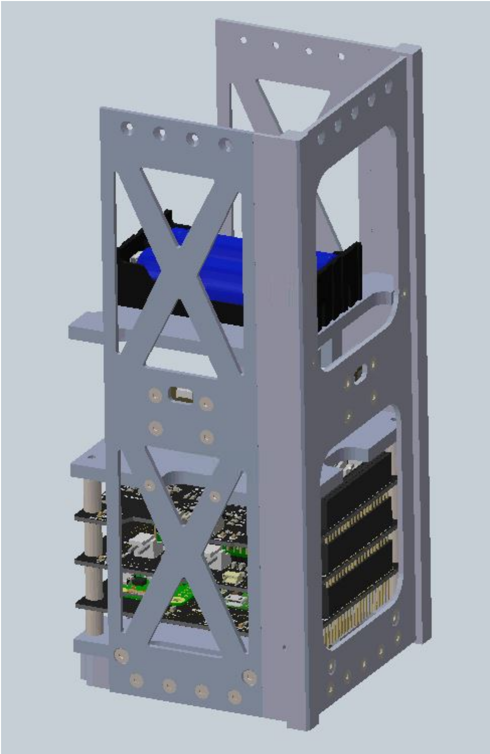
Figure 27: Power System Completed Subassembly

4.6 PCB Stack Insertion

The completed PCB stack assembly is then mounted into the enclosure. The bottom plate of the stack is fastened to the side panels of the enclosure using M3 countersunk screws (two screws per side), for a total of eight screws. This ensures a secure and flush fit with the enclosure frame. The top plate of the stack is secured to the enclosure by fastening it to the two cross-side panels (panel 2 and panel 3) using four M2 screws (two per panel). This dual-point anchoring provides additional structural stability and minimizes vibration or movement during operation.



(a) Unassembled



(b) Assembled

Figure 28: PCB Stack Insertion

4.7 Myler Layers

MLI (10-20 layers) is then installed on the internal side of structural panels to minimise radiative heat transfer from sunlit walls.

4.8 Magnetorquer Assembly

In order to assemble the magnetorquers the moulds for the three magnetorquers need to first be 3D printed. This 3D printing is done using Carbon Fiber Nylon Filament. These moulds can be seen in Figure 29, Figure 30 and Figure 31.

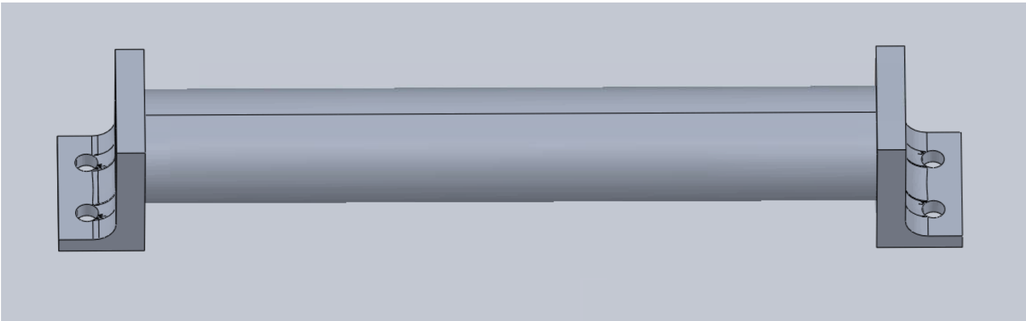


Figure 29: X-Axis Magnetorquer Mount

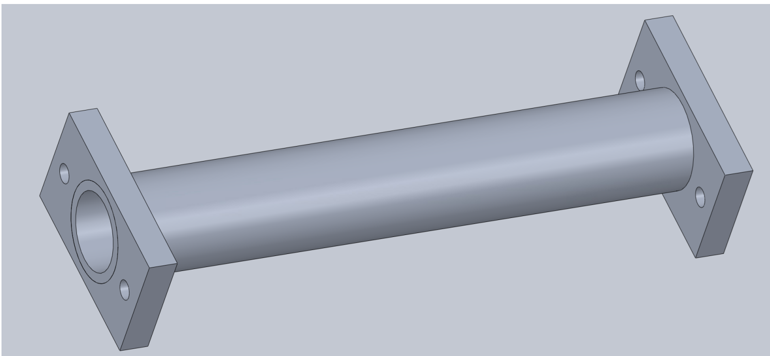


Figure 30: Y-Axis Magnetorquer Mount

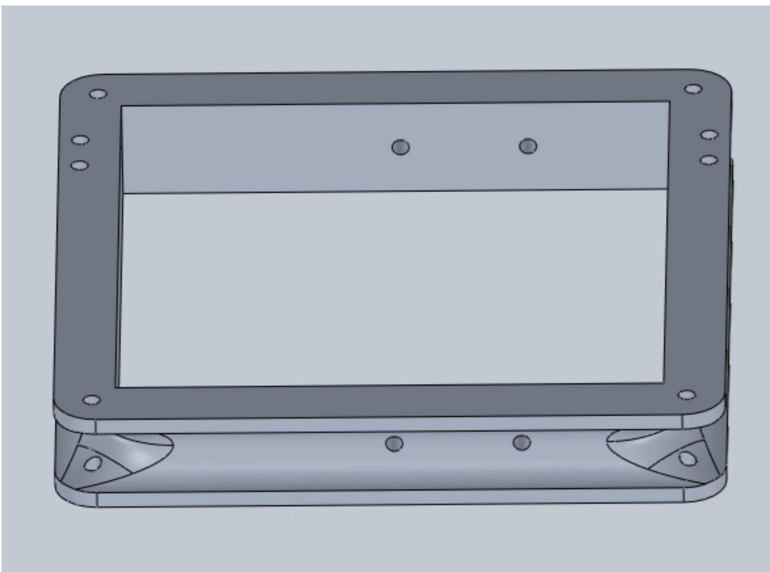


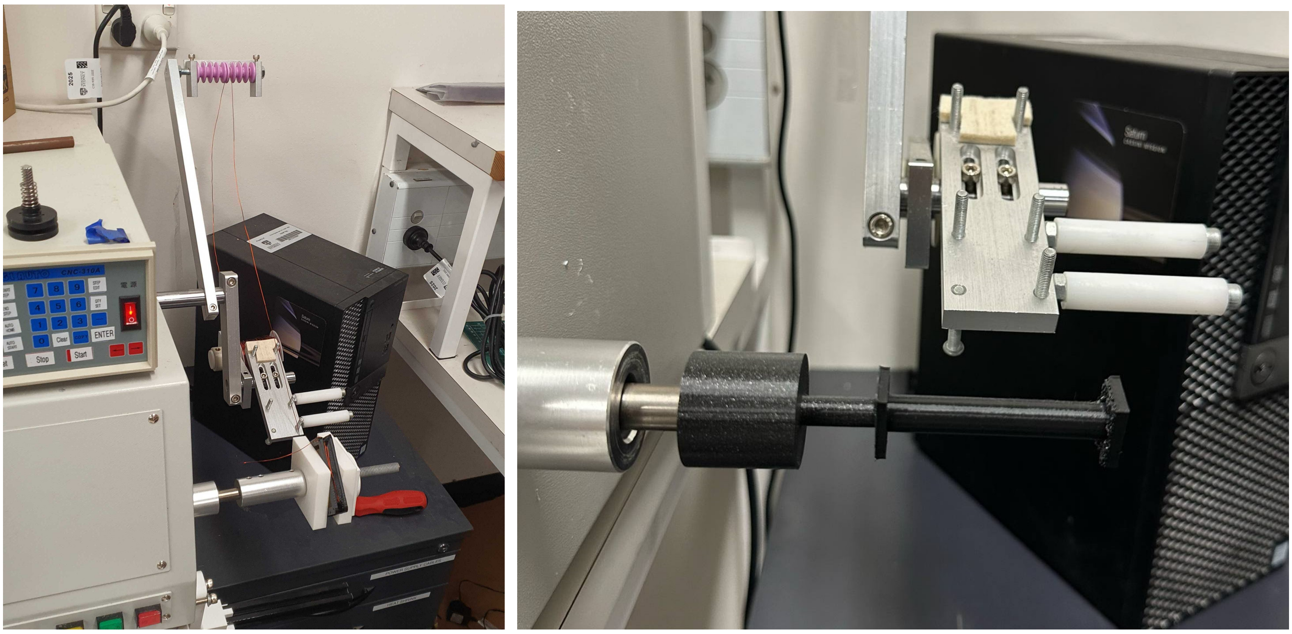
Figure 31: Z-Axis Magnetorquer Mount

The enamel copper wire needs to then be wound onto each of the three mounts. To do this, the Hongi Auto CNC-310A CNC Automatic Coil Winding Machine was used [1]. For the winding process two unique attachments needed to be designed and 3D printed to secure the mounts to the coiler. The designs of these attachments are seen in Figure 32. The first attachment utilises a friction fit where the size of the extrusion on the attachment is equal to the size of the hole on each of the rods. A filet is added to the end of the attachment to allow the extrusion to be inserted into the rods. The second attachment utilises the metal attachment that is included with the coiler but incorporates supports which are larger in area than the flat magnetorquer to secure the mould.

(a) Rod Magnetorquer Attachment (b) Flat Magnetorquer Attachment

Figure 32: Attachments to secure magnetorquer mounts to coil winder

These were then secured to the coil winder and the 0.5 mm Enamel Copper wire spool was attached as seen in Figure 33a [2].



(a) Z-Axis Magnetorquer (b) X and Y Axis magnetorquer

Figure 33: Magnetorquer winding setup

To start the coiling process the end of the wire was threaded through one of holes and tied such that it was secured to the mount, this was done to prevent the coil from unraveling on the starting side. The coil winder was then calibrated by inputting the diameter of the wire, length of the mount and the number of turns required. The first three turns were performed manually to help start the process before the winder was turned on. This process was repeated for each of the three magnetorquers. For the two rod magnetorquers, the machine was paused when it reached the end and then the first three coils for the second layer were performed manually prior to the machine being switched on again. The two rod magnetorquers were wrapped with three layers of coil. Once each coil was wound the final step was to evenly drip epoxy across the coils to prevent them from coming unraveling in the CubeSat. The coiled magentorquers are seen in Figure 34, Figure 35 and Figure 36. The total number of turns in each of the magnetorquers are outlined in Table 3.

Table 3: Magnetorquer Coils

Axis	**Number of Coils (turns)**
X	300
Y	270
Z	50

Figure 34: X-Axis Magnetorquer

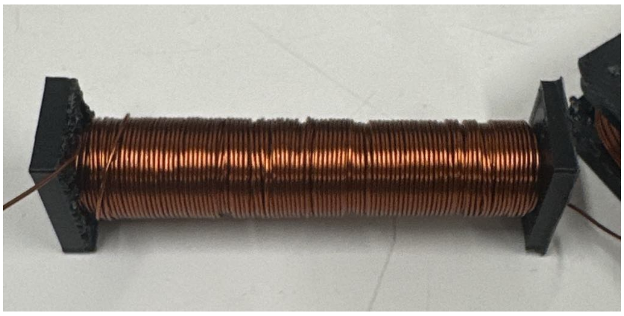


Figure 35: Y-Axis Magnetorquer

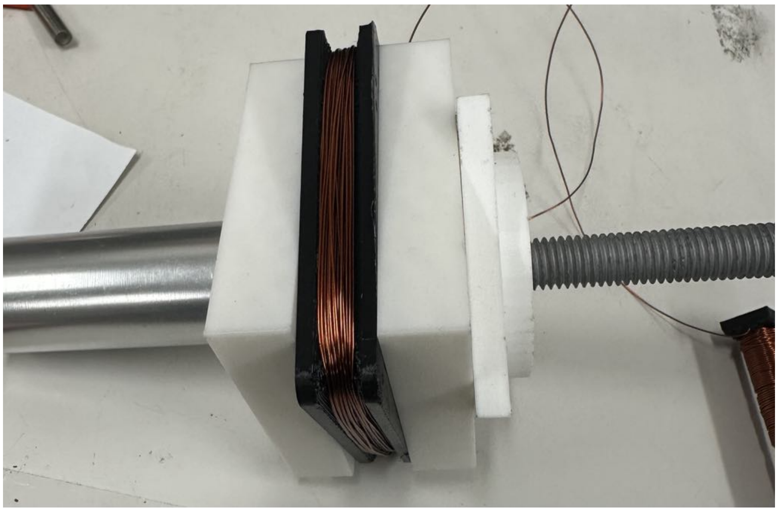


Figure 36: Z-Axis Magnetorquer

It is important to note that the Y-Axis magnetorquer should be wound first and secured to the Z-axis mount with 4 Countersunk M3 Screws that are inserted from through the Z-axis mount side. Once this is done the Z-axis coils can be wound. Finally the X-axis coils are wound and the x-axis mount is secured to the Z-axis mount once again using 4 more Countersunk M3 screws which are inserted from the top down. As there only 50 coils around the Z axis mount the protrusions of these screws will not impact the magnetorquer. The final magnetorquer assembly is seen in Figure 37.

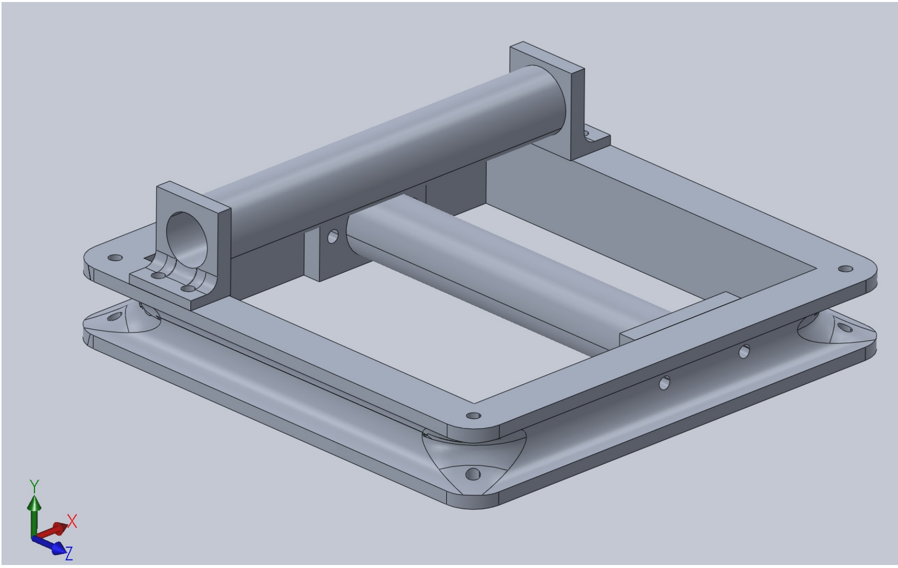
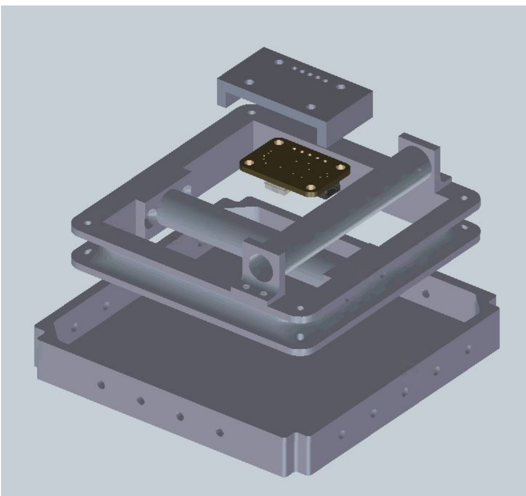


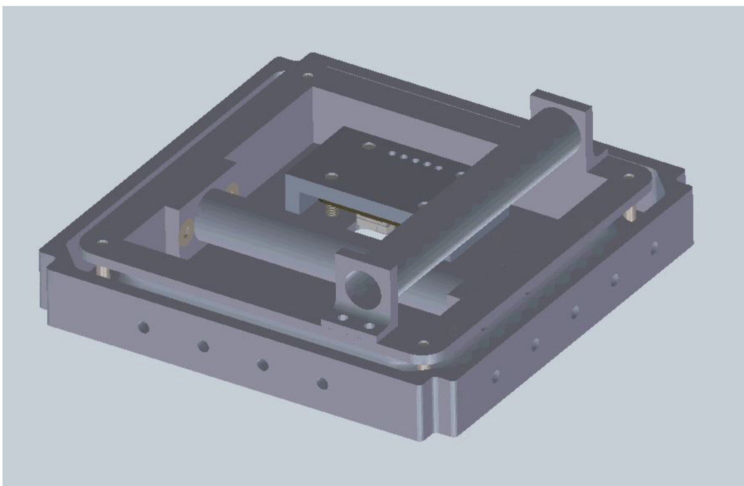
Figure 37: Magnetorquer Assembly

4.9 Top End Plate Assembly

The top end plate comprises of the magnetorquer sub assembly, a sun sensor, a sun sensor mount and the top plate. The top plate will again be constructed using CNC'd aluminum while the sun sensor mount will be 3D printed with Carbon Fiber Nylon Filament. The magnetorquer is then screwed to the top plate using 4 M3 Countersunk 12 mm Screws as shown in Figure 38. The Sun Sensor can then be placed on top of the top Plate, followed by the Sun Sensor Mount on top. Four 8mm M3 Countersunk screw are then drilled into the holes such that they hold the three components together, as seen in Figure 39.



(a) Unassembled



(b) Assembled

Figure 38: Top End Plate Assembly

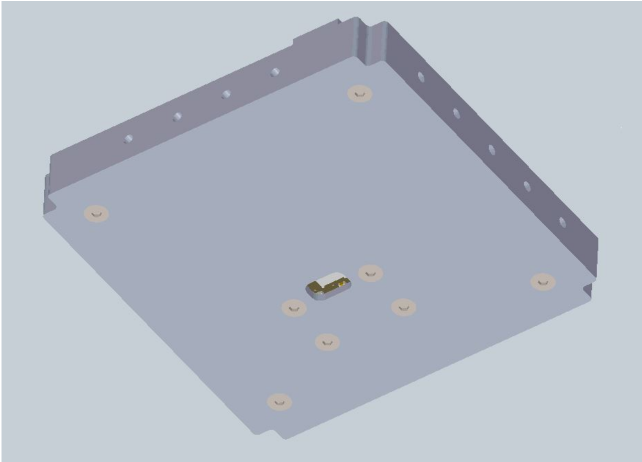
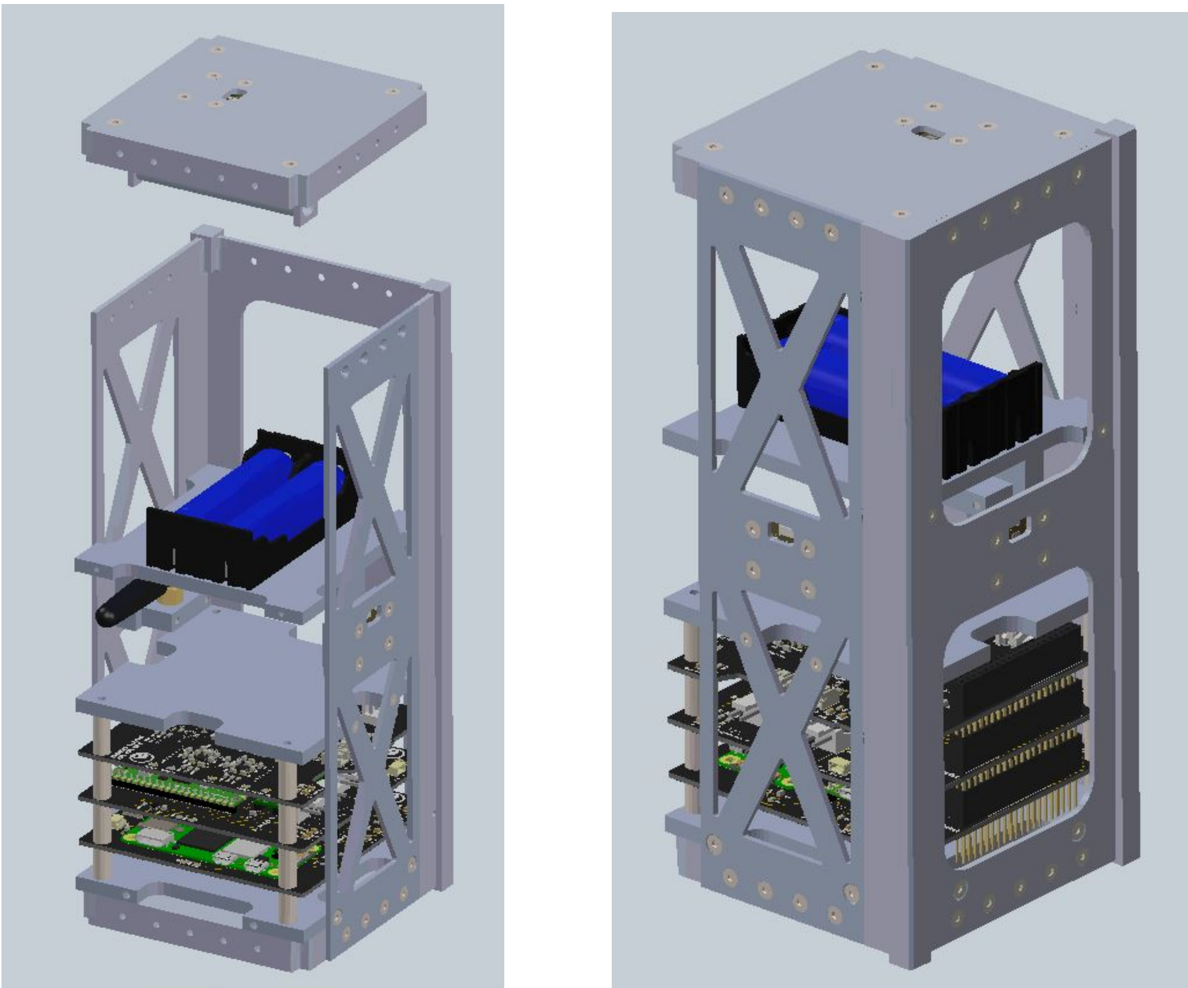


Figure 39: Top End Plate Screw Positions

4.10 Top End Assembly Insertion

The top end assembly is then slotted on top. It is attached to sides 1 and 3 using 4 M3 Countersunk 4mm screws. It is attached to Side 2 using 5 M3 Countersunk 4 mm screws to complete this sub assembly. This can be seen in Figure 40.

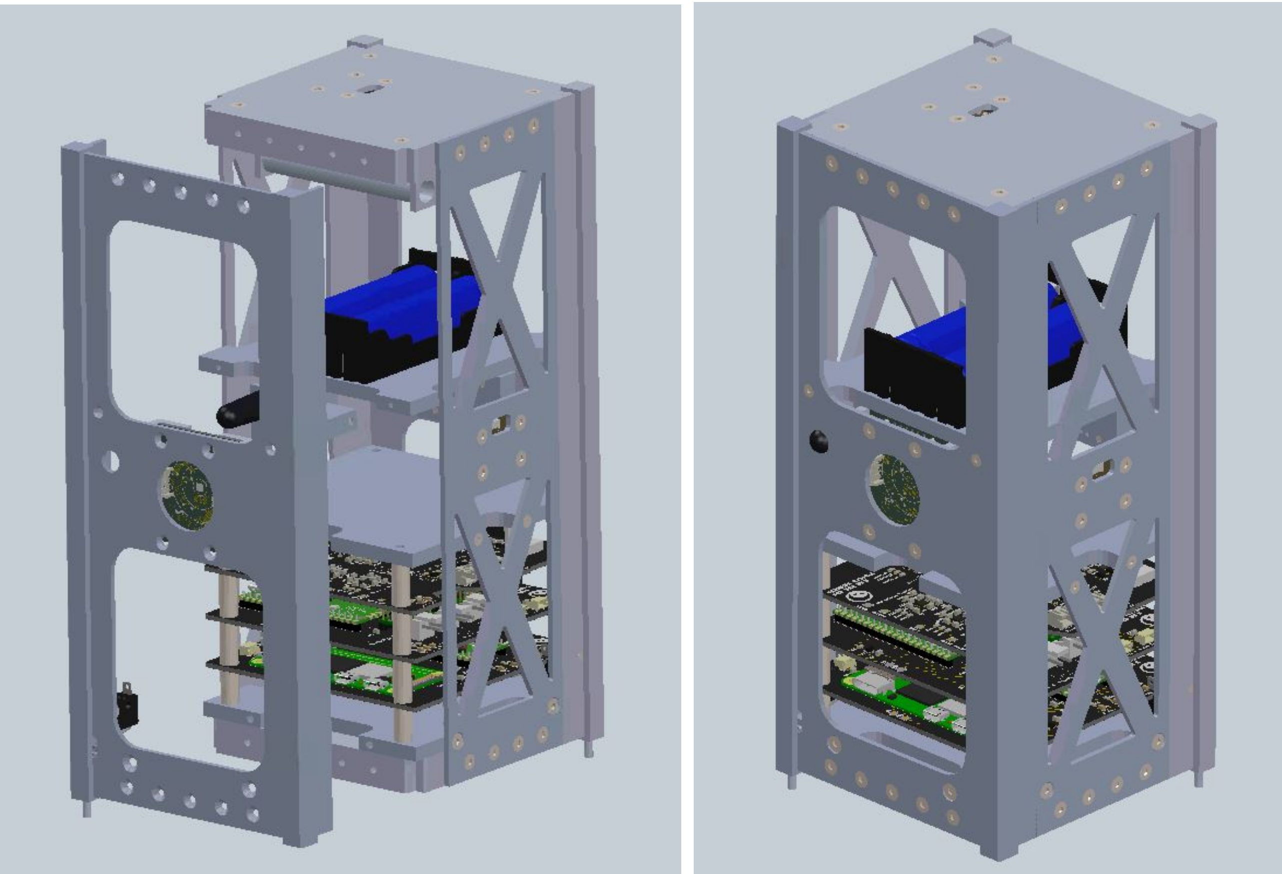


(a) Unassembled (b) Assembled

Figure 40: Top End Subassembly Insertion

4.11 Side Plate 4 Insertion

The assembly for side plate 4 can then be attached to the C-Shaped housing. This will involve 5 4mm M3 Countersunk Screws at the top and another 5 4mm M3 Countersunk Screws at the bottom. This can be seen in Figure 41.



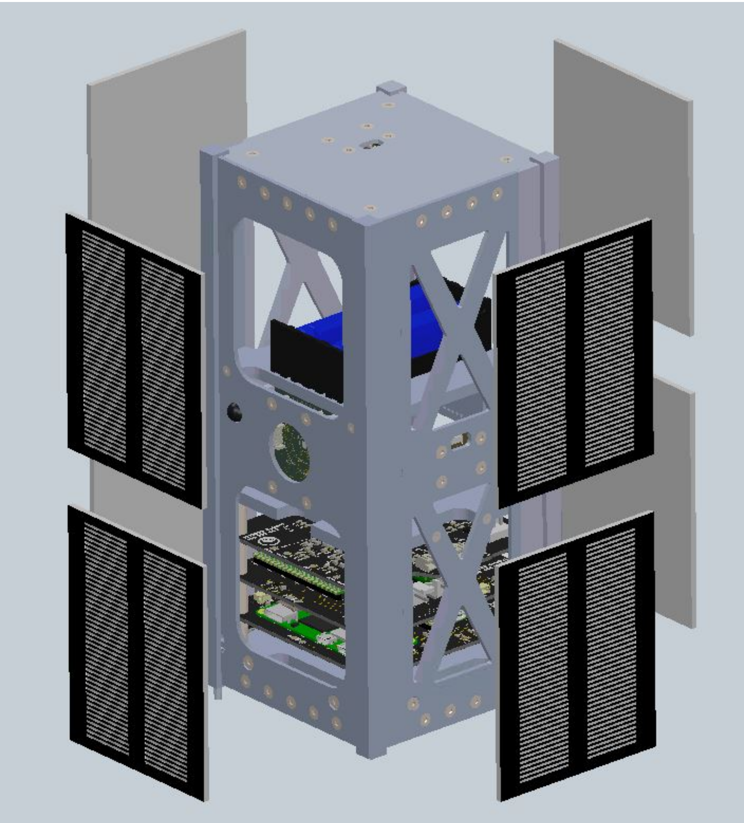
(a) Unassembled

(b) Assembled

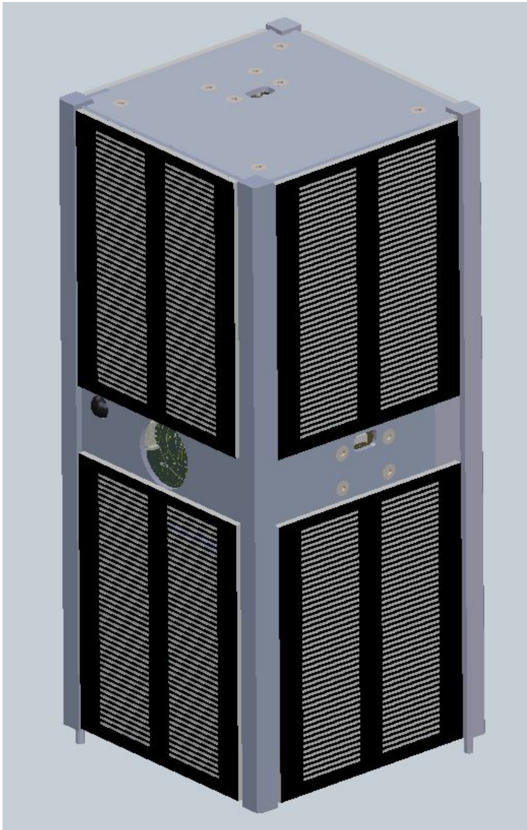
Figure 41: Side Plate 4 Assembly

4.12 Solar Panel Insertion

The final step of the assembly process involves using epoxy resign to attach the solar panels to the CubeSat structure. This process is shown in Figure 42.



(a) Unassembled



(b) Assembled

Figure 42: Solar Panel Assembly

5 Testing

The testing requirements for each subsystem are detailed below. Included a references to the relevant System Requirements satisfied by the test.

5.1 Mechanical Testing

Table 4: Mechanical Testing

Test ID	Req.	Description	Method	Pass Criteria
T-MEC-01	S-2.1.1	Quasi-static Acceleration	FEA simulation and lab test	The CubeSat shall withstand, without any degraded performance, the quasi-static acceleration indicated by S-2.1.1
T-MEC-02	S-2.2.1 S-2.2.2	Natural Frequency Survey	FEA simulation and lab test (one before vibrations and shock testing and one after)	Lowest natural frequency of the FM of the CubeSat shall be $>$ 90 Hz
T-MEC-03	S-2.3.1	Sinusoidal vibrations	FEA simulation and lab test	The CubeSat shall withstand, without any degraded performance, the sinusoidal vibrations indicated by S-2.3.1
T-MEC-04	S-2.4.1	Random vibrations	FEA simulation and lab tests	The CubeSat shall withstand, without any degraded performance, the random vibrations indicated by S-2.4.1
T-MEC-05	S-2.5.1	Shock Loads	FEA simulation and lab tests of shocks alog all axes twice	The CubeSat shall withstand, without any degraded performance, the shock levels indicated by S-2.5.1

5.2 Thermal Testing

Table 5: Thermal Testing

Test ID	Req.	Description	Method	Pass Criteria
T-THE-01	S-2.7.1	Thermal cycle testing	Thermal cycling in a thermal vacuum chamber shall be run between the temperatures of -40^o C and $+80^o$ C, with stationary time at extremes for 1 hour and temperature gradient of $< 1^o$ C/min	Components remain functional, measured thermal variation $< 1^o$ C/min
T-THE-02	S-2.8.1	Thermal bake-out testing	Longer duration bake-out test at the extreme -40^o C and $+80^o$ C run in a thermal vacuum chamber	Components remain functional, measured thermal variation $< 1^o$ C/min
T-THE-03	S-2.7.1 S-2.8.1	Surface coating verification	Titanium Dioxide White Paint is inspected for full coverage, adhesion, and uniformity on sun-facing surfaces.	100% coverage on designated surfaces with no bubbling, peeling, or visible defects.
T-THE-04	S-2.7.1 S-2.8.1	MLI installation check	Visual and tactile inspection of installed Mylar MLI (10–20 layers) around temperature-sensitive components.	Full enclosure with no tears, compression damage, or misalignment. Layers should be intact and undisturbed.
T-THE-05	S-2.7.1 S-2.8.1	Kapton tape application validation	Visual inspection of Kapton tape used around thermal/electrical interfaces. Check adhesion and correct application per design drawing.	Tape must be bonded securely, with no wrinkles, misplacement, or signs of peeling. Interface thermal/electrical insulation must be maintained.

5.3 OBC Testing

Table 6: OBC Testing

Test ID	Req.	Description	Method	Pass Criteria
T-OBC-0	S-OBC-01 S-OBC-2	Validate the Cubesat collects WOD data for every minute including all required fields and stores it on the OBC.	Start the Cubesat in nominal mode. Wait for 30 minutes. Confirm that a WOD packet is sent with 30 WOD results for each minute.	There are 30 WOD results.
T-OBC-1	S-OBC-03	Validate the onboard computer and ground station both use UTC time.	Compare time stamps from OBC telemetry with time stamps on the ground station.	Time stamps match within an acceptable drift margin (e.g. ¡ 500 ms).
T-OBC-2	S-OBC-04	Validate that the OBC has real time clock information with an accuracy of 500 ms.	Query the RTC from the OBC and compare it with an external reference clock.	OBC clock time within ±500 ms of reference.
T-OBC-3	S-OBC-05	Validate that the OBSW only contains code intended for use on LUNATICS-0.	Conduct code review and check for absence of unrelated functionality.	No unrelated modules or functionality present.
T-OBC-4	S-OBC-06	Validate that the OBSW includes comments and sensible variable names.	Review source code and check for adequate inline comments and descriptive variable names.	90% of code blocks have relevant comments; variable names reflect function.
T-OBC-5	S-OBC-07	Validate that the OBSW has a command to delete all science data that exists before a parameter of a certain timestamp.	Send a delete command with a timestamp parameter. Confirm deletion of older data.	All data before given timestamp is deleted and confirmed.
T-OBC-6	S-OBC-08	Validate that the OBSW will restart if it stops working for 60 s.	Simulate software hang and observe system behavior for 60 s.	Watchdog timer triggers automatic restart of OBSW.
T-OBC-7	S-OBC-09	Validate that the OBSW has deterministic execution.	Run software multiple times under same conditions and compare outputs.	Identical results produced for identical inputs across runs.
T-OBC-8	S-OBC-10	Validate that the OBSW has backup paths and failover methods.	Simulate failure in primary function (e.g. sensor data unavailable) and observe fallback operation.	OBSW continues operation via defined backup path.
T-OBC-9	S-OBC-11	Validate that the OBSW handles single event upsets.	Inject simulated SEU faults (e.g., bit-flips) and monitor behavior.	OBSW detects fault and recovers without system crash.

5.4 EPS Testing

Table 7: EPS Testing

Test ID	Req.	Description	Method	Pass Criteria
T-EPS-01	S-EPS-01	Test the batteries to provide power during eclispse	With the solar panels in shadow, measure current via current sensors 1 and 2.	$5 \cdot I_1 + 3.3 \cdot I_2 > 1.0$ W
T-EPS-02	S-EPS-01	Test the 3.3 V regulator converts voltage correctly	Probe testing point `TP5` with a multimeter	$3.0V < V$ and $V < 3.6V$
T-EPS-03	S-EPS-01	Test the 5 V regulator converts voltage correctly	Probe testing point `TP4` with a multimeter	$4.7V < V$ and $V < 5.3V$
T-EPS-04	S-EPS-01	Test the solar panels produce current when sunlit	Measure current through current sensors 3 to 6, rotating the satellite in the Sun 90^o to expose each face.	100 mA $< I$ and $I <$ 180 mA
T-EPS-05	S-EPS-02	Test the system powers on once solar panels and batteries are connected	From an open position, close the kill switches. Probe testing point `TP5` to measure V1 and `TP4` to measure V2 with a multimeter.	$3.0V < V1$ and $V1 <$ 3.6 V, $4.7V < V2$ and $V2 < 5.3V$
T-EPS-06	S-EPS-03	Test the solar panels are disconnected when the kill switch is open.	Probe testing point `TP1` and `TP2` with a multimeter	$V_{\mathrm{TP1}} > 0V$ and $V_{\mathrm{TP2}} = 0V$
T-EPS-07	S-EPS-03	Test the batteries are disconnected when the kill switch is open.	Probe testing point `TP3` with a multimeter	$V_{\mathrm{TP3}} = 0V$
T-EPS-08	S-EPS-04	Test the batteries are protected from over-charge voltage	Probe the voltage across BATT terminal 1 and 3	During charging $7.4 \leq V \leq 8.4$, during discharging $6.6 \leq V \leq 8.4$
T-EPS-09	S-EPS-04	Test the solar panels are protected against back-current	With the solar panels in shadow, and the battery fully charged, probe the voltage at `TP1`	$V_{\mathrm{TP1}} \approx 0V$

5.5 Communications Testing

Table 8: Communications Testing

Test ID	Req.	Description	Method	Pass Criteria
T-TTC-0	S-TTC-01	Verify the use of the unique satellite ID **LTIC01** in any transmission.	Send a message using the UI frame from the AX.25 protocol. Check the `Source Address` field within the header.	If the `Source Address` from our satellite is **LTIC01**
T-TTC-1	S-TTC-02	Verify the satellite sends WOD data every 30s.	Connect to the satellite. Run a timer. Every 30s, verify that a message containing WOD data has been sent, with relevant information.	The satellite sends the WOD data with 100 % success rate.
T-TTC-2	S-TTC-02	Verify the satellite sends payload data at 9.6 kbps when in view of ground station.	Create an empty buffer. While timing, get the satellite to send continuous data to the testing computer. Divide the amount of data received by the amount of time recorded for the data rate.	Data rate is above 9.6 kbps
T-TTC-3	S-TTC-02	Verify the satellite uses the AX.25 protocol	Get the satellite to send a message to the test computer. Verify that the UX frame is used by testing each bit of the message. Run test T-TTC-2.	UX frame is being used and passes T-TTC-2
T-TTC-4	S-TTC-03	Verify the data type is specified in the SSID in the destination address of the AX.25 frame	Send data from the satellite to a test computer. Check the **Type** field.	The type holds a byte representing the type of data being sent.
T-TTC-5	S-TTC-03	Verify the data type of science data is `0b1111` and WOD with `0b1110`	Send both science data and WOD data from the satellite to the test computer. Check the **Type** field.	If the **Type** for science is received as `0b1111` and for WOD data it is `0b1110`
T-TTC-6	S-TTC-04	Verify CubeSat data is decoded and is able to be viewed clearly.	A GUI will be run on the test computer. Verification that it shows decoded values and not binary data will be performed.	If the data shows on the GUI as decoded.

5.6 ADCS Testing

Table 9: ADCS Testing

Test ID	Req.	Description	Method	Pass Criteria
T-AOC-01	S-AOC-02	Verify change in magnetic flux density due to magnetorquers is greater than the required value	Use the magentometer on a mobile phone to measure the change in magnetic flux density	Verify using the MATLAB Mobile Application and a phone magnetometer
T-AOC-02	S-AOC-02	Verify sun sensor measurement data	Shine a torchlight at varying angles over the sensor.	The relative sensitivity values at any given angle should match the relative sensitivity vs angular displacement graph provided on the datasheet.
T-AOC-03	S-AOC-02	Verify Inertial-Measurement-Unit (accelerometer, gryoscope and magnetometer) data	The IMU was rotated 360° around each axis: roll, pitch, yaw. The data is compared to expected trends.	IMU data matches the expected trends.
T-AOC-04	S-AOC-02	Verify estimation of quaternion and angular velocity	Implement the Quaternion Estimator and Extended Kalman Filter on the Waratah Seed on an air bearing table, and comparing the estimated attitude to the absolute attitude from the Motion Tracking in the Bennett lab. Note, the sun sensor measurements will not be included in the EKF for testing and demonstration.	The estimated attitude matches the absolute attitude from the Motion Tracking in the lab.
T-AOC-05	S-AOC-01	Verify power is supplied to magnetorquers	Probe voltage across the magnetorquers	Measure $V > 4.7$ V
T-AOC-06	S-AOC-01	Verify that power to magnetorquers can be varied via H-Bridge	Vary the duty cycle and measure the strength of the magnetic field	Magnetic field increases and decreases in strength with duty cycle.
T-AOC-07	S-AOC-01	Verify that B-Dot algorithm can detumble the satellite	Observe the transient response to a disturbance and measure the time to come to rest	Observe that B-Dot detumbles faster than without
T-AOC-08	S-AOC-02	Verify the nadir-pointing algorithm can perform pointing	Observe rotation in each axis due to the magnetorquers	Measure adequate rotation in the algorithm's desired direction

5.7 Structure Testing

Table 10: Structure Testing

Test ID	Req.	Description	Method	Pass Criteria
T-STR-01	S-STR-01	Verify hold-down release mechanism activates successfully	Hold down both switches and let go and see if the electronic system starts	The system shall activate when the switches are released
T-STR-02	S-STR-03	Verify deployment switch activates during release	Simulate deployment event by actuating the release system and check continuity across switch terminals	Switch signal transitions from open to closed not before 30 minutes after deployment switch activation and no elements will be deployed before

5.8 Payload Testing

Table 11: Payload Testing

Test ID	Req.	Description	Method	Pass Criteria
T-PAY-01	P-PAY-01	Spectrometer powers on	Apply a 3.3 V voltage to the spectrometer power input pins, read from I2C port on spectrometer	Values are received from the I2C ports
T-PAY-02	P-PAY-01	Spectrometer produces accurate intensity curve	Expose spectrometer to a light source with known spectrum	Experimental curve matches known spectrum

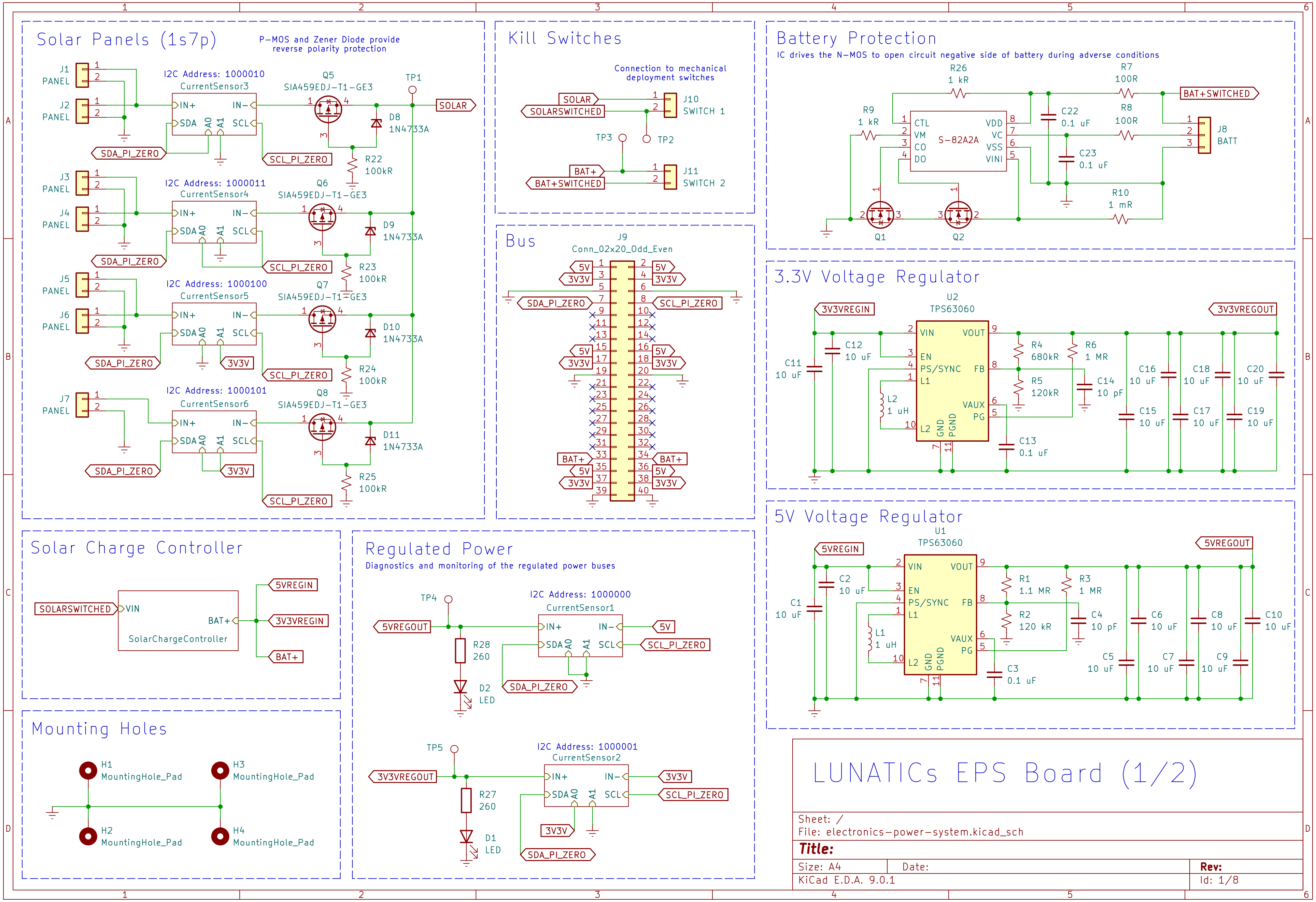
References

[1] "High quality new computer cnc automatic coil winder coil winding machine for 0.03-1.2mm wire 110/ 220v factory outlet," https://www.aliexpress.com/item/1005003522101667.html, accessed: 2025-04-30.

[2] "0.5mm enamel copper wire spool," https://www.jaycar.com.au/0-5mm-enamel-copper-wire-spool/p/WW4016, accessed: 2025-04-30.

Appendix A Electrical Diagrams

The electrical diagrams are contained on the subsequent pages.


Solar Panels (1s7p)
P-MOS and Zener Diode provide reverse polarity protection
J1 PANEL
J2 PANEL
J3 PANEL
J4 PANEL
J5 PANEL
J6 PANEL
J7 PANEL
I2C Address: 1000010
CurrentSensor3
I2C Address: 1000011
CurrentSensor4
I2C Address: 1000100
CurrentSensor5
I2C Address: 1000101
CurrentSensor6
Q5 SIA459EDJ-T1-GE3
Q6 SIA459EDJ-T1-GE3
Q7 SIA459EDJ-T1-GE3
Q8 SIA459EDJ-T1-GE3
D8 1N4733A
D9 1N4733A
D10 1N4733A
D11 1N4733A
R22 100kR
R23 100kR
R24 100kR
R25 100kR
TP1
SOLAR
SDA_PI_ZERO
SCL_PI_ZERO
3V3V
Kill Switches
Connection to mechanical deployment switches
SOLAR
SOLARSWITCHED
J10 SWITCH 1
TP3
TP2
BAT+
BAT+SWITCHED
J11 SWITCH 2
Bus
J9
Conn_02x20_Odd_Even
5V
3V3V
SDA_PI_ZERO
SCL_PI_ZERO
BAT+
Battery Protection
IC drives the N-MOS to open circuit negative side of battery during adverse conditions
R26 1 kR
R7 100R
R8 100R
R9 1 kR
R10 1 mR
C22 0.1 uF
C23 0.1 uF
S-82A2A
CTL VM CO DO VDD VC VSS VINI
BAT+SWITCHED
J8 BATT
Q1
Q2
3.3V Voltage Regulator
U2 TPS63060
3V3VREGIN
3V3VREGOUT
VIN VOUT EN PS/SYNC FB L1 VAUX PG L2 GND PGND
C11 10 uF
C12 10 uF
R4 680kR
R6 1 MR
R5 120kR
C14 10 pF
C13 0.1 uF
L2 1 uH
C16 10 uF
C18 10 uF
C20 10 uF
C15 10 uF
C17 10 uF
C19 10 uF
5V Voltage Regulator
U1 TPS63060
5VREGIN
5VREGOUT
C1 10 uF
C2 10 uF
R1 1.1 MR
R3 1 MR
R2 120 kR
C4 10 pF
C3 0.1 uF
L1 1 uH
C6 10 uF
C8 10 uF
C10 10 uF
C5 10 uF
C7 10 uF
C9 10 uF
Solar Charge Controller
SOLARSWITCHED
VIN
BAT+
SolarChargeController
5VREGIN
3V3VREGIN
BAT+
Regulated Power
Diagnostics and monitoring of the regulated power buses
TP4
5VREGOUT
R28 260
D2 LED
I2C Address: 1000000
CurrentSensor1
5V
SCL_PI_ZERO
SDA_PI_ZERO
TP5
3V3VREGOUT
R27 260
D1 LED
I2C Address: 1000001
CurrentSensor2
3V3V
SCL_PI_ZERO
SDA_PI_ZERO
Mounting Holes
H1 MountingHole_Pad
H2 MountingHole_Pad
H3 MountingHole_Pad
H4 MountingHole_Pad
LUNATICs EPS Board (1/2)
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Rev:
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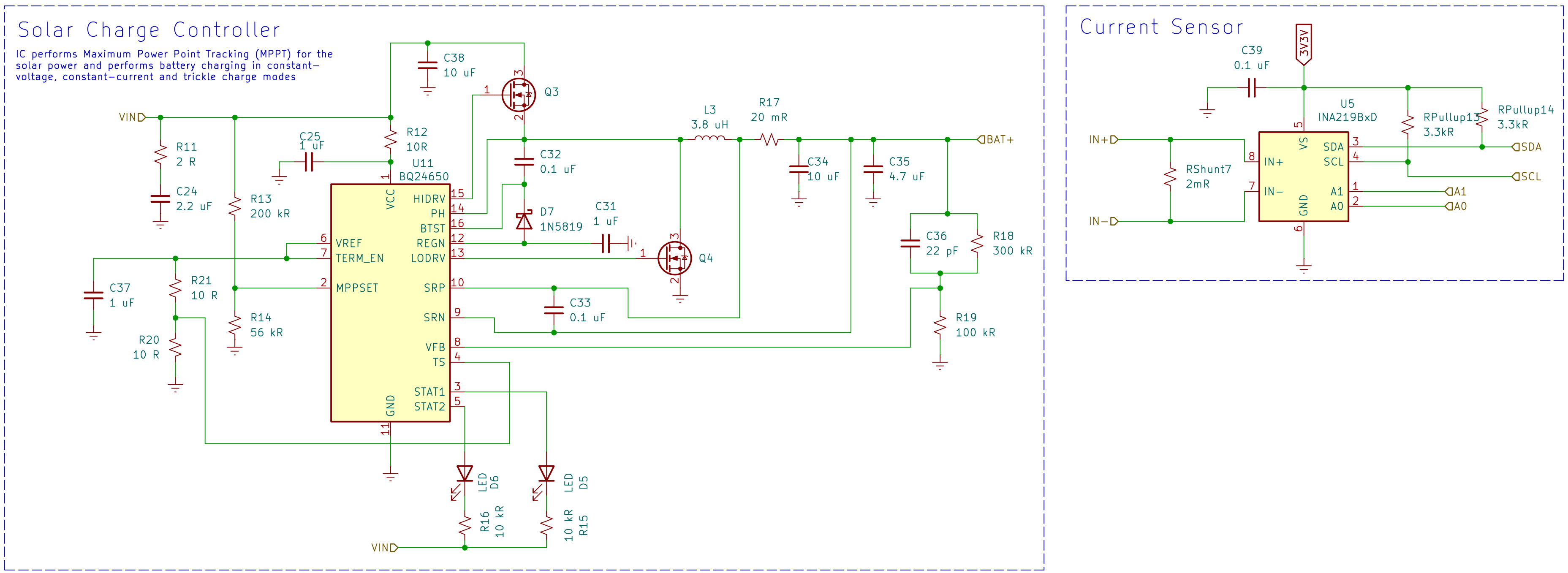
Id: 1/8



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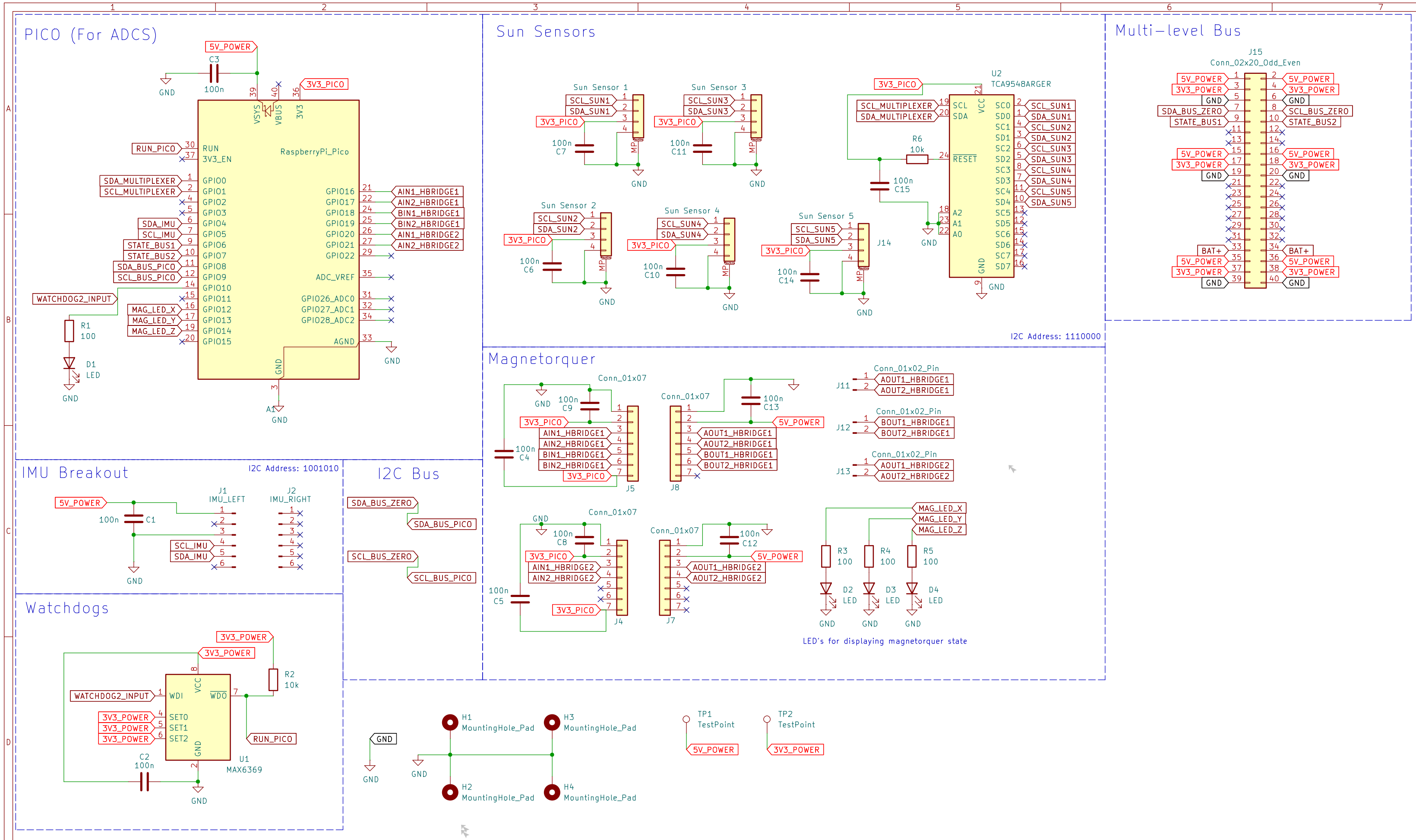

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LUNCATICS

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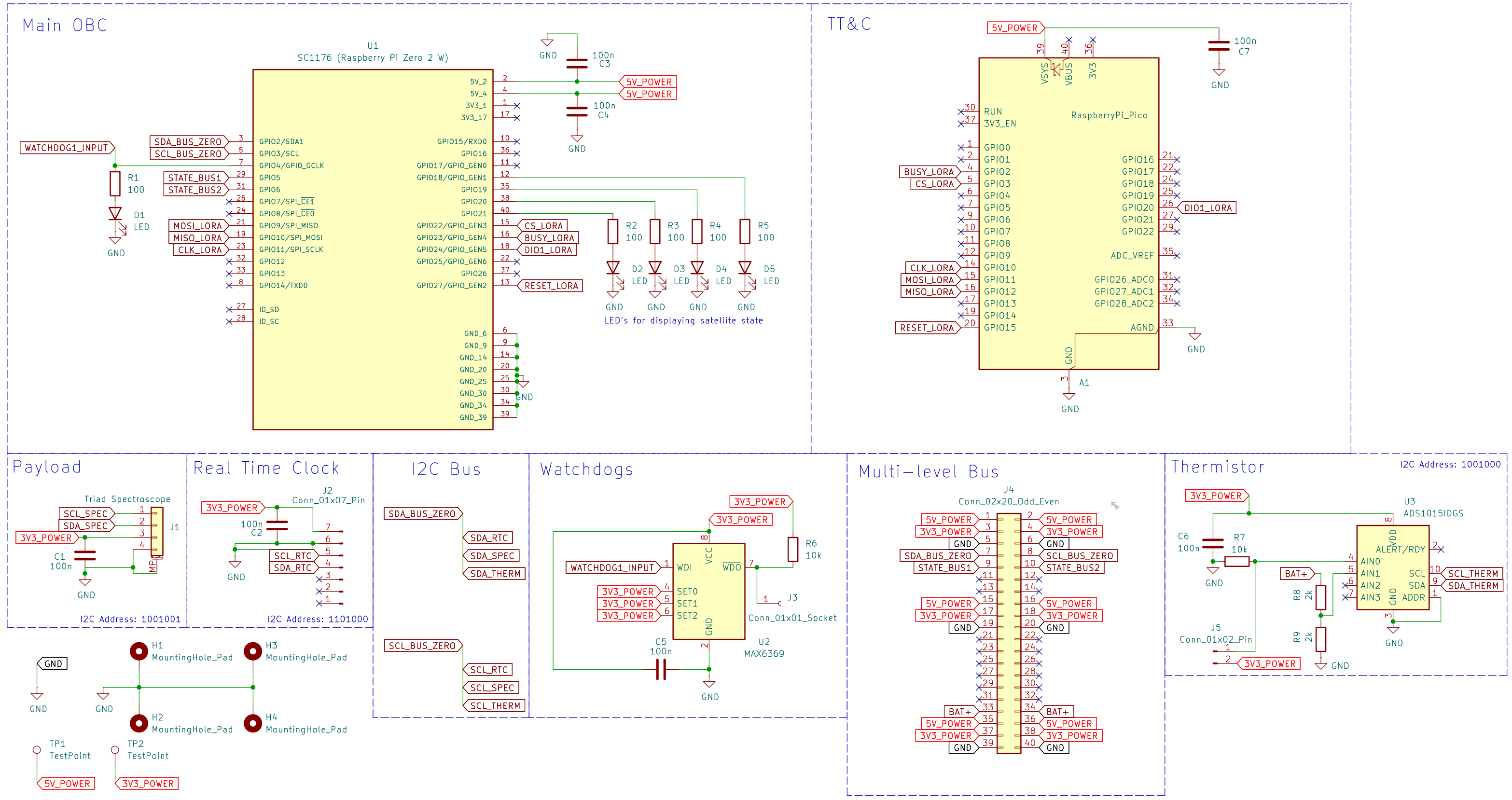
Size: A3 | Date: | **Rev:**

KiCad E.D.A. 9.0.1 | Id: 1/1



LUNATICs OBC Board (1/1)

LUNCATICS

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Title: LUNATIC-0

Size: A3 Date: Rev:

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