FOSSASAT-1 Hardware Assembly and Testing Procedure

Assembly Manual and Electrical / Mechanical Test Plan.

Fossa Systems

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Abstract

This document is intended as a guide with regards to the electromechanical assembly and testing of the FossaSat-1 satellite architecture. FossaSat-1 is a 5cm sided PocketQube picosatellite developed by Fossa Systems. Set to launch in Q4 of 2019, FossaSat-1's mission is to reduce overall development and launch cost by using fully in-house manufactured hardware and miniaturizing technology to decrease launch mass / volume and thus cost.

The use of fully in house manufactured hardware decreases cost, allows new technological development and increases mission specific flexibility. This former however also implies that a more complex manufacturing process has to be carried out which is not just limited to assembly and testing of the satellite as a whole unit and includes: PCB Manufacturing, Components Soldering, Electrical Testing, Space rating etc. These processes must be carried out in a controlled, organized and standardized manner.

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Modification Log

V1 FossaSat-1 Assembly and Testing Manual	First issue	29/06/2019

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1 Manufacturing

1.1 Introduction

This chapter will cover the manufacturing procedure at the Subsystem level, more specifically the individual PCB's which need to be soldered before the assembly of these can be carried out to form the final satellite. This process is obviously done in a cleanroom to avoid contamination of the flight components, an initial set of engineering models were initially manufactured in a "dirty" laboratory environment to validate their functionality. The procedures followed are exactly the same though.

1.2 Standards & Protocol

The ECSS-Q-ST-70-08C Space Product Assurance Soldering Standard (http://esmat.esa.int/ecss-q-st-70-08c.pdf) is to be followed during soldering and PCB assembly procedures.

Cleanroom protocol is specific to each facility; proper garments, entry procedures and precautions should be taken in order to avoid contamination.

1.3 Facility and Equipment

Manufacturing is to be done in an ISO 7 class cleanroom, more specifically the LABCADIO Juan Carlos University facility kindly provided to Fossa Systems for the completion of this project. This facility presents the following characteristics necessary for correct manufacturing:

- Facility Cleanliness, ECSS-Q-ST-70-08C article 5.2
- Environmental Conditions, ECSS-Q-ST-70-08C article 5.3
- Proper Lighting, ECSS-Q-ST-70-08C article 5.4
- ESD safety, ECSS-Q-ST-70-08C article 5.5. Grounded plugs and grounding ports.
- Fume Hood, very important for Soldering with regards to contamination and personnel safety.

The following equipment is necessary and will be used during the manufacturing process, it must be properly cleaned using IPA Isopropyl alcohol before entering the cleanroom.

Electrical Equipment:

- 30W Power Supply (With Mains Cable)
- Temperature Controlled Soldering Iron
- Hot Air Gun (With corresponding attachments)
- Visual inspection Digital Microscope (With corresponding cabling and PSU)
- 2x Digital Multimeters
- Multimeter and PSU breakout leads for testing
- Jumper Wires
- Laptop containing Schematics, PCB files and instructions (with charger)
- Precision Scale

- Camera
- FTDI Adapter (with Mini USB)
- SDR Radio and Arduino Ground Station
- Extensions lead / Multi Prong Adapter

Tools, Consumables and Non-electrical Equipment:

- Soldering Iron Tips and cleaning Sponge
- Solder Wire
- Solder Flux, with needles and syringes
- Solder Paste, with needles, syringes and spreading card for stencils
- AFA Aerosol Conformal Coating
- Snips
- Tweezers
- Needle Nose Pliers
- Caliper
- Scissors
- Screwdriver Set
- Fossa PocketQube Stand
- Pelican Case for Satellites
- IPA Isopropyl cleaning alcohol
- Sponge Swabs
- Loctite 222
- Kapton Tape (Double Sided & Thick)
- PCB Vice and spare PCB's
- Vacuum Pickup tool

ESD Equipment

- ESD Mat
- ESD Protection harness wiring
- ESD Bracelets
- ESD Bags
-

1.4 Setup and Placement

A single desk is necessary in the clean-room environment, this desk will be used for inspecting, testing and assembling components. The ESD Mat must be placed on the desk, personnel should be grounded as well as all electrical equipment on the desk. Assembly is to be done on the Fossa PocketQube Stand which should also be grounded.

All soldering shall be done in the fume hood, once components are soldered, they shall be cleaned in the fume hood using IPA alcohol and transferred to the clean room desk. Fume hood soldering equipment should also be grounded and using an ESD Mat and harness.

1.5 EPS Board

Two EPS boards shall be manufactured following this procedure. Prepare Schematic and PCB file to check component placement. Following the same procedure, a mock-up of this board is assembled in a “Dirty” environment to validate its functionality beforehand.

BOM 2x:

ID	Name	Designator	Footprint	Quantity
1	SPV1040	U1,U2,U3	TSSOP-8	3
2	1kohm R	R1,R6,R12	0603'	3
3	150kohm R	R4,R10,R16	0603'	3
4	330kohm R	R5,R11,R17	0603'	3
5	10uf C	C17,C4,C5,C9,C10,C14	0603'	6
6	1nf C	C1,C2,C7,C8,C11,C12	0603'	6
7	10uH	L2,L3,L1	5040	3
8	TC1262-3.3VDBTR	U5	SOT-223	1
9	1uf C	C16,C18,C3,C6,C13	0603'	5
10	510mohm R	R2,R3,R7	0603'	3
11	1kohm R	R8,R9,R13,R14,R15,R18	0603'	6
12	1*6P Header Conn	P2,P4	HDR-6X1/2.54	2
14	EPS PCB			1
15	PCB STENCIL			1

Step 1: Turn on fume hood and prepare all equipment and components for soldering, clean soldering iron / Hot air gun and check all temperatures are within limits (250 – 380c). **MAKE SURE ESD SAFE**

Step 2: Visually inspect the PCB and Stencil for incorrect traces or damage using microscope, clean PCB and stencil using IPA and sponge swabs.

Step 3: Using stencil apply solder paste to PCB, visually inspect correct application using microscope. Apply or remove Flux or Solder paste as necessary to the PCB. If alignment incorrect repeat application using NEW PCB or clean old with IPA.

Step 4: Using vacuum pickup tool and tweezers, place all components onto the board from smallest to largest. Do not add connectors

Step 5: Using swirling motion and temperature control, evenly heat the board incrementally trying to follow the reflow profile of the solder. (Preheat from 0 to 150c in 80s, hold 150c until 180s, heat to 245c until 240s, reduce to 100c by 360s)

Step 6: Clean all surfaces using IPA, visually Inspect all solder joints correct using microscope and if necessary, use soldering iron to fix. If cold weld visible repeat reflow profile after cooldown.

Step 8: Solder connectors using soldering Iron and clean using IPA.

Step 7: Place in ESD protective bag until testing.

1.6 OBC / Communication Board

Two OBC boards shall be manufactured following this procedure. Prepare Schematic and PCB file to check component placement. Following the same procedure, a mock-up of this board is assembled in a “Dirty” environment to validate its functionality beforehand.

BOM 2x:

ID	Name	Designator	Footprint	Quantity
1	Atmega 328P (Bootloaded)	U1	TQFP-32	1
2	100nF	C8,C3,C9,C7,C4,C6,C5,C1	0603'	8
3	10kohm R	R7,R6,R9,R11	0603'	4
4	8MHz Resonator	X2	3213	1
5	MAX6369KA+T	U7	SOT-23-8	1
6	6*1P Header	P3	HDR-6X1/2.54	1
7	TMP100NA/3KG4	U3	SOT-23-6	1
8	U.FL-R Conn	JP1	U.FL-R-SMT-1(10)	1
9	TPS2553DBVR	U6,U5	SOT-23-6	2
10	100kohm R	R3,R2	0603'	2
11	1uF C	C10,C2	0603'	2
12	INA226	U2	MSOP-10	1
13	150kohm	R4	0805'	1
14	RLIM	R5,R10	0603'	2
15	FDC855N	Q3,Q2	(SSOT-6)	2
16	FDN359BN	Q1	SOT-23(SOT-23-3)	1
17	1*6P Header Conn	P1,P2	HDR-6X1/2.54	2
18	4.7kohm R	R1,R8	0603'	2
19	SX1278T	U8	SX1262/68	1
14			EPS PCB	1
15			PCB STENCIL	1

Same procedure as 1.5

Note: Make special care to avoid solder under the RF Module and the UFL connector touching both GND pads.

1.7 Deployable Solar Cells

A total of 8 deployable solar panels need to be manufactured. The solar cells shall be opened only once in the clean room.

BOM 8x:

ID	Name	Quantity
1	TrisolX Solar Cells	16
2	0 Ohm Resistor	16
3	1.8 Ohm Resistor	1
4	Panel PCB	1

Step 1: Inspect and IPA clean the PCB, manually add the necessary solder paste to the GND pads on one side of the panel

Step 2: Place Solar cells on the PCB using vacuum tool. Using swirling motion and temperature control, evenly heat the board incrementally trying to follow the reflow profile of the solder. (Preheat from 0 to 150c in 80s, hold 150c until 180s, heat to 245c until 240s, reduce to 100c by 360s)

Step 3: Flip panel using paper on bottom to avoid scratching.

Step 4: Repeat Soldering Operation, CAREFUL DO NOT OVERHEAT AND DESOLDER BOTTOM

Step 5: Manually solder the 0Ohm and 1.8Ohm Resistor using liquid flux and solid core solder to the positive pad. Inspect and clean with IPA.

Step 6: Mask the connectors, screw holes and hinge zone using Kapton Tape. Clean zone in preparation for Spray. SPRAY ONLY INTERNAL SIDE

Step 7: When applying AFA care must be taken to ensure the can is not shaken before use. Shaking the can will introduce excessive air bubbles and will give a poor coating finish. The can should be held at 45°, and 200mm from the substrate to be coated. The valve should then be depressed when the can is pointing slightly off target and moved at about 100 mm/s across the target. To ensure the best coating results are achieved try to use a smooth sweeping motion with small overlap for successive rows. To ensure penetration of the coating beneath the components and in confined spaces, spray the assembly from all directions to give an even coating. After spraying, the boards should be placed in an air-circulating drying cabinet and left to dry.

Step 8: Cut power wires to length and solder using solid core and flux, clean with IPA and inspect.

1.8 Side Solar Panels

A total of 6 side solar panels need to be manufactured. The solar cells shall be opened only once in the clean room.

BOM 6x:

ID	Name	Quantity
1	TrisolX Solar Cells	8
2	0 Ohm Resistor	8
3	MAX400200	4
4	Panel PCB	1

Step 1: Inspect and IPA clean the PCB, manually add the necessary solder paste to diode pads on the solar panel.

Step 2: Place components on PCB and solder following reflow profile.

Step 3: Inspect and IPA clean the PCB, flip side, inspect and IPA clean, manually add the necessary solder paste to the GND pads on one side of the panel

Step 4: Place Solar cells on the PCB using vacuum tool. Using swirling motion and temperature control, evenly heat the board incrementally trying to follow the reflow profile of the solder. (Preheat from 0 to 150c in 80s, hold 150c until 180s, heat to 245c until 240s, reduce to 100c by 360s)

Step 6: Manually solder the 0OhmResistor using liquid flux and solid core solder to the positive pad. Inspect and clean with IPA.

Step 7: Mask the connectors, screw holes and hinge zone using Kapton Tape. Clean zone in preparation for Spray. SPRAY ONLY SOLAR SIDE

Step 8: When applying AFA care must be taken to ensure the can is not shaken before use. Shaking the can will introduce excessive air bubbles and will give a poor coating finish. The can should be held at 45°, and 200mm from the substrate to be coated. The valve should then be depressed when the can is pointing slightly off target and moved at about 100 mm/s across the target. To ensure the best coating results are achieved try to use a smooth sweeping motion with small overlap for successive rows. To ensure penetration of the coating beneath the components and in confined spaces, spray the assembly from all directions to give an even coating. After spraying, the boards should be placed in an air-circulating drying cabinet and left to dry.

Step 9: Cut power wires to length and solder using solid core and flux, clean with IPA and inspect.

1.9 Antenna Panel

Due to location of the vector network analyser, the antenna panel must be tested beforehand at a "dirty" facility. This first assembly consists of the bare PCB with two paint stripped tape measure frequency specific cut strips that have been drilled and attached to the former using M2 Bolts, Loctite 222 and Locking nuts. Explanation on testing this preliminary piece can be found in 2.7

BOM 2x:

ID	Name	Quantity
1	TrisolX Solar Cells	4
2	0 Ohm Resistor	4
3	MAX400200	3
4	UFL Connector	1
5	M2*5mm Bolt	4
6	Locking Nuts	4
7	Panel PCB	1

Once this part has been calibrated to frequency, the panel is cleaned using IPA before entering the cleanroom.

Step 1: Inspect and IPA clean the PCB, manually add the necessary solder paste to diode pads on the solar panel.

Step 2: Place components on PCB and solder following reflow profile.

Step 3: Inspect and IPA clean the PCB, flip side, inspect and IPA clean, manually add the necessary solder paste to the GND pads on one side of the panel

Step 4: Place Solar cells on the PCB using vacuum tool. Using swirling motion and temperature control, evenly heat the board incrementally trying to follow the reflow profile of the solder. (Preheat from 0 to 150c in 80s, hold 150c until 180s, heat to 245c until 240s, reduce to 100c by 360s)

Step 6: Manually solder the 0OhmResistor using liquid flux and solid core solder to the positive pad. Inspect and clean with IPA.

Step 7: Cut power wires to length and solder using solid core and flux, clean with IPA and inspect.

1.10 Baseplate

2 baseplate panels need to be manufactured.

BOM x2

ID	Name	Quantity
1	TrisolX Solar Cells	8
2	0 Ohm Resistor	8
3	MAX400200	2
4	D2F Limit Switch	2
5	FPC 6*1P Connector	1
6	Baseplate PCB	1

Step 1: Inspect and IPA clean the PCB, manually add the necessary solder paste to diode pads on the solar panel.

Step 2: Place components on PCB and solder following reflow profile.

Step 3: IPA clean, inspect and manually solder the FPC Connector.

Step 4: Inspect and IPA clean the PCB, flip side, inspect and IPA clean, manually add the necessary solder paste to the GND pads on one side of the panel

Step 5: Place Solar cells on the PCB using vacuum tool. Using swirling motion and temperature control, evenly heat the board incrementally trying to follow the reflow profile of the solder. (Preheat from 0 to 150c in 80s, hold 150c until 180s, heat to 245c until 240s, reduce to 100c by 360s)

Step 6: Manually solder the 0OhmResistor using liquid flux and solid core solder to the positive pad. Inspect and clean with IPA.

Step 7: Solder limit switches, clean IPA and inspect.

Step 8: Cut power wires to length and solder using solid core and flux, clean with IPA and inspect.

Step 9: Screw limit switches using locknuts and Loctite.

1.11 Top Plate Solar Panel

2 top plate panels need to be manufactured.

BOM x2

ID	Name	Quantity
1	TrisolX Solar Cells	8
2	0 Ohm Resistor	8
3	MAX400200	1
4	TMP100 Sensor	1
5	Panel PCB	1

Step 1: Inspect and IPA clean the PCB, manually add the necessary solder paste to diode pads on the solar panel.

Step 2: Place components on PCB and solder following reflow profile.

Step 3: Inspect and IPA clean the PCB, flip side, inspect and IPA clean, manually add the necessary solder paste to the GND pads on one side of the panel and the TMP pads.

Step 4: Place Solar cells on the PCB using vacuum tool and TMP. Using swirling motion and temperature control, evenly heat the board incrementally trying to follow the reflow profile of the solder. (Preheat from 0 to 150c in 80s, hold 150c until 180s, heat to 245c until 240s, reduce to 100c by 360s)

Step 5: Manually solder the 0OhmResistor using liquid flux and solid core solder to the positive pad. Inspect and clean with IPA.

Step 8: Cut power wires to length and solder using solid core and flux, clean with IPA and inspect.

2 Sub-Assembly Testing

2.1 EPS Testing

2.1.1 Voltage Conformity Test

Using the lab bench power supply set to 2.33v and 233mA, connect to X input on the EPS Board. Measure the Output voltage at battery and at regulated 3.3v LDO BUS voltage.

Voltage at Battery should be 4.1v +/- 0.03v. If outside tolerance, replace both voltage set resistors.

Voltage at LDO should be 3.3v +/- 0.01v. If outside tolerance and Voltage at battery correct, replace LDO.

Check voltage using both multimeters, cycle the test minimum 5 times.

REPEAT FOR Y and Z CIRCUITS

2.1.2 Battery Float Charge

Using the lab bench power supply set to 2.33v and 233mA, connect to X input on the EPS Board. Connect the Li-Ion Battery to the EPS board. Start timer. Connect precision mustimeter between charging leads to measure charging current. Connect other multimeter to monitor charging voltage.

Initial charging efficiency on start-up should be minimum 85%.

Initial battery voltage should be 3.9v or under. Final battery voltage once power draw is <10mW should be 4.1v +/- 0.03v. If outside tolerance, replace both voltage set resistors.

REPEAT FOR Y and Z CIRCUITS

2.1.3 Low batt voltage Charge

Using the lab bench power supply set to 2.33v and 233mA, connect to X input on the EPS Board. Connect the Li-Ion Battery to the EPS board. Start timer. Connect precision multimeter between charging leads to measure charging current. Connect other multimeter to monitor charging voltage.

Initial charging efficiency on start-up should be minimum 85%.

Initial battery voltage should be **3.5v**. Final battery voltage once power draw is <10mW should be 4.1v +/- 0.03v. If outside tolerance, replace both voltage set resistors.

REPEAT FOR Y and Z CIRCUITS

2.1.4 Efficiency at different currents

Connect PSU to X input on the EPS Board. Connect the Li-Ion Battery or ideally a constant load to the EPS board. Connect precision multimeter between charging leads to measure charging current. Connect other multimeter to monitor output voltage.

Using the lab bench power supply starting from 0mA at 2.33v, increment in 30mA steps and measure input and output mW. Plot graph with data to ensure above 75% efficiency in ALL scenarios. **REPEAT FOR Y and Z CIRCUITS**

2.1.5 Triple Input

Using 3 different Power supplies set to 2.33v 230mA. Connect to each X, Y and Z input on the EPS. Measure current and voltage on each input and output current and voltage when connected to Li-ion battery. Cycle minimum 3 charges from 3.7v to 4.1 and calculate efficiency every 0.1V.

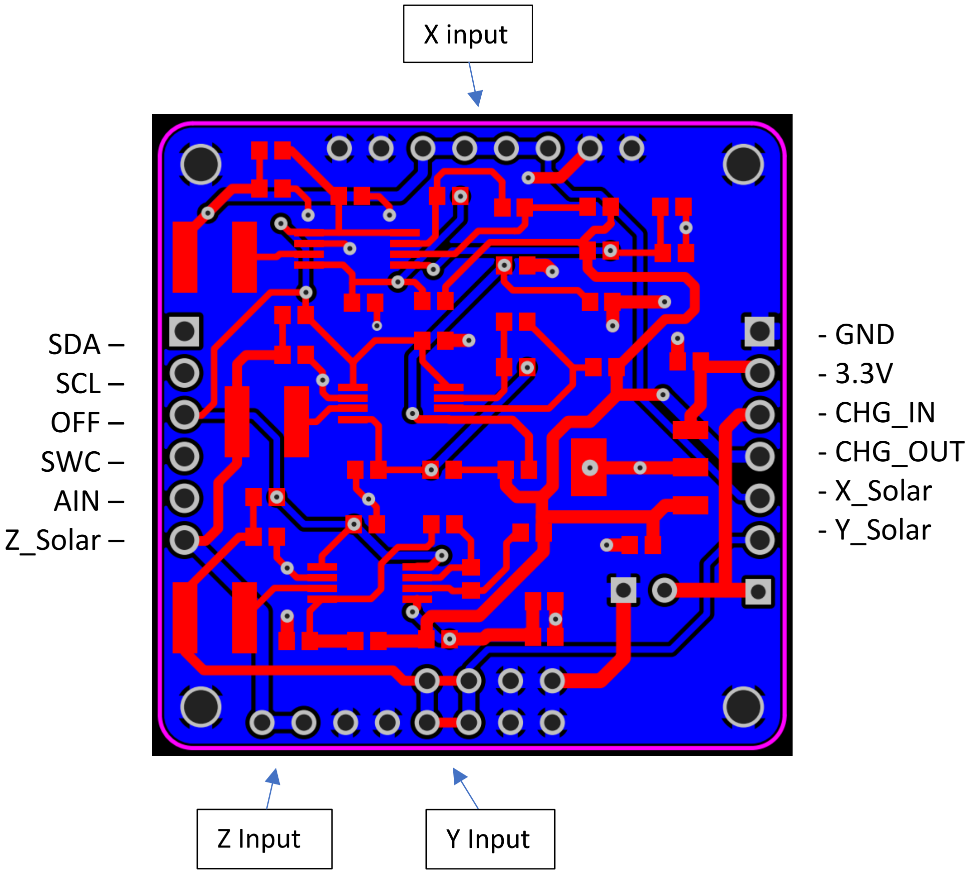
2.1.6 Reverse Current

Measure power draw into the circuit when battery connected. Should be <1uA.

2.1.7 OFF Pin

Pull LOW Off pin while X circuit powered to 2.33v and 230mA, voltage should be under 3v at output. R**EPEAT FOR Y and Z CIRCUITS**

2.1.8 PCB Pinout Diagram



EPS Test Measurement, BOARD A

	Voltage X (V)		Voltage Y (V)		Voltage Z (V)	
Initial Charge Voltage						
LDO BUS Voltage						
Float Voltage Battery						
	Input (V)	Input (mA)	Input (mA)	Output (V)	Output (mA)	Efficiency
3.5v Charge EFF						
3.6v Charge EFF						
3.7v Charge EFF						
3.8v Charge EFF						
3.9v Charge EFF						
4v Charge EFF						
4.1v Charge EFF						
	Eff X		Eff Y		Eff Z	
25mA						
50mA						
75mA						
100mA						
125mA						
150mA						
175mA						
200mA						
225mA						
250mA						
	Voltage X (V)		Voltage Y (V)		Voltage Z (V)	
OFF PIN						

EPS Test Measurement, BOARD B

	Voltage X (V)		Voltage Y (V)		Voltage Z (V)	
Initial Charge Voltage						
LDO BUS Voltage						
Float Voltage Battery						
	Input (V)	Input (mA)	Input (mA)	Output (V)	Output (mA)	Efficiency
3.5v Charge EFF						
3.6v Charge EFF						
3.7v Charge EFF						
3.8v Charge EFF						
3.9v Charge EFF						
4v Charge EFF						
4.1v Charge EFF						
	Eff X		Eff Y		Eff Z	
25mA						
50mA						
75mA						
100mA						
125mA						
150mA						
175mA						
200mA						
225mA						
250mA						
	Voltage X (V)		Voltage Y (V)		Voltage Z (V)	
OFF PIN						

2.2 OBC Testing

Power via FTDI will not reach the SX1268 Chip, jumper wire to 3.3v in shall be used following the MPPT pinout.

2.2.1 Analog Read.

Upload using 3.3v FTDI simple example sketch, check ATMEGA 328P Working correctly. Check system reboots after 30s

2.2.2 Watchdog Test

Upload watchdog test and ensure system does not reboot

2.2.3 TMP100 Test.

Upload TMP100 test via FTDI and check serial for temperature difference. Use external temp sensor to contrast values.

2.2.4 INA226 Test

Upload INA226 test via FTDI and check serial for bus voltage.

2.2.5 Mosfet Test

Upload blink and check pin 8 and pin 9 functionality. Cycle 5 times.

TBD: Load test of the mosfet with deployable solar panel resistor to be carried out at subsystem level individually or as whole satellite unit.

2.2.6 SX1268 Test

Test the following example in high to low bandwidth scenarios, check no lost packets or drift on SDR.

DO NOT TRANSMIT WITHOUT LOAD ANTENNA

FSK RX/TX
LoRa RX/TX
RTTY

Leave transmitting at 20dBm every 5s for 5s for minimum 2h.

2.2.7 OFF Test

Pull OFF pin low digitally, measure continuity.

2.2.8 Current Draw Test

Measure current draw of the OBC/Comms in the following situations:

	Standby	LoRa RX	LoRa/RTTY TX	Low-Power
Current (mA)				

2.3 Deployable / Fixed Solar Panel Testing

2.3.1 Ideal Diode Test

Using the continuity function on the multimeter, make sure the diode is not allowing reverse power flow.

2.3.2 Expected Current / Voltage Measurement

Using the fixed WAVELABS-SINUS-70 AAA Solar Simulator at 1000w/m^2 verify that panels have the following characteristics:

Type	Maximum Power Current (mA)	Maximum Power Voltage (V)	Voltage Open Circuit (V)
4 Cell Panel	58.4	2.28	2.57
8 Cell Panel	116.8	2.28	2.57

Tolerances should not exceed +/- 0.1V and +/- 5mA in a nominal case due to AFA Conformal coating or external disturbances.

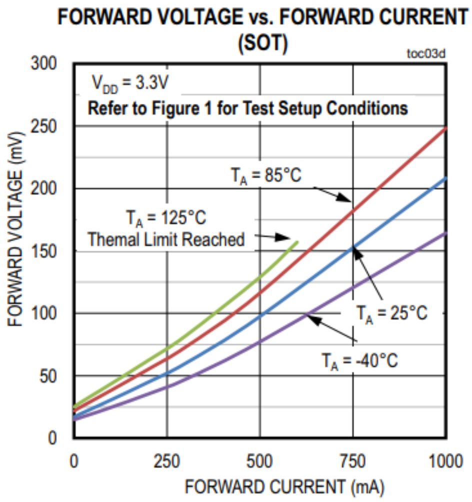
Other fixed lighting may be used for testing and comparing between panels but solar simulator is recommended. Use masking tape or similar to keep track of panel number. Measure Voltages and Currents in table

See 2.3.4 for writing down data in table.

2.3.3 Voltage Drop

The MAX40200 present a forward voltage or voltage drop as shown in the following graph.

Measure the drop in 2.3.4 table and ensure not above expected result on graph.



2.3.4 Solar Cell Efficiency

The efficiency of the TrisolX solar cell cut-offs is of 28%, their approximate active cell area is 1.3cm^2.

Calculate efficiency using following formula: $Eff = \frac{P_{max}}{E \cdot A_C} \cdot 100$

Where:

Pmax = Maximum Panel power in Watts

E = Incident radiation flux (watts / m^2)

A_c = Area of collector in m^2 (1.3 x 10^{-4} m^2 * nº of cells)

2.3.5 Measurement Tracking

DEPLOYABLE PANELS	Open Circuit (mA)	Open Circuit (V)	Maximum (mA)	Maximum (V)	Pre-Diode Open (V)	Eff (%)
Deployable Panel A1 Internal						
Deployable Panel A1 External						
Deployable Panel A2 Internal						
Deployable Panel A2 External						
Deployable Panel A3 Internal						
Deployable Panel A3 External						
Deployable Panel A4 Internal						
Deployable Panel A4 External						
Deployable Panel B1 Internal						
Deployable Panel B1 External						
Deployable Panel B2 Internal						
Deployable Panel B2 External						
Deployable Panel B3 Internal						
Deployable Panel B3 External						
Deployable Panel B4 Internal						
Deployable Panel B4 External						

FIXED PANELS	Open Circuit (mA)	Open Circuit (V)	Maximum (mA)	Maximum (V)	Eff (%)
Fixed Panel A1					
Fixed Panel A2					
Fixed Panel A3					
Antenna Panel A					
Top Panel A					
Baseplate Panel A					
Fixed Panel B1					
Fixed Panel B2					
Fixed Panel B3					
Antenna Panel B					
Top Panel B					
Baseplate Panel B					

2.4 Bottom Plate Testing

2.4.1 EGSE Connector functionality

Using the EGSE FPC Ribbon Cable and the FPC Breakout, check continuity between the cables and the Breakout. Check continuity to batter connection Lead.

2.4.2 Limit Switch Circuit

Check continuity when both limit switches are pressed at the same time.

2.5 Top Plate Testing

2.5.1 TMP100 Test

Using external Arduino Pro Mini, test TMP100 temperature and contrast to actual temperature.

2.6 Battery Testing

2.6.1 Battery Discharge / Charge Cycle

Using the IMAX B6, Charge the battery to 4.1v. Once stable, discharge the battery to 3.3v.

Measure total capacity and repeat cycle 3 more times.

Cycle 1

	Dis Capacity (mAh)	Dis Time (h)	CHA Capacity (mAh)	CHA Time (h)
Battery A				
Battery B				

Cycle 2

	Dis Capacity (mAh)	Dis Time (h)	CHA Capacity (mAh)	CHA Time (h)
Battery A				
Battery B				

Cycle 3

	Dis Capacity (mAh)	Dis Time (h)	CHA Capacity (mAh)	CHA Time (h)
Battery A				
Battery B				

2.6.2 Load Testing / Temperature

Using an adjustable load, discharge the battery at 0.25C, 0.5C and 1C starting from a full charge voltage of 4.1v until 3.5v. Attach thermocouple to the battery and measure temperature during load test.

	Max Temp (Cº)	Discharge Time (h)
1.5A Batt A		
1.5A Batt B		
1A Batt A		
1Batt B		

2.7 Antenna Panel Testing

2.7.1 SWR Return Loss Testing

The antenna panel measurements mainly consist in analysing the SWR performance of the antenna. Antenna panel should have both aluminium structures attached, centre stack attached, external panels, all grounded accordingly.

	VSWR	Db
Antenna A		
Antenna B		

ADDITIONAL NOTES ON TESTING:

3 Satellite Assembly

This chapter is intended to cover the assembly of the satellite's subsystems into a single unit. This process is to be carried out using the FOSSA PocketQube holder, partly inside the fume hood due to the necessity to solder wires for proper assembly. Note that some testing procedures occur before complete assembly has been finished.

3.1 Components List

The following components are necessary for the assembly: (x2)

PCBs	**Satellite A**	**Satellite B**
- EPS Board		
- OBC Board		
- 3x Fixed Solar Panels		
- 4x Deployable Solar Panels		
- Bottom Solar Panel		
- Top Solar Panel		
- 2x Name Plate PCBs.		
Mechanical		
- Bottom Inner Structure CNC		
- Upper Hinge Structure CNC		
- 4x Hinges CNC		
- 4x Torsion Springs		
- 4x Conical Springs		
- Magnet Holder CNC		
- 4x 35mm standoffs		
- PCB Stack standoffs (as needed)		
- Locking Nuts M2		
- M2 Nuts		
- M2 Bolt Selection		
Miscellaneous		
- 2x N35 Magnets		
- Hysteresis Material		
- Silicone Wire		
- Li-Ion Battery		
- Kapton Tape		
-		
- U. FL 5cm Cable		
- Dyneema Wire		

3.2 Assembly Procedure

3.2.1 Centre Stack

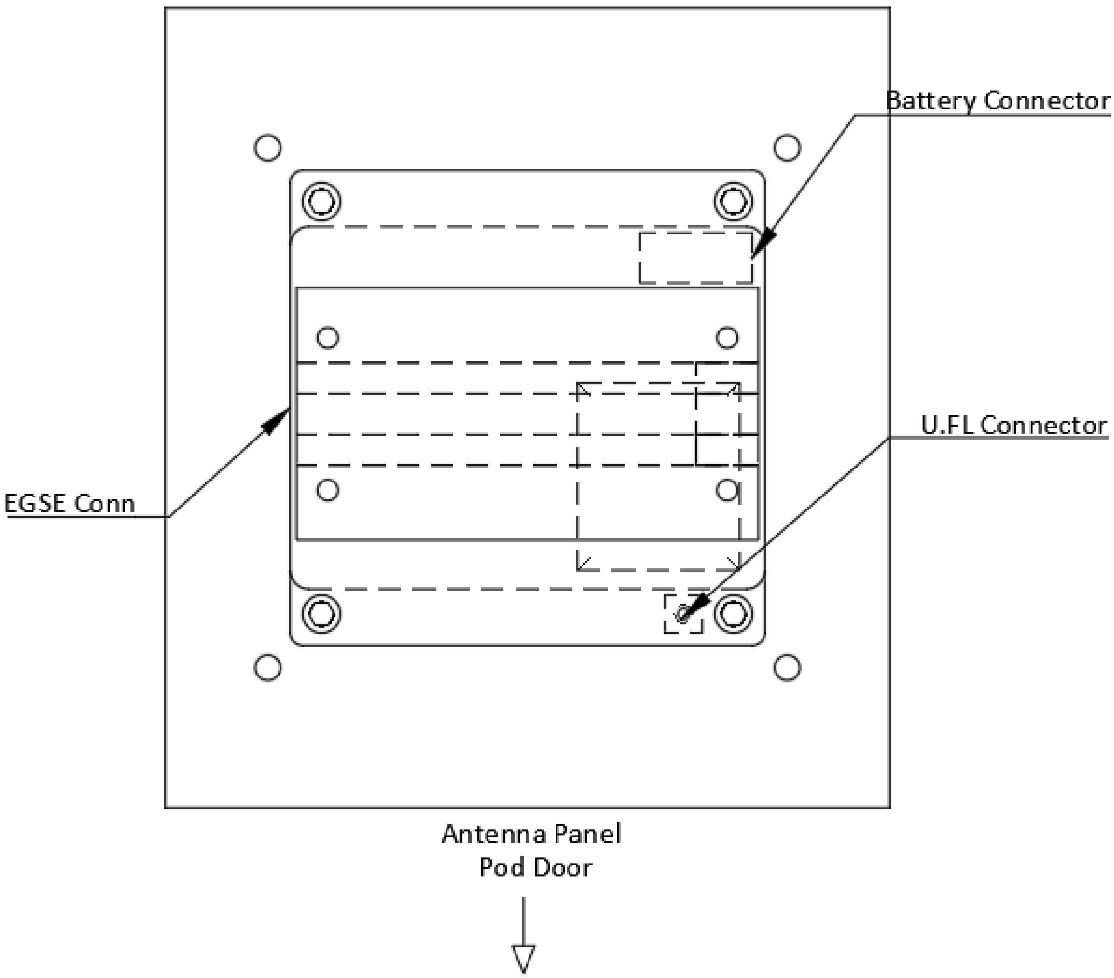
Before assembly refer to 4.1 with regards to preliminary stack testing.

Solar Panels should be soldered to the EPS Board before centre stack assembly, cutting wires to estimated length beforehand and leaving panels to side. Leave outer Z axis solder connector free to solder the Top Solar panel later on in assembly.

Using the M2 standoffs or M2 Rod (TBD), assemble the centre stack accordingly following this order from bottom to top: EPS Board, OBC Board, Battery (Make sure Kapton isolation to prevent short and that the batter is not touching metal structure for heat dissipation), Name Plate, Name Plate.

The top-most nameplate is used to hold the passive attitude control system. Using 4 M2 Bolts, tighten the CNC structures in order to hold the magnet/s in place. If necessary, use Kapton tape to enlarge magnets (do not deviate axis).

Board direction is critical, follow the diagram below.



Magnet orientation is critical, South pole should be facing outward panel at 55º angle as shown in the diagram below.