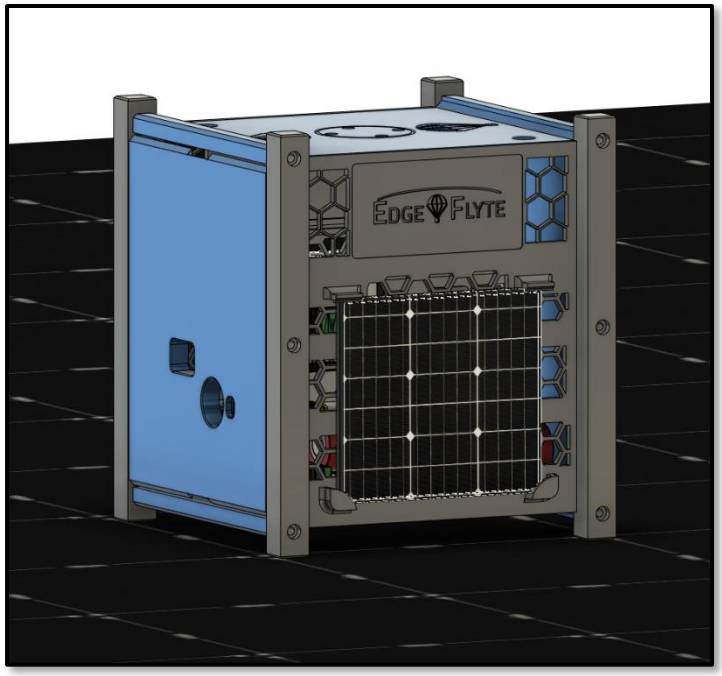


CubeSat Kit

Assembly Guide

Kit Description

Introducing the Educational CubeSat Kit, an all-in-one educational package designed to demystify satellite technology and space science. This 1U CubeSat Kit replicates the real deal, with onboard electronics, solar panels, atmospheric sensors, and a transceiver for wireless communication. The kit provides comprehensive resources for hands-on learning, fostering STEM education, problem-solving, and project-based learning. It's perfect for schools, hobbyists, STEM clubs, and anyone passionate about exploring space. Embark on your space journey with this inspiring educational tool!

Kit Outcomes

This miniature satellite kit provides students with a unique opportunity to gain practical insights into satellite design, construction, and deployment. One of the key outcomes of working with this kit is the development of critical problem-solving skills as students tackle real-world engineering challenges. Additionally, this kit can spark a lifelong passion for space exploration and technology, inspiring the next generation of scientists and engineers. Furthermore, CubeSat projects often result in tangible accomplishments, such as successful launches and data collection, reinforcing the value of teamwork and persistence in achieving scientific goals. This CubeSat Kits offers a dynamic and engaging platform for students to learn, explore, and engage in the exciting field of space exploration.

For inquiries, assistance, or technical support related to this manual, please feel free to reach out to our dedicated support team. We are here to help you with any questions or concerns you may have. Your feedback and input are invaluable to us, and we are committed to providing the best possible assistance.

Contact Information:

Technical Support Email: cs@edgeflyte.com

Phone Support: +1 (307) 202-8309

Website: www.edgeflyte.com/contact

Our team is available during our regular business hours, and we aim to respond to your queries promptly.

Thank you for choosing EdgeFlyte, and we look forward to assisting you with your technical needs.

Table of Contents

1.0 | Systems Overview

Section Highlights:

This section highlights the main internal systems of the 1u CubeSat. It additionally contains information about sensor integration, module expansion, test pads, and system depictions.

1.1
Main Control Board (MCB)

The Main Control Board (MCB) functions as the central control of the CubeSat. The primary microcontroller, a Raspberry Pi Pico (RP2040), interfaces with the rest of the MCB sensors, and communicates with the rest of the CubeSat's onboard and connected modules. To fit inside the EdgeFlyte 1u CubeSat frame, the board is 83x83mm at a 1mm board thickness. Additionally, there is a 1.5mm 'keep out zone' on the right and left sides of the board to ensure proper placement inside the frame. A list of onboard components is as follows:

- RPI Pico (RP2040)
- NRF24L01 Module
- AT-09 Bluetooth Low Energy Module
- Micro SD Card Receptacle
- Buzzer
- 3.5mm Audio Jack Receptacle
- RGB Indicator Light
- MPU9250 IMU
- SHT3x Series Temp. and RH Sensor
- NEO 6m GPS Module

Additionally, the MCB is equipped with expansion ports which can be interfaced with compatible sensors, modules, and units. Additional programming may be necessary for attached modules; please see section 6 for more information. A list of expansion ports is as follows:

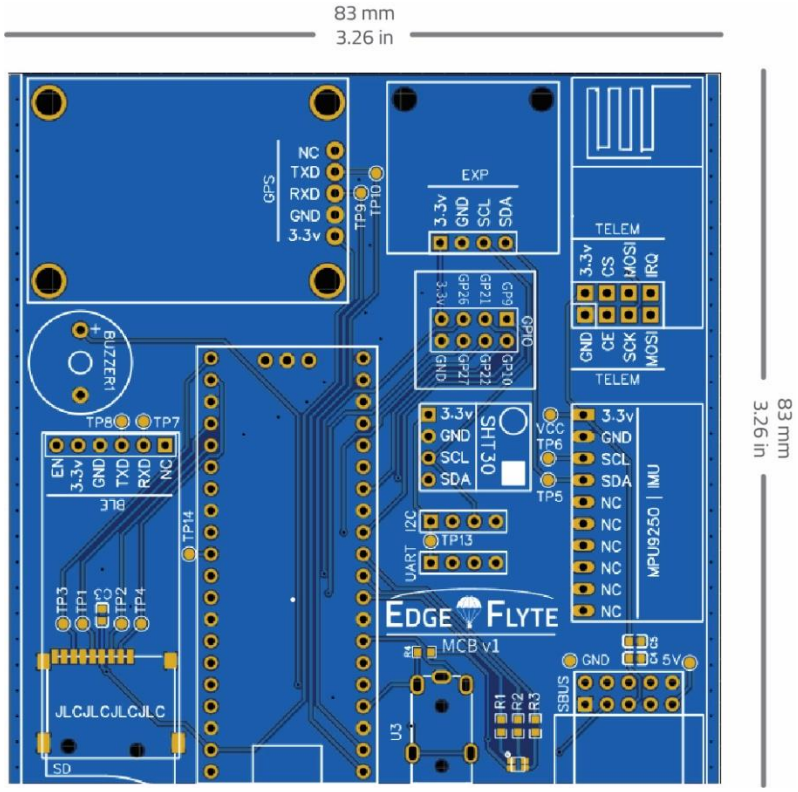
- EXP (I2C)
- GPIO (8 pin GPIO Header)
- I2C
- UART

The MCB also features a series of test pads, useful when diagnosing problems, observing inter-module communications, and ensuring nominal states. In-depth information about these pads can be found in section *6.2 Schematics*. A brief list of these pads and their connections is as follows:

- TP1: SPI SCK
- TP2: SPI MOSI
- TP3: SPI MISO
- TP4: SD CS
- TP5: I2C SDA
- TP6: I2C SCL
- TP7: UART1 TX
- TP8: UART1 RX
- TP9: UART0 TX
- TP10: UART0 RX
- 5V: USB 5v
- VCC: 3.3v BMS Input
- TP13: Board 3.3v
- TP14: RESET
- GND: Board Ground

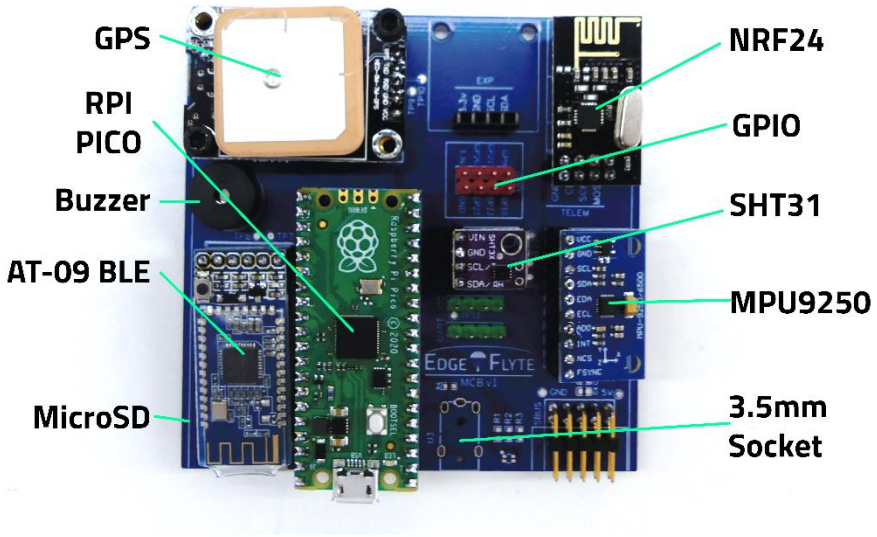
Raw Board

Pictured is the MCB without any components. *Fig 1.1.1*



Assembled Board

Pictured is the MCB fully assembled additionally labeling the components. *Fig 1.1.2*

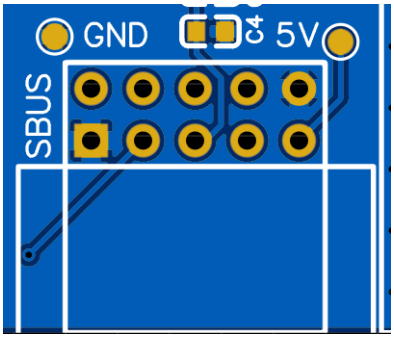


Component Functions

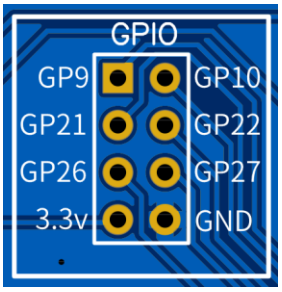
Neo 6m GPS Module	Used for coordinate positioning of the CubeSat.
Buzzer	Operating through 3.3v PWM signals, used to notify system status.
AT-09 BLE Module	Used for connecting to the CubeSat from a mobile device.
SHT3x Module	Senses the immediate surroundings Temperature and Relative Humidity.
RPI Pico (RP2040)	Controls entire CubeSat systems.
NRF24L01 Module	Establishes a telemetry link between the CubeSat and the ground station.
MPU9250 IMU	Used for determining the exact orientation of the CubeSat through acceleration, gyroscopic, and magnetic sensing.
MicroSD Card Socket	Used to log all system data to an attached Micro SD card.

3.5mm Socket	When connected to the ‘Remove Before Flight’ tag, enables a pre-flight mode of the system. Additionally, can be interfaced using UART to access the MCB information and configuration.
SBUS Header	Handles inter-board communication and board power.

IO & Expansion Ports

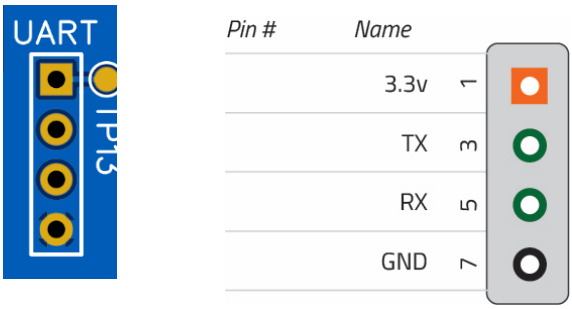


Pin #	Name			Name	Pin #
	0v GND	1	2	Bus TX	
	Bus RX	3	4	Bus 3.3v	
	CH1 3.3v	5	6	CH2 3.3v	
	CH3 3.3v	7	8	CH4 5v	
	5v Input	9	10	0v GND	



Pin #	Name			Name	Pin #
9	GPIO 9	1	2	GPIO 10	10
21	GPIO 21	3	4	GPIO 22	22
26	GPIO26	5	6	GPIO 27	27
	3.3v	7	8	0v (Ground)	

Pin #	Name	
	3.3v	1
	SDA	3
	SCL	5
	GND	7



For information on how to interface with these IO and Expansion Ports, please see refer to section 6.

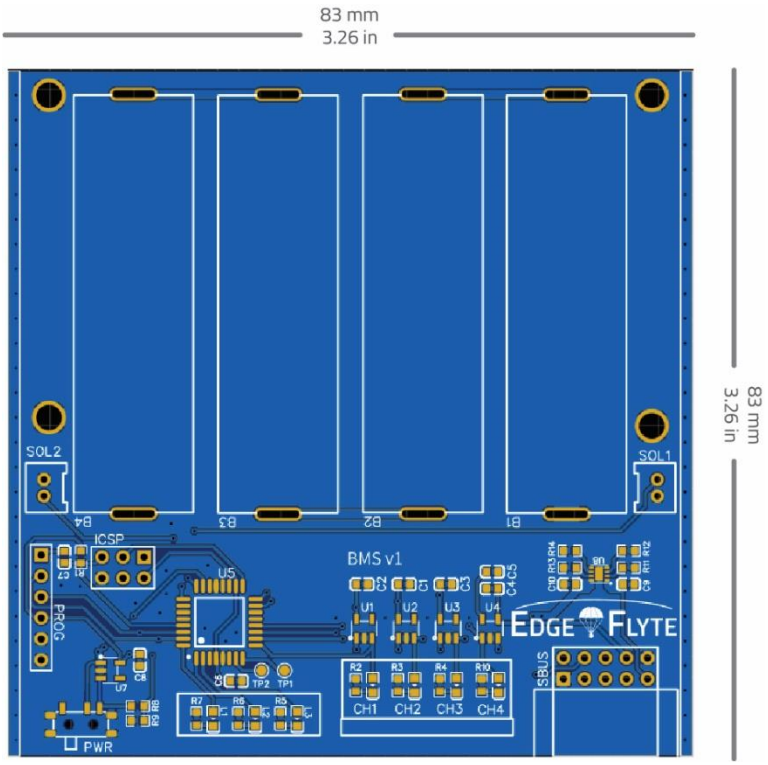
1.2
Battery Management System (BMS)

The Battery Management System (BMS) v1 functions as primary power source for the CubeSat. Onboard, the system features a NiMH/NiCad battery system, four independent LDO regulators, and solar cell inputs. It is capable of supplying power to three independent channels at 3.3v, 150mA. Additionally, it is capable of outputting one 5v channel at 250mA and inputting 5v at 800mA for charging the battery cells. A list of onboard components is as follows:

- Atmega328PB
- 4x AA size NiCad Batteries
- 4x Low Drop Out Regulators
- 1x System Power Switch
- 2x Solar Panel Connectors

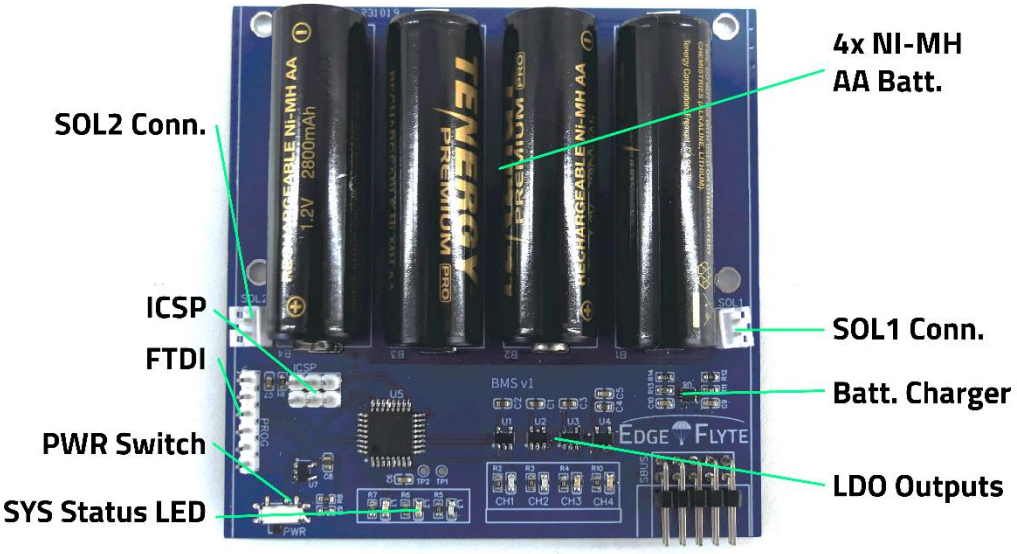
Raw Board

Pictured is the BMS without any components. *Fig 1.2.1*



Assembled Board

Pictured is the BMS v1 fully assembled additionally labeling the components. *Fig 1.2.2*



Component Functions

SOL1 & SOL2	Used to connect solar cells to the CubeSat.
CH1-4 LDO	Used to regulate and switch current to Channels 1-4. CH1-3 operates at 3.3v. CH4 operates at 5v.
Battery Charger Circuit	Charges the NiCad Battery Bank from the 5v received from the MCB USB IN.
4s 1p NiCad Battery Bank	Main power reserve for the CubeSat.
PROG and ICSP	Used to interface the Atmega328PB chip.
SBUS Header	Handles inter-board communication and board power.

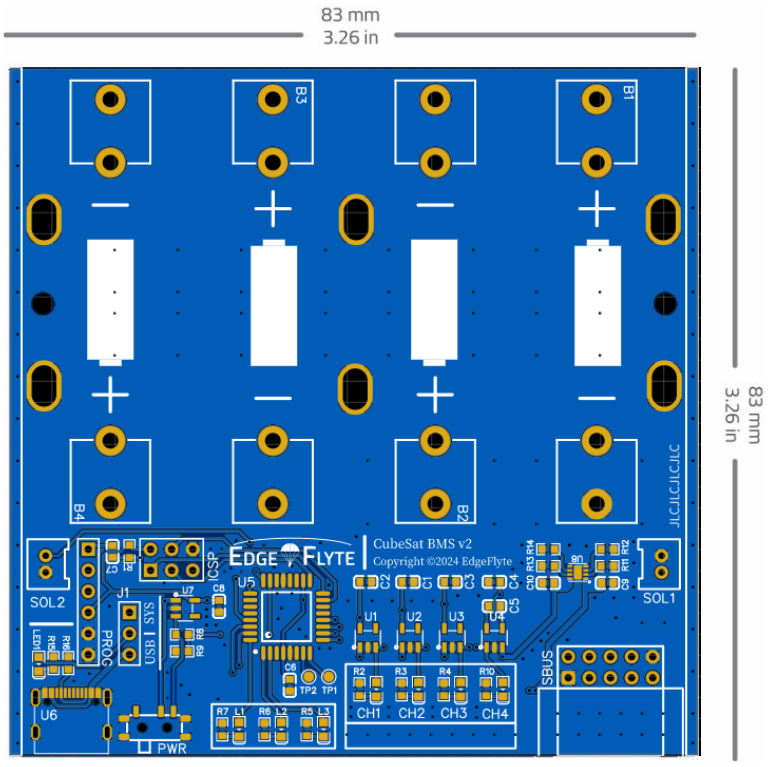
BMS v2

The Battery Management System (BMS) v2 functions identical to BMS v1, with a few added changes. Onboard, v2 includes a USB-C port and power jumper (J1) switch for charging selecting. Additionally, batteries are no longer directly soldered to the board itself. This allows flexibility for using both rechargeable and non-rechargeable AA batteries. *NOTE: when using non-rechargeable AA batteries, disconnect the jumper on J1 to disconnect the charging functionality entirely.* A list of onboard components is as follows:

- Atmega328PB
- 4x AA Battery Holder (NiMh/Alkal.)
- 3x 3.3v Low Drop Out Regulators
- 1x 5v Regulator
- 1x System Power Switch
- 2x Solar Panel Connectors
- 1x USB-C Socket
- 1x Charge Selection Jumper

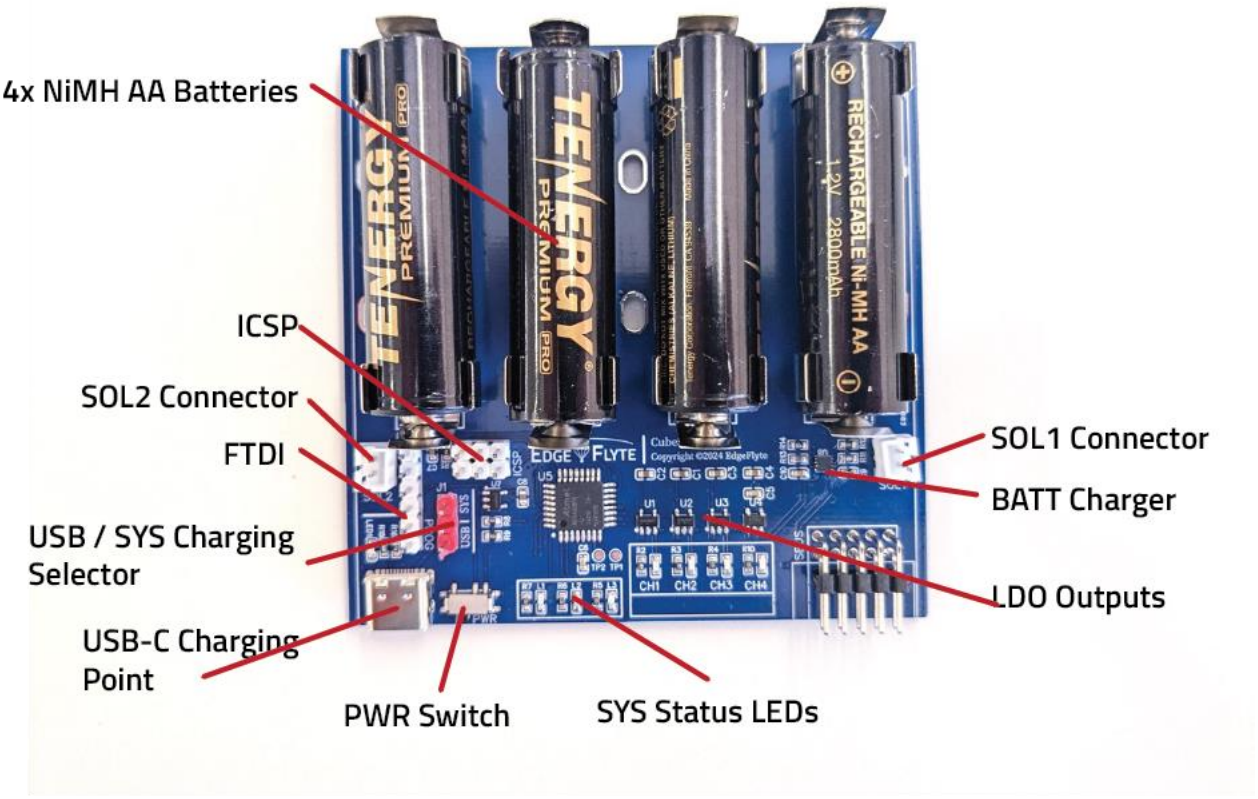
Raw Board

Pictured is the BMS v2 board without any components. *Fig 1.2.3*



Assembled Board

Pictured is the BMS v2 fully assembled additionally labeling the components. *Fig 1.2.4*



Component Functions

SOL1 & SOL2	Used to connect solar cells to the CubeSat.
CH1-4 LDO	Used to regulate and switch current to Channels 1-4. CH1-3 operates at 3.3v. CH4 operates at 5v.
BATT Charger	Charges the NiCad Battery Bank from either the USB-C port or from the SYS power.
4s 1p NiCad Battery Bank	Main power reserve for the CubeSat.
PROG and ICSP	Used to interface the Atmega328PB chip.
SBUS Header	Handles inter-board communication and board power.
USB/SYS CHG Point	Switches between USB-C power and SYS for charging.

1.3
Atmospheric Sensing Board (ASB)

The Atmospheric Sensing Board (ASB) is an integrated suite of sensors tasked with measuring atmospheric conditions.

A list of onboard components is as follows:

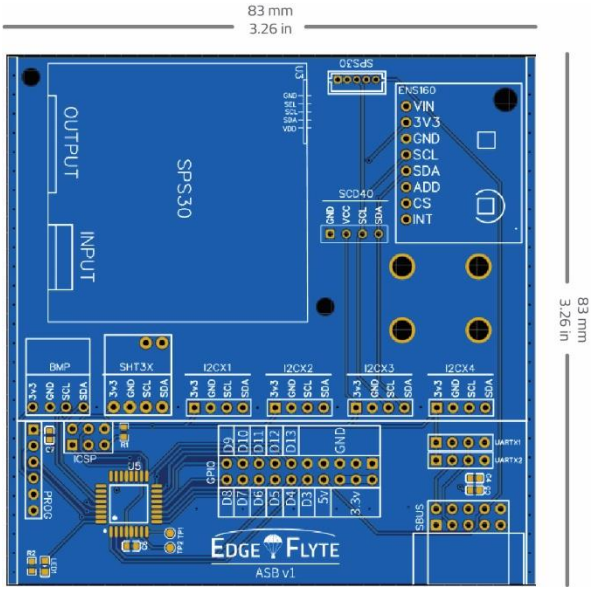
- Atmega328PB
- BMP180 Pressure Sensor
- SHT31 Temp. and RH Sensor
- ENS160 Multi-Gas sensor
- SCD40 CO2 Sensor
- SPS30 Particulate Matter Sensor

Additionally, the ASB is equipped with expansion ports which can be interfaced with compatible sensors, modules, and units. Additional programming may be necessary for attached modules; please see section 6 for more information. A list of expansion ports is as follows:

- GPIO (20 pin GPIO Header)
- 4x I2C
- 2x UART

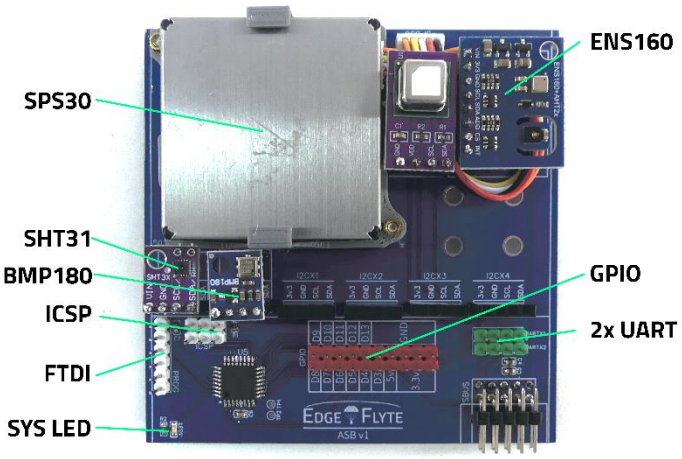
Raw Board

Pictured is the ASB without any components. *Fig 1.3.1.*



Assembled Board

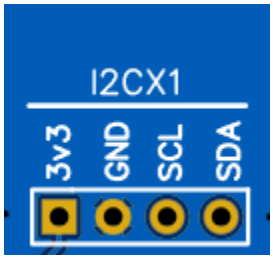
Pictured is the ASB fully assembled additionally labeling the components. *Fig 1.3.2*



Component Functions

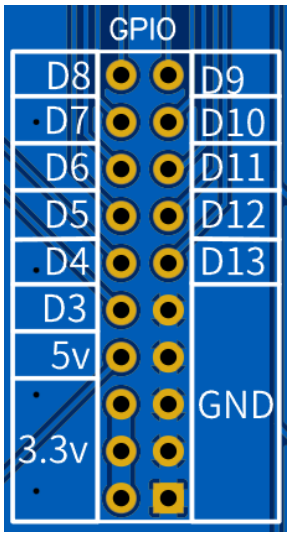
Atmega328PB	Main processor.
BMP180	Senses atmospheric pressure.
SHT31	Senses atmospheric temperature and relative humidity.
SPS30	Measures atmospheric particulate matter density and particulate sizes.
ENS160	Detects the presence of volatile organic compounds (VOCs) including ethanol, toluene, hydrogen, and oxidizing gases.
SCD40	Senses carbon dioxide (CO2).
SBUS Header	Handles inter-board communication and board power.
20 Pin GPIO Header	Used for expansion and interfacing other atmospheric sensors.

IO & Expansion Ports



Pin #	Name		
	3.3v	1	
	SDA	3	
	SCL	5	
	GND	7	

Pin #	Name		
	3.3v	1	
	TX	3	
	RX	5	
	GND	7	



Pin #	Name				Name	Pin #
	0v GND	1		2	3.3v	
	0v GND	3		4	3.3v	
	0v GND	5		6	3.3v	
	0v GND	7		8	CH4 5v	
	0v GND	9		10	GPIO 3	3
13	GPIO 13	11		12	GPIO 4	4
12	GPIO 12	13		14	GPIO 5	5
11	GPIO 11	15		16	GPIO 6	6
10	GPIO 10	17		18	GPIO 7	7
9	GPIO 9	19		20	GPIO 8	8

For information on how to interface with these IO and Expansion Ports, please see section 6.

2.0 | Frame Assembly

2.1
1u Frame Assembly

Component Bags Required:

- STR01
- HW01
- SP01

Tools Required:

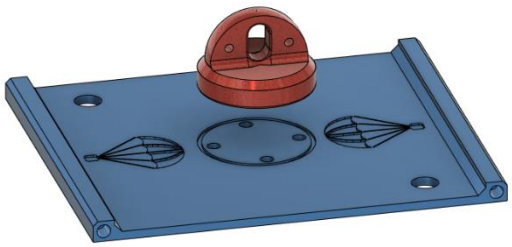
- 2mm Allen Wrench

Step 1:

OPTIONAL:

Attach the top mounting bracket to the top plate.

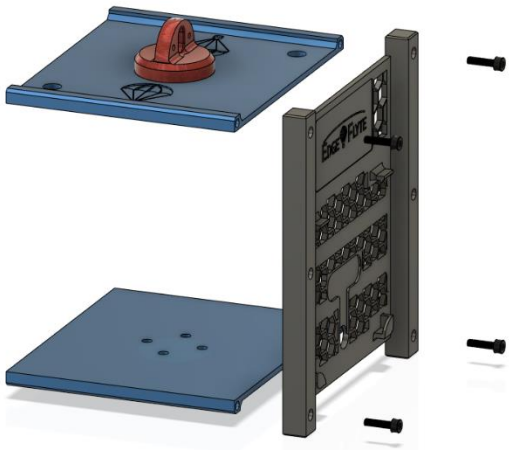
- 1x Top Plate
- 4x 2.5 x 6 mm Bolts
- 1x Top Mounting Bracket



Step 2:

Attach 1 side rail to top and bottom plates.

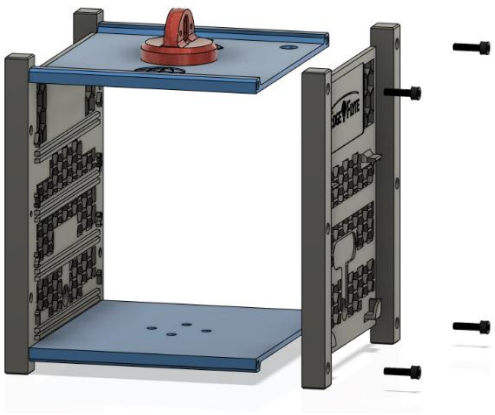
- 4x 2.5 x 10 mm Bolts
- 1x Bottom Plate
- 1x Side Rail



Step 3:

Attach secondary side rail to the existing assembly.

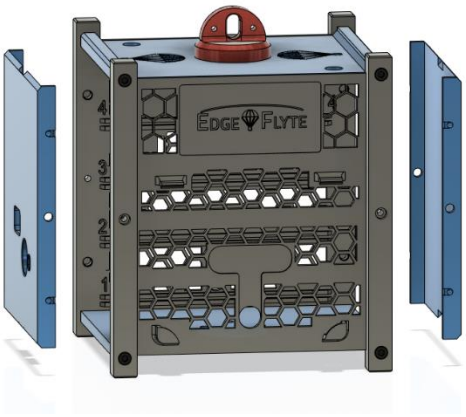
- 1x Side Rail
- 4x 2.5 x 10 mm Bolts



Step 4:

Place IO Covers.

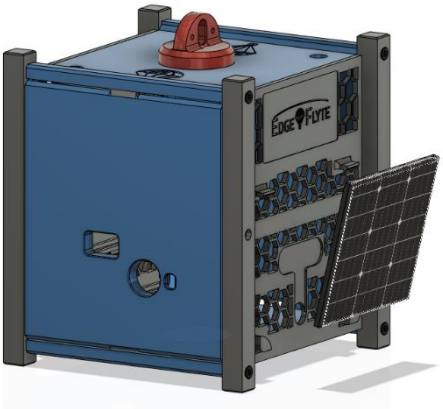
- 1x Front IO Plate
- 1x Back Cover Plate



Step 5:

Attach Solar Cells.

- 2x Solar Cells w/ attached power cable

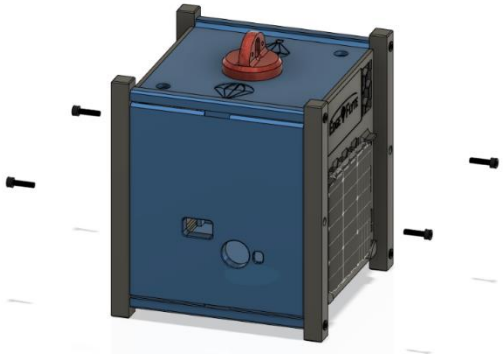


Step 6:

OPTIONAL:

Secure IO Covers for Flight.

- 4x 2.5 x 10 mm Bolts

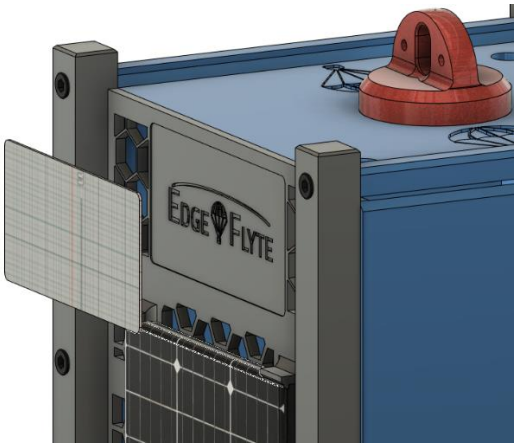


Step 7:

OPTIONAL:

Adhere custom labels to side rails.

See *6.3 Drawings* for size requirements of custom labels.



Overview:

Final Assembly.

Optional components not shown.

2.2
Replacement Parts

Bag | SP01

Item	QTY	Link
55 x 65 mm Solar Panel w/ Con	2	

Bag | STR01

Item	QTY	Link
1u CubeSat Rails	2	https://www.thingiverse.com/thing:6282465
Front and Back IO Plates	2	https://www.thingiverse.com/thing:6282465
Top and Bottom Plate	2	https://www.thingiverse.com/thing:6282465
Top Mounting Bracket	1	https://www.thingiverse.com/thing:6282465

Bag | HW01

Item	QTY	Link
2.5 x 10 mm Socket Cap Bolt	12	
2.5 x 6 mm Socket Cap Bolt	4	
2 mm Allen Wrench	1	

If you find that a part is missing from your kit, we're here to help! Get in touch with our customer support at:

cs@edgeflyte.com | +1 (307) 202-8309 | www.edgeflyte.com/contact

Let us know what you are missing, and we will send you a replacement free of charge!

3.0 | No-Solder Assembly Kit

Section Highlights:

This section outlines the construction of the 1u CubeSat internal boards and modules. Though the No-Solder and Solder kit functions the same; assembly of each is vastly different. After the assembly of each board, section 3.4 Visual Inspection highlights what to look for when confirming a successful assembly.

3.1
BMS Assembly

BMS v1

Component Bags Required:

- BNS01
- BIC01

Tools Required:

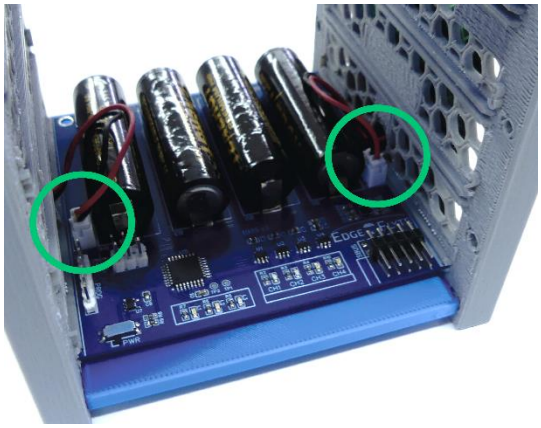
- None

(BMS v1) | Step 1:

Insert BMS into Frame

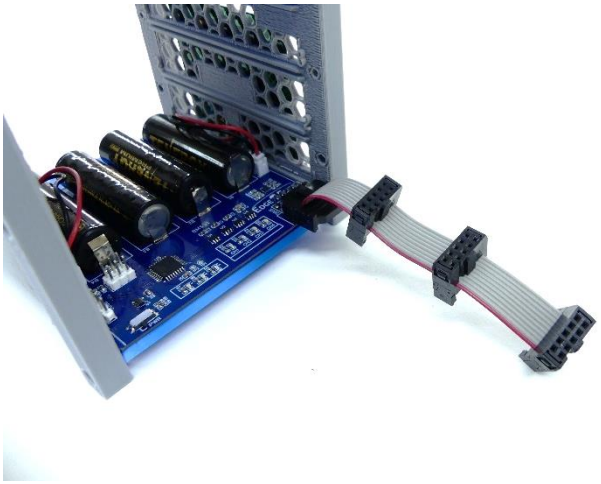
(BMS v1) | Step 2:

Connect Solar Jumpers to SOL1 and SOL2



(BMS v1) | Step 3:

Connect Board Interconnect Cable



BMS v2

Component Bags Required:

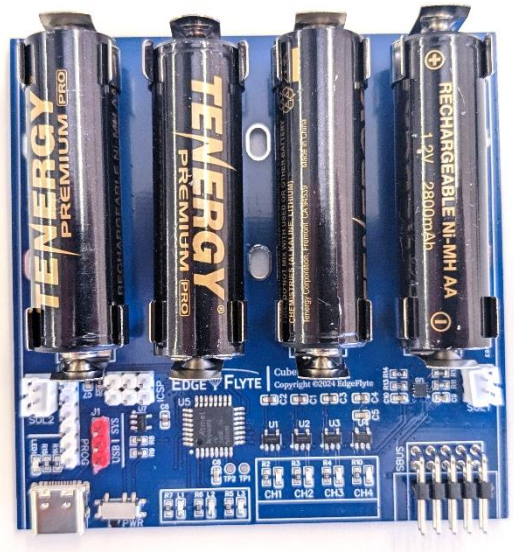
- BNS01
- BIC01
- BAT02

Tools Required:

- None

(BMS v2) | Step 1:

Insert NiMH Batteries with proper orientation.

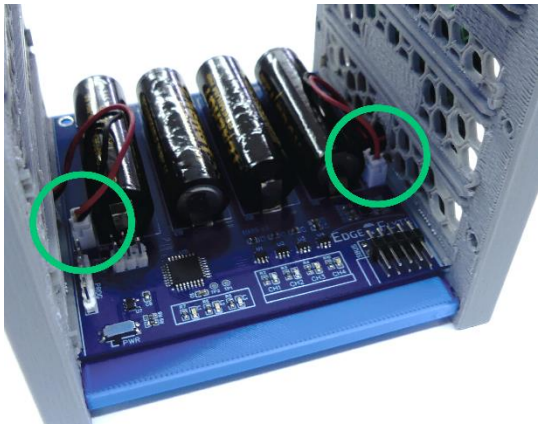


(BMS v2) | Step 2:

Insert BMS into Frame

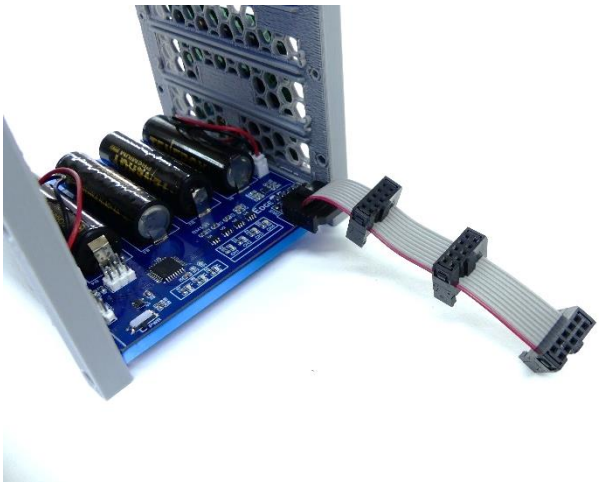
(BMS v1) | Step 3:

Connect Solar Jumpers to SOL1 and SOL2



(BMS v1) | Step 3:

Connect Board Interconnect Cable



3.2
MCB Assembly

Component Bags Required:

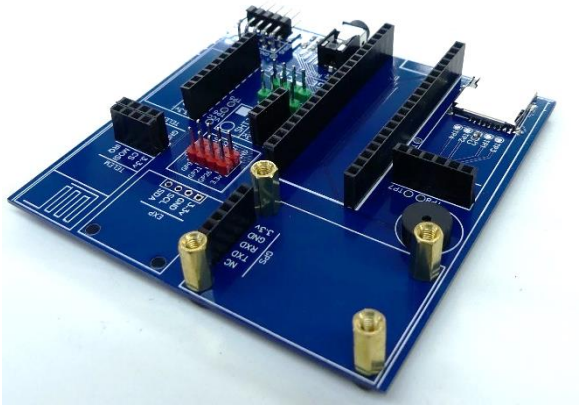
- BNS02
- MBC01
- HW02

Tools Required:

- Needle Pliers
- Phillips Driver

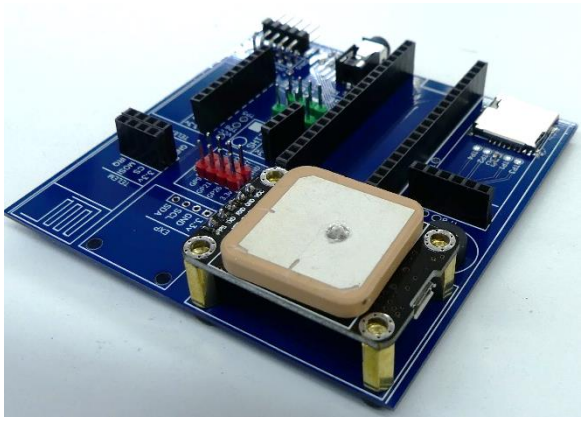
Step 1:

Install GPS standoffs.



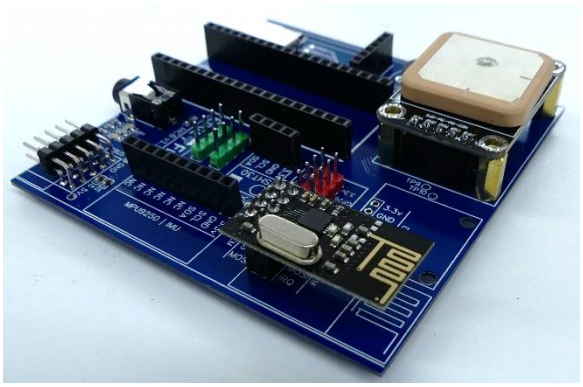
Step 2:

Place GPS Module



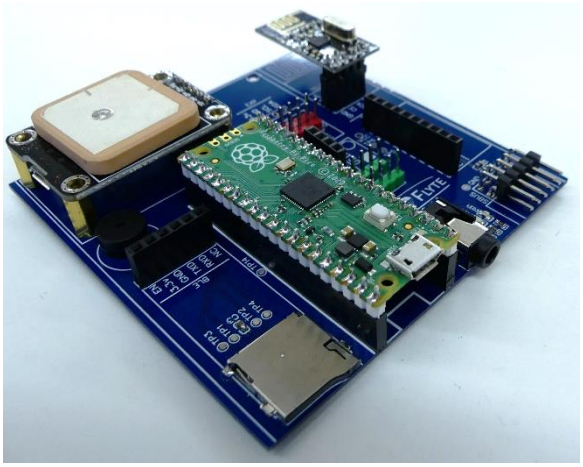
Step 3:

Place NRF24L01 Telemetry Module



Step 4:

Place RPI Pico (RP2040)

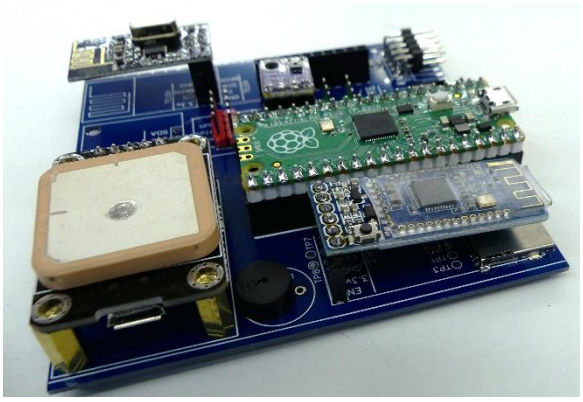


Step 5:

Place SHT31 Board Temperature Module

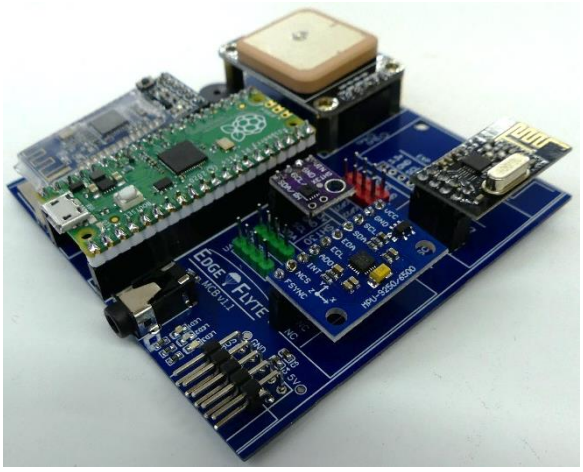
Step 6:

Place AT-09 Bluetooth Low Energy Module



Step 7:

Place MPU9250 Module



Step 8:

Insert Board into Rail 2
of the 1u CubeSat Frame

Step 9:

Connect the BIC cable to the board.

3.3
ASB Assembly

Component Bags Required:

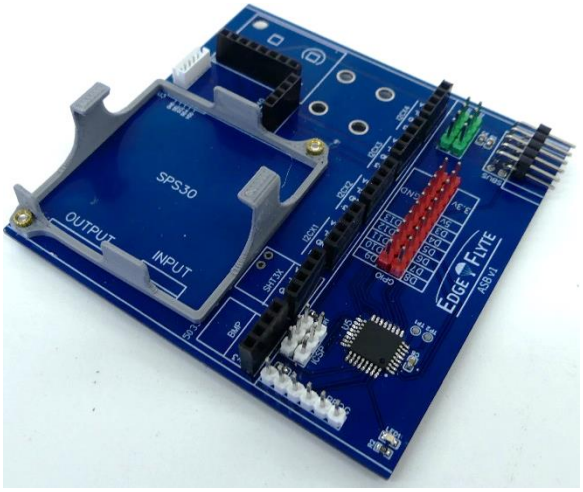
- BNS03
- HW03
- SNS01
- SNS02

Tools Required:

- 2mm Allen Wrench

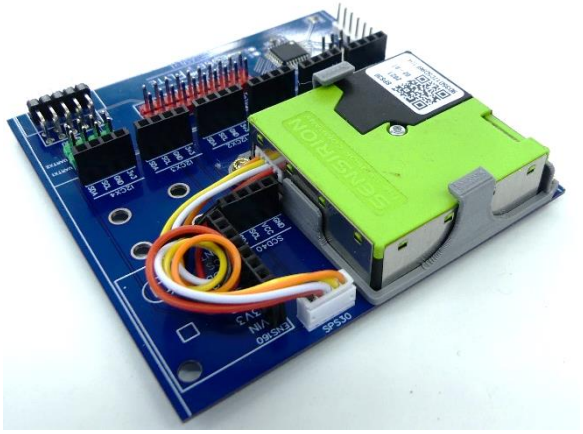
Step 1:

Mount SPS30 Bracket.



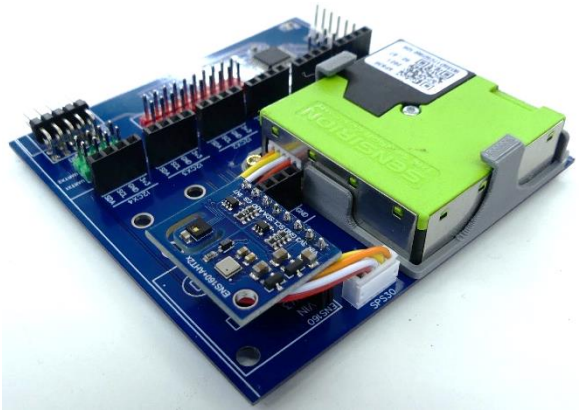
Step 2:

Place SPS30 Sensor.



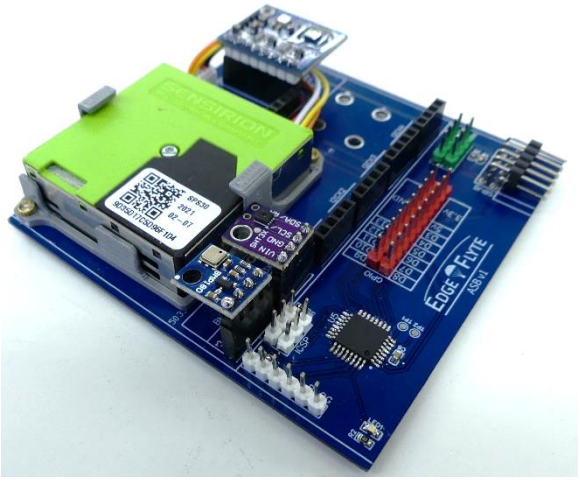
Step 3:

Place ENS160 Sensor.



Step 4:

Place BMP180 and SHT31 Sensor



Step 5:

Insert board into Rail 3 of the
1u CubeSat frame.

Attach Board Interconnect Cable to SBUS Port

4.0 | Solder Assembly Kit

Section Highlights:

This section outlines the construction of the 1u CubeSat internal boards and modules. Though the No-Solder and Solder kit functions the same; assembly of each is vastly different. After the assembly of each board, section 4.4 Visual Inspection highlights what to look for when confirming a successful assembly.

4.1
BMS Assembly

BMS V1

Component Bags Required:

- BIC02
- BAT01
- BSC01

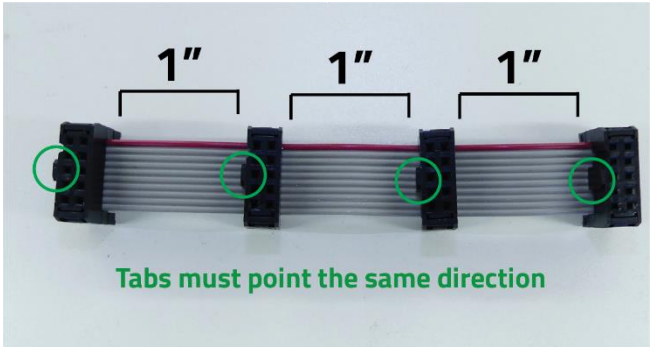
Tools Required:

- Soldering Iron
- Side Cutters (optional)
- Rosin Core Solder
- Component Helping Hands (optional)
- Pliers
- Ruler

(BMS v1) | Step 1:

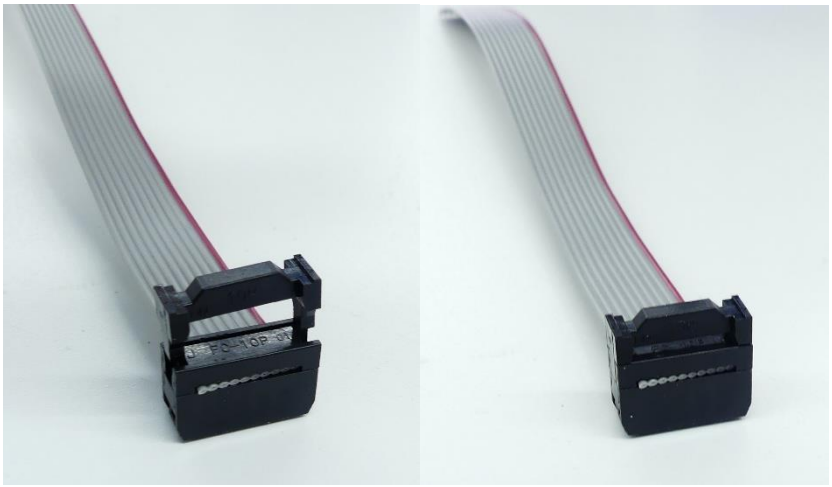
Assemble the Board Interconnect Cable using component bag BIC02, a pair of pliers, and a ruler.

Ensure connectors are spaced at 1-inch intervals additionally noting proper orientation of the connector.



Using pliers is the recommended technique for crimping connectors to the cable.

Optionally attach the included pull tab for convenience.

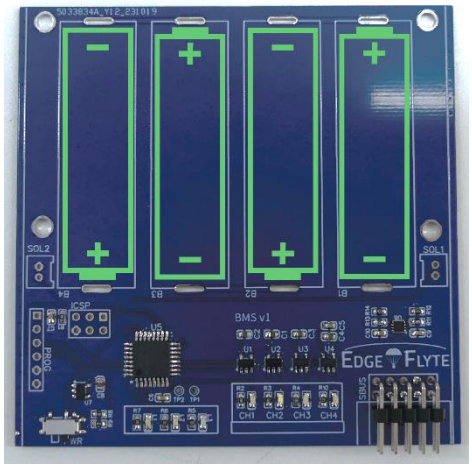


(BMS v1) | Step 2:

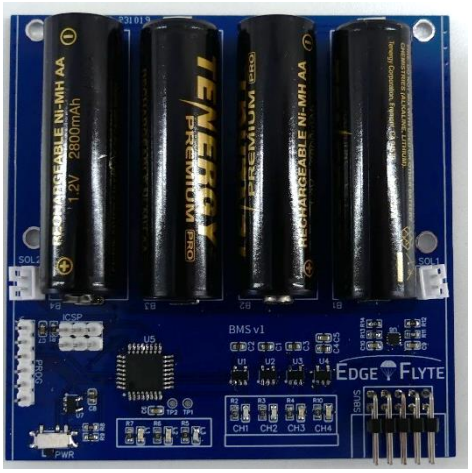
Solder Batteries to Board (ensure PWR switch off position)

Warning: Shorting batteries together may cause sparks.

IMPORTANT: Ensure proper polarity of batteries when inserting and soldering!



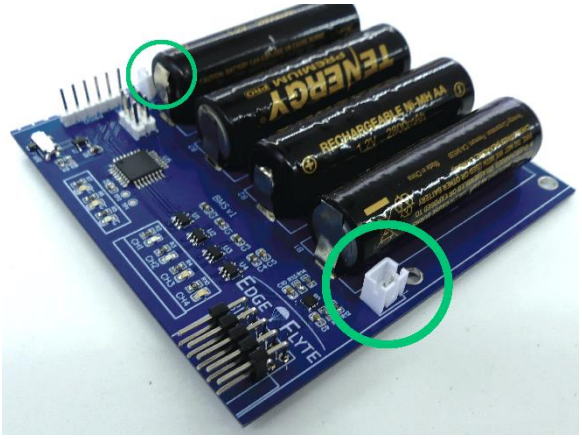
Additional components shown in following steps.



(BMS v1) | Step 3:

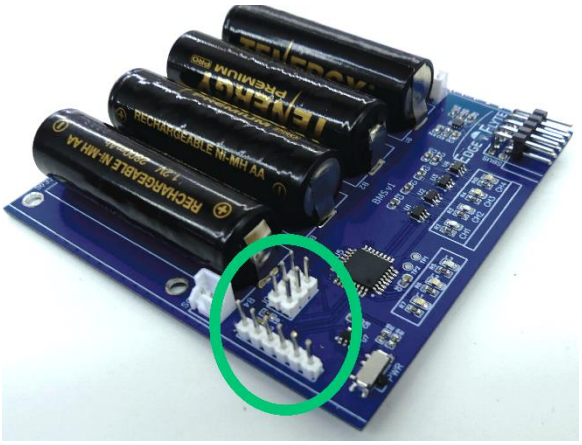
Solder SOL1 and SOL2 Connectors to Board

NOTE: Ensure proper orientation of headers.



(BMS v1) | Step 4:

Solder PROG, ICSP, and SBUS connector

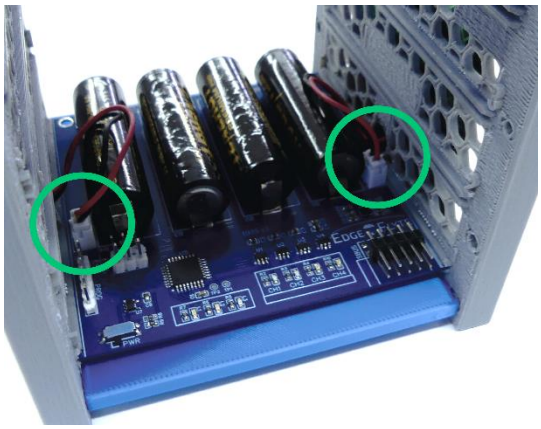


(BMS v1) | Step 5:

Insert Board into Rail 1 of 1u Frame.

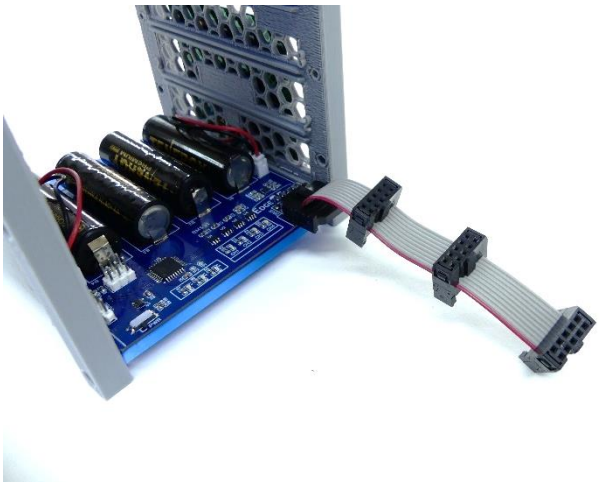
(BMS v1) | Step 6:

Connect Solar Panel connectors to SOL1 and SOL2



(BMS v1) | Step 7:

Connect BIC to SBUS Header



BMS V2

Component Bags Required:

- BIC02
- BAT02
- BSC01

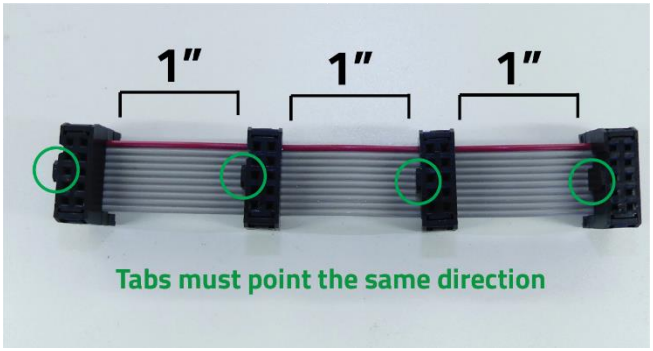
Tools Required:

- Soldering Iron
- Side Cutters (optional)
- Rosin Core Solder
- Component Helping Hands (optional)
- Pliers
- Ruler

(BMS v1) | Step 1:

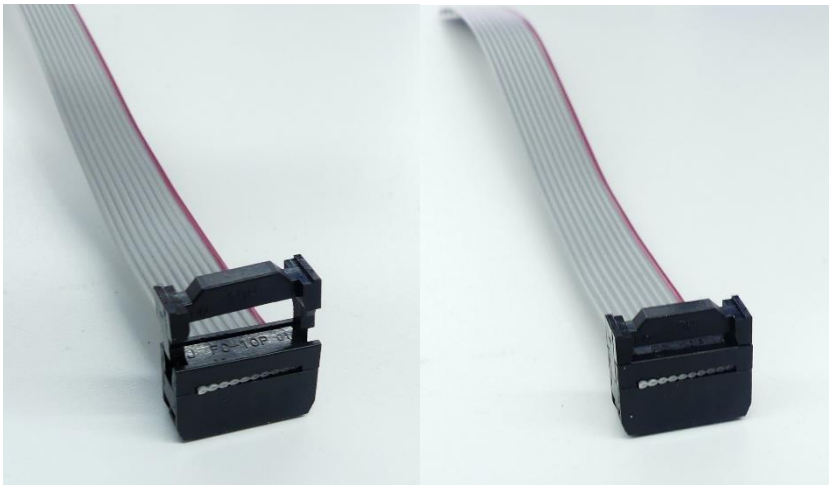
Assemble the Board Interconnect Cable using component bag BIC02, a pair of pliers, and a ruler.

Ensure connectors are spaced at 1-inch intervals additionally noting proper orientation of the connector.



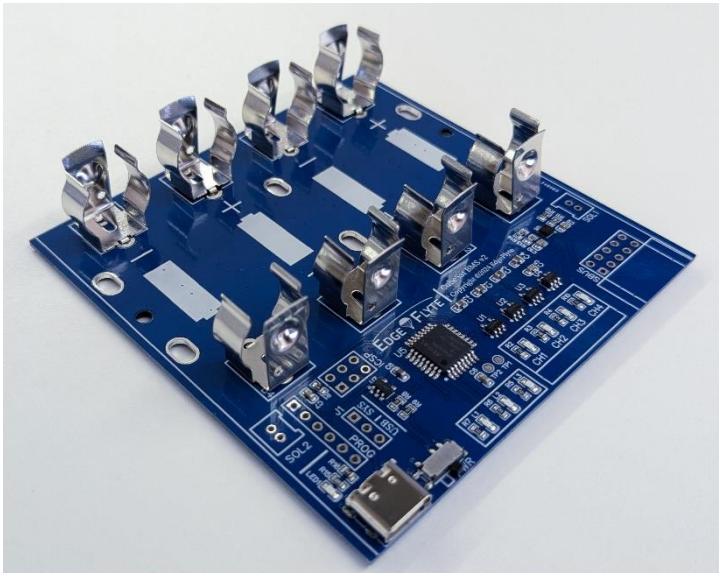
Using pliers is the recommended technique for crimping connectors to the cable.

Optionally attach the included pull tab for convenience.



(BMS v1) | Step 2:

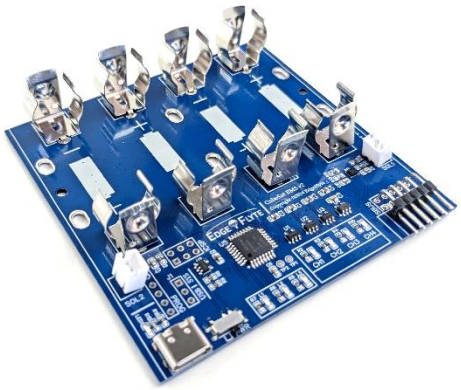
Solder Batteries Clips to Board



(BMS v1) | Step 3:

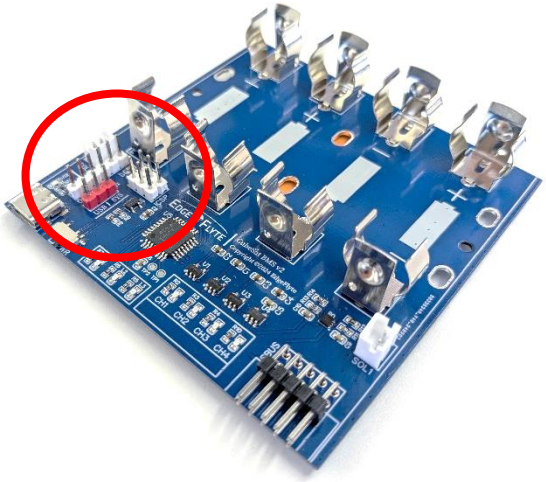
Solder SOL1 and SOL2 Connectors to Board

NOTE: Ensure proper orientation of headers.



(BMS v1) | Step 4:

Solder PROG, ICSP, and J1 connector



(BMS v1) | Step 5:

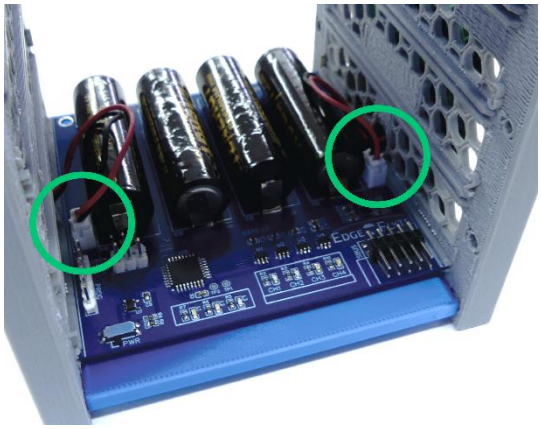
Insert 4x NiMH Batteries with the proper orientation.

(BMS v1) | Step 6:

Insert Board into Rail 1 of 1u Frame.

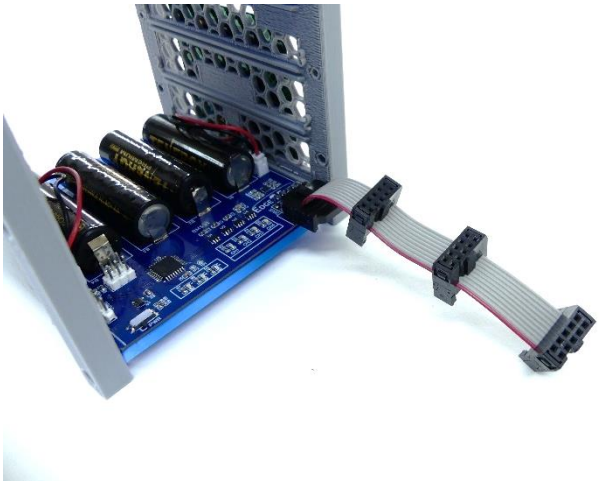
(BMS v1) | Step 7:

Connect Solar Panel connectors to SOL1 and SOL2



(BMS v1) | Step 8:

Connect BIC to SBUS Header



4.2
MCB Assembly

Component Bags Required:

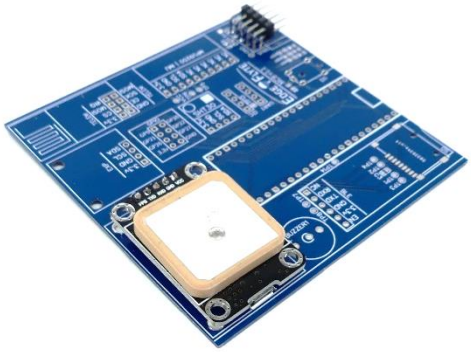
- MCB
- BSC02
- BSC03

Tools Required:

- Needle Nose Pliers
- Soldering Iron
- Side Cutters
- Rosin Core Solder
- Component Helping Hands (optional)

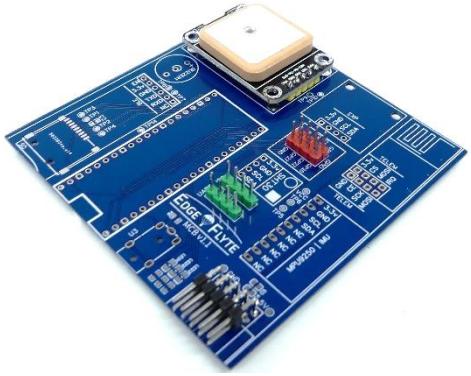
Step 1:

Solder GPS Module.



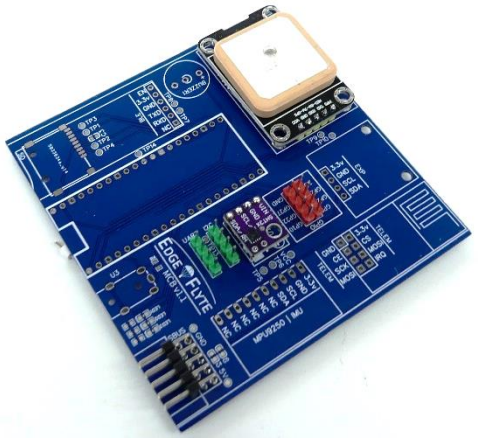
Step 2:

Solder Headers



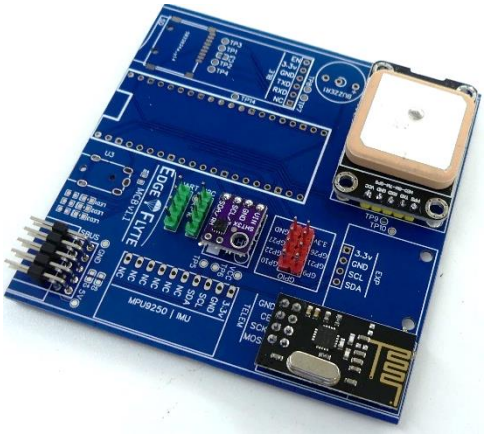
Step 3:

Solder SHT31 Module



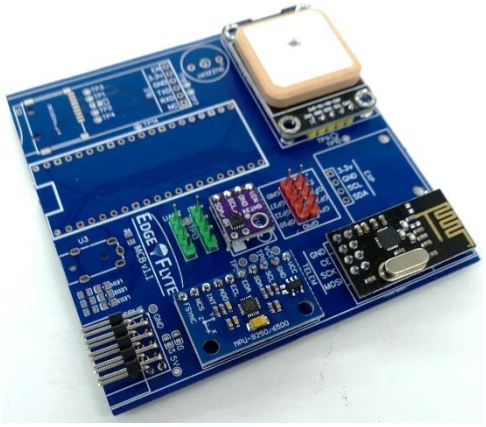
Step 4:

Solder NRF24 Module



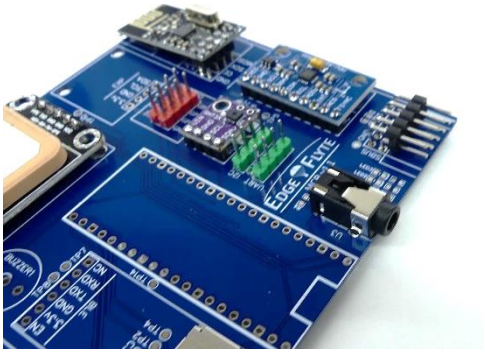
Step 5:

Place and solder the MPU9250 Module



Step 6:

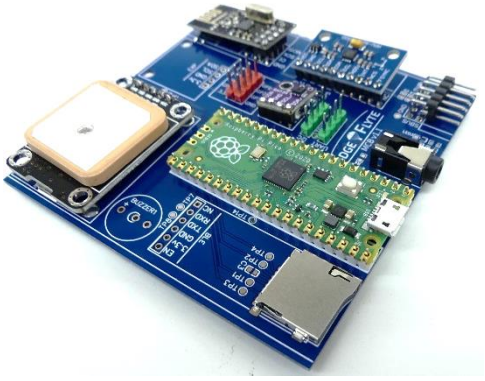
Place and solder the 3.5mm socket.



Step 7:

Place and Solder the RPI Pico.

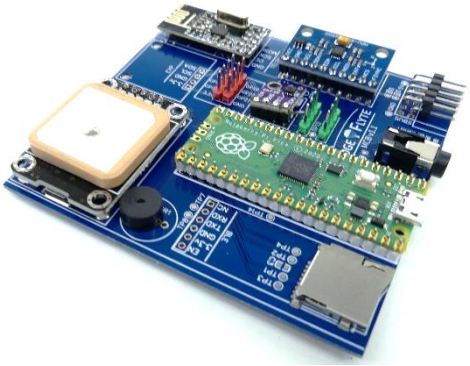
IMPORTANT: Ensure proper orientation!



Step 8:

Place and solder the buzzer.

IMPORTANT: Ensure proper orientation!



Step 9:

Place and solder the AT-09 BLE Module.

Step 10:

Insert Board to Rail 2 of 1u Frame

Step 11:

Connect BIC Cable to SBUS

4.3
ASB Assembly

Component Bags Required:

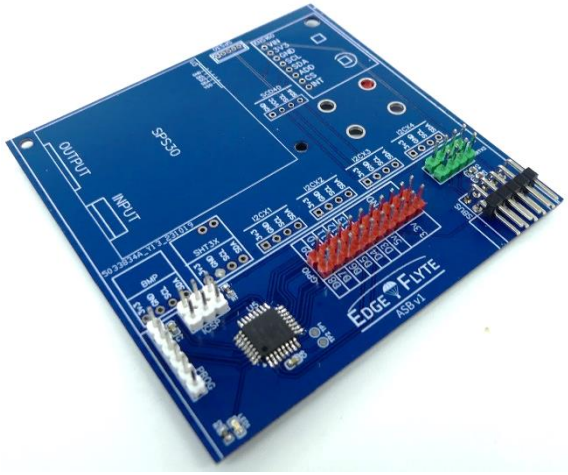
- SNS02
- SNS03
- BSC04
- HW03

Tools Required:

- 2mm Allen Wrench
- Soldering Iron
- Side Cutters (optional)
- Rosin Core Solder
- Component Helping Hands (optional)

Step 1:

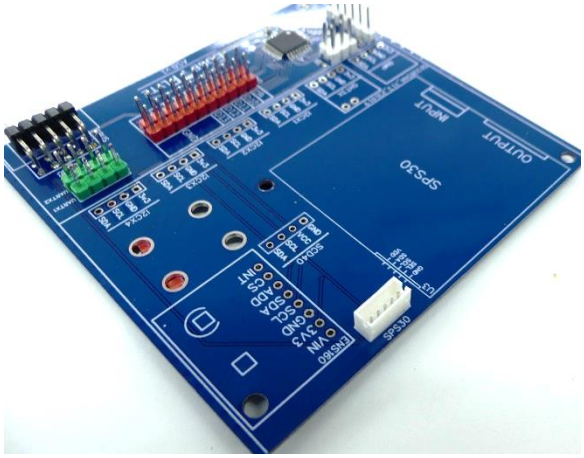
Solder 2x UART, PROG, ICSP, and GPIO Headers



Step 2:

Solder SPS30 JST ZH 5Pos Female Connector

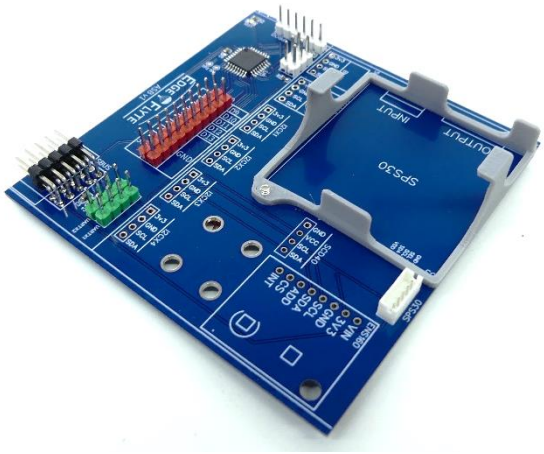
IMPORTANT: Ensure proper orientation!



Step 3:

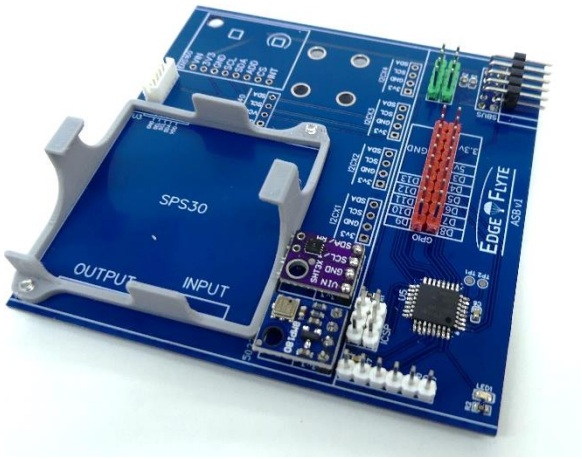
Mount the SPS30 Bracket.

IMPORTANT: Ensure proper orientation!



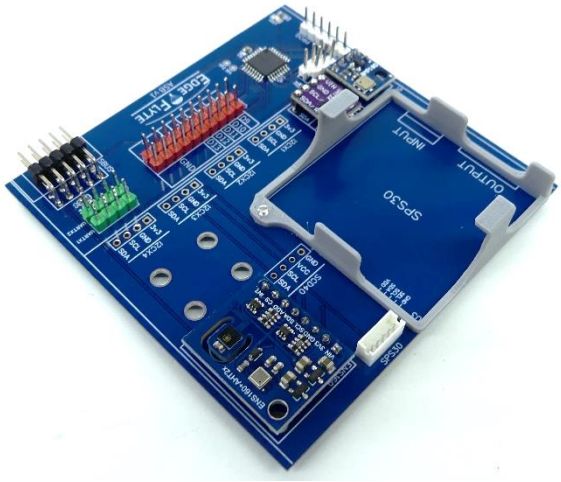
Step 4:

Place and solder the BMP180
and SHT31 Sensor



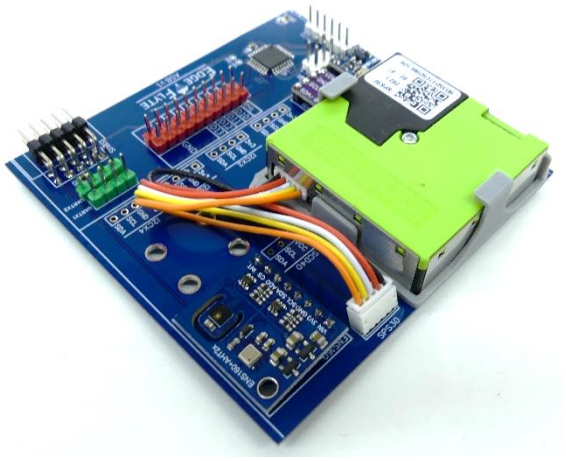
Step 5:

Place and solder the ENS160 Sensor



Step 6:

Attach SPS30 Cable and Place Sensor



Step 7:

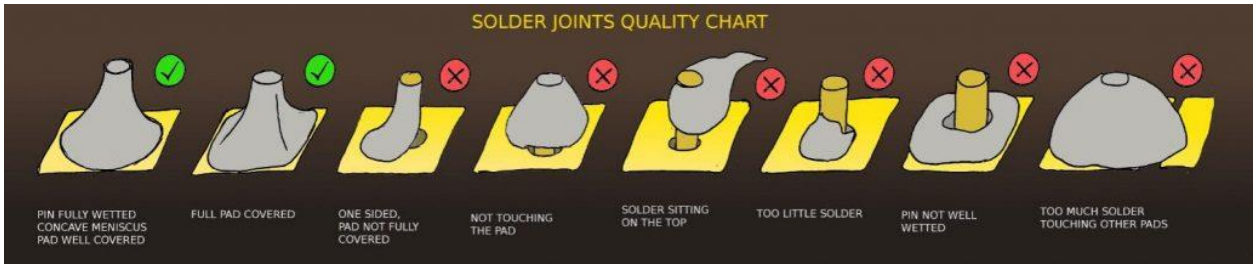
Insert Board into Rail 3 on 1u Frame.

Attach Board Interconnect Cable to SBUS Port.

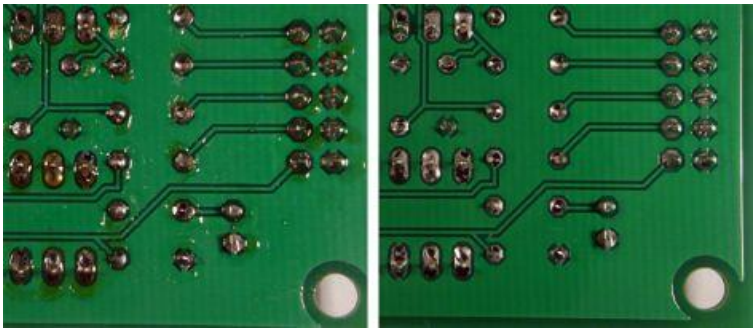
4.4
Visual Inspection

Soldering Overview:

Though this guide does not thoroughly instruct proper soldering practices, listed below are a few common problems to check for to ensure nominal function of the CubeSat. Ensure proper connections before applying power to the module.



Additionally, if excess flux/rosin remains on the board, it can be cleaned using isopropyl alcohol applied to a rag, cloth, or paper towel.



Before connecting power, inspect plastic headers and connectors for deformation from soldering which may lead to greater problems or may impede intended operation. Repair or replace as necessary.

Additionally ensure that soldered modules are properly oriented and connected before powered on. Failure to properly connect the modules may lead to permanent damage to both the module, board, and power system.

5.0 | Ground Station

5.1
Ground Station Software

Software can be found at: https://edgeflyte.com/downloads/cubesats

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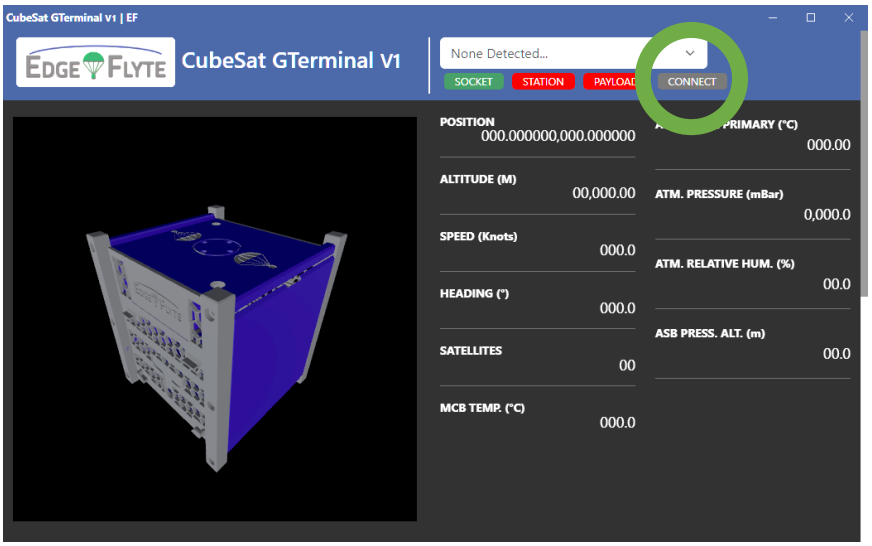
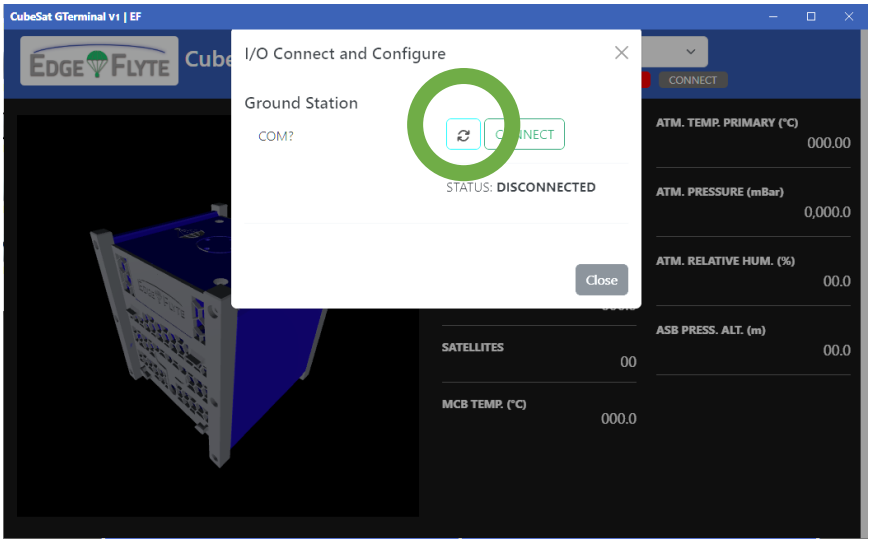
Initial View

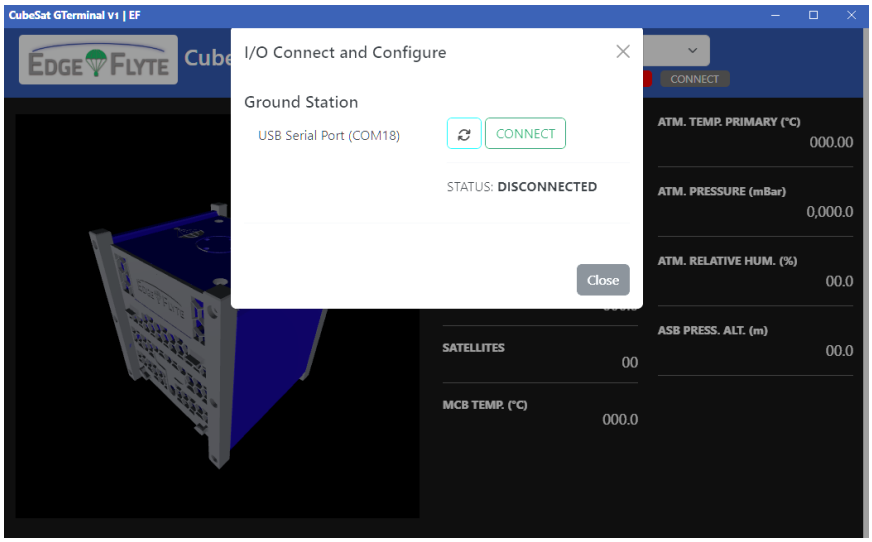
To connect to the Ground Station, press 'CONNECT.'



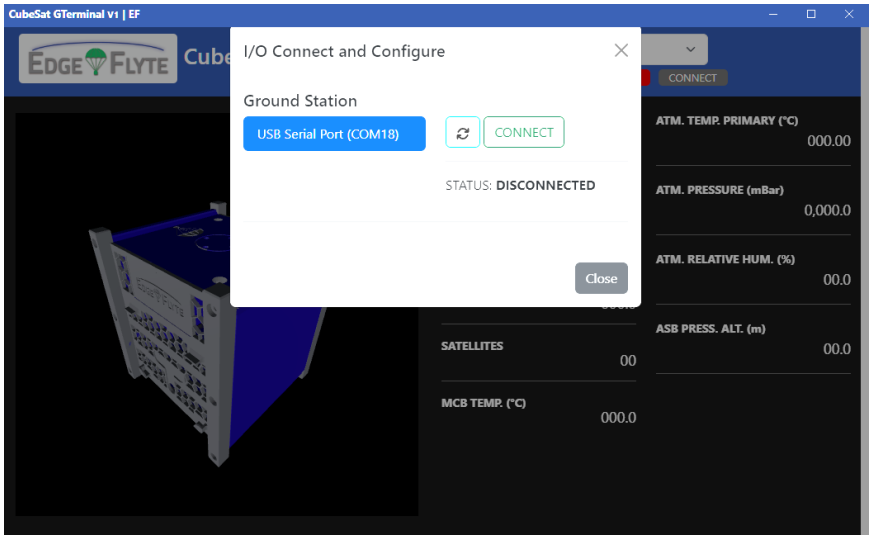
After inserting the Ground Station into the computer, press the Refresh icon.



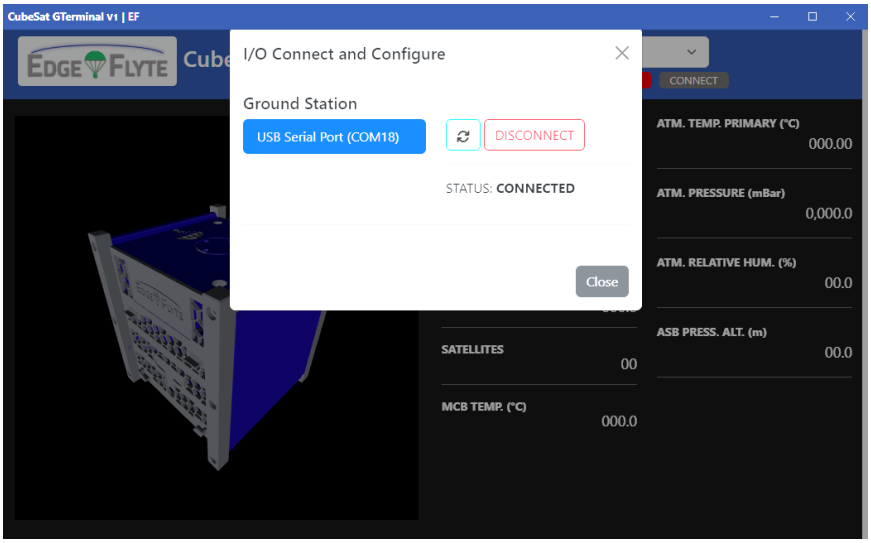
Available serial ports will be displayed. Select the proper port for the device.



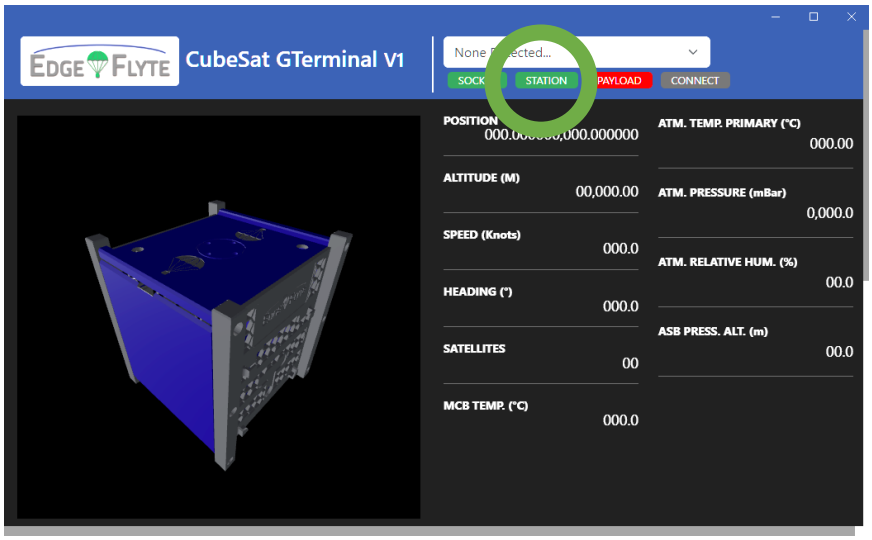
Selected device option will be highlighted in Blue. Press 'CONNECT' to connect to the device.



A successful connection is indicated by the 'STATUS' changing to 'CONNECTED' and the option to DISCONNECT from the device present.

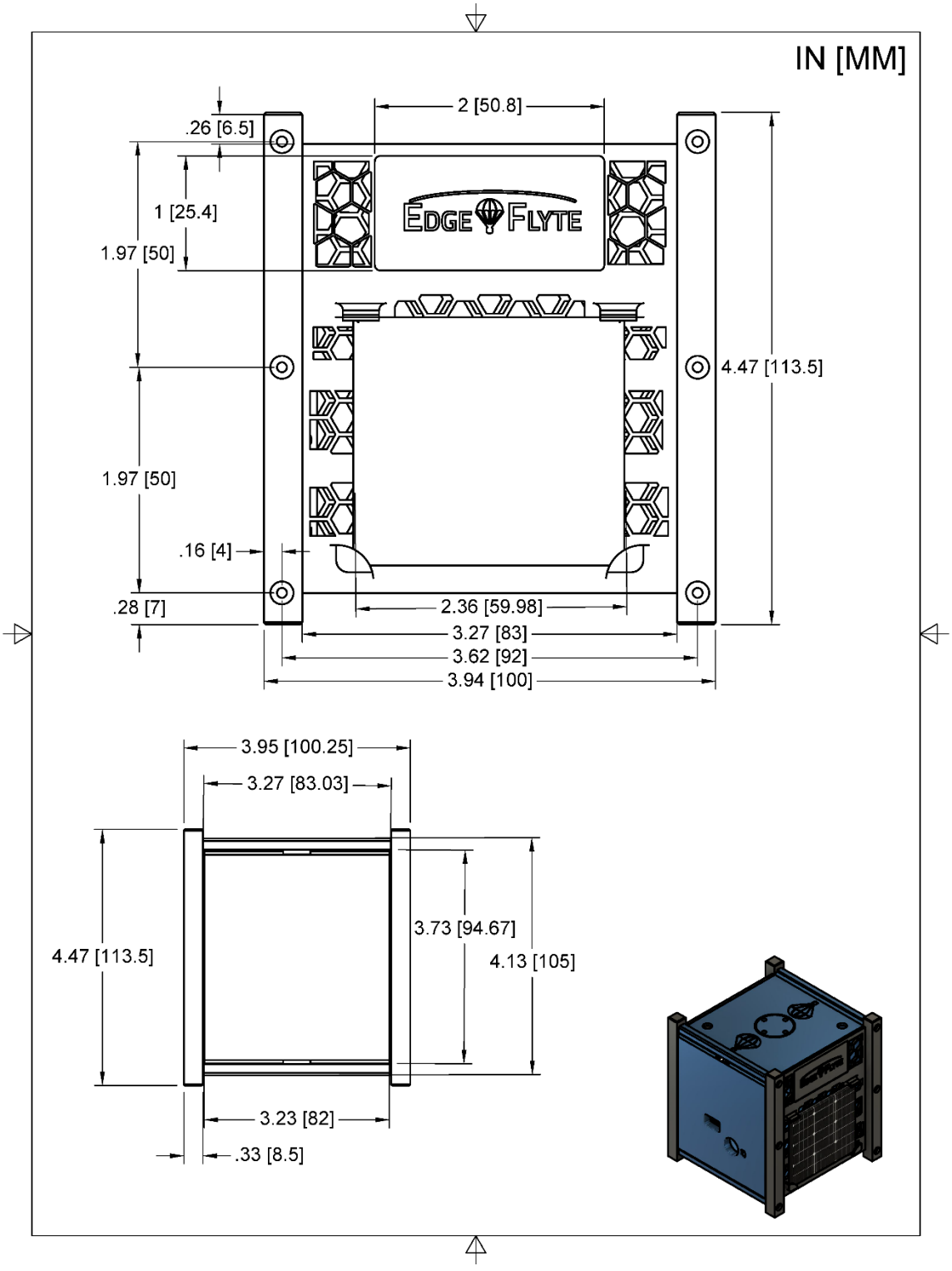


Additionally, the Ground Station Status Indicator will become green.

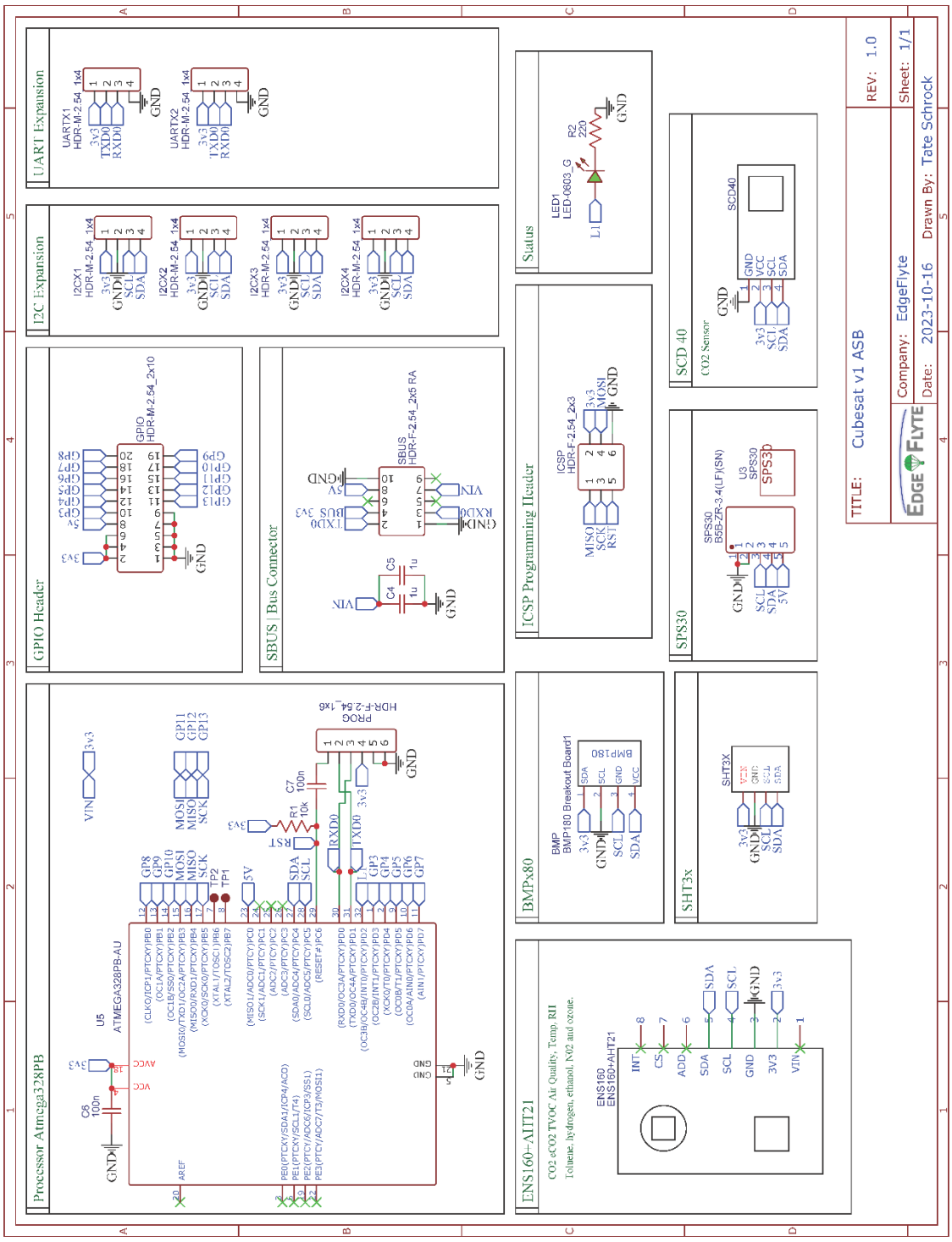


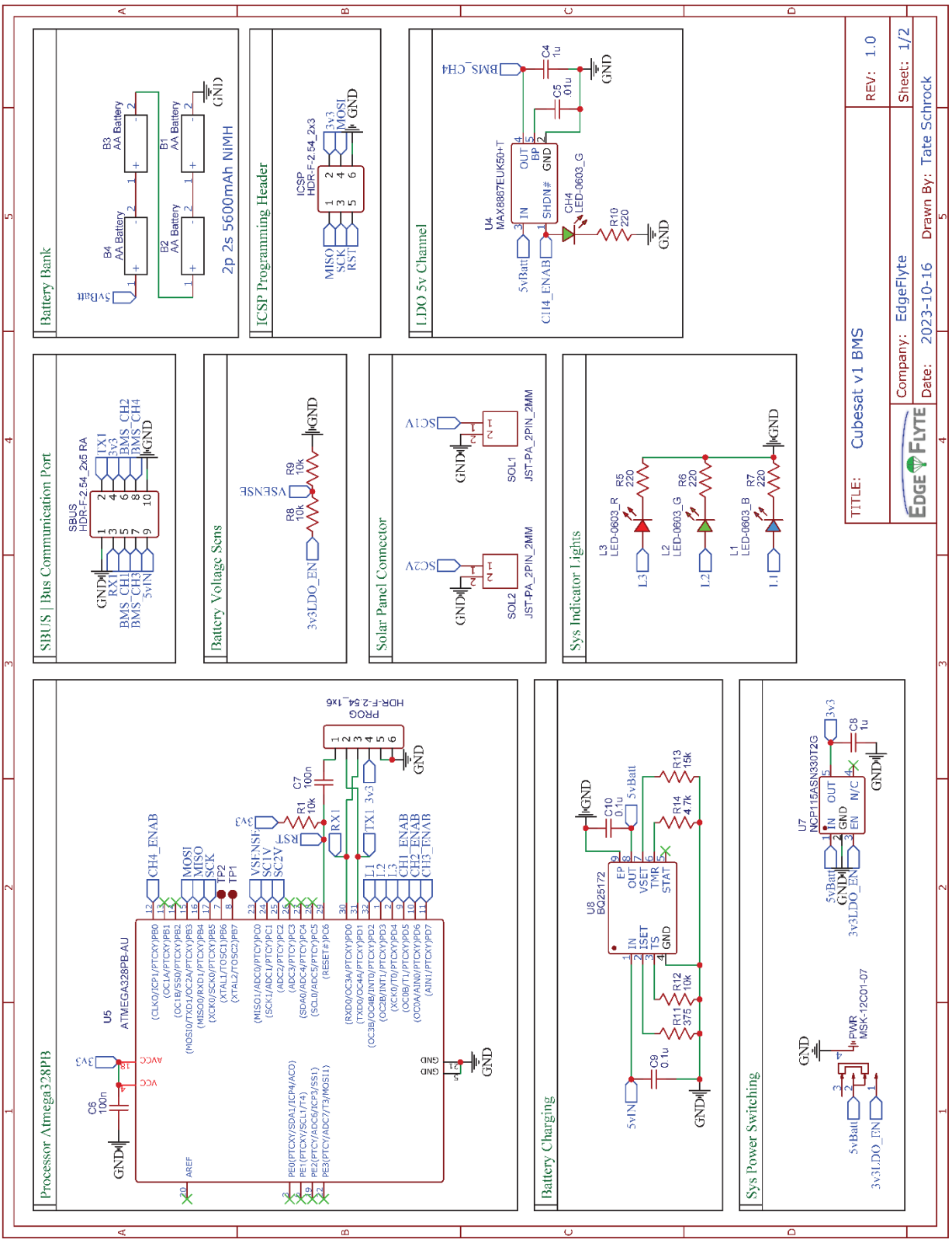
6.0 | Appendix

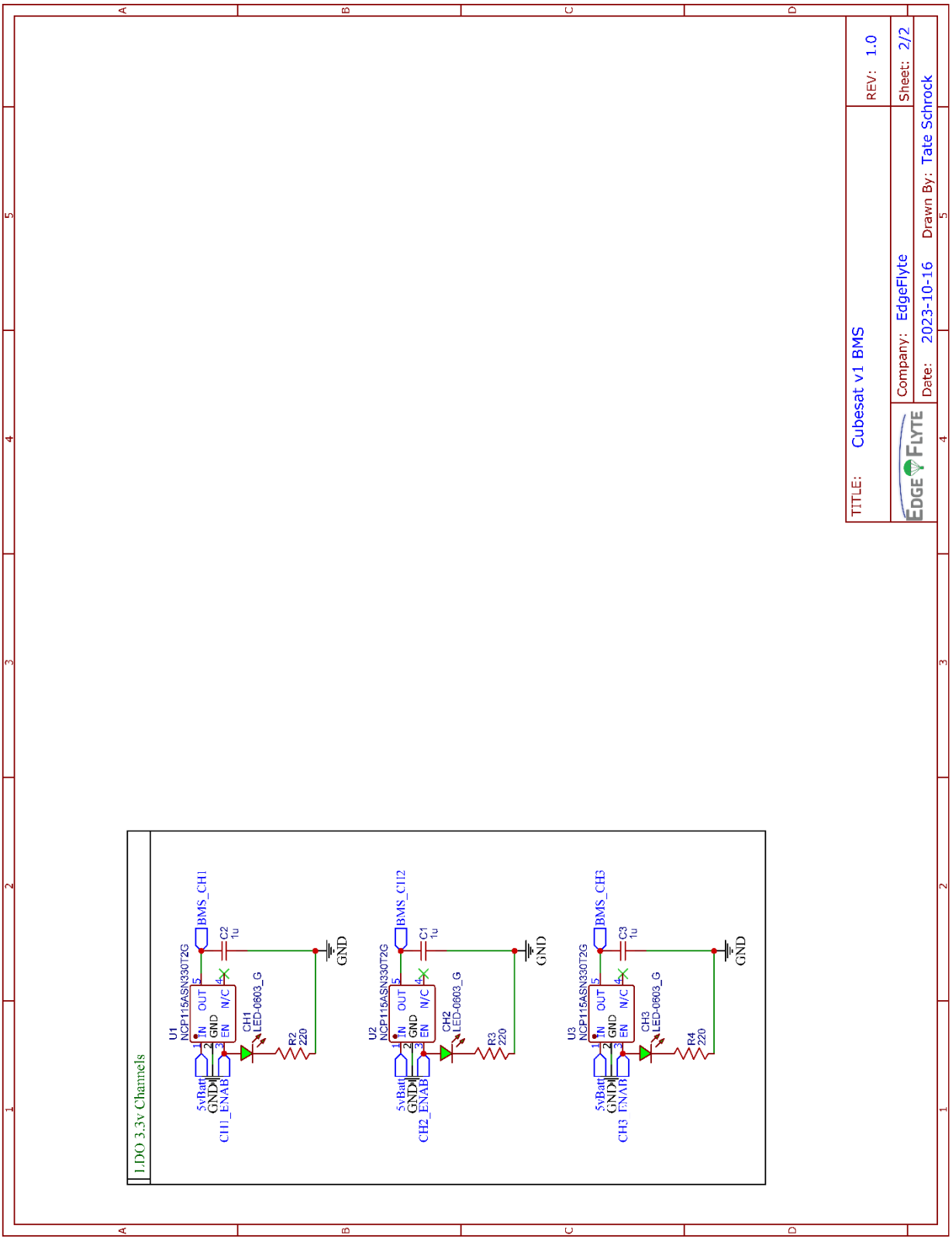
6.1
Drawings

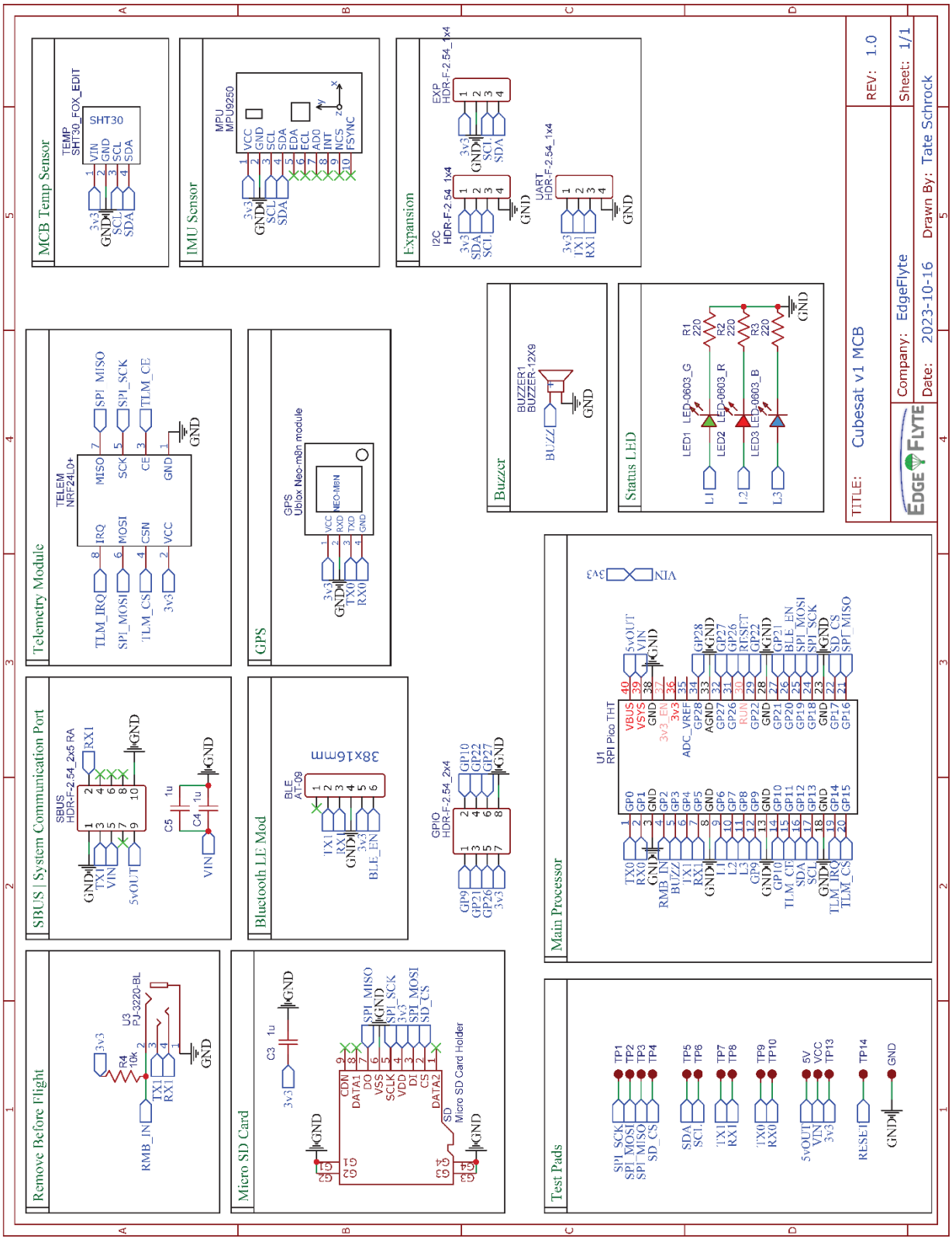


6.2
Schematics









6.3
Links

Software Downloads

https://edgeflyte.com/downloads/cubesats

3D Models

Available at: https://www.thingiverse.com/thing:6282465

Source Code

Available at: https://github.com/edgeflyte/CubeSatV1