

Power Distribution System for a CubeSat

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June 17, 2023

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Objective

To design and implement a fully autonomous power generation, storage and distribution system for a CubeSat

Methodology

- Identifying the power requirements
 - Architecture design and topology selection
 - Forming Specifications
 - Design and simulation
 - Procurement of components
 - Fabrication and testing

System Architecture

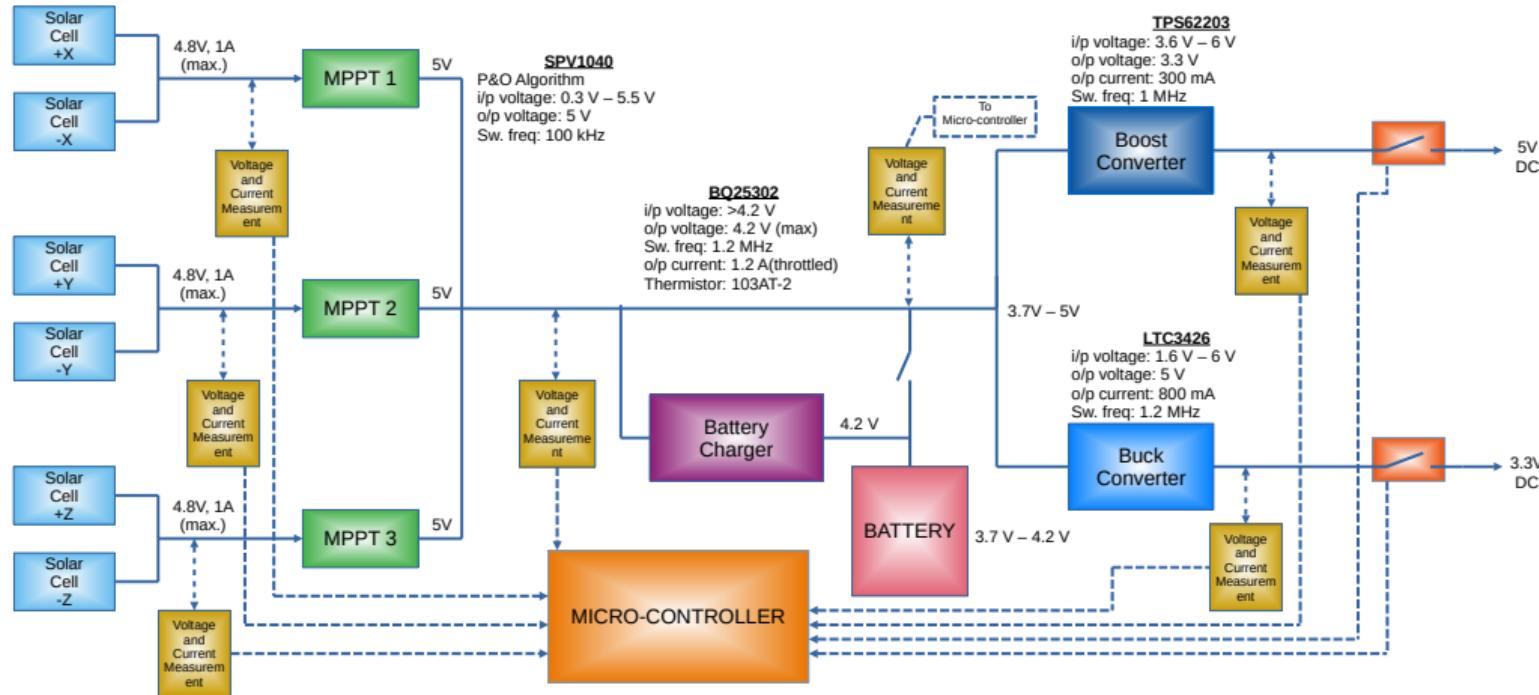


Figure 1: CubeSat EPS Architecture

Hardware Design - Buck and Boost Converters with Monitoring

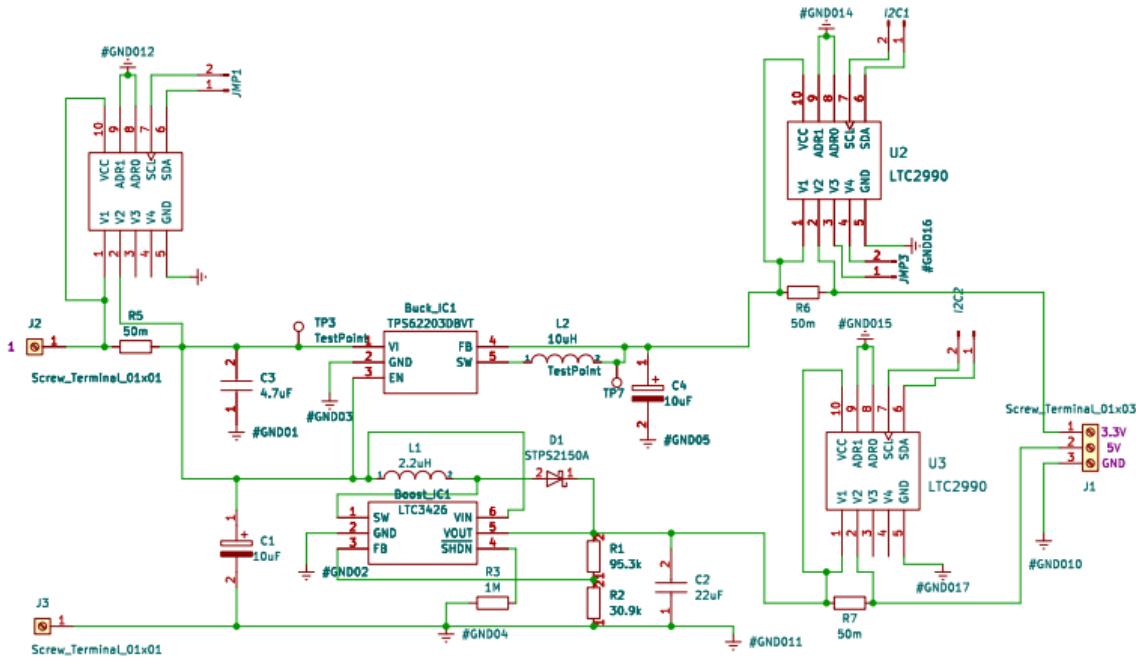


Figure 2: Circuit design of buck and boost converters with monitoring

Hardware Design - Buck and Boost Converters (Contd.)

Synchronous Buck Converter: TPS62203

- Input Voltage: 3.6 - 5V
- Output Voltage: 3.3V
- Switching Frequency: 1MHz
- Output Current: 300mA (max.)

Boost Converter: LTC3426

- Input Voltage: 3.6 - 5V
- Output Voltage: 5V
- Switching Frequency: 1.2MHz
- Output Current: 800mA (max.)

All converters operate in continuous conduction mode.

Hardware Design - Buck and Boost Converters with Monitoring (Contd.)

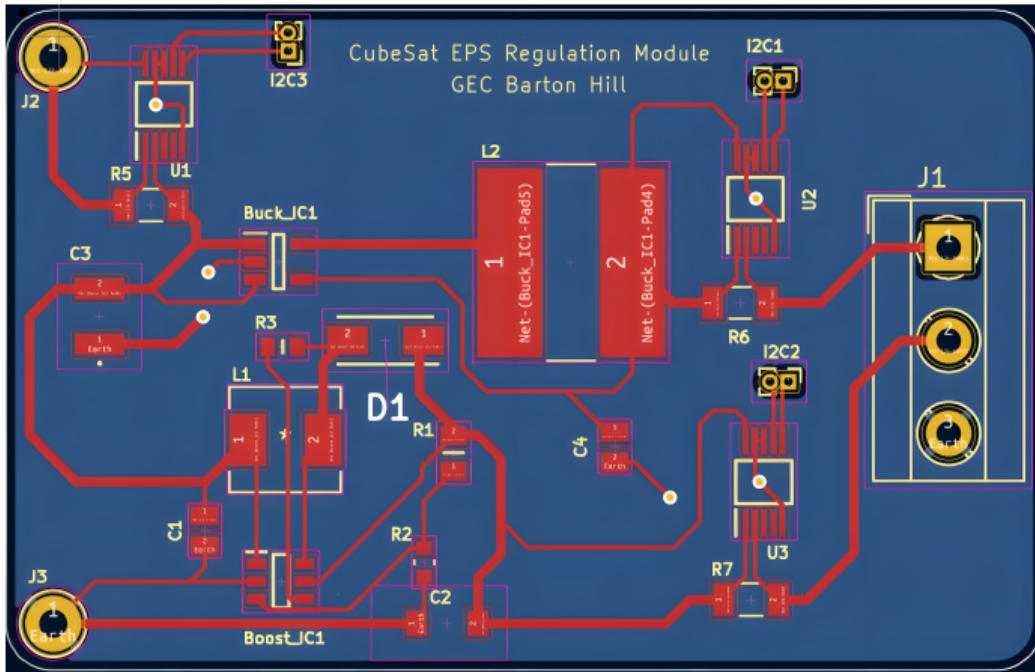


Figure 3: PCB Layout of buck and boost converters with monitoring (55mm x 35mm)

Hardware Design - Buck and Boost Converters with Monitoring (Contd.)

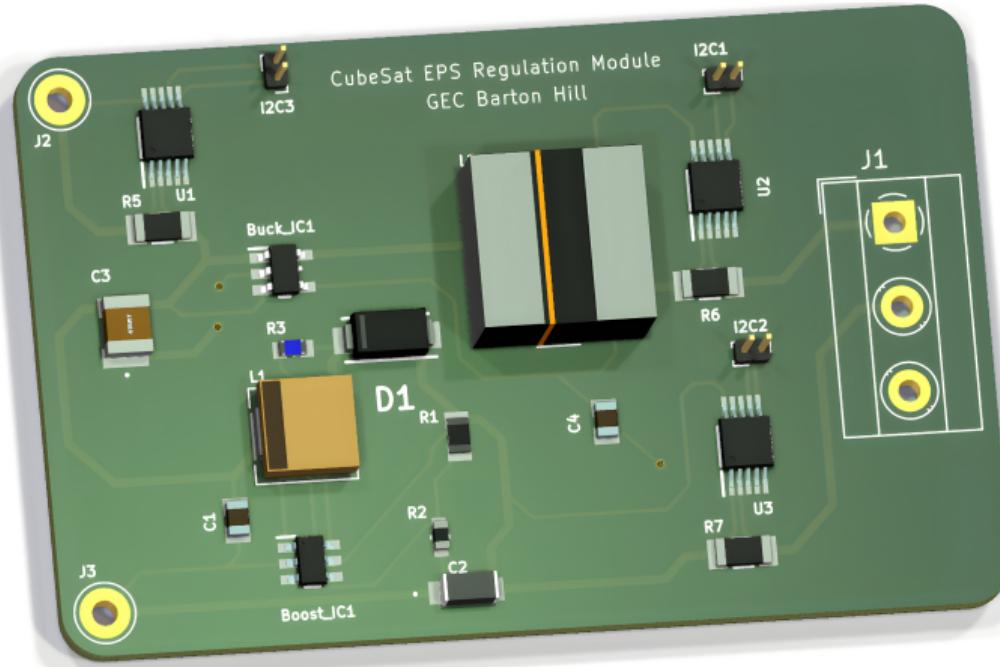


Figure 4: 3-D model of buck and boost converters with monitoring

Hardware Design - Voltage and Current monitoring IC

- IC: LTC 2990
- Operating Voltage: 2.9V - 5.5V
- Quad input
- 14 bit ADC
- Voltage ($\pm 0.1V$ accuracy) and Current Monitoring
- Inbuilt Internal Temperature Monitoring ($\pm 0.5^{\circ}C$ Accuracy, $0.06^{\circ}C$ Resolution)
- Communication via I2C serial interface

Hardware Design - Battery Charger

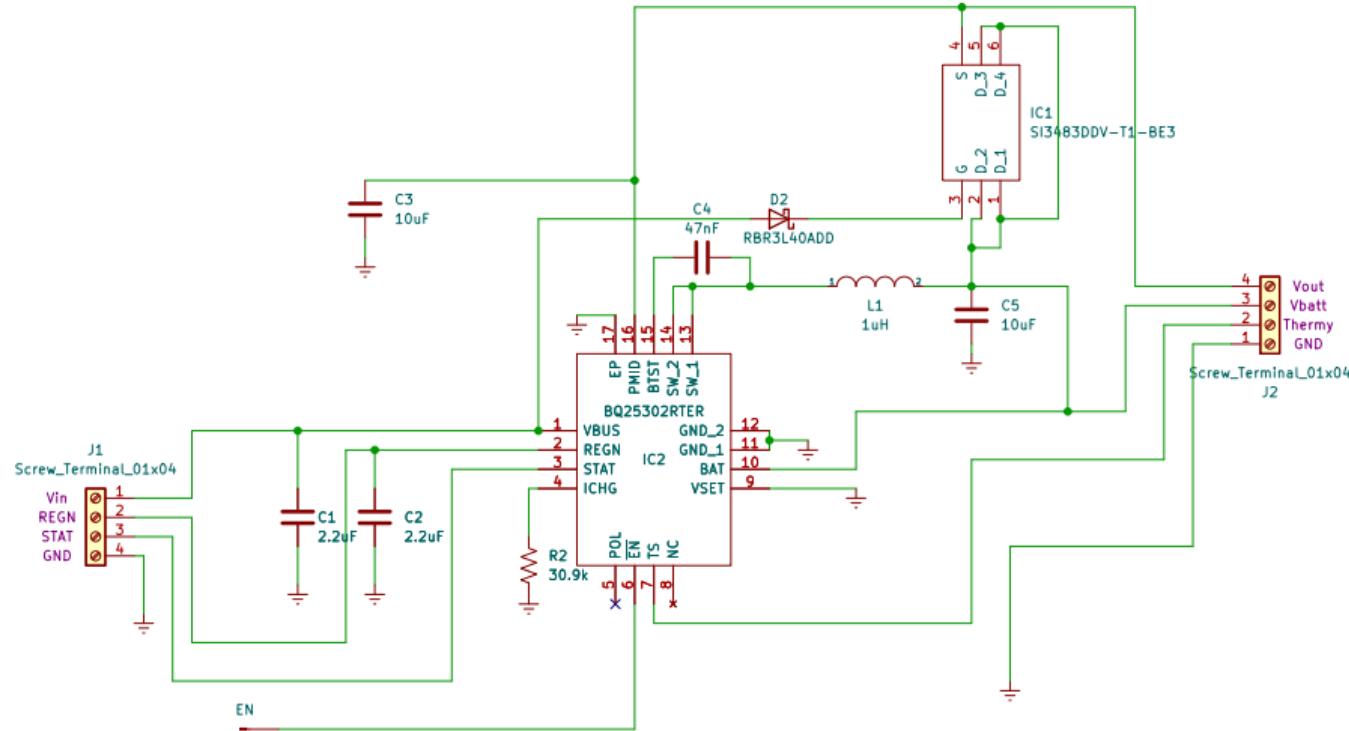


Figure 5: Circuit design of Battery Charger

Hardware Design - Battery Charger (Contd.)

Synchronous Buck Battery Charger:

- IC: BQ25302 (With External Power Path configuration)
- Input Voltage: 5V
- Output Voltage: 4.2V (max.)
- Switching Frequency: 1.2MHz
- Output Current: Limited to 1.2A
- Thermistor: Semitec 103AT-2 ($10k\Omega$)
- Charging Temperature: Limited between 0 - 45 C
- Track width: 0.25mm
- Power Path Track width: 0.52mm

Hardware Design - Battery Charger (Contd.)

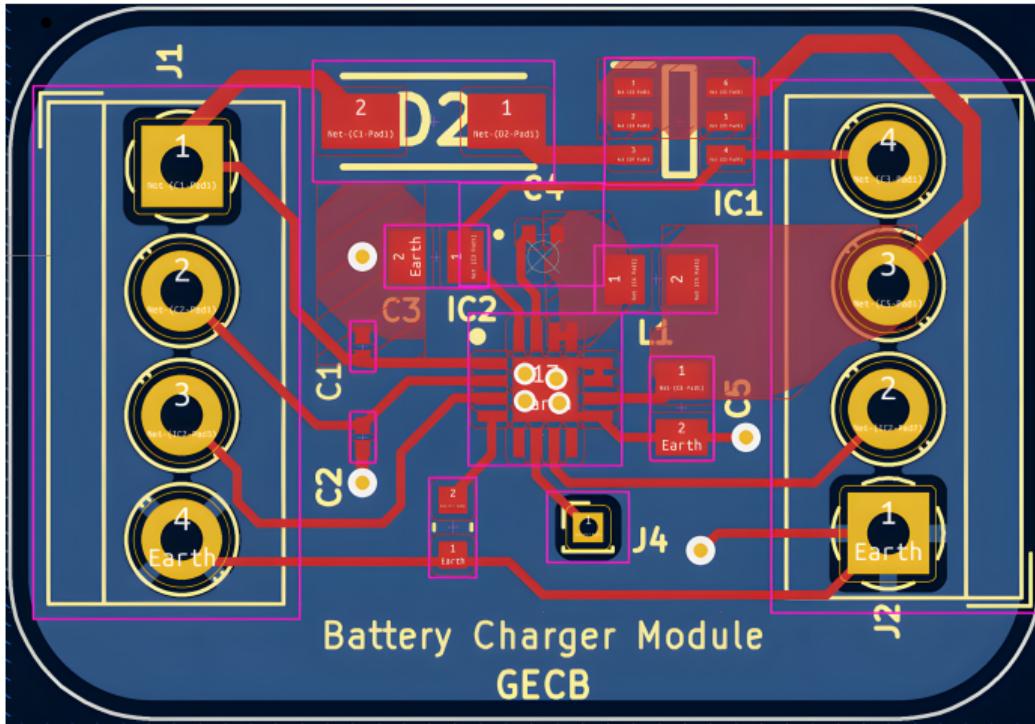


Figure 6: PCB Layout of Battery Charger (29mm x 20mm)

Hardware Design - Battery Charger (Contd.)

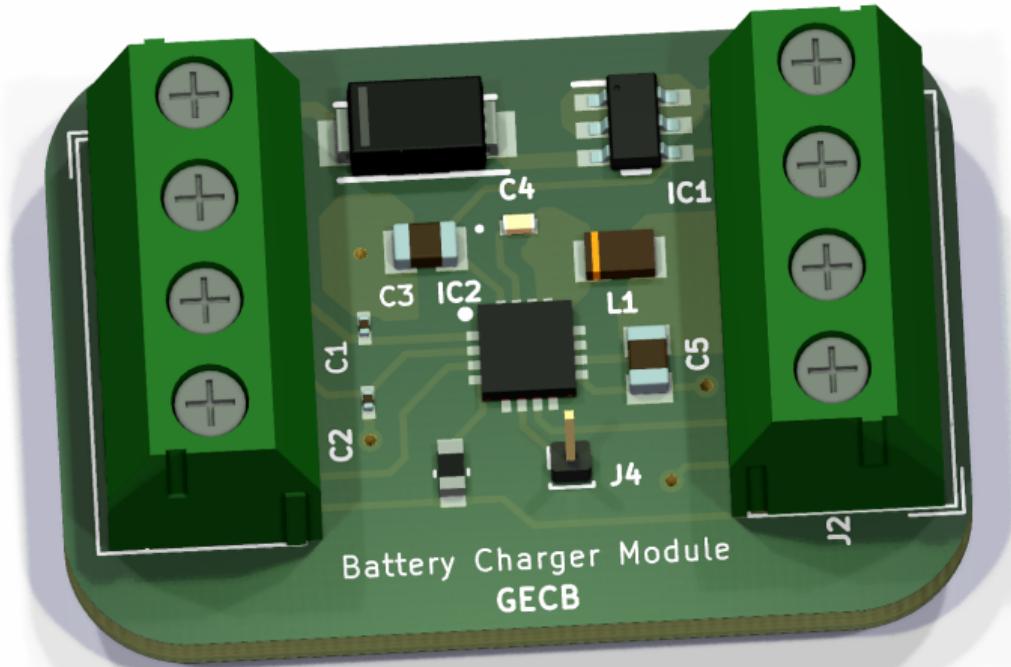


Figure 7: 3-D model of Battery Charger

Hardware Design - Maximum Peak Power Transfer (MPPT)

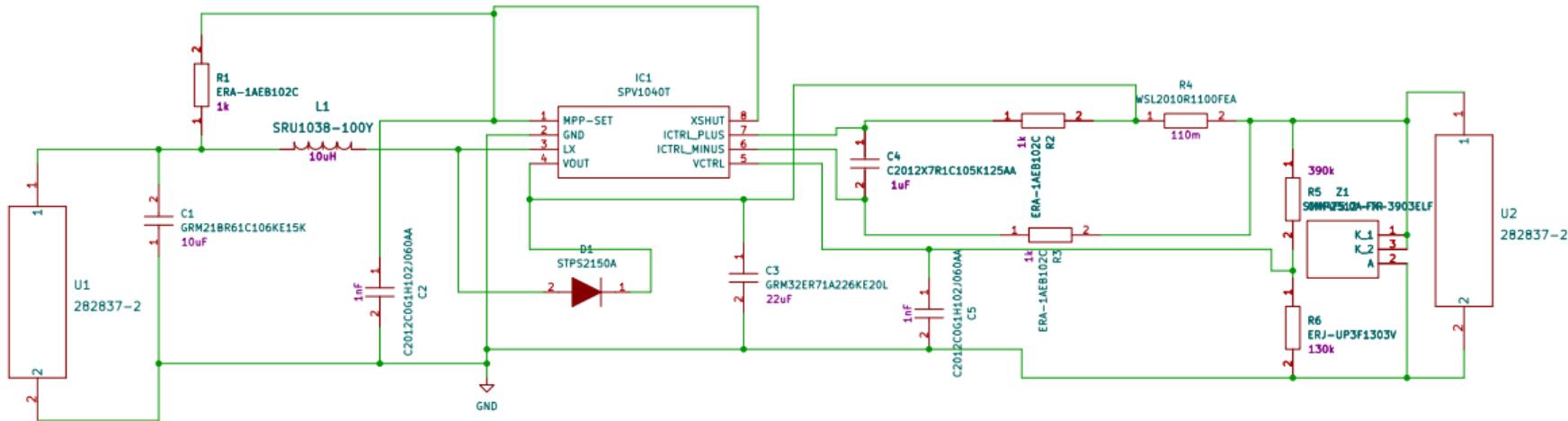


Figure 8: Circuit design of MPPT

Hardware Design - MPPT (Contd.)

- IC: SPV1040
- MPPT with Perturb and Observe algorithm
- Input Voltage: 0.3 - 5.5V
- Output Voltage: 5V
- Switching Frequency: 100kHz
- Inbuilt over-current, temperature protection
- Efficiency: 95%

Hardware Design - MPPT (Contd.)

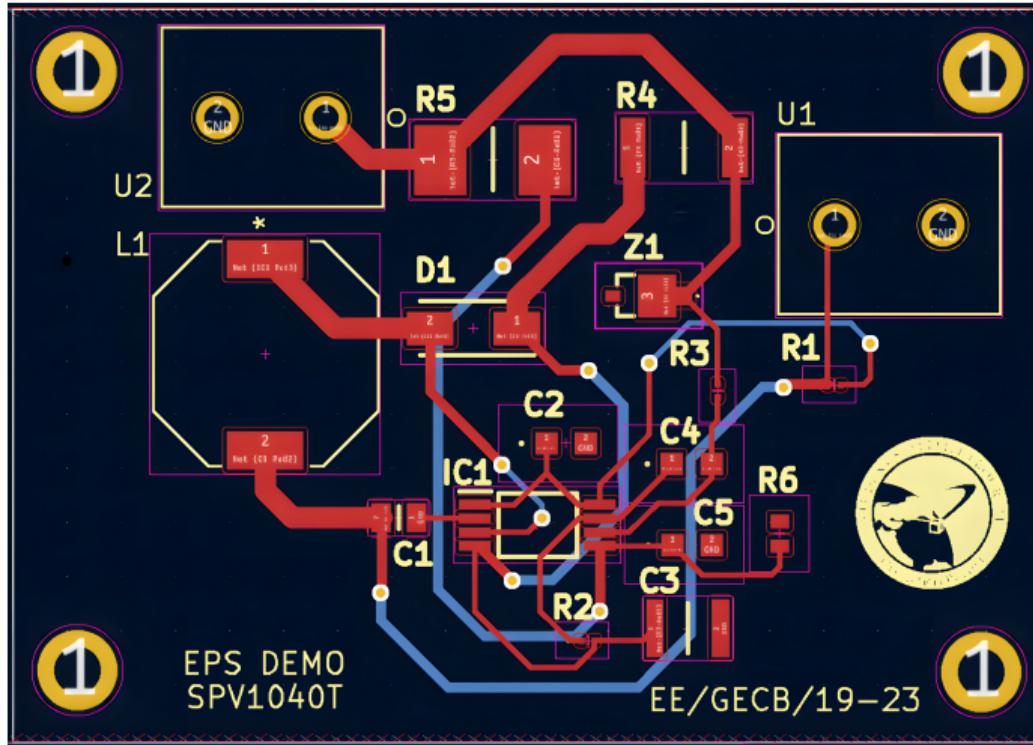


Figure 9: PCB Layout of MPPT (48mm x 34mm)

Hardware Design - MPPT (Contd.)

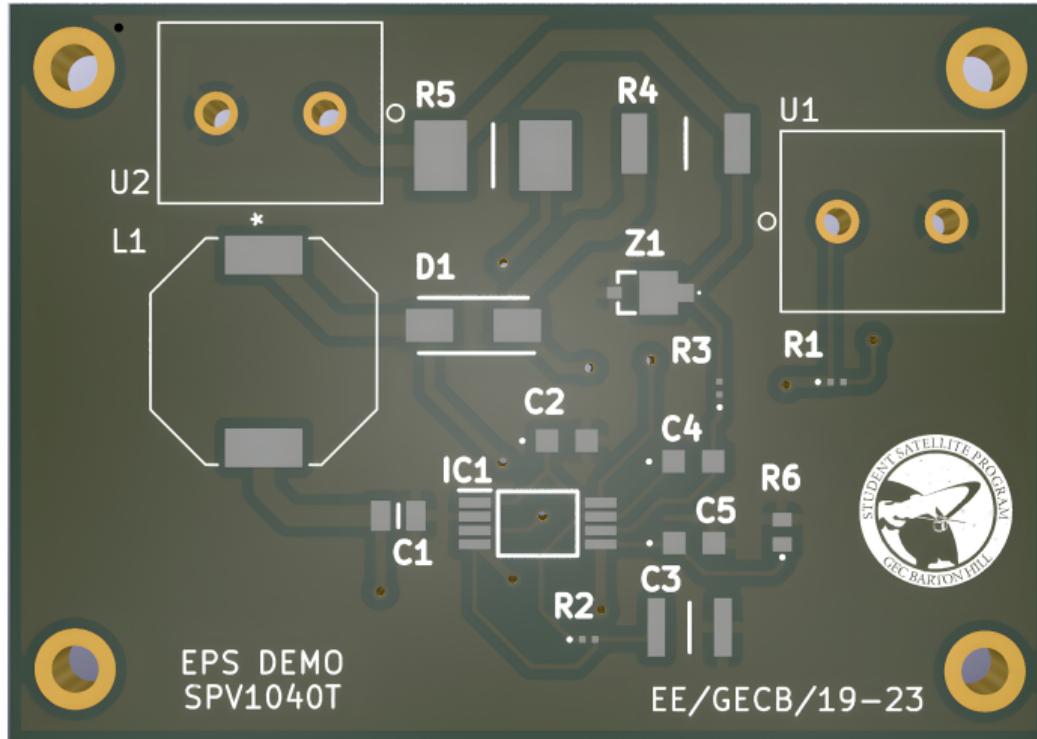


Figure 10: 3-D model of MPPT

PCB Specifications

- Manufacturer: ROBU.IN
- Material: FR-4 (Flame retardant epoxy resin and glass fabric composite)
- Board Thickness: 1.6mm
- Surface finish: HASL¹(with lead)
- Finished Outer Layer Copper: 1 oz
- Finished Inner Layer Copper: 0.5 oz
- PTH² Via diameters: 0.8 mm, 0.6mm (For thermal)
- PTH Via hole: 0.4 mm
- No. of boards: 4 designs x 5 pcs.
- Total cost: Rs. 3096

¹Hot Air Solder Levelling

²Plated Through Hole

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Thank You