Power Distribution System for a CubeSat

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Contents

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

Power Budget

Sub-system		Voltage (V)	Max. Current (mA)	Power (mW)	Contingency 5%	Margin 20%	Duty Cycle (%)	Energy (Wh)
ADCS	ADCS	3.3	20	66	69.3	83.16	100	0.133725438
	Magnetorquer	3.3	100	330	346.5	415.8	50	0.334313595
OBC	OBC	5	40	200	210	252	100	0.4052286
Rx-Tx	Telemetry	5	300	1500	1575	1890	11	0.334313595
	Beacon	5	20	100	105	126	100	0.2026143
	GPS	3.3	40	132	138.6	166.32	30	0.0802352628
Payload	LoRa	5	20	100	105	126	10	0.02026143
EPS	EPS	-	-	160	168	201.6	100	0.32418288
	Thermal	-	-	250	262.5	315	32	0.16209144
					Tot Power(mW)	**3575.88**	**Tot. Energy**	**1.997**

System Architecture

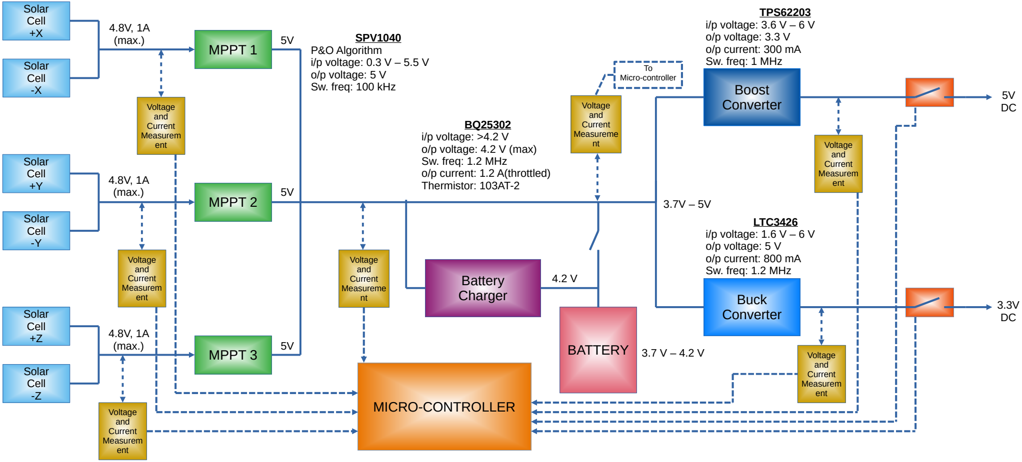

Figure 1: CubeSat EPS Architecture

Hardware Design

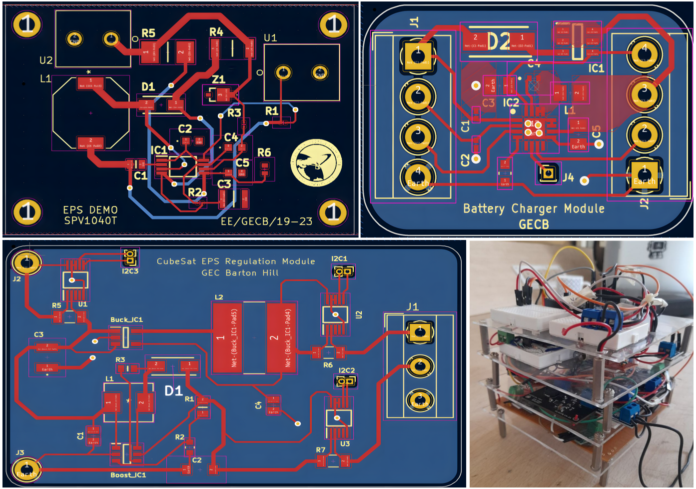

Figure 2: PCB Designs

Fully Integrated EPS

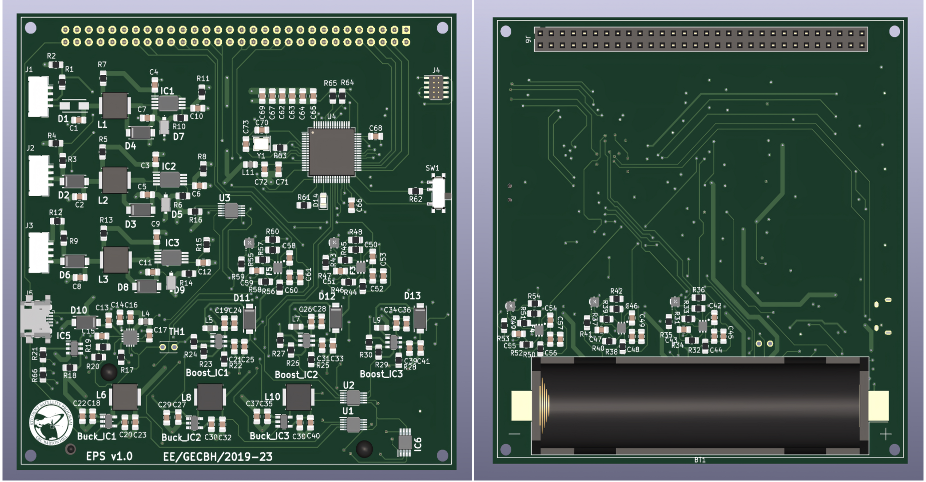

Figure 3: PCB design of EPS (9.5 cm x 9.5 cm)

Results

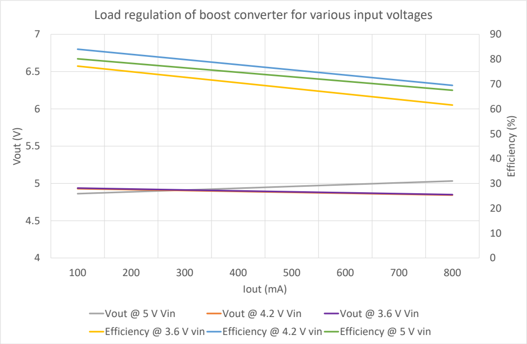

Figure 4: Load regulation of boost converter

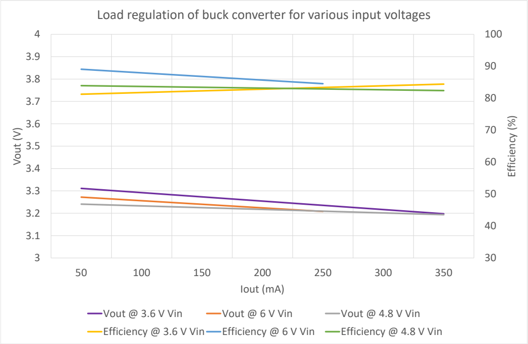

Figure 5: Load regulation of buck converter

Results

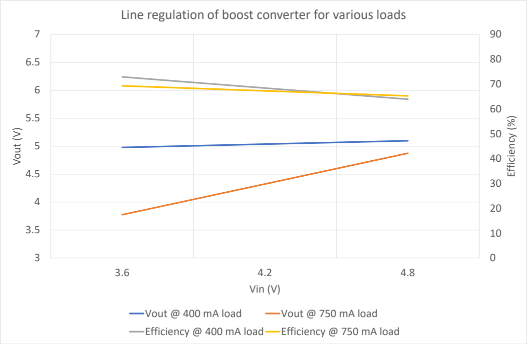

Figure 6: Line regulation of boost converter

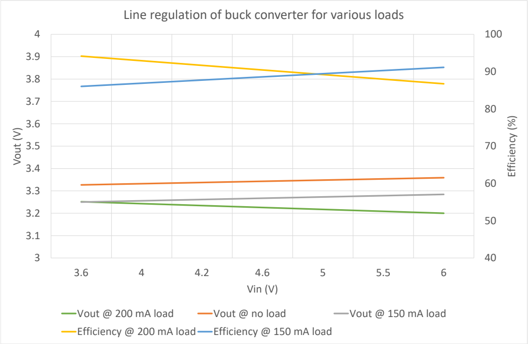

Figure 7: Line regulation of buck converter

Results

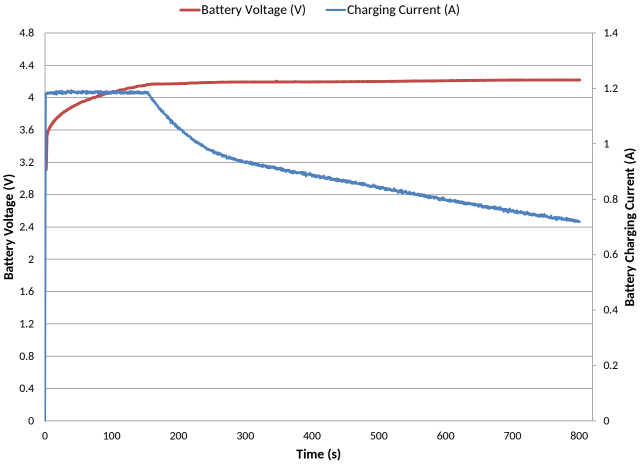

Figure 8: CC CV battery charging

Conclusion

- Conclusion
  - Initial power budget was established to determine the power requirements.
  - System architecture was designed, considering the functional requirements and scalability.
  - PCB design, fabrication and soldering processes was completed and preliminary testing of all modules were conducted to identify any potential issues or design flaws.
  - Power converters were tested to ensure stable power delivery.
  - Fully integrated EPS was designed in KiCad, incorporating improved designs, protection, and monitoring circuits.
- Future Scope
  - Update power budget
  - Improvements in design
  - Battery heater, Remove Before Flight pin, Watchdog timer
  - Circuit Redundancy
  - FreeRTOS in STM32 microcontroller

Selected References

[1] Knap, Vaclav & Vestergaard, Lars & Stroe, Daniel-Ioan (2020)
A Review of Battery Technology in CubeSats and Small Satellite Solutions
Energies, vol. 13

[2] A. Edpuganti, V. Khadkikar, H. Zeineldin, M. S. E. Moursi and M. Al Hosani (2021)
Comparison of Peak Power Tracking Based Electric Power System Architectures for CubeSats
IEEE Transactions on Industry Applications, vol. 57, no. 3, pp. 2758-2768, May-June 2021

[3] A. Edpuganti, V. Khadkikar, M. S. E. Moursi, H. Zeineldin, and K. Al Hosani (2022)
A Comprehensive Review on CubeSat Electrical Power System Architectures
IEEE Transactions on Power Electronics, vol. 37, no. 3, pp. 3161-3177, March 2022

[4] Aulia Indana, Dharu Arseno, Edwar, and Adilla Safira (2020)
Output Power Analysis of Tel-USat Electrical Power System
AIP Conference Proceedings 2226

Thank You