Power Distribution System for a CubeSat

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November 9, 2022

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Contents

Objective

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

Project Outline

CubeSat(1U):

- Dimensions-10x10x10 cm^3
- Weight-2 kg.

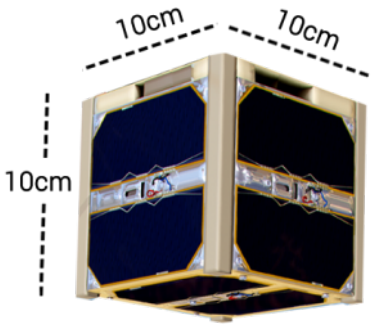

Figure 1: CubeSat 1U (Source: GIS Geography)

Project Outline (Contd.)

Electrical Power System (EPS):

- Harvests energy from the solar panels
- Manages power storage and distribution
- Protects circuits from damage
- Redundant architecture

Literature Review

Power Generation and Storage:

- Solar cells and batteries used for generation and storage of power respectively
- Batteries supply power during absence of solar energy
- Li-ion batteries are preferred to Ni-MH [1]

Power Conditioning:

- DC-DC converters are preferred to linear voltage regulators to reduce losses
- Peak power transfer is preferred to direct power transfer for solar output [2]
- Trickle charge method is used to charge the batteries
- 5V and 3.3V DC-DC convertors outputs regulated voltage to their respective DC buses

Literature Review (Contd.)

Power Distribution:

- Distributed EPS scheme [3] is preferred to increase flexibility
- 5V and 3.3V DC-DC convertors outputs regulated voltage to their respective DC buses

Power Monitoring and Converter control:

- The microcontroller monitors the voltage levels and currents in the circuit and DC buses
- It is responsible for PWM generation, over-current protection and logging
- STM 32 microcontroller is selected due to it's low power usage and radiation tolerance.

System Architecture

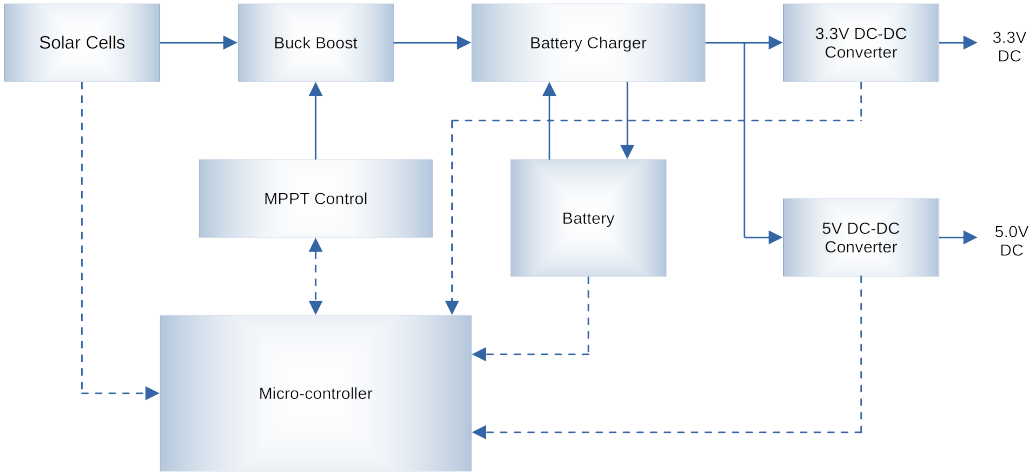

Figure 2: CubeSat EPS Architecture

Methodology

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

Requirements

Equipments Requirements:

- SMD Soldering Station
- Oscilloscope
- Power Supply
- Function Generator

Software Requirements:

- MATLAB/Spice
- KiCad
- STM32 CubeIDE

Budget Estimate: Component cost

Sl. No.	Item	Amount (Rs.)
1	STM32 NUCLEO Development Board	3000
2	SMD soldering station	9000
3	Li-ion Cell (x2)	1000
4	Regulated Multi-Output Power Supply	5000
5	Solar Panel	2000
6	Components	8000

Budget Estimate: Fabrication cost

Sl. No.	**Item**	**Amount (Rs.)**
1	PCB Printing	3000
2	SMD soldering	990
3	Inductor Fabrication	1000

Project Timeline

Activity	**October 3rd & 4th week**	**November 1st & 2nd week**	**November 3rd & 4th week**
Literature Review			
Hardware Design			
Report Writing			

Project Timeline

Activity	Oct 3rd week	Oct 4th week	Nov 1st week	Nov 2nd week	Nov 3rd week	Nov 4th week
Literature Review						
Hardware Design						
Report Writing						
Component Procurement						
Fabrication						
Software Development						
Testing						

References I

[1] E. Ayoub and N. Karami
Review on the charging techniques of a Li-Ion battery
Third International Conference on Technological Advances in Electrical, Electronics and Computer Engineering (TAEECE), 2015, pp. 50-55

[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] B. Hussein, A. M. Massoud and T. Khattab (2022)
Centralized, Distributed, and Module-Integrated Electric Power System Schemes in CubeSats: Performance Assessment
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