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

Project Outline

CubeSat (1U):

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

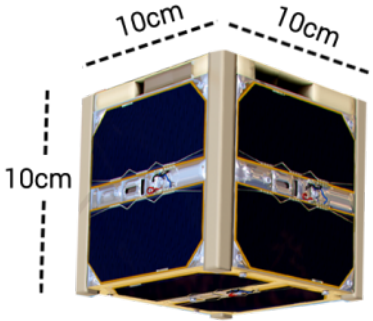

Figure 1: CubeSat 1U (Source: GIS Geography)

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 [3] 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 [4] 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

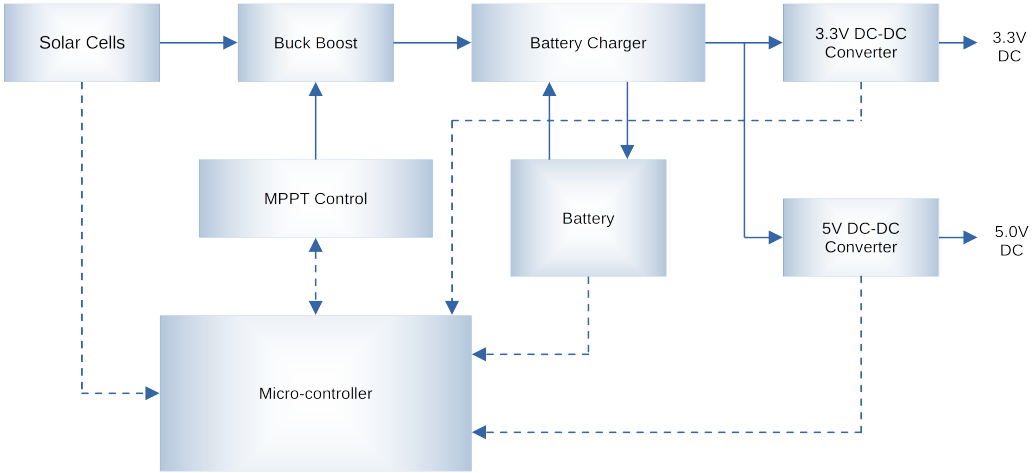

Figure 2: CubeSat EPS Architecture

Methodology

- Identifying the power requirements
- Architecture design and topology selection
- Forming Specifications
- 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	Oct Week 3-4	Nov Week 1-2	Nov Week 3-4	Dec Week 1-2	Dec Week 3-4
Literature Review					
Hardware Design					
Report Writing					
Component Procurement					
Fabrication					
Software Development					
Testing					

References I

[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] 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

References II

[4] B. Hussein, A. M. Massoud and T. Khattab (2022)
Centralized, Distributed, and Module-Integrated Electric Power System Schemes in CubeSats: Performance Assessment
IEEE Access, vol. 10, pp. 55396-55407