



# An Affordable, Efficient, 1U CubeSat Electrical Power System Scalable for 2U and 3U Systems

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# Overview of System

1) Plug & play system requiring no input from the satellite microcontroller unit (MCU) to function
2) Outputs status to MCU and interfaces easily (Panel voltages, battery voltages, etc)
3) Fits on a 80X80mm PCB (excluding batteries)
4) Provide efficiencies comparable to, or better, than Commercial Off-The-Shelf (COTS) solutions
5) Price per unit remain under $600 (Parts + PCB)

# Advantages

- Designed to include at least 6 Maximum Power Point Tracking (MPPT), opposed to most COTs that have 3
- No programming is required to function
  - All switching is accomplished by logic circuitry
- Orders of magnitude cheaper than most COTs

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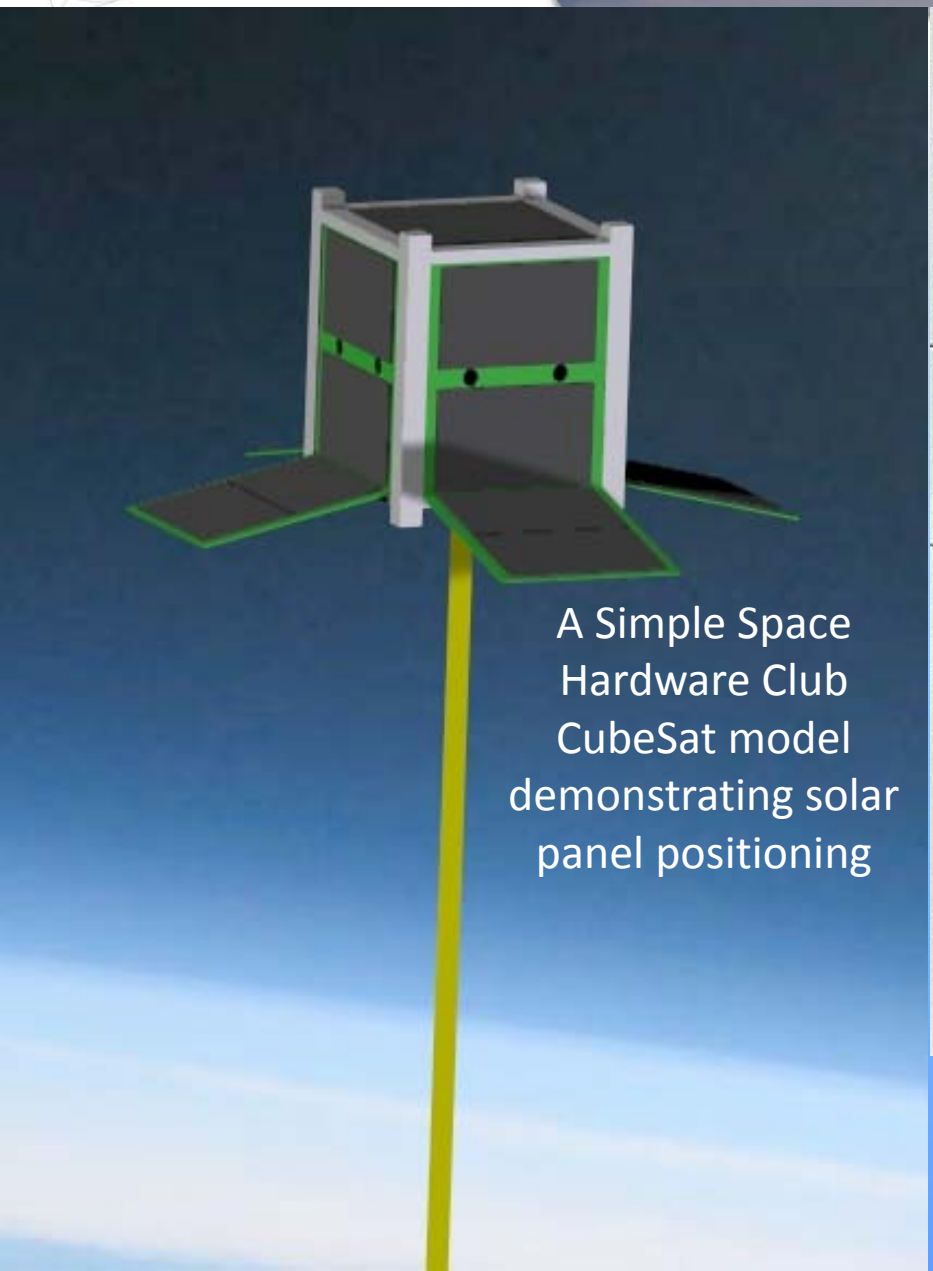
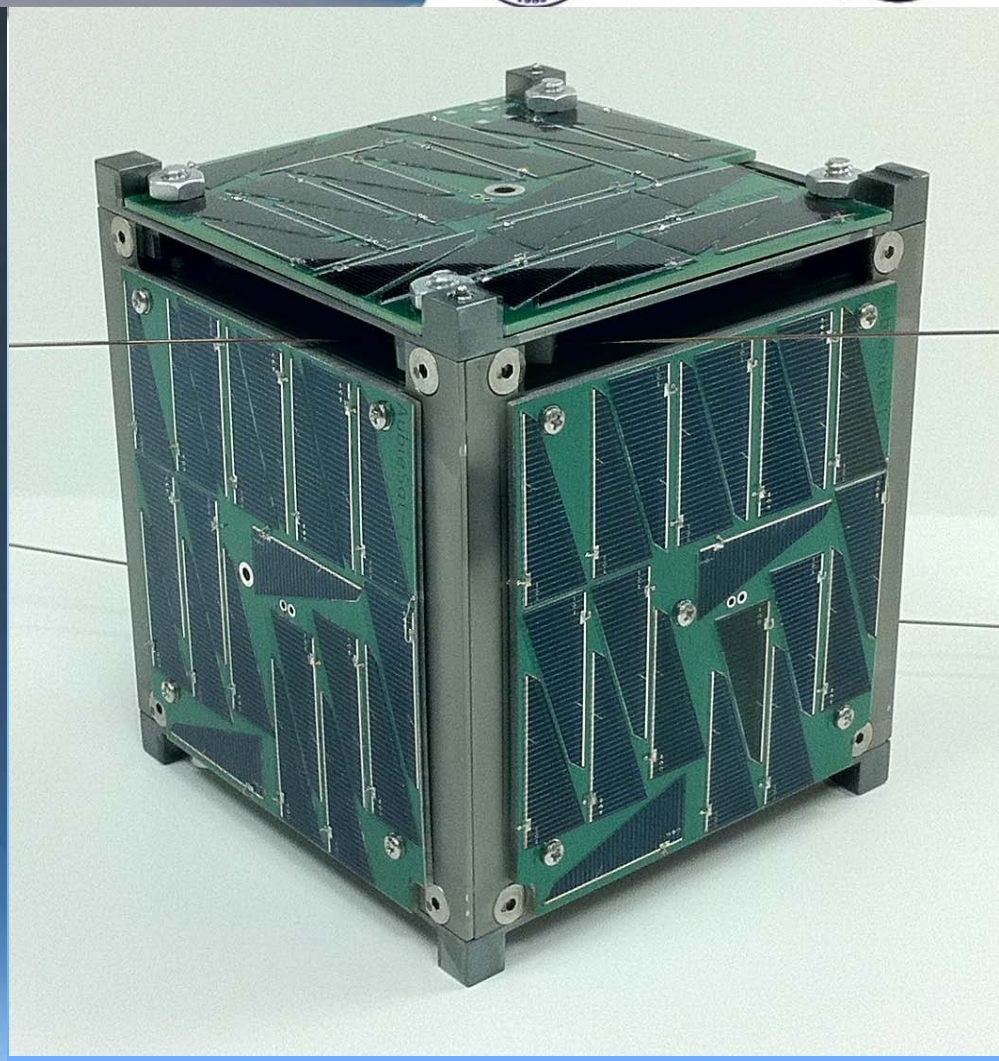


A Simple Space Hardware Club CubeSat model demonstrating solar panel positioning



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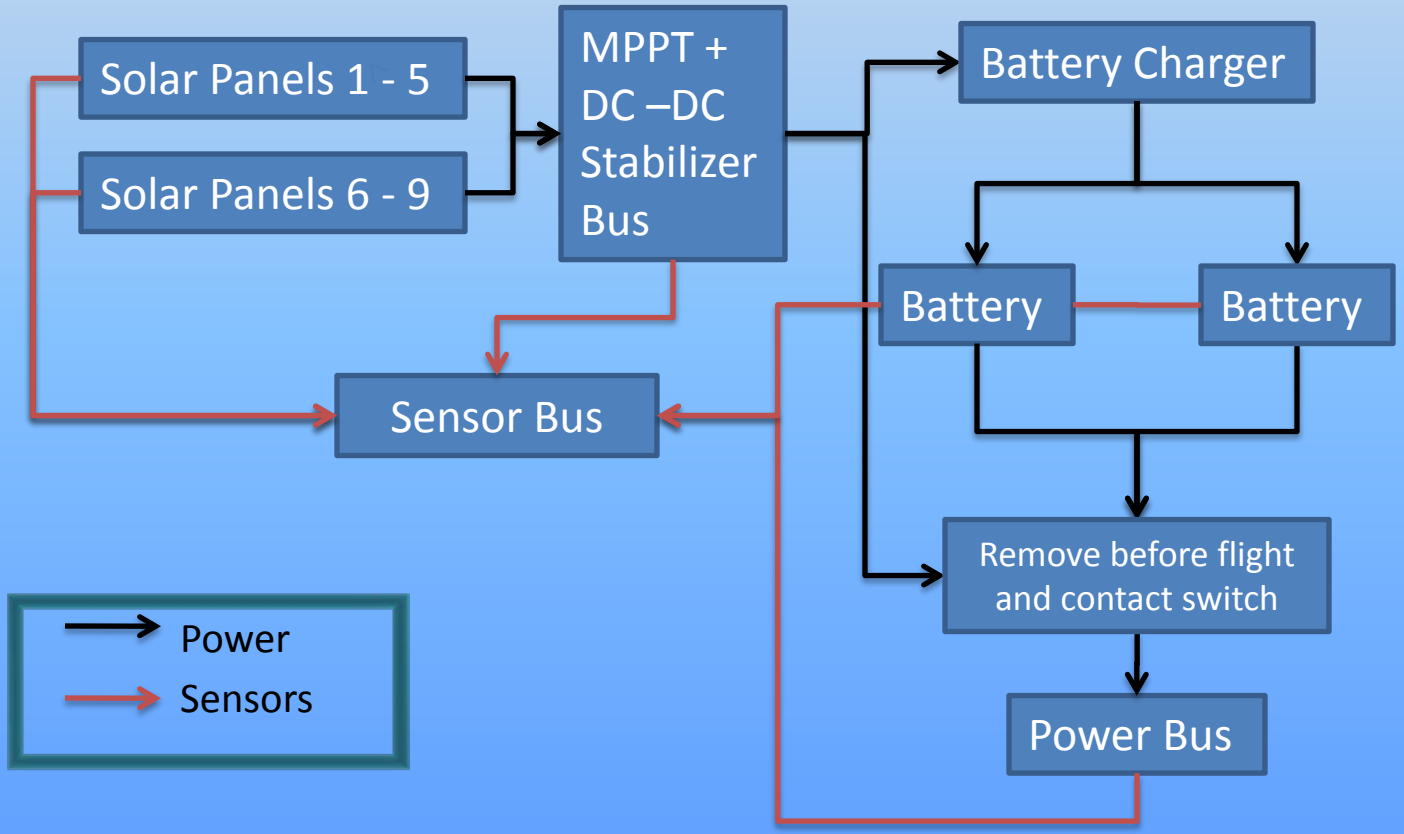
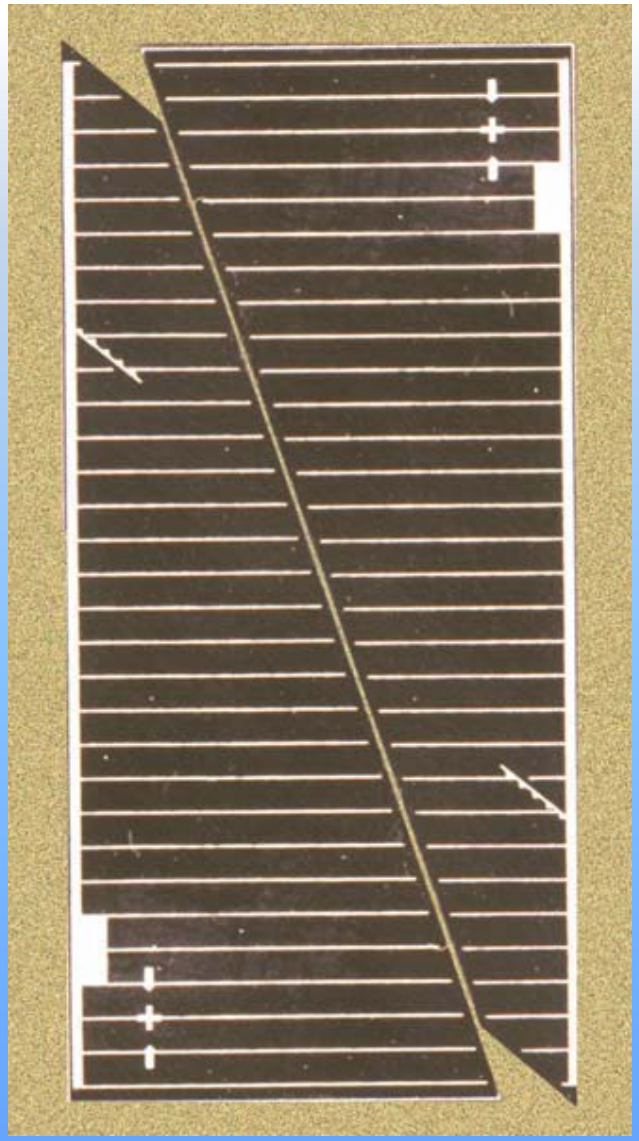
# Electrical Power System (EPS)



# Solar Cells

- Triangular Advanced Solar Cells
- Improved triple-junction gallium arsenide
- TASC-IJT
- 27% (+/- 3%)
- Very affordable
  - Under $1000 for complete CubeSat coverage



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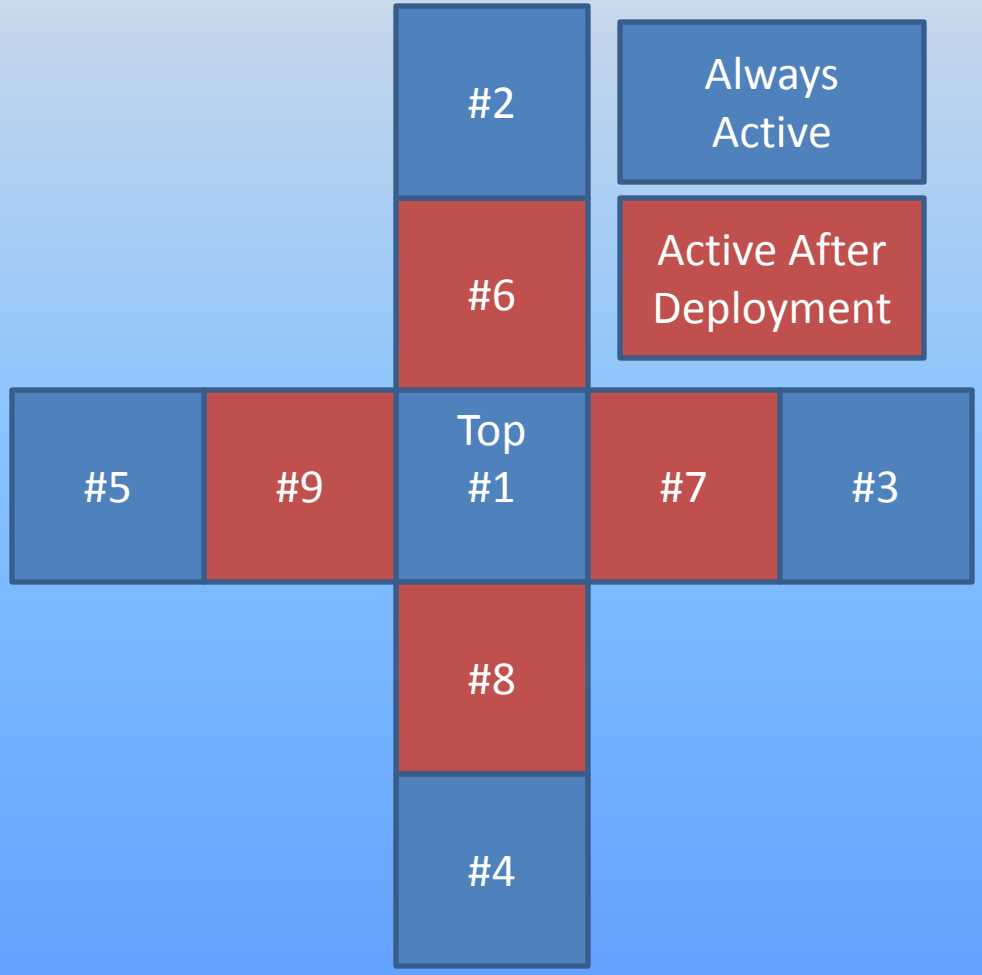
# Solar Panel Layout



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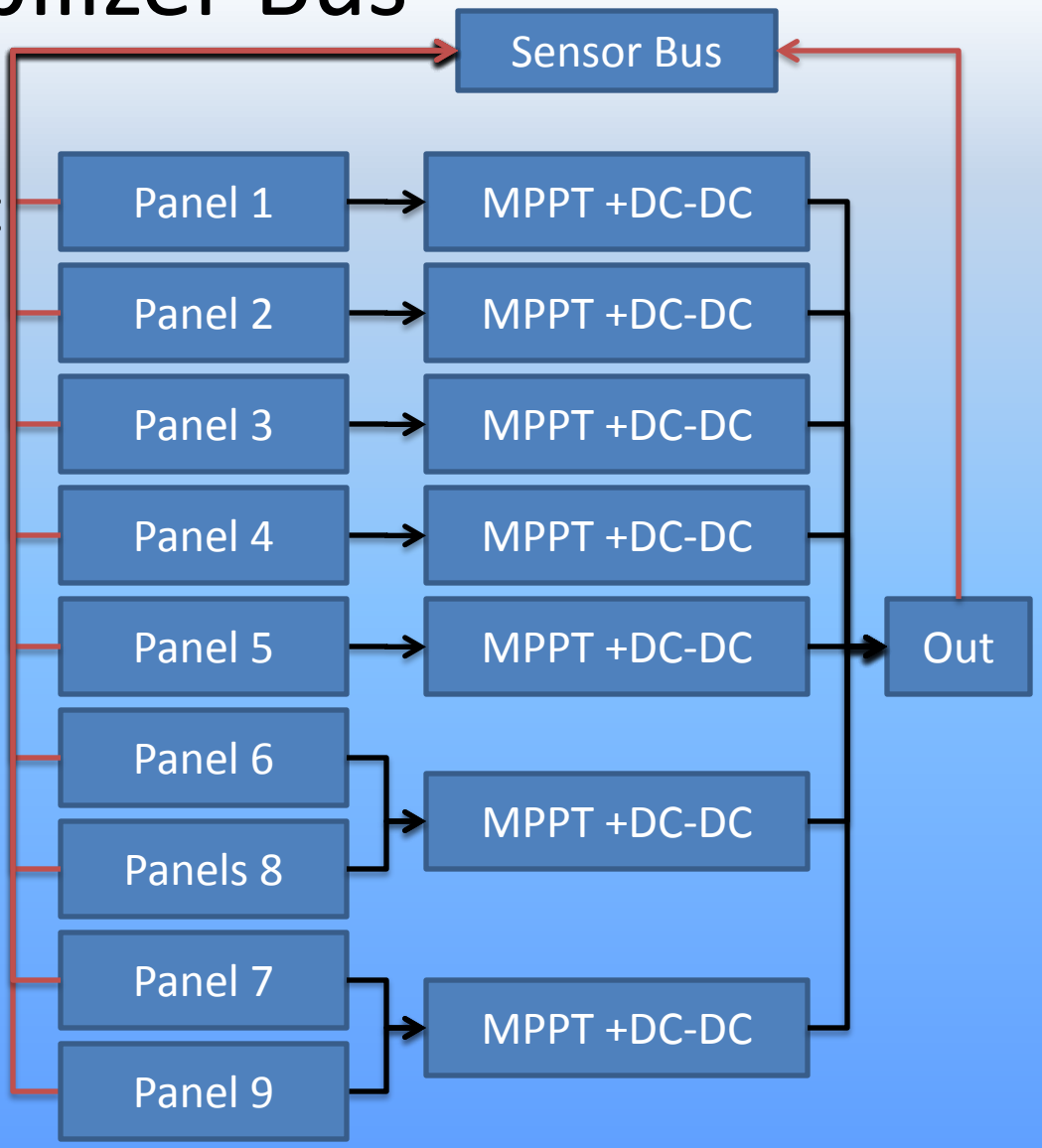
# MPPT + DC-DC Stabilizer Bus

- Based on LTC3015
- Roughly 80% - 92% efficient at 25 °C (varies with load)
- 25mV noise under 1W load
- Sensors
  - Panel Voltages
  - Output Voltage
  - Output Current
- Status
  - Built
  - Electrical Testing



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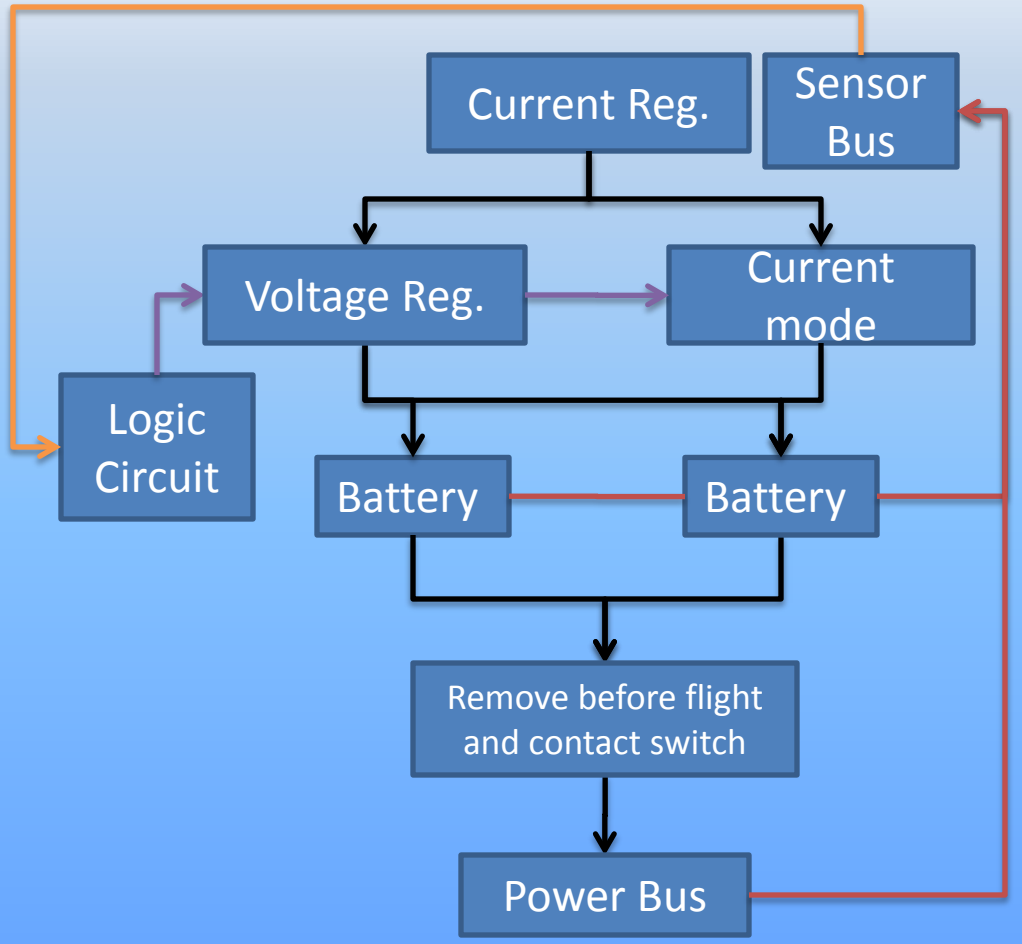
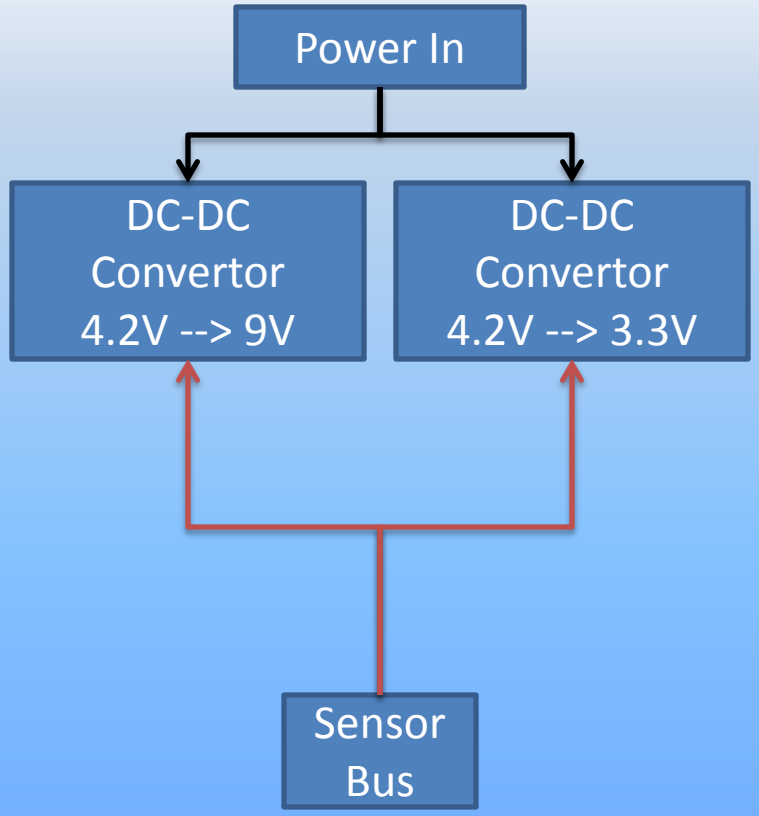
# Battery Charger & Battery

- Temperature compensation
- LiPo Batteries
  - Largest energy density to mass ratio
  - 2 Batteries for redundancy
- Sensors
  - Temperature
  - Voltage
  - Output Current
  - Charge Current
- Status
  - Designed, Building



# Power Bus

- Based on Max1771
- Roughly 80-92% efficient at 25C (varies with load)
- 25mV noise under 1W load
- Sensors
  - Output Voltage
- Status
  - Built
  - Electrical Testing



# Sensors and MCU Interface

- Voltage
  - Solar Panel
  - Output of MPPT + DC-DC
  - Battery
  - Output Rails
- Current
  - Output of MPPT + DC-DC
  - Output of Battery Charger
  - Output of Batteries
- Temperature
  - PCB
  - Battery

- # of Data Lines = 2

- Utilizing 2 LTC2499
  - 24 bit 16 channel ADCs
  - Communicates via $I^2C$

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# Conclusion

- This EPS is more affordable than similar COTS solutions
- Contains up to 7 MPPT circuits which gives this system access to Earth's albedo
- Fits on a 80mmX80mm PCB
- Easy to interface
- Plug and play!

# References


- SpectroLab Inc., Triangular Advanced Solar Cells
- Maxim Integrated Products, MAX1771
- Linear Technology Corporation, LTC3015
- Linear Technology Corporation, LT3092
- Linear Technology Corporation, LTC2942
- Linear Technology Corporation, LT6105
- Linear Technology Corporation, LTC2499