Solar Aircraft MPPT Charge Controller Design

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Motivation

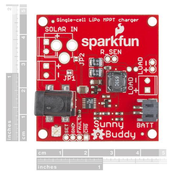
- Autonomous solar powered UAV for environmental monitoring and data collection
- New aircraft designed with larger battery capacity needs a redesigned solar charge controller

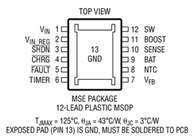
Background Research

- Power output of a solar panel varies with weather and solar irradiation conditions
- Maximum Power Point Tracking (MPPT) is a technique to efficiently charge solar panels
- Common MPPT techniques include: current sweep, incremental conductance, constant voltage, etc.
- Understanding the specifications of battery and solar panels is needed to design the circuit
- Battery: 3s LiPo 4500mAh (TP4500-3SHV)
- Solar Panels: .96V Alta Single Solar Cells, rated at 214 mW
- 15 solar cells will be placed in series with about 20 sets in parallel on the wing of the aircraft

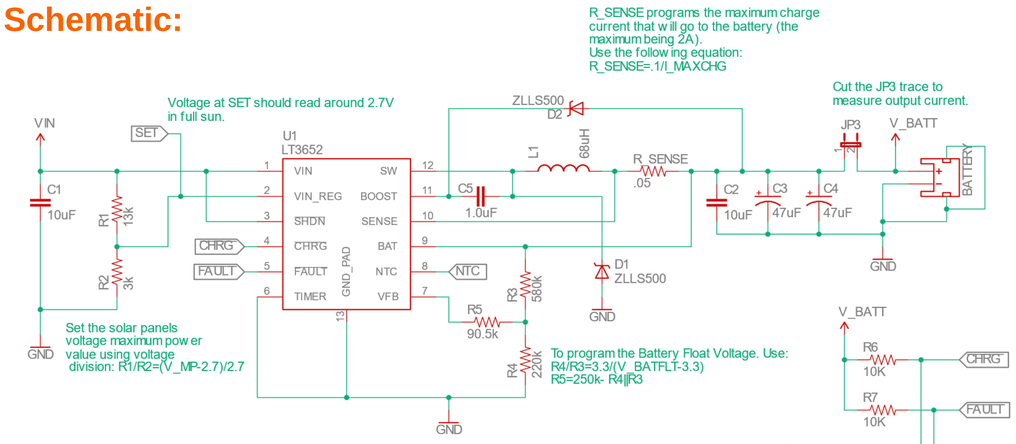
Materials and Method

- SparkFun Sunnybuddy Dev Board and schematic was used to understand the MPPT circuit
- The LT3652HV Power Tracking 2A Battery Charger Integrated Circuit (IC) was used in the final design as the MPPT device
- EAGLE was used to design the final PCB

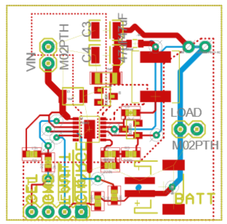




Schematic:



PCB Layout:



Calculations

Must program 3 specifications into the LT3652HV MPPT IC. The following values were determined by studying the battery and solar panels, and programmed by analyzing the circuit and LT3652HV data sheet:

1. Maximum power voltage of solar panels V_{MP}:

   15 Solar cells in series → V_{MP} = 15x.96V= 14.4V

   R1/R2=(V_{MP}-2.7)/2.7 → R1=13kΩ, R2=3kΩ

2. Maximum charging current of battery I_{MAX_CHRG}:

   4500mAh battery at 2C charging capacity → I_{MAX_CHRG} =2*4.5A= 9A, however LT3652 handles max of 2 A so I_{MAX_CHRG}= 2A

   R_SENSE= .1/I_{MAX_CHRG} → R_SENSE=.05Ω

3. Float charging voltage of battery V_{FB}:

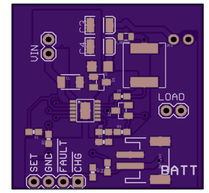
   3S LiPo battery with about 4 V float each cell → V_{FB}=3*4V= 12V

   R4/R3=3.3/(V_{FB} - 3.3) → R3=580kΩ, R4=220kΩ

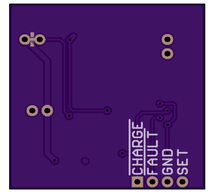
Results and Conclusion

- A MPPT charge controller was carefully researched and designed on EAGLE
- The final circuit was much more compact than the original SparkFun design
- PCBs will be printed and wired in parallel to account for higher currents

Front:



Back:



Future Work

- Improving the LT3652HV MPPT design to match the needed specifications
- Testing and improving the circuit with flight trials
- Eventually the circuit could be efficient enough to support nonstop flight for weeks or longer

Acknowledgements

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