Smart Battery Charger

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Background & Requirements

As renewable energy sources are being adopted more widely adopted in both large and small scale by electric companies and private residential units alike, the center for smart grid at Cal Poly Pomona decided to investigate the impact of this new energy source on the grid. The first obstacle we face with this new energy is that the optimal generating period neither consistent nor reliable; therefore, the need for an efficient energy storage system is crucial in the future of the smart grid as renewable energy become a more prominent part of the grid, especially since California's official state mandate is to have 33% of the electrical grid supplied by renewable energy by 2020.

The Smart Grid Project's main parts are a Distribution module, a Substation module, and a new Solar and Wind Generation module. The goal is to store the excess energy generated while the grid is underutilized and supply it back as needed in an efficient and seamless manner as to not disrupt the operation of the grid. Different commercial solutions and methods was studied and a prototype was constructed with this capability

Design

The main component of the charging circuit is a Linear Technology LT1512 chip. This chip feature a current sense feedback circuit for accurately controlling output current of a fly back or SEPIC (Single-Ended Primary Inductance Converter) topology charger. These topologies allow the current sense circuit to be ground referred and completely separated from the battery itself, simplifying battery switching and system grounding problems. In addition, these topologies allow charging even when the input voltage is lower than the battery voltage.

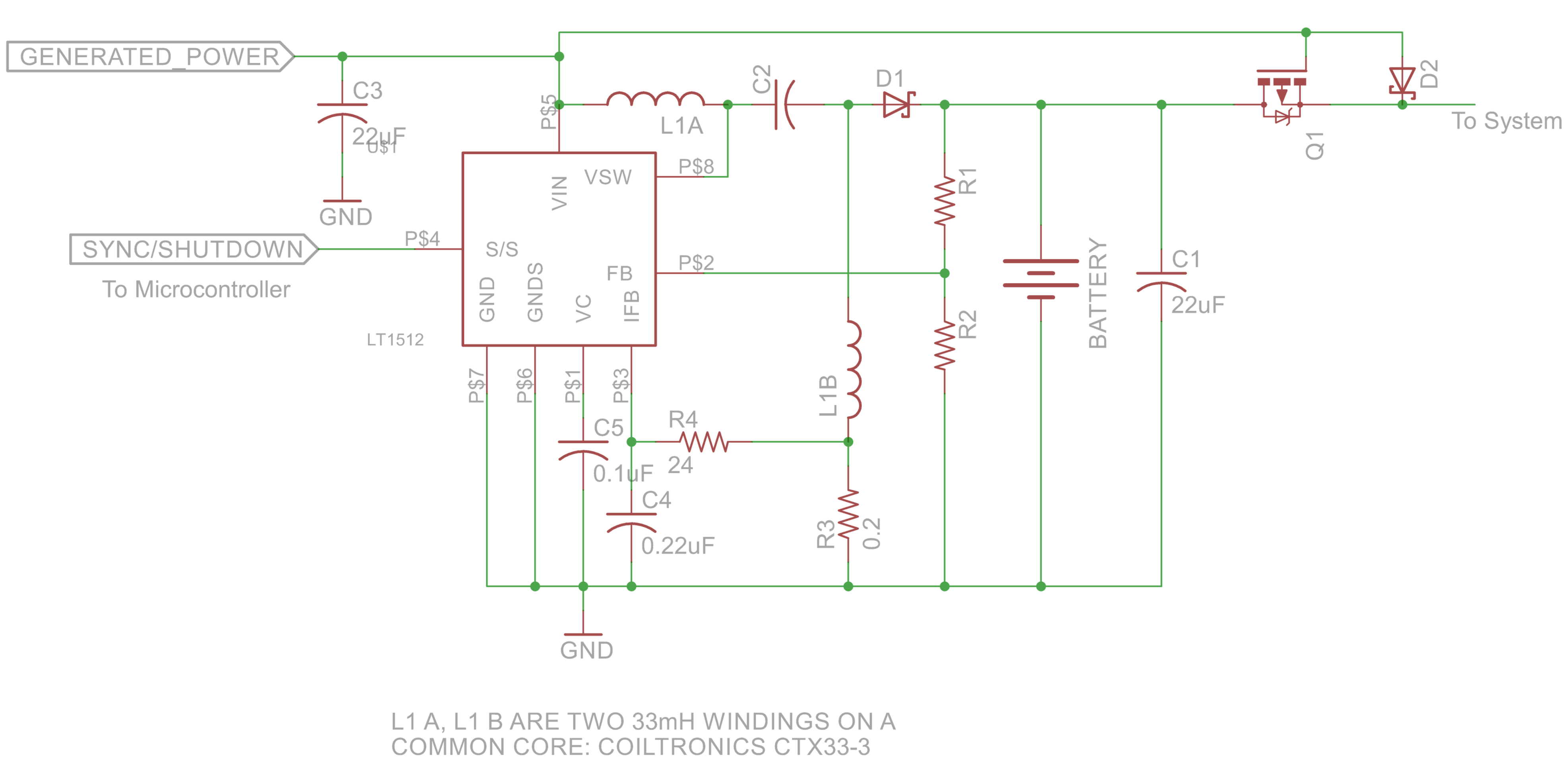
The floating battery voltage is set by the resistor pair R1 and R2 and can easily be configured for compatibility with a broad range of batteries.

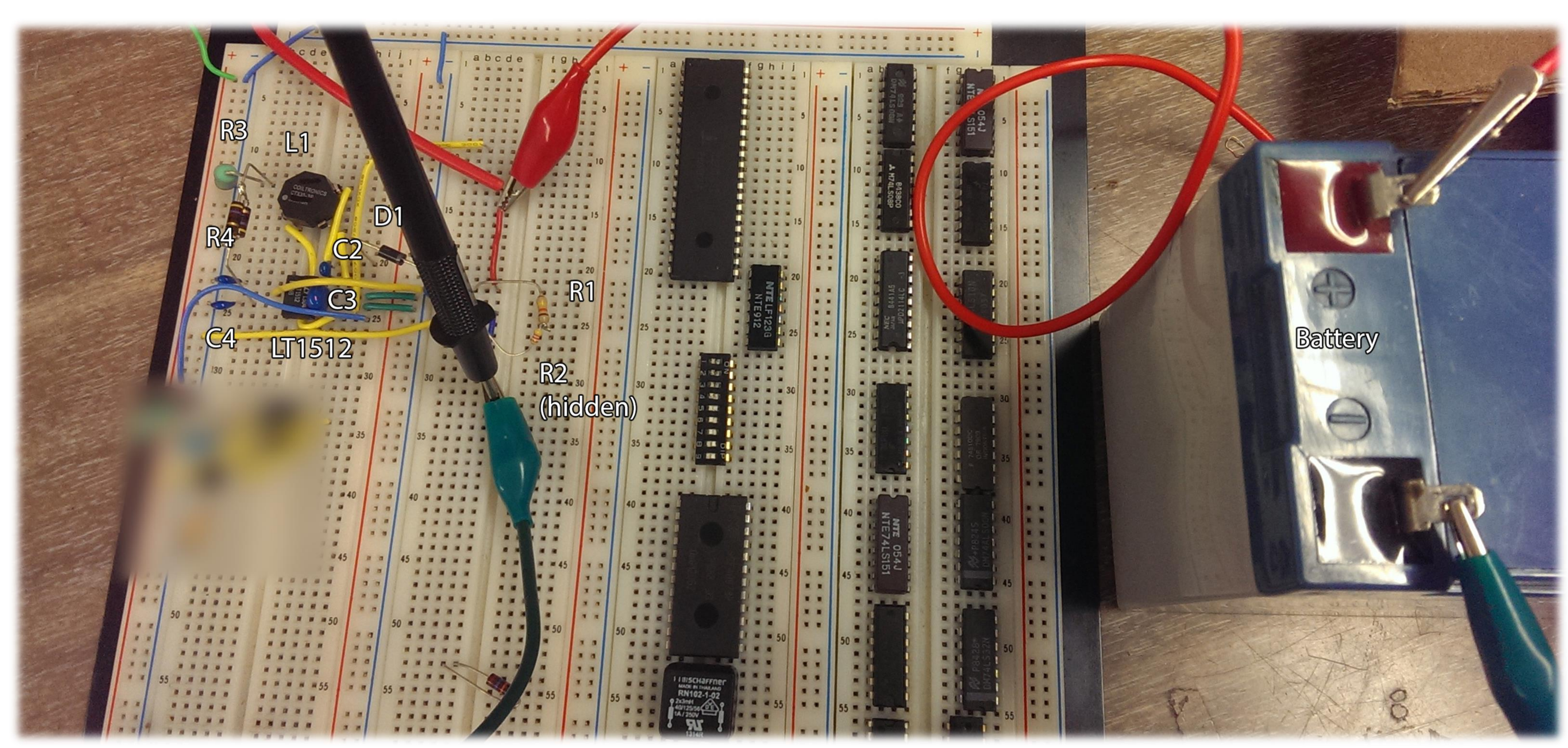
Test & Results

Laboratory testing of this circuit yielded the following results:

- This charger work with the source voltage as low as 5V. This is great because our solar and wind generations fluctuate radically depend on time of day and weather condition
- When there is more power generated than is needed to charge the battery, the P-channel MOSFET Q1 is turned off so that system is powered by the generators directly.
- When power is insufficient or off, the system is able to get its power from the battery.

Schematic





Future Additions

- Battery voltage monitor
- Temperature sensor
- Make the MOSFET controlled by a microcontroller for more precise and flexible power flow management

References

1512fa: SEPIC Constant-Current/Constant-Voltage Battery Charger**.** Linear Technology. Web.

Institute for Energy Research. "Renewable Electricity Mandates and Goals." *Institute for Energy Research*. N.p., n.d. Web. 17 Mar. 2014