Battery Powered LED Driver

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Overview

There exists a need for portable lighting systems having the capability of operating off-grid in remote locations. Example applications include:

- Construction Sites
- Field Hospitals
- Emergency or Disaster Situation

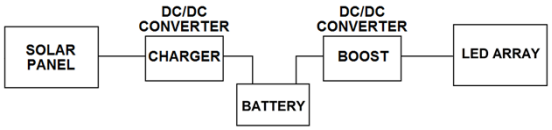
Our Goal:

- Portable
- Battery Powered
- Solar Rechargeable
- High Light Output
- Dimmable

Source: Wiki Commons

Circuit Description

The LED Driver is a current-regulated power supply designed to drive an LED array from a 12 volt sealed lead-acid (SLA) battery. The circuit can deliver up to 400 milliamps DC at a nominal 120 volts. The design utilizes a photovoltaic panel to recharge the battery for true off-grid operation.



Charger Circuit

- Based on LT3652A controller by Linear Technology
- 2 ampere charging current
- 13.6 V float voltage supports SLA battery chemistry
- Incorporates maximum power point tracking for maximum solar efficiency

Boost Circuit

- Based on LT3757 controller by Linear Technology
- Approximately 10:1 boost ratio
- Adjustable 100 to 400 ma current regulation for limited dimming range
- Overvoltage cut-out for open-circuit protection

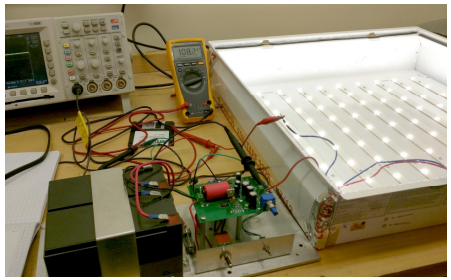
Results

Design Goal:

- Current-regulated 400mA at up to 120V output

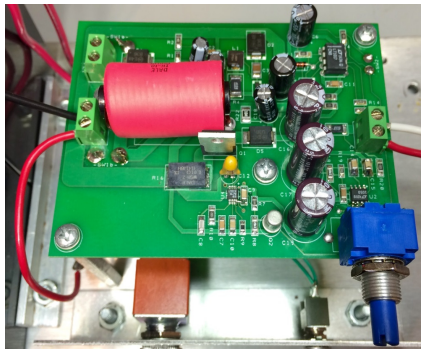
Actual Results:

- Initial testing yielded maximum load current of 50mA, with significant LED flicker
- Problem due to non-linear load; large current spikes were amplified by feedback amplifier causing LT3757 to fold back and reset
- Feedback amplifier reconfigured to a non-inverting low-pass filter, resulting in flicker-free operation over output current range of 50 to 110 milliamps
- need to modify gain for 400 mA operation



PC Board Assembly

- Layout designed in DesignSpark PCB software
- Power and ground traces sized to carry large currents in boost circuit critical paths
- Kelvin connections made at switching shunt nodes as well as load shunt nodes
- Boost switch loop made as compact as possible to minimize parasitic effects
- Mix of surface-mount and through-hole components
- SMT components reflow soldered
- Through-hole components hand soldered



Lessons Learned

We learned a great deal in the execution of this project:

- Simulation does not equal reality! Our design performed well in simulation, but had controller fold-back/reset issues due to current spikes through the non-linear load
- Troubleshooting/debugging your own design is not easy – there is no history or reference on which to base your efforts
- Component specifications are important! Thick-film versus thin-film resistors; electrolytic, ceramic, or tantalum capacitors – knowing why and where to use each can make or break a design
- Printed circuit layout can influence circuit behavior and response, especially when high current and high frequencies are involved
- Adding extra pads on our printed circuit board layout at key nodes would have aided in testing and troubleshooting
- Seek out and trust the advice of an experienced mentor; read and re-read datasheets