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DESIGN NOTES

A 4-Cell Ni-Cad Regulator/Charger for Notebook Computers – Design Note 54

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The new LTC1155 Dual Power MOSFET Driver delivers 12V of gate drive to two N-channel power MOSFETs when powered from a 5V supply with no external components required. This ability, coupled with its micropower current demands and protection features, makes it an excellent choice for high side switching applications which previously required more expensive P-channel MOSFETs.

A notebook computer power supply system is a good example of an application which benefits directly from this high side driving scheme. A four cell, Ni-Cad battery pack can be used to power a 5V notebook computer system. Inexpensive N-channel power MOSFETs have very low ON resistance and can be used to switch power with low voltage drop between the battery pack and the 5V logic circuits.

Figure 1 shows how a battery charger and an extremely low voltage drop 5V regulator can be built using the new LTC1155 and three inexpensive power MOSFETs.

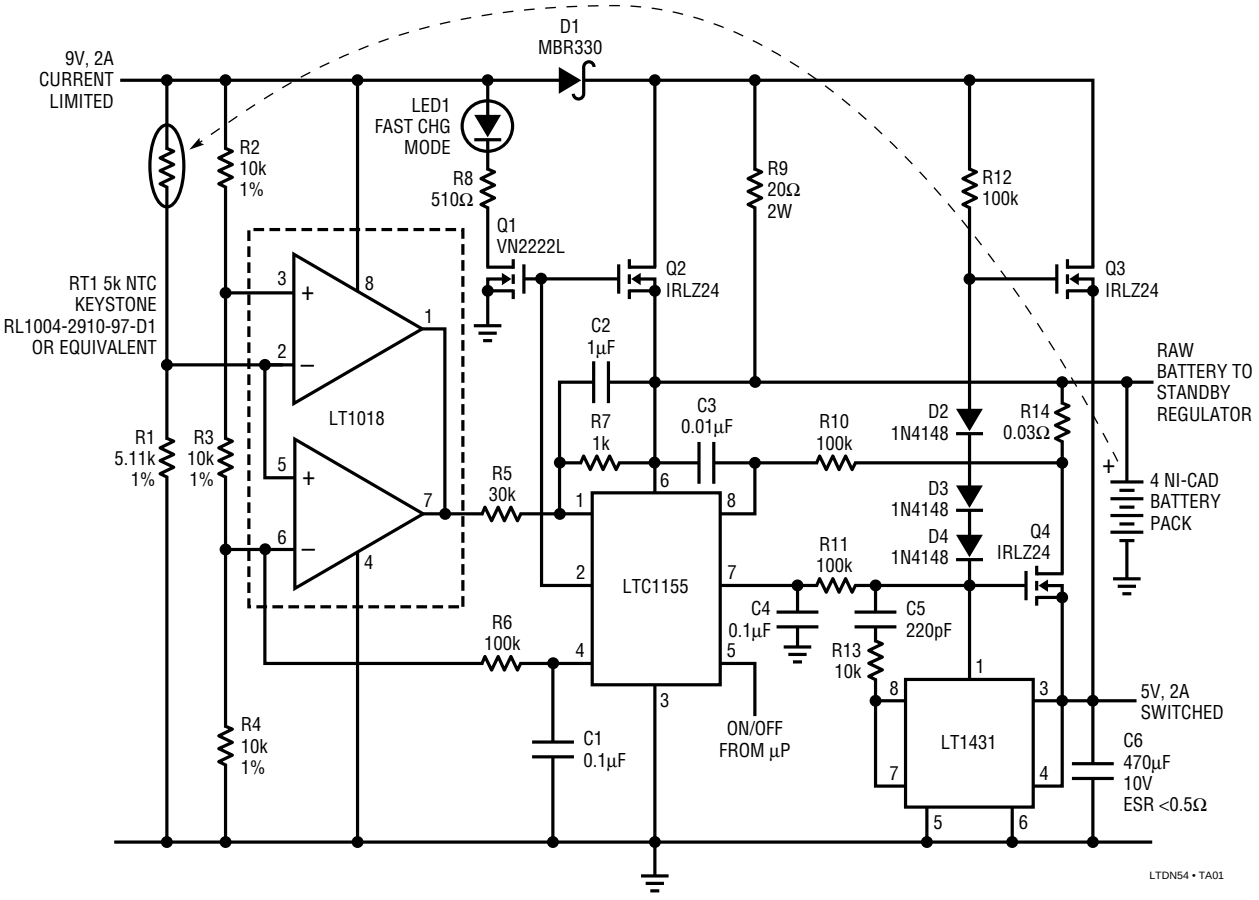

Figure 1. The LTC1155 Dual MOSFET Driver Provides Gate Drive and Protection for a 4-Cell Ni-Cad Charger and Regulator

Quick Charge Battery Charger

One half of the LTC1155 Dual MOSFET Driver controls the charging of the battery pack. The 9V, 2A current limited wall unit is switched directly into the battery pack through an extremely low resistance MOSFET switch, Q2. The gate drive output, Pin 2, generates about 13V of gate drive to fully enhance Q1 and Q2. The voltage drop across Q2 is only 0.17V at 2A and, therefore, can be surface mounted to save board space.

An inexpensive thermistor, RT1, measures the battery temperature and latches the LTC1155 OFF when the temperature rises to 40°C by pulling low on pin 1, the Drain Sense Input. The window comparator also ensures that battery packs which are very cold (<10°C) are not quick charged.

Q1 drives an indicator lamp during quick charge to let the computer operator know that the battery pack is being charged properly. When the battery temperature rises to 40°C, the LTC1155 latches OFF and the battery charge current flowing through R9 drops to 150mA.

Extremely Low Voltage Drop Regulator

A four-cell Ni-Cad battery pack produces about 6V when fully charged. This voltage will drop to about 4.5V when the batteries are nearly discharged. The second half of the LTC1155 provides gate voltage drive, pin 7, for an extremely low voltage drop MOSFET regulator. The LT1431 controls the gate of Q4 and provides a regulated 5V output when the battery is above 5V. When the battery voltage drops below 5V, Q4 acts as a low resistance switch between the battery and the regulator output.

A second power MOSFET, Q3, connected between the 9V supply and the regulator output "bypasses" the main regulator when the 9V supply is connected. This means that the computer power is taken directly from the AC line while the charger wall unit is connected. The LT1431 provides regulation for both Q3 and Q4 and maintains a constant 5V at the regulator output. The diode string made up of diodes D2-D4 ensure that Q3 conducts all the regulator current when the wall unit is plugged in by separating the two gate voltages by about 2V.

R14 acts as a current sense for the regulator. The regulator latches OFF at 3A when the voltage drop between the second Drain Sense Input, pin 8, and the supply, pin 6, rises above 100mV. R10 and C3 provide a short delay. The μP can restart the regulator by turning the second input, pin 5, OFF and then back ON.

The regulator is switched OFF by the μP when the battery voltage drops below 4.6V. The standby current for the 5V, 2A regulator is less than 10μA. The regulator is switched ON again when the battery voltage rises during charging.

Very Low Power Dissipation

The power dissipation in the notebook computer is very low. The current limited wall unit dissipates the bulk of the power created by quick charging the battery pack. Q2 dissipates less than 0.5W. R9 dissipates about 0.7W. Q4 dissipates about 2W for a very short period of time when the batteries are fully charged and dissipates less than 0.5W as soon as the battery voltage drops to 5V. The three integrated circuits shown are micropower and dissipate virtually no power.

Cost Effective and Efficient Power System

The circuit shown in Figure 1 consumes very little board space. The LTC1155 is available in a 8-pin SO package and the three power MOSFETs can also be housed in SO packaging. Q4 must be heatsinked properly for the short period of time that the battery voltage is above 5.5V. (Consult the MOSFET manufacturer data sheet for SO heatsink recommendations).

The LTC1155 allows the use of inexpensive N-channel MOSFET switches to directly connect power from a 4-cell Ni-Cad battery pack to the charger and the load. This technique is very cost effective and is also very efficient. Nearly all the battery power is delivered directly to the load to ensure maximum operating time from the batteries.

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