LINEAR TECHNOLOGY

DESIGN NOTES

Complete Battery Charger Solution for High Current Portable Electronics

3.5A Charger for Li-Ion/LiFePO$_4$ Batteries Multiplexes USB and Wall Inputs

Design Note 496

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Introduction

The LTC®4155 and LTC4156 are dual multiplexed-input battery chargers with PowerPath™ control, featuring I^{2}C programmability and USB On-The-Go for systems such as tablet PCs and other high power density applications. The LTC4155's float voltage (V_{FLOAT}) range is optimized for Li-Ion batteries, while the LTC4156 is optimized for lithium iron phosphate (LiFePO$_4$) batteries, supporting system loads to 4A with up to 3.5A of battery charge current. I^{2}C controls a broad range of functions and USB On-The-Go functionality is controlled directly from the USB connector ID pin.

Input Multiplexer

A distinctive feature of the LTC4155/LTC4156 PowerPath implementation is a dual-input multiplexer using only N-channel MOSFETs controlled by an internal charge pump. The input multiplexer has input priority selection and independent input current limits for each channel.

Applications include any device with a high capacity Li-Ion or LiFePO$_4$ battery that can be charged from a high current wall adapter input or from the USB input—such as a tablet PC. Figure 1 shows a typical application and Figure 2 shows its efficiency.

This dual input multiplexer implementation allows the use of inexpensive, low $R_{DS(ON)}$ N-channel MOSFETs. The MOSFETs also provide overvoltage protection (OVP) and if desired, backdrive blocking and reverse-voltage

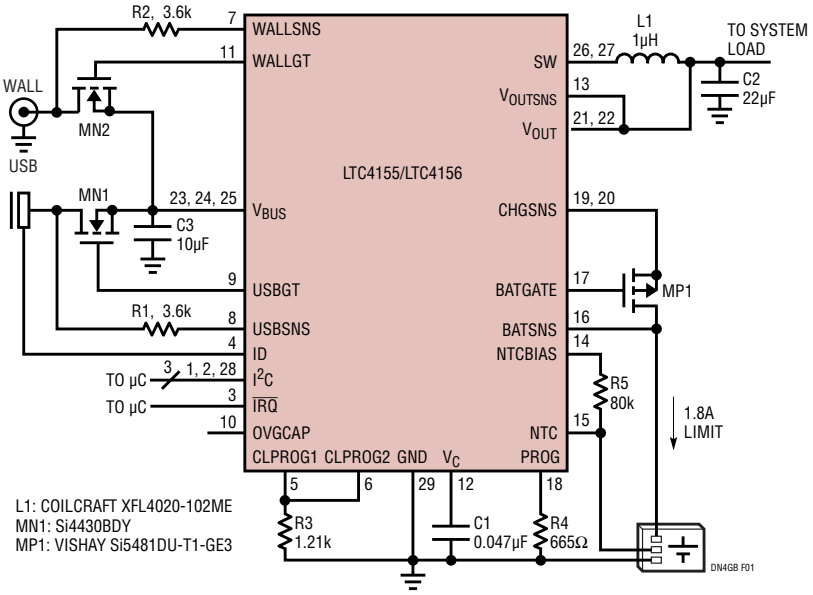
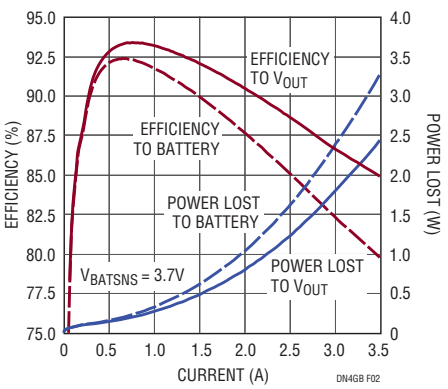


Figure 1. Typical Application Using a Simple Input Multiplexer with No Backdrive Protection



INCLUDES LOSSES FROM 2× Si7938DP OVP FETS
XFL4020-102ME INDUCTOR AND Si5481DU CHARGER FET

Figure 2. Switching Regulator Efficiency

protection (RVP). Backdrive blocking prevents voltage on the wall input from backdriving the USB, or vice-versa. Backdrive blocking can be implemented on one or both inputs. Reverse-voltage protection prevents a negative voltage applied to the protected input from reaching downstream circuits.

Dual High Current Input Application

Figure 3 shows a dual 3.5A input application, featuring OVP, RVP and backdrive protection. The FDMC8030 MOSFETs provide ±40V of OVP and RVP protection.

0V~6V Input on Either WALL or USB

In the circuit of Figure 3, when a 0V~6V input is present on either input, the corresponding gate signal rises to approximately twice V_{IN}, enabling the two series N-channel MOSFETS and connecting the input to V_{BUS}. The undervoltage lockout (UVLO) is approximately 4.35V on each channel.

The LTC4155/LTC4156 have an input priority bit, which defaults to WALL. If a valid voltage is present on both inputs, only WALLGT is activated. The input priority bit can be changed via I^2C to make the USB channel preferred when both inputs are present.

>6V Input on Either WALL or USB

When either input goes above 6V, the corresponding WALLGT or USBGT pin is pulled low, shutting off the corresponding MOSFETs and disconnecting the input. If both inputs have 5V on them, and the input that is enabled by the input priority bit goes above 6V, the LTC4155/LTC4156 automatically and seamlessly switches to the other input—with no disturbance on V_{OUT}.

The diode-connected NPNs (Q3 and Q4) serve to prevent excess V_{GS} on the MOSFET closest to the input of the corresponding channel current from the input flows through the diode, through the B-C junction of the NPN bipolar transistor, and pulls the gate up through the 5M resistor. This prevents the gate from dropping below the source by more than 2V.

A voltage greater than 6V on one input does not prevent the other input from operating normally.

< 0V Input on Either WALL or USB

The USBSNS and WALLSNS pins ignore any negative inputs, but clamp the pins to $-V_F$ (about –0.6V). The negative voltage forward-biases the base-emitter junction of the NPN bipolar transistor, shorting the gate to the input and ensuring that the gate is never more than about 0.5V above the source.

A negative voltage on one input does not prevent the other input from operating normally.

OTG Operation

The LTC4155/LTC4156 drive the USBGT pin high when USB On-The-Go operation is enabled, connecting V_{BUS} to the USB input and enabling up to 500mA to be sourced.

Conclusion

The LTC4155/LTC4156 implement an overvoltage and reverse-voltage protected, prioritized input multiplexer for products that need to support multiple system power or battery charging functionality. Optional backdrive blocking prevents the appearance of voltages at an unconnected input.

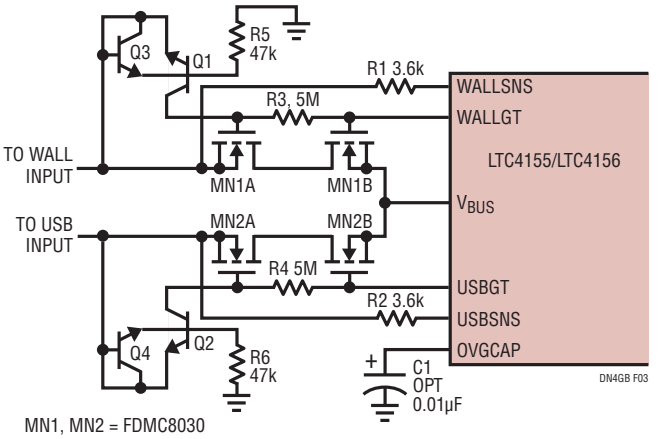


Figure 3. LTC4155/LTC4156 Input Multiplexer with OVP, RVP and Backdrive Blocking

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