

DESIGN NOTES

Smart Battery Charger Reduces Circuit Size – Design Note 1005

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LTC® 4100 Single Smart Battery Charger

The predominant design challenge in most single-battery applications, such as tablet PCs and portable instrumentation, is how to save space. Typically such applications require low power from the battery. With this in mind, every feature of the LTC4100 Smart Battery charger exists to reduce board real estate and profile requirements. The LTC4100 is a Level 2 (slave) Smart Battery charger that is compliant with both Smart Battery Charger V1.1 and SMBus V1.1 standards.

Figure 1 shows a typical compact single battery charger. This circuit can charge batteries with up to 4A and switch continuously down to zero load current. This circuit takes advantage of the ceramic capacitors' space saving features while avoiding any audible noise. The high 300kHz switching frequency allows the use of a small low cost 10 μ H inductor.

Input voltage range is 6V to 32V while the output charge voltage range is from 6.4V to 26V. A 10-bit current DAC and 11-bit voltage DAC, with current accuracy of 5% and voltage accuracy of 0.8%, respectively, provide precision charge capabilities. A topside P-channel MOSFET allows 98% maximum duty cycle, dramatically reducing total part count and IC pin count while maintaining efficiency greater than 95% (see Figure 2). The LTC4100 also offers many unique features, including a patented current limit and voltage limit system that prevents SMBus data corruption errors from generating harmful charge values*. An SMBus accelerator increases data rates in high capacitance traces while preventing bus noise from corrupting data (see Figure 3).

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*U.S. patent number 6650174 **U.S. patent number 5723970

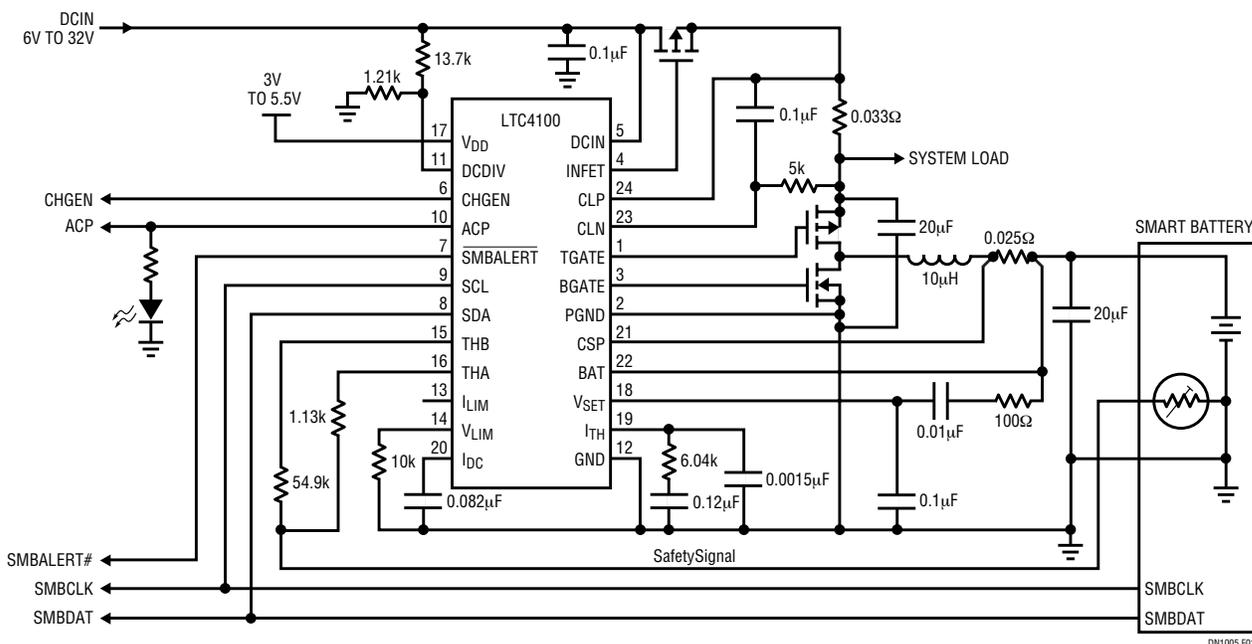


Figure 1. Smart Battery Charger Provides Up to 4A and 26V of Charge Power

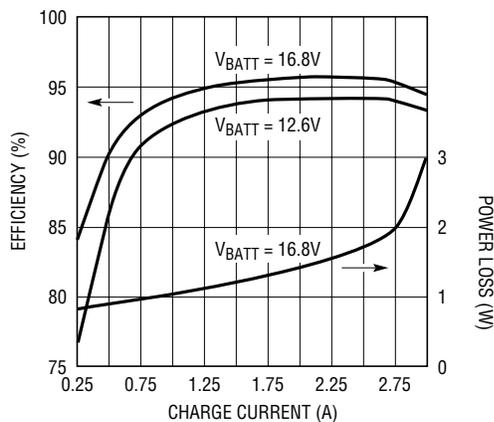


Figure 2. Efficiency at 19V V_{IN}

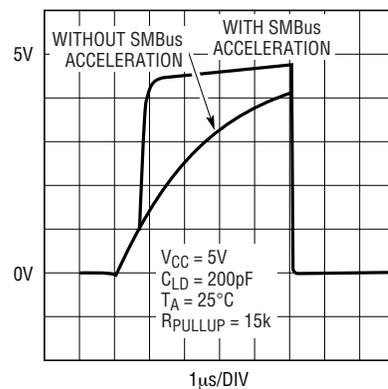


Figure 3. Built-In SMBus Accelerator Improves Risettime Performance and Noise Margin

Other features include: an AC present signal with precision 3%-accurate user adjustable trip points; a safety signal circuit that rejects false thermistor tripping due to ground bounce caused by the sudden presence of high charge currents; a DC input FET diode circuit that prevents battery current from flowing backwards into the wall adapter or DC power source and an ultrafast overvoltage comparator circuit that prevents voltage overshoot when the battery is suddenly removed or disconnects itself during charge. Finally, the LTC4100 features an input current limit sensing circuit that is used to limit charge current to prevent wall adapter overload as the system power increases**.

Ceramic Capacitors Reduce Size and Improve Reliability

One of the biggest space saving changes that has occurred in recent years is the use of high capacitance and voltage (high C/V) ceramic capacitors. In switching regulator applications, the low ESR of ceramics allows them to handle a relatively large ripple current per microfarad while remaining relatively inexpensive. Battery chargers can reap the same benefits provided their feedback loops are stable with ceramic capacitors.

Ceramics come with their own unique challenges such as piezo-electric properties that can result in audible noise if there are AC currents with audible frequencies present. Such frequencies can occur in battery chargers at two load extremes: The first condition is low dropout and the second is light load.

Battery chargers run up against wall adapter voltages that are often just a few volts above the peak battery voltage. Depending on the design, as the charger approaches 100% duty cycle, the switching frequency passes through the audible range on the way to DC. Alternatively, conditions where the charge current falls below the PWM controller's ability to maintain regulation force discontinuous switching cycles or cycle skipping. Cycle skipping switching periods may be in the audible range. This typically happens when batteries momentarily disconnect themselves during the charge process for termination condition evaluation, thus forcing the charge current to zero. The circuits in the LTC4100 are designed to avoid these problems.

Increased Switching Frequencies Keep Inductors Small

Charger system designers are often driven to reduce inductance values to take advantage of smaller form factor components. The problem is that less inductance for a given switching frequency results in more inductor ripple current, which increases the output capacitor size. However, if one increases the switching frequency proportional to the reduction in inductance, the output capacitance can remain the same.

Conclusion

The LTC4100 Smart Battery charger directly addresses the space problems presented by the constraints within the latest consumer electronics.

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