LINEAR TECHNOLOGY

DESIGN NOTES

Dual Battery Power Manager Increases Run Time by 12% and Cuts Charge Time in Half – Design Note 277

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Introduction

To save space and provide longer battery run times, many high performance notebook computers support dual, swappable batteries, where each battery bay can hold a battery or an optional peripheral. Two batteries are obviously better than one, providing increased run time over a single battery, but how much better are they? The answer is that two batteries can produce performance that is better than twice that of a single battery. The trick lies in simultaneously charging and discharging the two batteries, as opposed to the traditionally easier, sequential method.

Although a multibattery simultaneous charge and discharge system can be more difficult to implement than a sequential system, paralleling the charging and discharging dual batteries significantly reduces charge time and extends run time. The LTC®1960 solves many design complexities by placing all of the hard-to-design charge and discharge control functions in a single package, making implementation of dual battery management systems possible for a wide variety of applications. In addition to controlling simultaneous battery charging and discharging, it controls all PowerPath™ switching between the two batteries, the wall adapter and the equipment's DC/DC converters, plus it includes many circuit protection functions. Figure 1 shows a block diagram of a typical application.

The LTC1960 comprises two controllers: The PowerPath controller manages the delivery of power from the two batteries and a DC input supply while the charge controller manages charging the batteries.

The heart of the PowerPath controller is the ideal diode circuit that allows precise voltage tracking between the batteries. The ideal diode circuit uses the same MOSFET transistors that turn power on and off, and makes them act like diodes, but without the power loss or variation in voltage drop as a function of current. Voltage loss, and hence power loss, is typically reduced by a factor of 30 over a Schottky diode. High speed comparators monitor reverse current conditions and shut off the MOSFETs in microseconds. An undervoltage detector watches for sudden loss of voltage at the load and turns on all the power sources in 10 microseconds with no host intervention required. The host can also shut down the PowerPath in an emergency via a high speed shutdown input in the case of CPU overvoltage conditions or any other system-level crisis. Finally, there is a combined time and current based short-circuit protection system that protects the power path MOSFETs from destruction in the event of a short.

The charger controller uses synchronous rectification with a 0.5V low dropout capability and a 99% max duty cycle. An 11-bit voltage DAC with a system level accuracy of ±0.8% is provided along with a 5% system accurate

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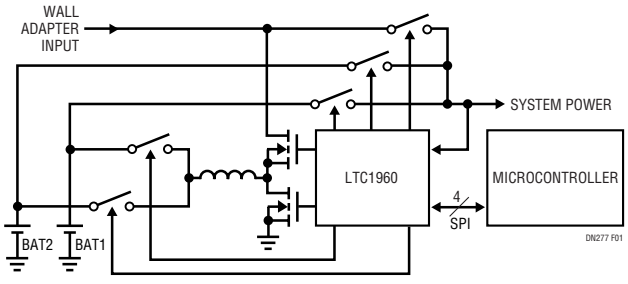
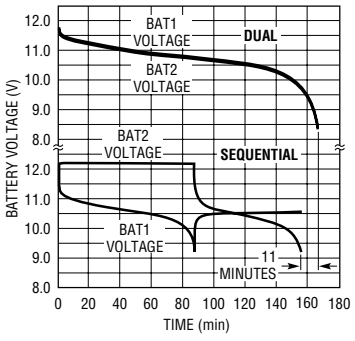


Figure 1. The LTC1960 System Architecture



BATTERY TYPE: 10.8V Li-Ion (MOLTECH NI2020)
LOAD CURRENT = 3A

Figure 2. Dual Discharge Extends Run Time

10-bit current DAC. With the ability to program from milliamps to amps, maintaining good current accuracy at low current is a challenge. The LTC1960 charger solves this problem by providing an optional pulse charge in the low current mode. A patented input current limit maximizes charge rate while the end product is operating without overloading the wall adapter. The IC's 5% precision current limit permits user to accurately size the wall adapter and avoid overdesign and higher cost. An overvoltage comparator detects a sudden battery disconnect and shuts off the charger until the overvoltage condition is cleared.

Automatic Current Sharing

The LTC1960 does not control the current flowing into and out of each battery as they are charged and discharged. The ideal diode feature helps optimize battery charge times by allowing the batteries themselves to control current sharing. This is because the capacity or Amp-Hour rating of each battery determines how the current is shared. The current simply divides according to the ratio of the batteries' capacity ratings. Automatic steering of current allows both batteries to reach their full charge or full discharge points at the same time.

Simultaneous Discharge Increases Run Time

In high current drain applications, discharging two batteries in parallel more than doubles the run time over that of a single battery (see Figure 2). When two batteries share the load current equally, the current is halved in each battery, so internal battery I^2R power losses are reduced by one fourth. This reduction in internal battery power loss can lead to longer run times with increases of 12% or more.

Faster Charge Times with a Second Battery

It is possible with the LTC1960 to charge two batteries in the time it would take to charge one, without having to create separate charge circuits. Batteries that use a Constant Voltage (CV) mode during charge termination take a long time to reach their full capacity relative to batteries that use a Constant Current (CC) mode. Specifically, a Li-Ion battery charges to about 85% of its capacity in the first half of a charge time cycle and spends the second half filling the remaining 15%.

If two batteries receive charge current at the same time in the CV phase, the result can be a 25% reduction of total charge time. Another 25%, or more, timesavings can come in the CC phase of charge, where the automatic current sharing of the batteries allows charging at a higher current rate relative to a single battery. In sum, you can reduce the charge time by about 50% relative to the sequential method, as shown in Figure 3.

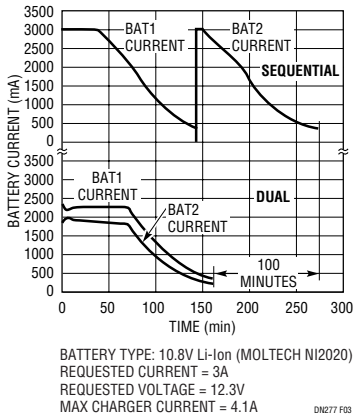


Figure 3. Dual Charge Shortens Charge Time

Automatic Crisis Power Management

An important feature of PowerPath control is the ability to handle sudden loss of power to the load. The LTC1960 manages power by monitoring the voltage on the power summing point of all three power sources comprising the wall adapter, battery 1 and battery 2. If there is a loss of power to the load, a programmable voltage comparator detects it and immediately connects all three sources to the load before it fails. This state is called 3-diode mode (3DM). The power source with the highest voltage will pick up the load, with multisource current sharing possible. The ideal diode circuit prevents energy transfer from any power source to any other power source. The system can remain in 3DM mode continuously making it possible to plug the LTC1960 into a circuit, without having to worry about control interfaces or programming—just plug and play.

Conclusion

The LTC1960 represents the first complete dual battery charge-discharge system solution on a chip. It reduces solution cost, development time, PCB space and part count while at the same time provides more control, safety, and automatic crisis management relative to any other solution available today. Combined with a host microcontroller, it has the flexibility to work in both user proprietary and Smart Battery based applications. The limits of what can be accomplished with LTC1960 are solely dependent on the software controlling the IC.

Data Sheet Download

http://www.linear.com/go/dnLTC1960

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