Compact Fuel-Gauge Increases Li+ Battery Runtime

Maxim Integrated Products introduces the MAX17047 fuel gauge for single-cell Li+ battery packs. Featuring the company's new ModelGauge m3 algorithm, the MAX17047 is the industry's only coulomb-counting fuel gauge that does not suffer from the abrupt corrections that occur with traditional coulomb-counter algorithms. Compared to other coulomb-counters, this ModelGauge m3 IC uses a smaller current-sense resistor and fewer external components. This saves both space and cost. The IC is ideal for fuel-gauging handheld single-cell and multicell Li+ batteries in a wide range of portable applications, including wireless handsets, smartphones, tablets, e-readers, portable game players, digital cameras, financial terminals, portable navigation equipment, and portable medical equipment.

The Challenge: Improve the Accuracy of Battery Capacity While Minimizing Cost and Space

Traditional Li+ battery fuel gauges are mounted inside the battery pack and require

multiple supporting discrete components. To estimate of battery capacity, the fuel gauges rely on coulomb counters. These coulomb counters have a problem because of the small ADC offset errors that accumulate indefinitely. To correct for these offset accumulation drifts, a large and expensive sense resistor is needed. In addition, the battery must go into full, empty, or standby states on a regular basis.

Some recent design advances implement the fuel-gauging function on the system side, instead of inside the battery pack. While this approach reduces the cost of the application, it has little effect on the board area, as a large sense resistor may still be required.

Finally, the currently available algorithms that correct these drifts have an undesirable side-effect: they introduce sudden jumps in the state of charge (SOC). This happens because the algorithms rely on measuring the battery voltage in a standby state, and then make a correction based on the relationship of the battery's open-cell voltage (OCV) to the battery SOC.

ModelGauge m3 Technology: Accurate and Economical Li+ Battery Fuel Gauging

ModelGauge m3 technology overcomes the limitations of the currently available fuel-gauging techniques. It combines the excellent short-term accuracy and linearity of a coulomb counter with the excellent long-term stability of a voltage-based fuel gauge. ModelGauge m3 cancels offset accumulation error in the coulomb counter, while providing better short-term accuracy than any only-voltage-based fuel gauge. This algorithm makes tiny corrections continually over time, so it does not suffer from the abrupt corrections that normally occur in coulomb-counter algorithms.

Since the ModelGauge m3 algorithm reduces the sensitivity to current-measurement ADC offset errors, the MAX17047 can use a smaller current-sense resistor without compromising the accuracy of the battery SOC estimate.

The MAX17047 also automatically compensates for aging, temperature, and discharge rate. It provides accurate remaining capacity in mAh or SOC % and time-to-empty over a wide range of operating conditions. It uses 75% less power than the competition, even adapts to changes in the battery over use and time, and warns of abnormal battery conditions. The device provides two methods for reporting the age/health of the battery: reduction in capacity and cycle odometer.

The IC provides precision measurements of current, voltage, and temperature. The temperature of the battery pack is measured using an external thermistor supported by ratiometric measurements on an auxiliary input. If the temperature information is available through some other means, then the system microcontroller can also write the temperature directly to the IC. That eliminates the thermistor, plus a resistor and capacitor associated with this external thermistor network.

The MAX17047 is shipped with factory calibration. This lowers manufacturing complexity and cost because it eliminates calibration in the end-equipment manufacturing line.

Finally, these ModelGauge m3 ICs can be mounted on the system-side instead of the battery pack. This allows the system manufacturer to control all costs and minimize the complexity of supply-chain constraints. Ultimately, it significantly reduces the expense of the battery pack.

Broad-Based Benefits for Portable, Battery-Powered Equipment

The MAX17047 uses the lowest supply current in the industry (25uA, typ, which is 75% less power than the competition), and this helps maximize the runtime/standby time. Besides the small current-sense resistor, this single-cell fuel gauge requires only one other resistor and three capacitors which use a very small PCB area. The MAX17047's measurement and power-supply inputs connect directly to the battery pack, thus alleviating the need for a separate regulator. This IC can also be adapted for multicell series configuration, battery-pack applications using an external buffer such as the MAX9910.

Several monitoring and alert functions ensure the reliable operation of the end equipment. A versatile programmable alert indicator warns the system microcontroller of critical battery voltage, SOC, and temperature conditions. For example, a low-battery condition can be used to take appropriate power-management actions when the battery is nearly empty. This feature further extends battery life, as the system microcontroller remains in sleep mode longer without having to poll the fuel gauge about battery status. The IC can alert the system in case of abnormal battery temperature and thus help maintain the safety and long life of the system. Finally, the MAX17047 can also alert the system whenever the battery is inserted or removed, and can manage the power up/down sequence gracefully.

The MAX17047 ModelGauge m3 fuel gauge is packaged in a lead-free, 10-pin, 3mm x 3mm TDFN. It communicates with the system microprocessor over an industry-standard 2-wire interface. Prices start at $1.24 (10k-up, FOB USA). For more information, please visit: http://www.maxim-ic.com/ModelGauge [1].

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[1] http://www.maxim-ic.com/ModelGauge