Using the bq2050

to Monitor Lead-Acid Batteries

bq2050 Based Lead-Acid Capacity Gauge

The bq2050 provides capacity estimates of lithium-ion batteries based on monitoring the current into and out of the battery. By monitoring voltage as well, the bq2050 presents the capacity information in watt-hours in addition to amp-hours. Capacity information is provided either by five segment pins capable of driving an LED bar graph and/or a one-bit serial communication port. Compensation factors are applied for charge and discharge rate, self-discharge, and temperature (via an on-board thermistor).

Capacity Compensation

The compensation values used for lithium-ion batteries are also applicable to many lead-acid battery applications. The decrease in available capacity via self-discharge is an important issue with many Pb-Acid applications. The bq2050 has two selections for self-discharge. Pb-Acid's self-discharge rate is about 1/580 C per day at 25°C, where the C value is the battery capacity. The bq2050 can be configured for 1/512 C per day or 0 C per day. Most applications can use the 1/512 value for acceptable results. The self-discharge rate will double for each 10°C increase in temperature. This doubling is accounted for by the bq2050.

The discharge compensation adjusts the displayed available capacity based on the battery temperature and the discharge rate. The temperature compensation for discharge capacity can be adjusted for the best fit to the application. If the average discharge rate is 0.05C, then PROG5 should be programmed low. For higher discharge rates, PROG5 should be programmed as Z. This programming will provide acceptable results up to about 0.15C. For higher discharge rates, the indicated capacity will be optimistic. For applications requiring much higher discharge rates, the indicated capacity can be adjusted outside the bq2050 after reading the uncompensated value over the serial interface.

The charge compensation will provide acceptable results for most applications. If the battery is charged at a temperature below 10°C, the increase in capacity as a function of charge input will be slightly pessimistic by less than 2%.

Sense Resistor

The sense resistor is used to monitor the charge and discharge current. The bq2050 data sheet explains the programming pin configuration as a function of millivolt-hours. The millivolt-hour value is determined by multiplying the amp-hour capacity by the sense resistor value. The bq2050 range of millivolt hours is from 8.8mVH to 614mVH. The choice of sense resistor should also be made knowing what the maximum current through the sense resistor will be. The typical application will choose a resistor that will have between 50mV to 100mV across the sense resistor during maximum current. The sense resistor should also provide at least 2mV to 10mV during the lowest current that requires measurement.

At very high current, the sense resistor must be sized to dissipate the required loss power. For example, at 100 amps and 100mV, the sense resistor will be dissipating 10 watts. This may require special consideration in mounting the resistor. Other current measurement methods such as Hall effect sensors can be used when the signal from such devices is properly scaled for the bq2050. These devices will add to the continuous drain on the battery unless the designer provides for a disconnect when the battery is not in use.

Voltage Monitoring

The bq2050 monitors the battery voltage to detect the end-of-discharge voltage and to report watt-hours. The battery voltage is scaled using an external resistor divider. The equation for choosing the proper divider is:

$RB1/RB2 = V_{EDVF}/1.47$

where:

V_{EDVF} = the voltage where the battery is considered empty.

RB1 = the resistor from the most positive battery terminal to the SB input of the bq2050.

RB2 = the resistor from the SB input of the bq2050 to the V_{SS} pin of the bq2050.

The resistor divider total resistance should range from 300kΩ to 1MΩ. A 0.1µF capacitor should be connected between the SB input and the V_{SS} pin of the bq2050. The capacitor should be located as close as practical to the bq2050.

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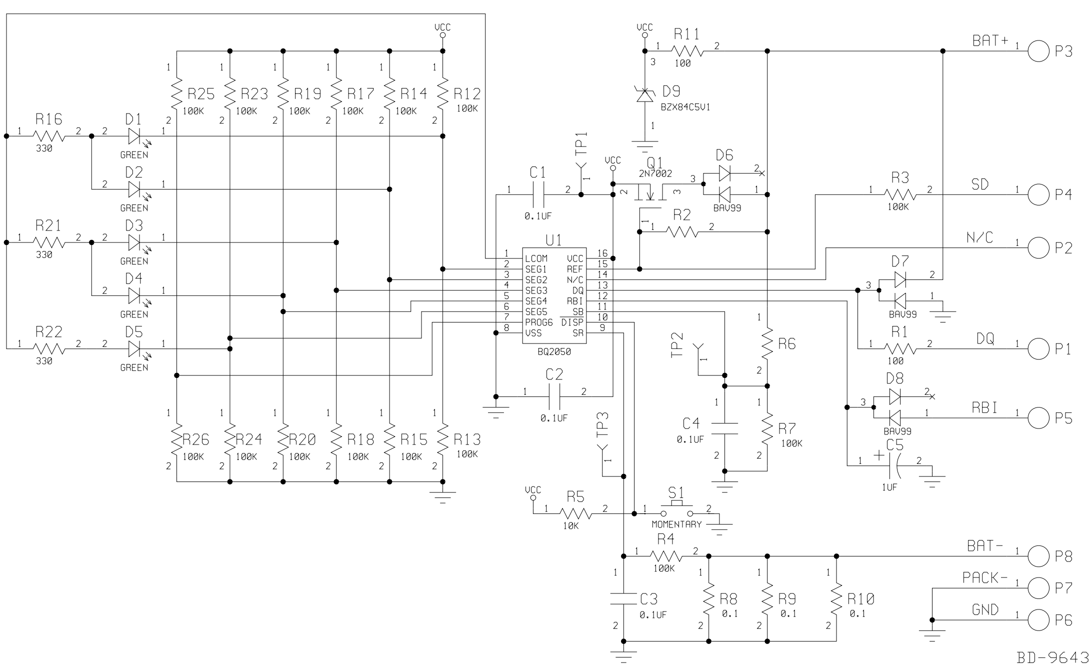
Power Requirements

The bq2050 capacity gauge is powered by the battery and presents a continuous load of about 120µA at 4.5V. A simple voltage follower circuit can be used to power the bq2050 as shown in Figure 1. This circuit uses the REF pin of the bq2050 to set the gate voltage of the MOSFET so that the voltage at the source pin of the MOSFET will be appropriate for the bq2050 V_{CC}. Take care to bypass adequately the bq2050 V_{CC}. This requires a minimum of a 0.1µF capacitor placed for minimum trace length between the V_{CC} and V_{SS} inputs. Parallel capacitors will improve performance.

Figure 1. bq2150 Schematic



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