GMR sensors manage batteries

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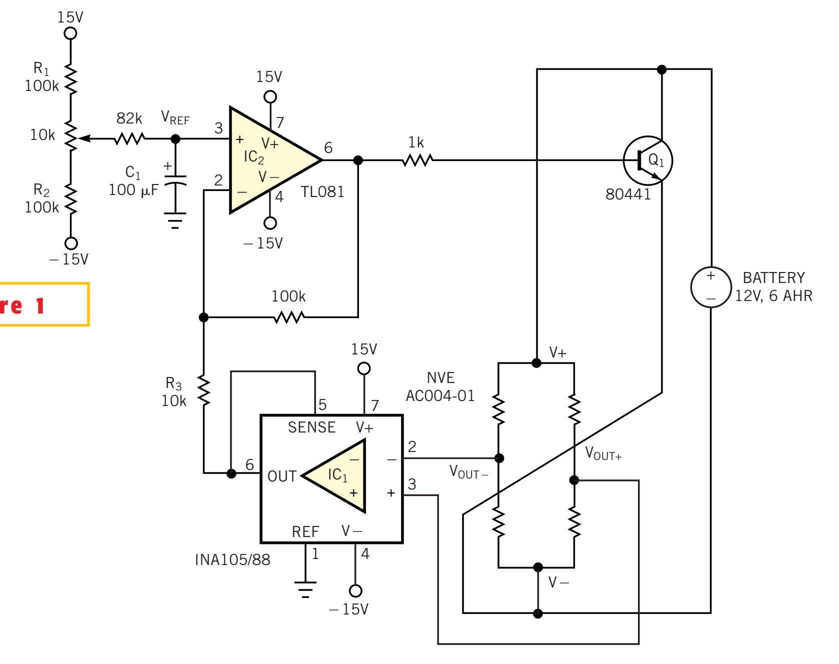
THE PAST FEW decades have seen remarkable progress in magnetic-sensor technology. Early and current sensors exploit the Hall effect; more recent devices use an effect called giant magnetoresistance (GMR). GMR sensors use semiconductor processing of materials such as indium-antimony. The GMR sensor in **Figure 1** comprises four GMR resistors in a Wheatstone-bridge configuration. Two arms of the bridge have active resistors; the other two resistors are shielded against magnetic fields. When a magnetic field impinges on the sensor, the GMR effect decreases the resistance of the active pair of resistors, and the values of the shielded pair remain constant. GMR-based semiconductors are suitable for current measurement because they respond to the magnetic field rising from the current. However, in this application, the Wheatstone-bridge topology allows you to measure and control power.

All you need to do is connect the power pins of the GMR sensor to the voltage terminal, V+, and place the cable or trace the battery current traverses near the sensor. The output voltage of the bridge then relates to the power, which is the product of V+ and the current. The circuit in **Figure 1** provides a way to check a battery's condition. Measuring a battery's voltage is not the best way to check its condition; it's better to measure the power that the battery delivers in a discharge process to evaluate the battery's energy capacity and life. The circuit in **Figure 1** discharges a battery in a constant-power mode. You can select the level of discharge power. The GMR sensor's output signal is related to the discharge power. The power stage uses a bipolar Darlington transistor, which draws little power from its op-amp driver. You place the GMR sensor over the pc-board trace that connects the Darlington's emitter to ground.

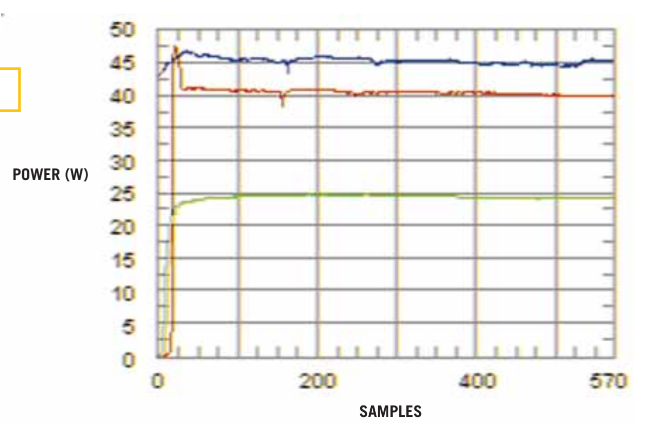
Using the GMR sensor in a negative-feedback closed loop, the circuit controls the battery discharge in constant-power mode. The difference amplifier (IC_1) converts the sensor's differential output signal to a unipolar signal; the op amp, IC_2, supplies the appropriate loop gain and compares the difference-amplifier output with the externally selected ref-

Figure 1



A GMR sensor and a closed-loop regulation circuit provide a constant-power discharge process for measuring a battery's energy capacity and life.

Figure 2



Sampling shows constant-power discharge profiles at 25, 40, and 45W for Figure 1's battery-management circuit.

erence voltage. IC_2 provides the base current for the Darlington transistor, which discharges the battery at a constant-power rate. **Figure 2** shows profiles of the constant-power battery discharge. **Figure 3** shows current, voltage, and power profiles of the constant-power discharge process. When the battery voltage decreases, the current discharge increases, and the power remains constant. (DI #2394).

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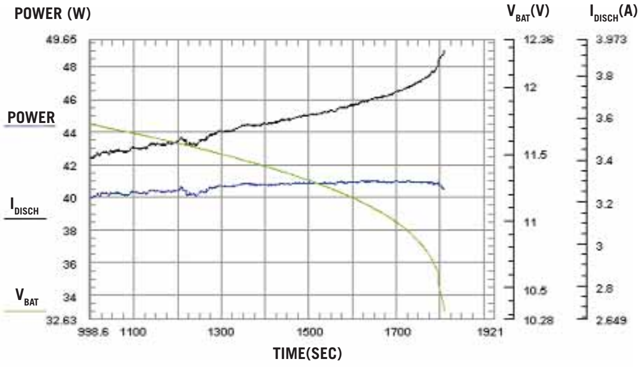
Figure 3



To provide constant-power discharge, the battery's voltage and current profiles have reciprocal, mirror-image slopes.