Circuit measures battery capacity

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6 Comments

Batteries and energy cells lose their capacity as they age. If a cell or battery's capacity is too low, your equipment may also soon stop working. You can use the circuit in **Figure 1** to measure a battery's discharge time. The circuit uses an electromechanical clock and a DVM (digital voltmeter). The cell should be fully charged before testing. The circuit discharges the cell at a fixed current and measures the time it takes to discharge the cell from 100 to 0%.

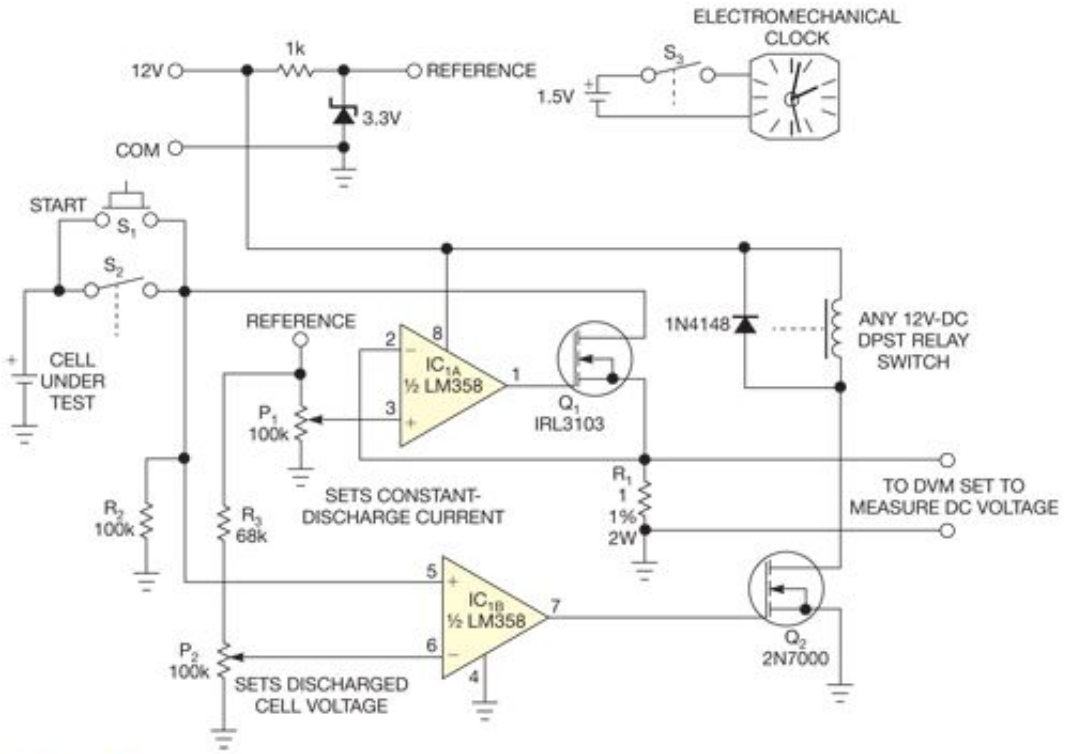

Figure 1 An electromechanical clock indicates a battery's discharge time.

For example, if a manufacturer rates a cell's capacity and you discharge the cell at a constant current equal to 0.1 times the capacity, the cell should take about 10 hours to discharge from full to empty. Manufacturers of NiCd (nickel-cadmium) or NiMH (nickel-metal-hydride) cells rate the end of the discharge voltage at 1V. At that point, the cell is using 0% of its capacity, is flat, and requires charging for further operation. If this procedure takes less than 10 hours, the cell's capacity is less than what the cell manufacturer rates.

Before testing the cell, charge it to full capacity using your charger. Apply 12V dc to the circuit and use potentiometer P_2 to set a voltage of 1V at Pin 6 of IC_{1B}. Set the clock to 12:00. An AA-size, 1.5V cell powers the clock through relay switch S_3.

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When you press the momentary pushbutton switch, S_1, the tested cell starts to discharge through transistor Q_1 and resistor R_1. Set the discharge current using potentiometer P_1. Op amp IC_{1A} keeps the voltage across resistor R_1 constant, thus providing stable cell-discharge current. Set the DVM to measure the dc voltage and measure the voltage across R_1. The display shows discharge current in amperes. For example, 0.25V corresponds to 0.25A. Because the initial cell voltage is higher than 1V, Pin 7 of op amp IC_{1B} is high, transistor Q_2 is on, and the DPST (double-pole/single-throw) relay coil is active. Relay-contact switch S_2 closes and bypasses the start pushbutton switch, S_1, which keeps the discharge process active. Closed relay-contact switch S_3 lets the clock keep time.

When the cell's voltage is equal to the end-of-discharge value, 1V, IC_{1B}'s output goes low and deactivates the relay coil, halting the discharge process. The clock also stops. To get the cell's capacity, multiply the set dischargecurrent value by the elapsed time. If the discharge-current value is small and the time necessary for the discharge of a cell is longer than 12 hours, you must check this value every 12 hours after you start the test and keep in mind laps of one to 12 hours.

This circuit also lets you estimate the self-discharge rate of the cell or battery you use. Charge your cell to 100% of its capacity and measure cell capacity according to this procedure. Charge your cell again, store it for a month, and then measure the cell capacity again. The difference between the two values is the monthly self-discharge rate.

If you arrange the cells in a stack, you should provide a reference voltage that's higher than the battery's end-ofdischarge voltage. If the battery voltage is higher than 12V, use a higher-voltage value to power the circuit. Furthermore, the reference voltage value should be higher than the battery's end-of-discharge value. Specifications of the discharge path comprising transistor $Q_1$and resistor R_1 should fit higher dischargecurrent requirements.

The circuit works with cells or batteries of any chemistry, including NiCd, NiMH, lead acid, and lithium- ion. You can also use this circuit to measure the real capacity of nonrechargeable cells, such as AA alkaline cells. In that case, the discharged cell's voltage should be equal to the lowest power-supply voltage of your device. A cell that has passed the test is not suitable for further use, but you can use its capacity information to estimate the capacity of the batteries of the same type and manufacturer.