Microamps monitor dual-supply batteries

BRUCE ANDERSON, UNIVERSITY OF WISCONSIN—MADISON

The low-power circuit in Figure 1 monitors two 9V batteries in a dual-supply configuration and turns on the Battery Low LED if either battery voltage drops below its limit. It also provides two shutdown signals you can use to turn off voltage regulators, such as Maxim s MAX663/664 positive and negative regulators. By using low-power voltage references and op amps, the circuit holds the current drain to approximately 45 µA from each battery, with the positive drain rising to approximately 1 mA when the LED turns on.

Each battery voltage undergoes comparison with a Motorola LM385Z 1.2V reference, using a Maxim 7612 op amp with hysteresis via a 2-MΩ resistor (R_5 and R_{11}). Cross-coupling via the 3-MΩ resistors (R_6 and R_{12}) ensures that if either shutdown signal goes true, both do, and the circuit locks up in the shutdown state with the Battery Low LED illuminated. C_1 and C_3 delay the reference voltages so that when the batteries switch on, the circuit comes up in the proper state. Positive Shutdown is at the positive rail when true. Negative Shutdown is at the negative rail when true. The values shown allow you to adjust the battery-low limits over a range of approximately 3.8 to 8.1V. For our applications with Eveready EN22 alkaline batteries, we typically set the limits at 6.5V. This setting uses a good portion of the battery life, yet allows some reserve for continued operation after the LED comes on.

The circuit has two convenient features that were unforeseen before testing. One is that when the batteries switch off the LED flashes briefly as the decoupling capacitors discharge. The flashing indicates that the batteries are not so totally dead that they cannot light the LED. The other is that the LM385 has an initial turn-on voltage about 10% higher than the steady-state 1.2V reference. Thus, when you switch the batteries on, they must have a voltage about 10% higher than the steady-state threshold to be considered good. So if the Battery Low LED stays off when the device turns on, the batteries will remain good for a while. Of course, if you are not using the shutdown signals to turn off regulators, you can set the threshold so that your device will continue to operate for a period after the LED comes on. Using the battery-discharge characteristics and your circuit s voltage and current requirements, you can select a threshold that gives appropriate reserve for your application. (DI #2169)

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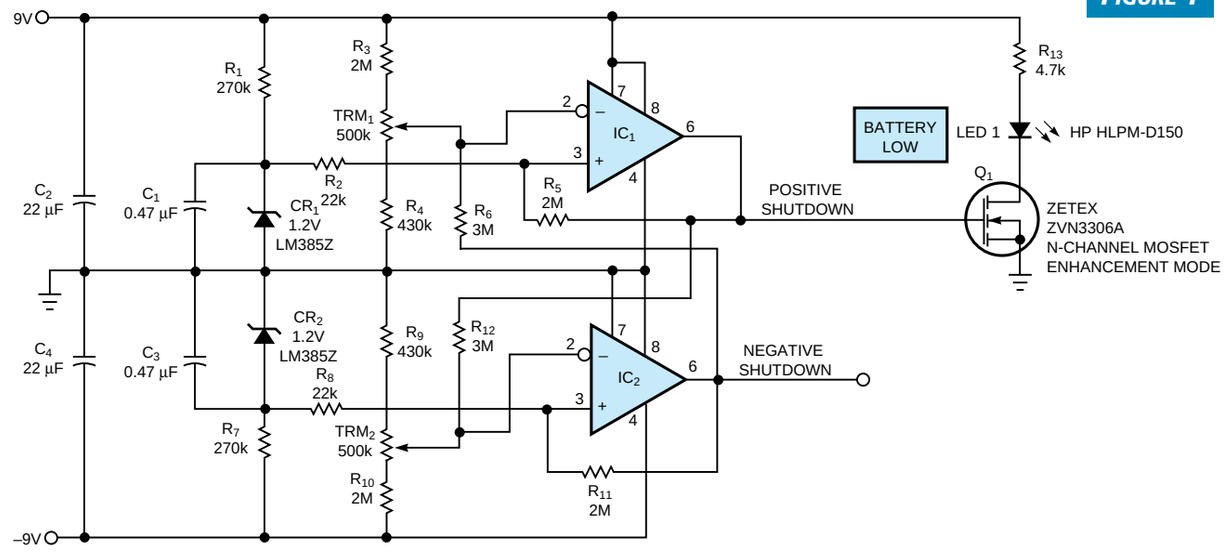
FIGURE 1



NOTES:

1. IC_1 AND IC_2 ARE MAXIM ICL7612ECPA.
2. CR_1 AND CR_2 ARE MOTOROLA LM385Z-1.2.
3. C_1 AND C_3 ARE 0.47 µF, 50V CERAMIC.
4. C_2 AND C_4 ARE 22 µF, 16V TANTALUM.
5. ALL RESISTORS ARE 1/4W, 5 OR 10% CARBON COMPOSITION.
6. TRM_1 AND TRM_2 ARE BOURNS 3296W.

If either battery voltage in a two-battery supply drops below a preset limit, a Battery Low LED turns on.