Scheme provides high-side current sensing for white-LED drivers

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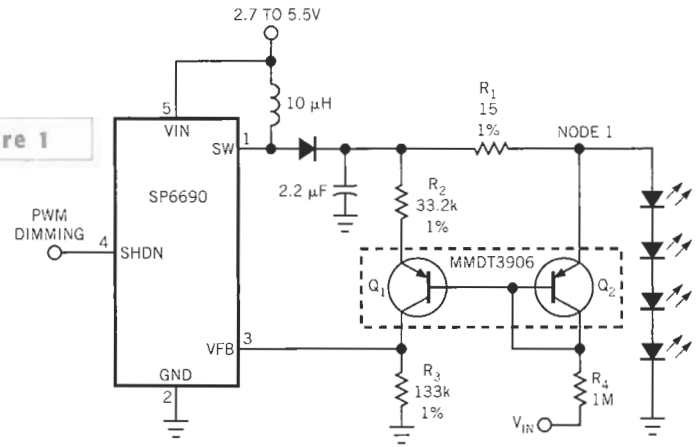
WHITE LEDs FIND WIDE use in backlighting color-LCD screens in most portable devices, such as cellular phones, PDAs, and MP3 players. Multiple LEDs often connect in series to ensure that the same current flows through every LED. To forward-bias these LEDs, a voltage of 10 to 16V comes from an inductor-based boost regulator, such as an SP6690. However, white LEDs are behind the display, whereas boost regulators are on the main pc board, and it is important to minimize the number of interconnects. You can obtain the best results if you implement high-side and differential-current sensing. In this case, the boost regulator's output looks like a high-voltage true current source. Of course, LEDs need to connect to ground at some point, but it is unimportant where they connect. For example, the display itself can locally pick up ground. This approach allows you to effect a "single"-wire connection. The simple circuit in **Figure 1** shows the implementation of the idea.

Figure 1



This circuit provides high-side current sensing for driving a string of white LEDs.

R_1 acts as a current-sense resistor. The diode-connected Q_2 level-shifts the voltage at Node 1 and applies it to the base of Q_1. These transistors come in one package and provide closely matched V_{BE} voltage when they operate at the same current. Because the V_{BE} values match, the emitter of Q_1 is at the same voltage as Node 1. As a result, the voltage across resistor R_2 matches the drop across R_1 and produces Q_1 emitter current that equals V_{R1}/R_2. This current flows to Q_1's collector and creates a voltage drop across R_3. The boost-regulator SP6690 regulates the voltage across R_3 at 1.22V, the IC's internal reference voltage. R_4 provides current bias for Q_2. The value of R_4 allows the Q_1 and Q_2 collector currents to match. You calculate the value of R_1 as follows: $R_1=R_3\times(V_{OUT}-V_{IN}-V_{BE})/1.22$, where V_{OUT} is the combined LED forward voltage. The output current is $I_{OUT}=0.3A/R_1$. The circuit in **Figure 1** sets I_{OUT} at 20 mA, but you can adjust it by using a different R_1 value. Note that you could return R_4 to ground, but it instead connects to V_{IN}. This connection removes quiescent current through the resistor and Q_1/Q_2 when the SP6690 is in shutdown mode.