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Linear-brightness controller for LEDs has 64 taps

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Applications that include LEDs but no microcontroller or other form of control intelligence can benefit from a simple circuit that provides manual control of the LEDs' light intensity. Among the devices suitable for this purpose are mechanical (analog) and electronic (digital) potentiometers. The digital potentiometer with up and down pushbuttons, an alternative to the mechanical potentiometer, is smaller, more reliable, and usually less expensive (**Figure 1**).

IC_2, a current regulator, drives a chain of LEDs with current as high as 200 mA. In a standard application circuit, IC_2's internal regulator senses the drop across current-sense resistor R_{SENSE} in series with the LED chain. Thus, IC_2 controls current through the chain by regulating voltage at the differential inputs, CS− and CS+, to the set value of 204 mV. Resistors R_A and R_B allow the output voltage IC_1's Pin 6 to adjust the current level. IC_1 is a 64-tap linear digital potentiometer whose resistance connects between ground and V5, a well-regulated voltage that IC_2 internally generates. You manually adjust the RW control voltage (Pin 6), a fraction of V5, using the up and down pushbuttons. A few assumptions allow a quick and simplified calculation of the necessary resistor values. Initially, you fix R_A and then calculate R_B and R_{SENSE}. The assumptions are that you can neglect the maximum 6.93-µA error induced by the bias current at CS+; that the value you choose for R_A is much higher than IC_1's equivalent resistance, for which the worst-case value at position 32 (top and bottom resistances plus the wiper series resistance) is 2.9 kΩ; and that R_{SENSE} is much less than R_B.

After setting R_A at 25.5 kΩ, $V_{WIPER}=(5V/63)\times N$, where N is the wiper setting (0 to 63). Then, you solve the equation $(V_{WIPER}-0.204V)/R_A=(0.204V-I_{LED}\times R_{SENSE})/R_B$. Solve the above equation for R_B under the conditions for which $I_{LED}=0$, which are N=63 and $V_{WIPER}=5V$ (top position): $R_B=25.5\ k\Omega\times 0.204V/(5V\times 0.204V)=1.085\ k\Omega$. You can choose R_B from the standard values of 1.07 kΩ (1% series) or 1.1 kΩ (5% series). At the bottom position, where $V_{WIPER}=0$ and LED current is the maximum of 200 mA, brightness should be the maximum available. Solving for R_{SENSE}, $R_{SENSE}=[0.204V+(0.204V\times(1.085/25.5))]/0.2A=1.063\Omega$; 1.07Ω is a standard value in the 1% series.

A graph of LED current versus tap position shows a slight nonlinearity

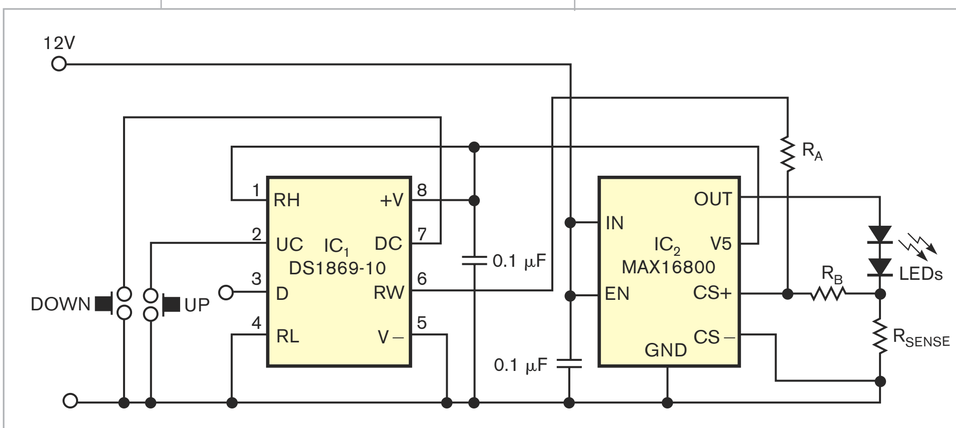

Figure 1 This brightness-control circuit lets you manually adjust the LED brightness using the up and down buttons.

because of the variation in resistance you see looking into the wiper at different tap positions (**Figure 2**). At the extreme ends of the potentiometer, you see only the 400Ω wiper resistance. As the wiper moves toward midpoint, the resistance increases toward a maximum of one-quarter of the end-to-end resistance value. Because IC_1 is a 10-kΩ potentiometer, the resistance the wiper sees at midpoint is about 2.5 kΩ in series with R_{WIPER}. This variation introduces a maximum linearity error of 8%, which is negligible in most LED applications. IC_2 offers thermal protection against excessive heat and overload conditions. For effective power dissipation and to avoid thermal cycling, you must connect the exposed pad of the package to a large-area ground plane. **EDN**

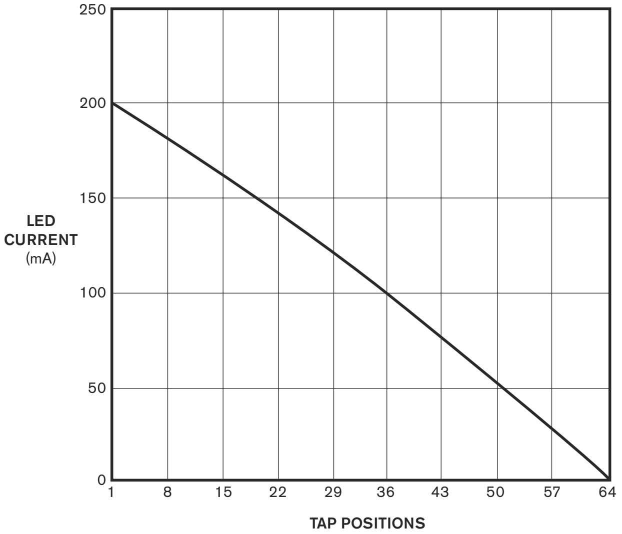

Figure 2 A plot of LED current versus tap position in Figure 1 exhibits only a slight nonlinearity.