LED-driver considerations

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Many of today's portable electronics require backlight LED-driver solutions with the following features: direct control of current, high efficiency, PWM dimming, over-voltage protection, load disconnect, small size, and ease of use. This article discusses each of these features and how they are achieved, and concludes with a typical circuit that implements each of these features.

Direct control of current

LEDs are current-driven devices whose brightness is proportional to their forward current. Forward current can be controlled in two ways. The first method is to use the LED V-I curve to determine what voltage needs to be applied to the LED to generate the desired forward current. This is typically accomplished by applying a voltage source and using a ballast resistor as shown in Figure 1. However, this method has several drawbacks. Any change in LED forward voltage creates a change in LED current. With a nominal forward voltage of 3.6 V, the LED in Figure 1 has 20 mA of current. If this voltage changes to 4.0 V, which is within the specified voltage tolerance due to temperature or manufacturing changes, the forward current drops to 14 mA. This 11% change in forward voltage causes a much larger 30% change in forward current. Also, depending upon the available input voltage, the voltage drop and power dissipation across the ballast resistor waste power and reduce battery life.

The second, preferred method of regulating LED current is to drive the LED with a constant-current source. The constant-current source eliminates changes in current due to variations in forward voltage, which translates into a constant LED brightness. Generating a constant-current source is fairly simple. Rather than regulating the output voltage, the input power supply regulates the voltage across a current-sense resistor. Figure 2 shows this implementation. The power-supply reference voltage and the value of the current-sense resistor determine the LED current. Multiple LEDs should be connected in a series configuration to keep an identical current flowing in each LED. Driving LEDs in parallel requires a ballast resistor in each LED string, which leads to lower efficiency and uneven current matching.

High efficiency

Battery life is critical in portable applications. For an LED driver to be useful, it must be efficient. An efficiency measurement of an LED driver differs from that of a typical power supply. An efficiency measurement of a typical power supply is defined as the output power divided by the input power. With an LED driver, the output power is not the parameter of interest. What is important is the amount of input power required to generate the desired LED brightness. This is easily determined by dividing the power in the LEDs by the input power. Defining the efficiency in this way means that the power dissipated in the current-sense resistor contributes to the power lost in the

Figure 1. Voltage source with ballast resistor

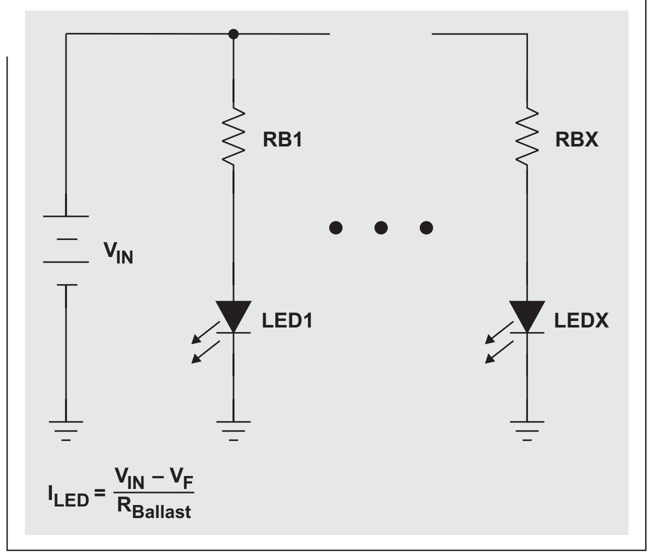

Figure 2. Constant-current source for driving LEDs