# Power an LED driver using off-the-shelf components

TA Babu, Chennai, India

High-power LEDs challenge electronics engineers to design accurate and efficient, yet simple, driver circuits. Conventionally, driving high-power strings with accurate current requires dedicated switching regulators. Choosing a discrete driver circuit requires an understanding of LED lighting to make the best trade-off. This Design Idea describes a simpler and equally good way to employ the ubiquitous 555 IC.

In the converter circuit in **Figure 1**, $IC_1$'s pins 2 and 6 connect together, which lets the device retrigger itself on each cycle. Thus, it operates as a free-running oscillator. During each cycle, capacitor $C_2$ charges up through timing resistor $R_1$ and discharges through resistor $R_2$. The capacitor charges up to two-thirds of the power-supply voltage, the upper comparator limit, which $0.693(R_1C_2)$ determines, and discharges itself down to one-third the power-supply voltage, the lower comparator limit, which $0.693(R_2C_2)$ determines. The total time period, T, is $0.693(R_1+R_2)C_2$.

During the on time, transistor $Q_1$ conducts and stores the energy in inductor $L_1$. When it stops conduction, the stored energy transfers to capacitor $C_3$ through Schottky diode $D_1$.

**ONCE THE VOLTAGE DROP REACHES THE BASE-EMITTER THRESHOLD OF TRANSISTOR $Q_2$, IT STARTS CONDUCTING.**

You can use the following **equations** to calculate the inductor value. The selection of an inductor depends on input voltage, output voltage, maximum current, switching frequency, and availability of standard inductor values. Once you know the inductance, you can choose the diode and the capacitor.

MOSFET $Q_1$ determines the duty cycle, according to the following **equation**:

$$D=1-\frac{V_{INMIN}\times\eta}{V_{OUT}},$$

where $V_{INMIN}$ is the minimum input voltage, $V_{OUT}$ is the desired output voltage, and $\eta$ is the efficiency of the converter, estimated at 80%.

The average inductor current is

$$I_{LAVG}=\frac{I_O}{1-D},$$

where $I_{LAVG}$ is the average inductor current and $I_O$ is the output current.

The peak inductor current is

$$I_{LPEAK}=I_{LAVG}+\frac{\Delta I_L}{2},$$

where $I_{LPEAK}$ is the peak inductor current and $\Delta I_L$ is the change in inductor current.

Assume that the change in inductor current is 25% over the average current. You can compute inductor $L_1$ as

$$L=(V_{IN}\times D)/(F_{OSC}\times\Delta I_L),$$

where $F_{OSC}$ is the oscillator frequency. The inductor's saturation-current rating should be greater than the peak current.

To ensure constant illumination, you must monitor the current through the LED. Resistor $R_3$ senses the output current. Once the voltage drop across this resistor reaches the base-emitter threshold of transistor $Q_2$, it starts conducting, and this conduction reduces the on time of the 555 timer.

The following **equation** thus sets the LED current:

$$I_{LED}=\frac{0.6V}{R_{SENSE}},$$

where $I_{LED}$ is the LED's current and $R_{SENSE}$ is the sense resistance.

The minimum and maximum input and output voltages for this circuit are 10.5 and 15V, respectively. The LED string's voltage and current are 21V and 350 mA, respectively. The 6W LED driver can find numerous applications, including battery-operated portable lighting, solar-operated garden lighting, automotive lighting, bike headlights, and underwater lights. Driving high-power LED strings with standard off-the-shelf components simplifies your design without sacrificing performance. EDN

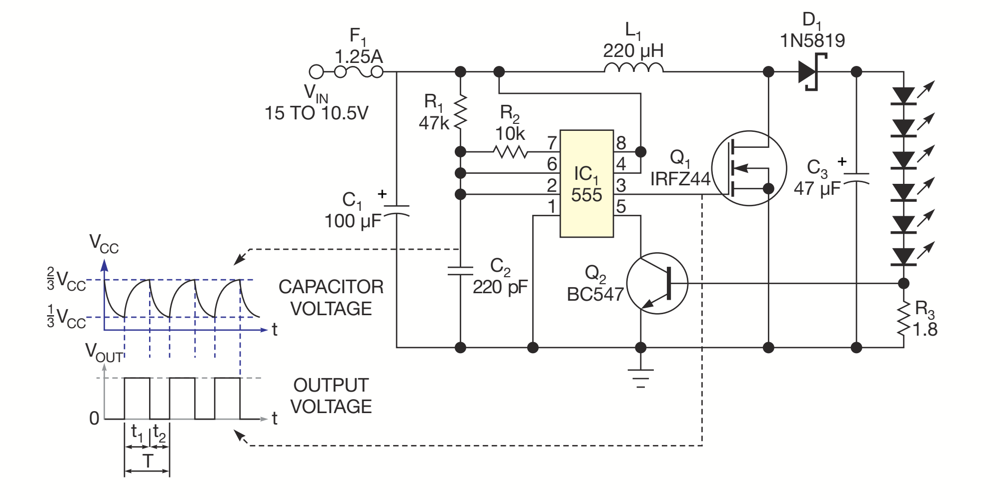


Figure 1 A free-running 555 timer provides the stimulus for driving a series of LEDs.