# White Light LED Driver With Gradual Dimming

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PMP/Portable Power DC-DC Applications

**ABSTRACT**

Many consumer products using white light LEDs for illumination and backlighting provide gradual LED illumination at turnon and turnoff. This gradual illumination is usually achieved with the aid of a microprocessor that provides PWM dimming control. This circuit uses the Texas Instruments TPS61040 white light LED driver to provide gradual illumination at turnon and turnoff without the use of a microprocessor.

The following circuit generates a 101mA constant current to drive up to 6 white LEDs for portable applications such PDAs and digital cameras. The input operating range is 1.8 V to 6 V, which covers two-cell alkaline and NiMh inputs (1.8 V to ~3 V), three-cell alkaline and NiMh inputs (2.7 V to ~4.8 V), and single-cell Li-Ion inputs (3 V~4.2 V). This boost converter uses R1 to set a constant current through the LEDs. A detailed description of this circuit can be found in the TPS61040 data sheet (SLVS413).

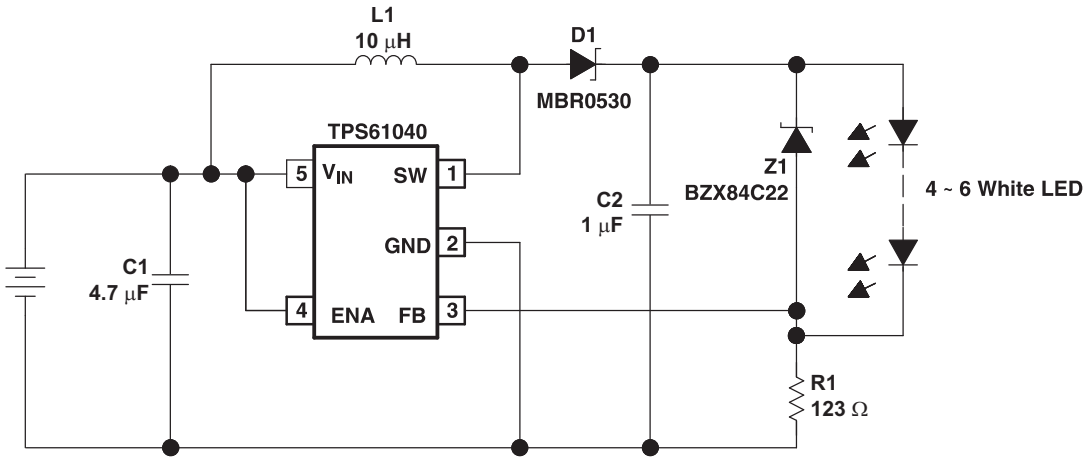


**Figure 1. Constant Current LED Drive Supply**

The circuit shown in Figure 1 instantly produces the maximum programmed load current at turnon and instantly goes to zero current at turnoff. The circuit shown in Figure 2 slowly (1–2 seconds) increases and decreased the LED brightness at turnon and turnoff. Only a slight modification of the original circuit is required to produce this effect.

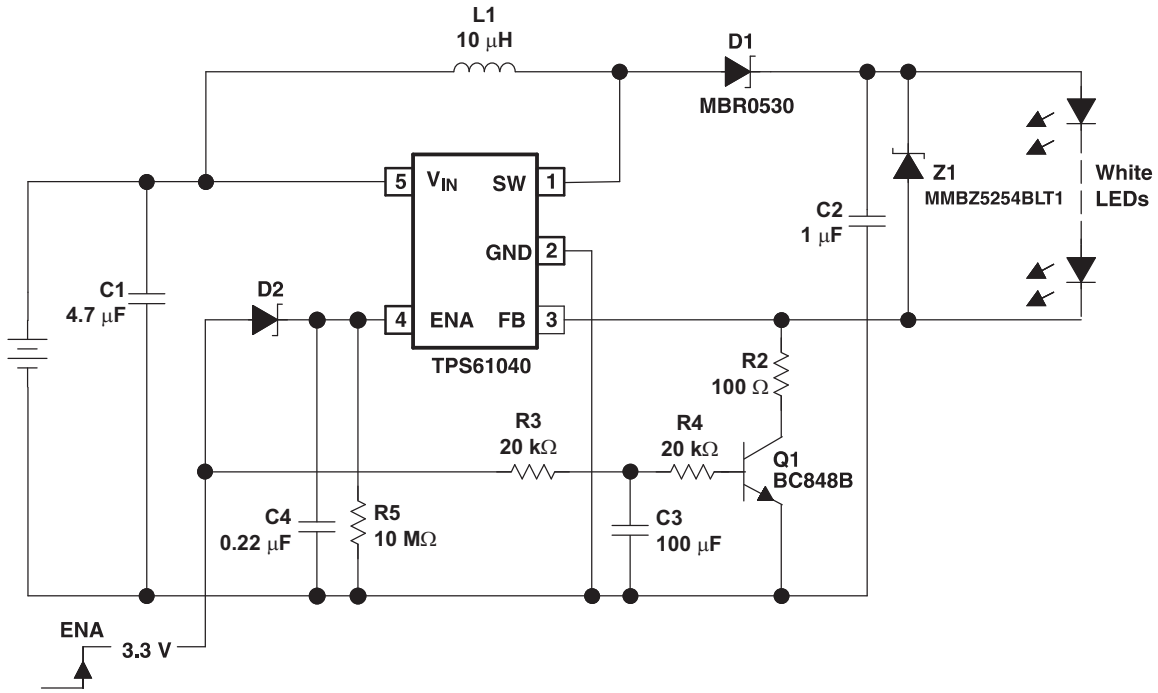


**Figure 2. Additional Components Provide Gradual Turnon and Turnoff of LED Current**

On application of the enable signal, R3 slowly charges C3, which slowly turns on Q1. The TPS61040 is immediately enabled through D2. During turnon, the initial resistance from FB to ground is extremely high, limiting the LED current to 0 mA. As Q1 slowly turns on, the effective resistance gradually drops. The drop in resistance directly correlates to a rise in LED current. The LEDs transition from 0% brightness to 100% brightness in 1–2 seconds, depending on the time constants chosen. Figure 3 shows the relevant waveforms during turnon.

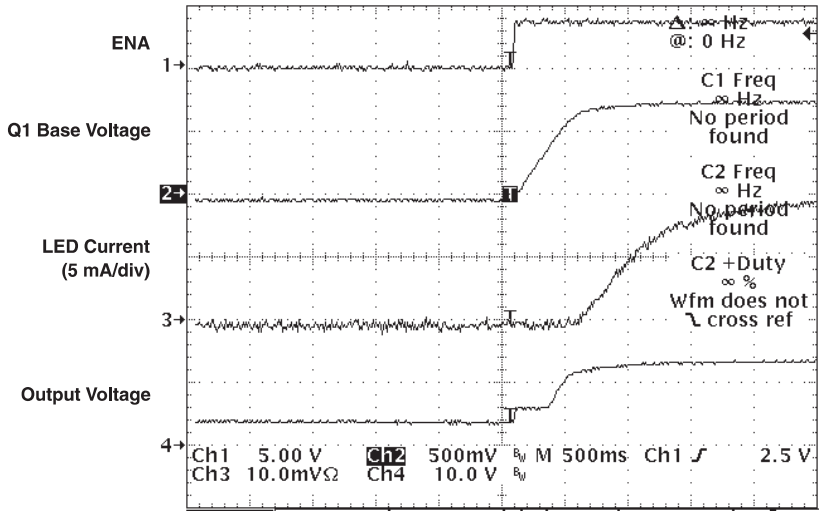


**Figure 3. Waveform During Turnon**

When ENA goes low during turnoff, D2 prevents C4 from discharging. The TPS61040 remains enabled until C4 discharges through R5. While the TPS61040 is still enabled, C3 begins to discharge through R3 and R4. As the available base current to Q1 drops, the effective resistance of Q1 starts to increase. The LED current drops in proportion to the increase in the total resistance seen at the FB pin. Figure 4 shows the relevant waveforms during turnoff.

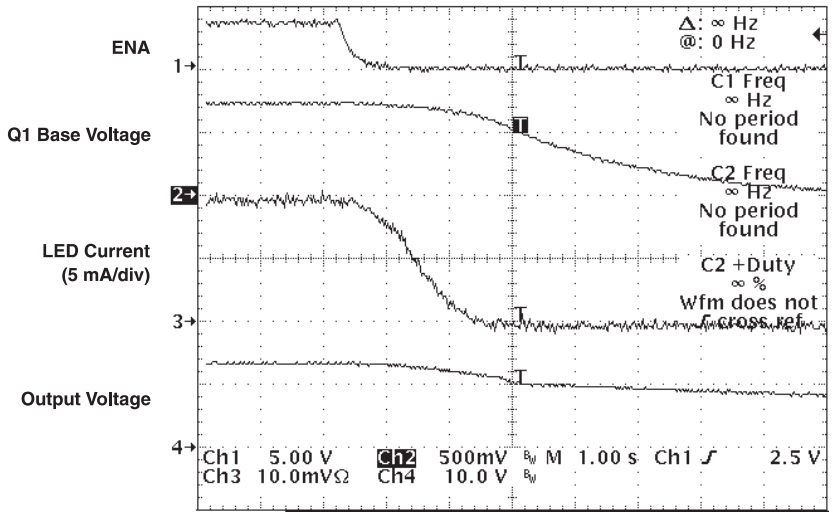


**Figure 4. Waveforms During Turnoff**

At turnon, a short delay occurs between the ENA signal going high and the start of the current flowing through the LEDs. This occurs because Q1 does not start to conduct until its base voltage reaches approximately 0.7 V. The addition of a 3.3-kΩ resistor, R6 shown in Figure 5, causes the base voltage to immediately jump to about 0.5 V at turnon. This reduces the start-up delay from 500 ms to about 100 ms. Turnon and turnoff waveforms with R6 added are shown in Figure 6 and Figure 7.

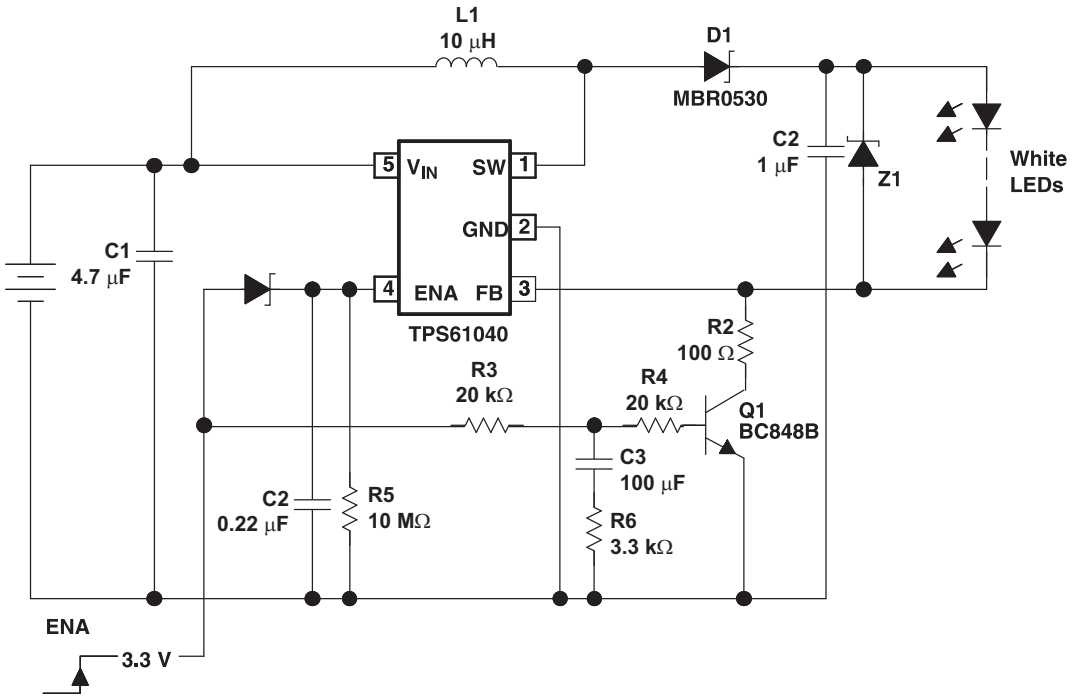


**Figure 5. Modification to Reduce Turnon Delay**

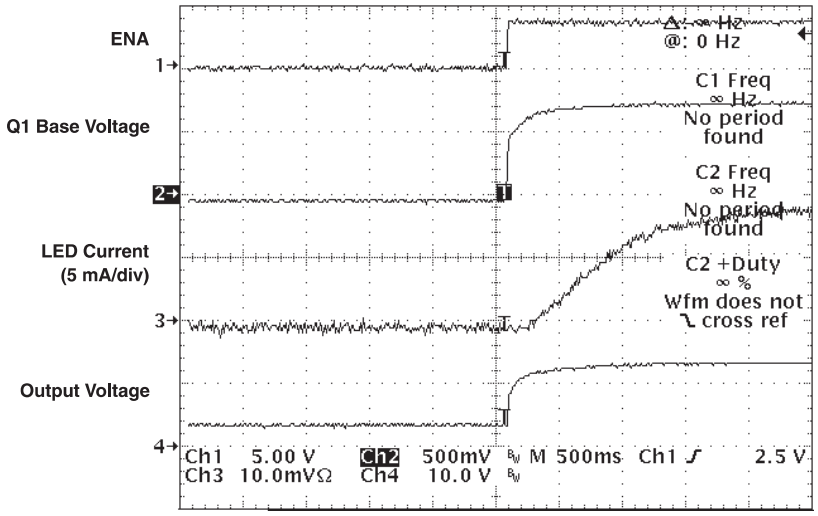


**Figure 6. Reduced Delay Turnon**

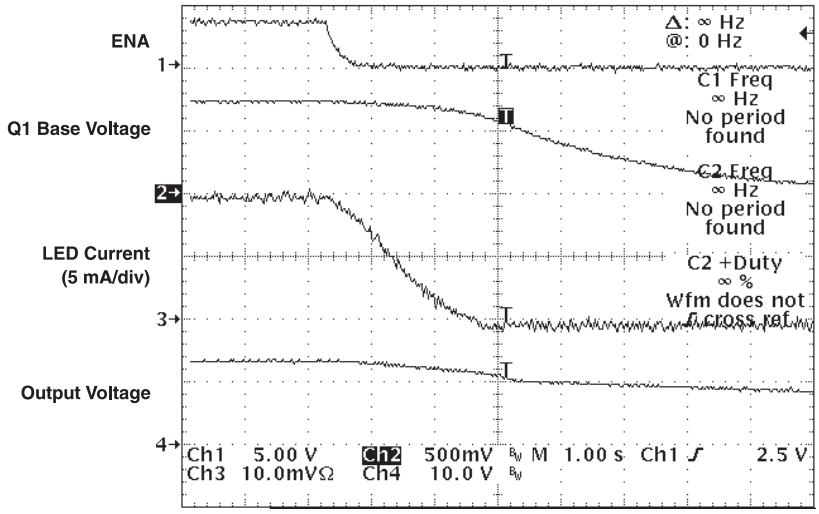


**Figure 7. Reduced Delay Turnoff**

This application report has shown how to provide a gradual turnon and turnoff of white light LEDs without the use of microprocessor control.

## References

1. *TPS61040* data sheet (SLVS413)
2. *TPS61040EVM-002* users guide (SLVU068)

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