Accurate PWM LED Dimming without External Signal Generators, Clocks or µControllers

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LEDs can be dimmed in two ways: analog and pulse-width modulation (PWM) dimming. Analog dimming changes LED light output by simply adjusting the DC current in the string, while PWM dimming acheives the same effect by varying the duty cycle of a constant current in the string to effectively change the *average* current in the string. Despite its attractive simplicity, analog dimming is inappropriate for many applications because it loses dimming accuracy by about 25%+ at only 10:1 brightness levels, and it skews the color of the LEDs. In contrast, PWM dimming can produce 3000:1 and higher dimming ratios (at 100Hz) without any significant loss of accuracy, and no change in LED color.

The LT3761 combines the simplicity of analog dimming with the accuracy of PWM dimming by generating its own PWM signal. High dimming ratios are possible by adjusting a simple DC signal at its dimming input—no additional PWM-generating microcontrollers, oscillators or signal generators are required. The LT3761's internal PWM signal can produce 25:1 dimming, while it can still deliver up to 3000:1 dimming with an external PWM signal.

HIGH POWER LED DRIVER

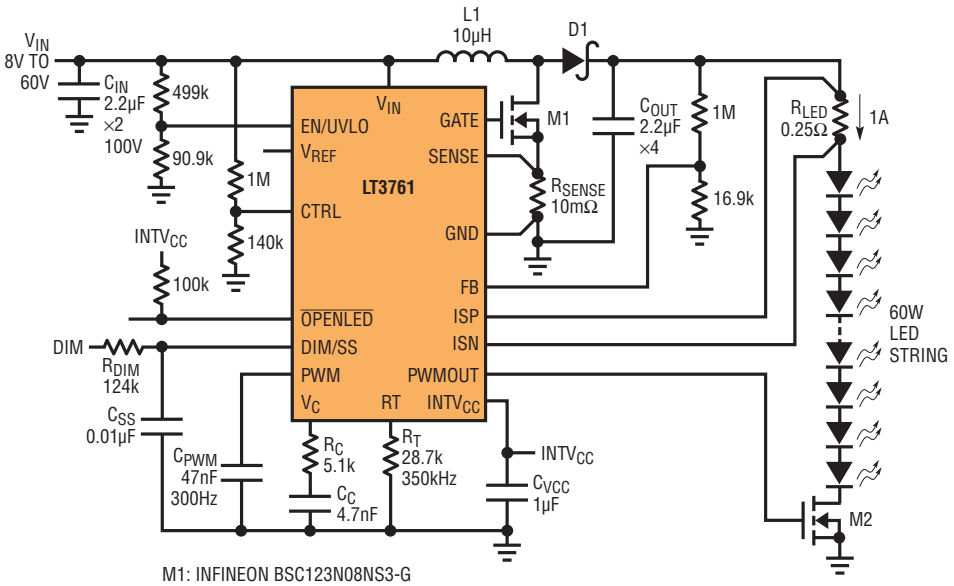
The LT3761 is a high power LED driver similar to the LT3755-2 and LT3756-2 family. It is a 4.5V-to-60V input to 0V-to-80V output single-switch controller IC that can be configured as a boost, SEPIC, buck-boost mode or buck mode LED driver. It has a 100kHz to 1MHz switching frequency range, open LED protection, extra internal logic to provide short-circuit protection, and can be operated as a constant voltage regulator with current limit or as a constant-current SLA battery or supercap charger.

Figure 1 shows a 94% high efficiency 60V, 1A (60W) 350kHz automotive headlamp application with PWM dimming. The LT3761 uses the same high performance PWM dimming scheme as the LT3755/LT3756 family, but with the additional feature of the internally generated PWM dimming signal and no additional pins.

INTERNAL PWM DIMMING GENERATOR

Unlike other high power LED drivers, the LT3761 can generate its own PWM dimming signal to produce up to 25:1 dimming. This enables it to produce accurate PWM dimming without the need for external PWM-generating components. The

Figure 1. 94% efficient boost LED driver for automotive headlamp with 25:1 internal PWM dimming

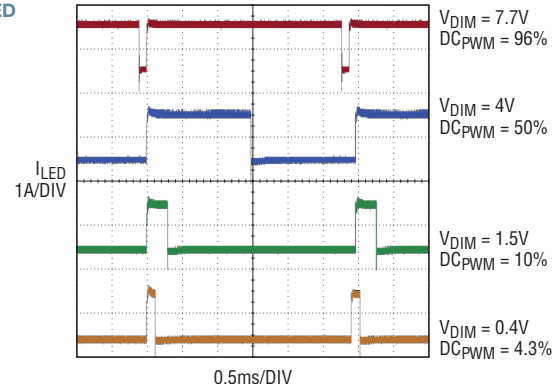


M1: INFINEON BSC123N08NS3-G
D1: DIODES INC PDS5100
L1: COILTRONICS HC9-100-R
M2: VISHAY SILICONIX Si2328DS
C_{OUT}, C_{IN}: MURATA GRM42-2X7R225K100R

(CURRENT DERATED FOR V_{IN} < 10V)

The LT3761 generates its own PWM signal to achieve accurate PWM dimming, but with the simple control of analog dimming. High dimming ratios are possible by adjusting a simple DC signal at its dimming input—no additional PWM-generating microcontrollers, oscillators or signal generators are required.

Figure 2. Internally generated PWM signal and LED current for the application in Figure 1



LT3761 requires only an external DC voltage, much like analog dimming control, for high performance PWM dimming at a chosen frequency. It can still receive a PWM input signal to drive the LED string with that signal in standard fashion.

The internal PWM dimming signal generator features programmable frequency and duty cycle. The frequency of the square wave signal at PWMOUT is set by a capacitor C_{PWM} from the PWM pin to GND according to the equation: f_{PWM} = 14kHz • nF/C_{PWM}. The duty cycle of the signal at PWMOUT is set by a µA-scale current into the DIM/SS pin as shown in Figure 3. Internally generated pull-up and pull-down currents on the PWM pin are used to charge and discharge its capacitor between the high and low thresholds to generate the duty cycle signal. These current signals on the PWM pin are small enough so they can be easily overdriven by a digital signal from a microcontroller to obtain very high dimming performance. The practical minimum duty cycle using the internal signal generator is about 4% if the DIM/SS pin is used to adjust the dimming ratio. For 100% duty cycle operation, the PWM pin can be tied to $INTV_{CC}$.

CONCLUSION

The high power and high performance LT3761 LED driver has its own onboard PWM dimming signal generator that is both accurate and easy to use. ■

Figure 3. Setting the duty cycle at the DIM/SS pin takes a µA-scale signal. This pin can also be used with an external PWM signal for very high dimming ratios.

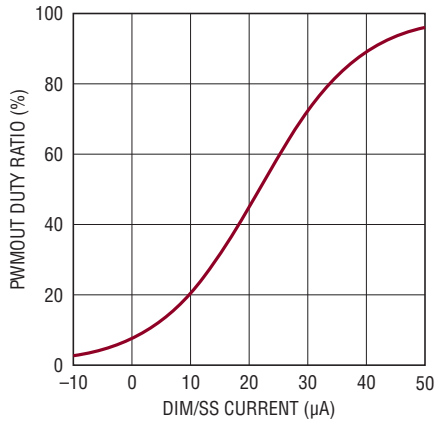


Figure 4. Given a high speed PWM input signal, the LT3761 still provides a high speed PWMOUT signal.