

# DESIGN NOTES

## Dual White LED Driver Features Integrated Switches and Schottky Diodes in 3mm × 3mm DFN Package – Design Note 1010

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### Introduction

Linear Technology's LT<sup>®</sup>3466 is a dual step-up converter capable of driving up to 20 white LEDs with a programmable constant current. The device is also capable of driving asymmetric LED strings with independent dimming and shutdown control for multipanel LCD backlight applications.

The LT3466 uses a constant-current, step-up architecture to directly regulate LED current, providing consistent light intensity and color across all LEDs regardless of variations in their forward voltage drop. Important features including soft-start, open LED protection, adjustable switching frequency and DC dimming control are integrated into the part, making the LT3466 LED driver an ideal solution for space-constrained portable devices such as cellular phones, PDAs and digital cameras.

### Li-Ion to a 2-LED and a 4-LED Display

Figure 1 shows a white LED driver to backlight two displays, a 4-LED main and a 2-LED sub display. This design generates a constant 20mA in each white LED string from Li-Ion (3V ~ 4.2V) or 5V adapter input. Two independent dimming and shutdown controls (via CTRL1

and CTRL2) simplify power management, extending battery life. The adjustable operating frequency, integrated Schottky diodes and optimized internal compensation result in a circuit smaller than 0.18in<sup>2</sup>.

Efficiency, as shown in Figure 2, is above 80% at 20mA for 3.6V input, which is significantly higher than that of switched-capacitor based solutions.

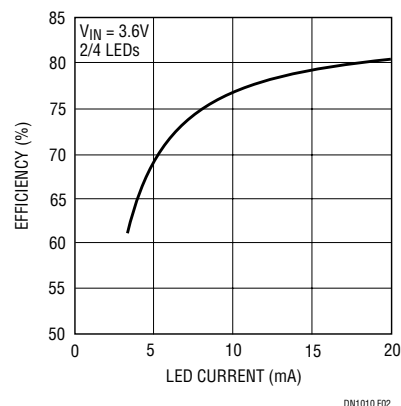


Figure 2. Efficiency vs LED Current, Circuit of Figure 1

### Li-Ion Powered Driver for 20 White LEDs

Figure 3 highlights LT3466's impressive input and output voltage range. This circuit is capable of driving two sets of ten, in-series LEDs with 12mA of constant current per converter. As shown in Figure 3, the circuit works from single Li-Ion (3V) battery or 5V wall adapter.

Inrush current during start-up is well controlled due to the internal soft-start circuitry of LT3466. The circuit is also protected with an internal 39V output clamp when the LEDs are disconnected or fail open. Efficiency is above 80% over a wide LED current range of 5mA to 12mA, reaching 83% at 12mA. The conversion efficiency with a 3.6V input is shown in Figure 4. To achieve the 92% duty cycle requirement in this application, the operating frequency was set to 400kHz using a 147k resistor at R<sub>T</sub> pin.

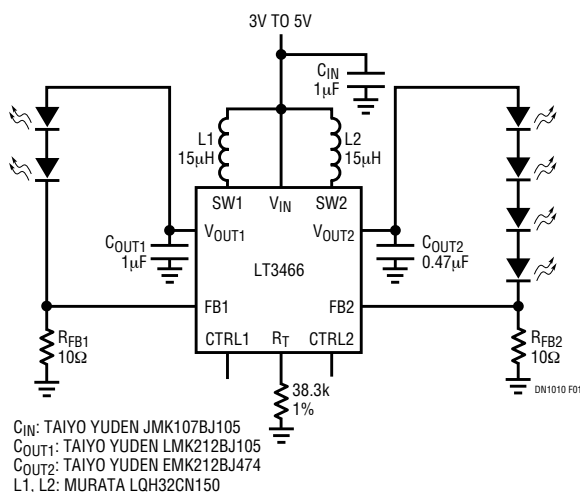


Figure 1. Li-Ion to 2/4 White LEDs

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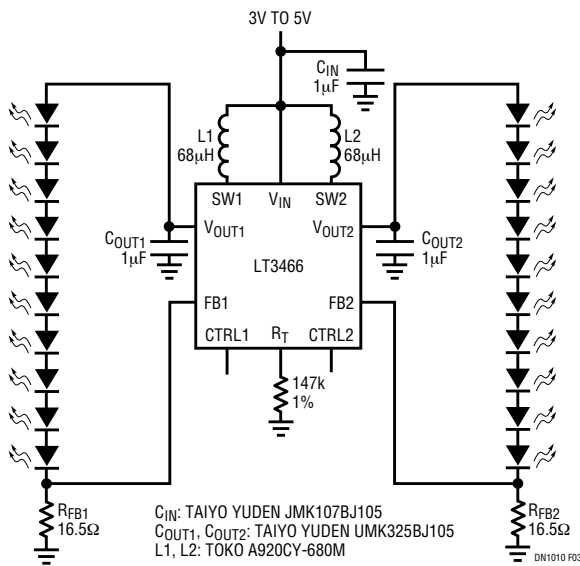


Figure 3. Li-Ion to 10/10 White LEDs

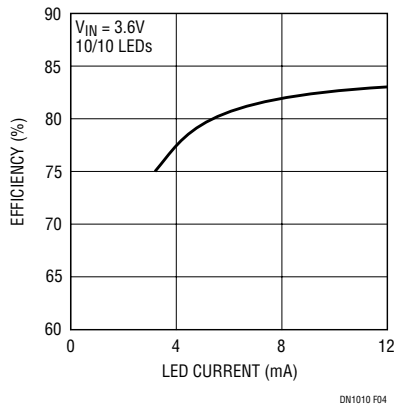


Figure 4. Efficiency vs LED Current, Circuit of Figure 3

The circuit can be further optimized for efficiency and size by programming the operating frequency over a 200kHz to 2MHz range using a single external timing resistor.

### Dimming Control

The LT3466 features single pin shutdown and dimming control for each converter. The LED current in the two drivers can be set independently by modulating the CTRL1 and CTRL2 pins. There are two different types of control methods: DC voltage dimming and filtered PWM signal dimming.

The LED currents are proportional to the voltages at the CTRL1 and CTRL2 pins. DC voltage dimming is achieved by reducing the voltage on the CTRL pin. As the CTRL voltage decreases, the feedback voltage across the LED current programming resistor decreases from 200mV to 0V, thus reducing the LED current from  $I_{LED}$  to 0A. Feedback voltage variation versus control voltage is shown in Figure 5.

PWM dimming works similar to DC voltage dimming except that the DC voltage input to the CTRL pins comes from an RC-filtered PWM signal. The corner frequency of R1 and C1 should be much lower than the frequency of the PWM signal for proper filtering. The dimming control using a filtered PWM signal is shown in Figure 6.

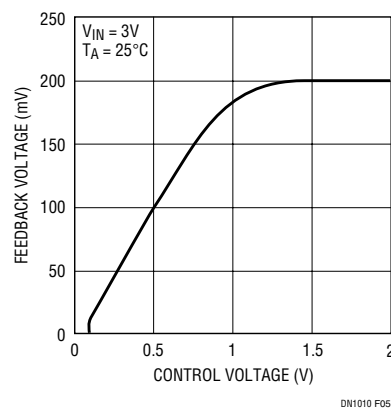


Figure 5. Feedback Voltage vs  $V_{CTRL}$

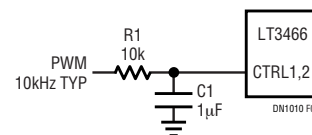


Figure 6. Filtered PWM Dimming

### Conclusion

The LT3466 is a dual channel white LED driver capable of driving up to 20 white LEDs from a single cell Li-Ion input. The device features 44V internal power switches, internal Schottky diodes, adjustable switching frequency, DC dimming control, automatic soft-start, open LED protection and optimized internal compensation. The LT3466 is an ideal solution for multipanel LCD backlight applications or space constrained portable applications such as cellular phones, PDAs and digital cameras.

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