



DESIGN NOTES

Monolithic Converter Drives High Power LEDs – Design Note 376

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Introduction

High power LEDs are quickly expanding their reach as the light source of choice for flat panel computer and TV monitors, TV projection, signage, portable lights and automotive interior, trim and brake lighting. The input voltage and LED voltage combinations across these applications are as diverse as the applications themselves, precluding the ability for a single topology to satisfy the needs of them all. Nevertheless, all LED drivers, whether buck, boost, buck-boost or SEPIC must regulate a constant LED current, regardless of input and output voltages. Now a single switching regulator with the ability to be configured in a large variety of topologies for high power constant LED current is available.

The LT[®]3477 can drive high power LEDs at constant current in any of the topologies stated above. It is a current mode, 3A DC/DC step-up converter that incorporates dual rail-to-rail current sense amplifiers and an internal 3A, 42V switch. It combines a traditional voltage feedback loop and two unique current feedback loops to operate as a constant-current and/or constant-voltage source. The floating rail-to-rail current sense amplifiers allow for both ground-referenced and floating LED solutions in different topologies, along with the added benefit of inrush current or short-circuit protection.

Both current sense voltages are 100mV and can be adjusted independently using the I_{ADJ1} and I_{ADJ2} pins.

Efficiencies of up to 91% can be achieved in typical applications. The LT3477 features a programmable soft-start function to limit inductor current during start-up. Both inputs of the error amplifier are available externally, allowing positive and negative output voltages. The switching frequency is programmable from 200kHz to 3.5MHz through an external resistor. It comes in two thermally enhanced packages: a 20-pin (4mm × 4mm) QFN and a 20-pin TSSOP.

Boost Driver

The LT3477's internal ground-referenced 3A NPN power switch is most commonly used for boost applications. Figure 1 shows a 5V to four 1W LED boost converter with open LED protection and 330mA constant LED current. The constant current is regulated using a current sense amplifier and a 0.3Ω sense resistor. The feedback voltage amplifier is only used for overvoltage protection in case the LEDs are removed from the circuit.

The forward voltage of the four LEDs ranges from 12V to 16V. The input voltage range is 2.5V (minimum LT3477 input voltage) up to just below the LEDs' forward voltage. The LT3477 can drive more LEDs as long as the peak switch current remains below 3A.

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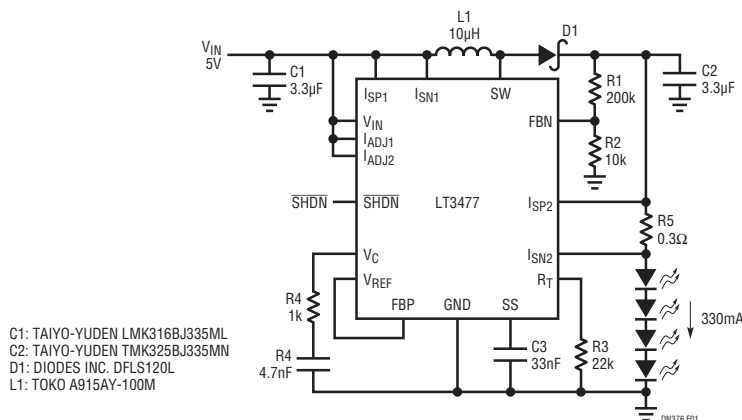


Figure 1. 330mA Boost LED Driver with Open LED Protection

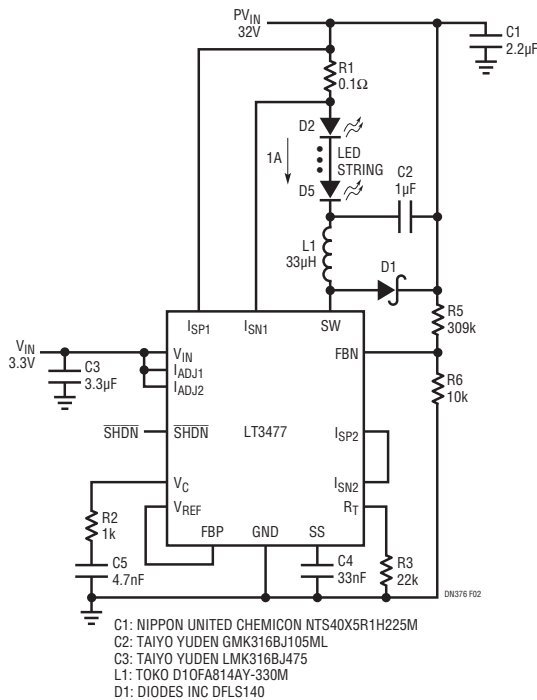


Figure 2. 1A Buck LED Driver

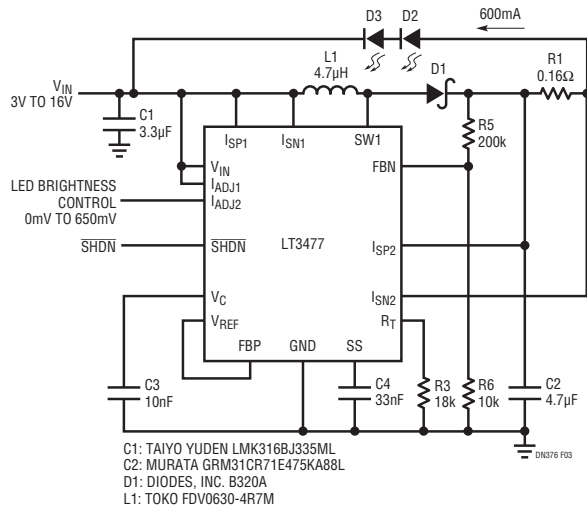


Figure 3. Buck-Boost LED Driver

Buck Driver

LEDs are best driven with a constant current source, but unlike most system loads, they do not have to be ground referenced. Therefore, the LT3477 with its floating current sense amplifiers can be converted into a buck LED driver with low LED ripple current. Figure 2 shows a 32V input voltage buck converter driving a string of 1A LEDs. The LEDs are tied to the input source through a sense resistor and the typical output Schottky catch diode is tied back to V_{IN} , converting the boost IC to a monolithic buck LED driver. Once again, the feedback voltage amplifier is only used for overvoltage protection—this time on the input—to prevent damage to the 42V switch. In buck mode, the V_{IN} pin need only be tied to a 3.3V or 5V source for maximum efficiency, and to keep it below its absolute maximum rating of 25V. The dimming I_{ADJ} pin functions work the same in buck mode as boost mode, reducing the LED current proportionally.

Buck-Boost Driver

If the battery range lies both above and below the forward voltage range of the LEDs, the LT3477 can simply be converted into a buck-boost converter as floating current sense amplifiers allow the LED string and its series sense resistor to be tied anywhere in the circuit. By altering the typical boost LED driver application so that the LED string returns to V_{IN} as opposed to ground, step-up/step-down capability is provided.

Conclusion

The LT3477 is a versatile, monolithic boost, buck, and buck-boost or SEPIC LED driver with a high power 3A, 42V switch. It can also be used for boost or SEPIC voltage converters requiring inrush or short-circuit protection. Two floating current sense amplifiers and a ground-referenced voltage feedback amplifier help give the LT3477 its high level of versatility. The externally programmable switching frequency, a shutdown pin, LED current dimming adjustment and a single soft-start capacitor satisfy the additional requirements of LED drivers and boost/SEPIC regulators.

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