

Tiny High Efficiency 2A Buck Regulator Directly Accepts Automotive, Industrial and Other Wide Ranging Inputs

by Kevin Huang

Introduction

Automotive batteries, industrial power supplies, distributed supplies and wall transformers are all sources of wide-ranging, high voltage inputs. The easiest way to step down these sources is with a high voltage monolithic step-down regulator that can directly accept a wide input range and produce a well-regulated output. The LT3480 is a new step-down regulator that accepts input from up to 38V (60V transient) while providing excellent line and load regulation and dynamic response. The LT3480 offers high efficiency solutions over wide load range and keeps the output ripple low during Burst Mode[®] operation.

LT3480 Features

Available in either a 10-pin MSOP or a 3mm x 3mm DFN package, the LT3480 offers an integrated 3.5A power switch and external compensation for design flexibility. The LT3480 employs a constant frequency, current mode architecture. The switching frequency can be set between 250kHz and

2.4MHz by using a resistor tied from the RT pin to ground. This allows a trade off between component size and efficiency. The switching frequency can be synchronized to an external clock for noise sensitive applications. An external resistor divider programs

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the output voltage to any value above the part's 0.8V reference.

The LT3480 offers soft-start via a resistor and capacitor on the RUN/SS pin, thus reducing maximum inrush currents during start-up. The LT3480 can withstand a shorted output. A cycle-by-cycle internal current limit protects the circuit in overload and limits output power; when the output voltage is pulled to ground by a hard short, the LT3480 reduces its operating frequency to limit dissipation

and peak switch current. This lower frequency allows the inductor current to safely discharge, thus preventing current runaway.

The high side bootstrapping boost diode is integrated into the IC to minimize solution size and cost. When the output voltage above 2.5V, the anode of the boost diode can be connected to output. For output voltages lower than 2.5V, the boost diode can be tied to a separate rail or to the input (<28V). For systems that rely on a well-regulated power source, the LT3480 provides a power good flag that signals when V_{OUT} reaches 90% of the programmed output voltage.

Modes of Operation: Low Ripple Burst and Forced Continuous

Two modes of operation can be selected through the SYNC pin. Applying a logic low to the SYNC pin enables low ripple Burst Mode operation, which maintains high efficiency at light load while keeping the output voltage ripple low. During Burst Mode

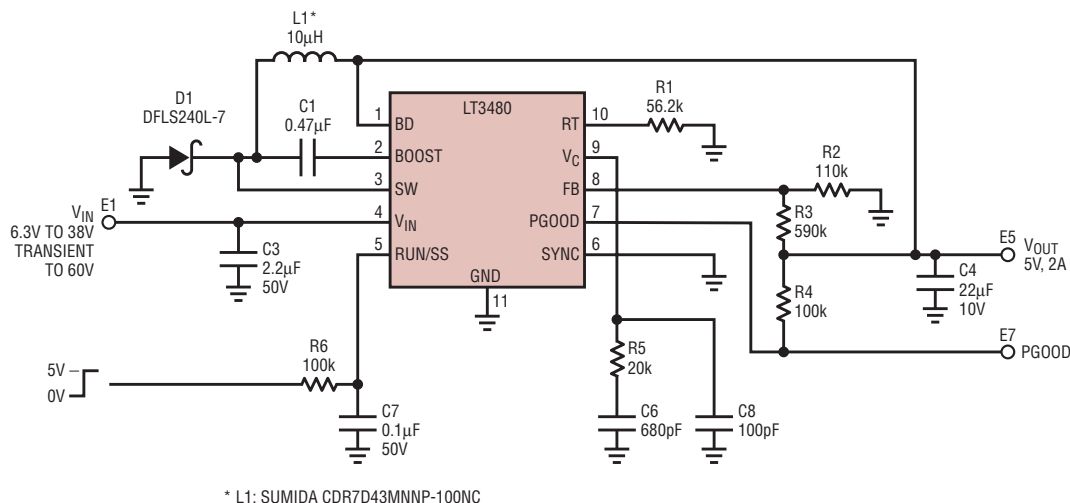


Figure 1. A 600kHz 6.3V-38V input DC/DC Converter using the LT3480 delivers 2A at 5V output.

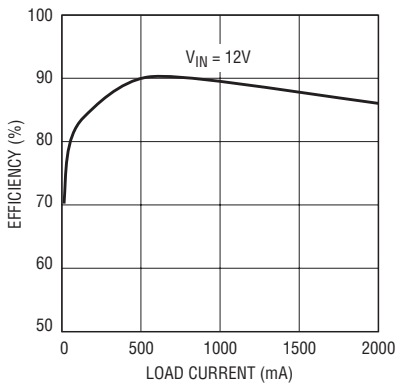


Figure 2. Efficiency for circuit in Figure 1

operation, the LT3480 delivers single cycle bursts of current to the output capacitor followed by sleep periods when the output power is delivered to the load by the output capacitor. Between bursts, all circuitry associated with controlling the output switch is shut down, reducing the input supply current and BD quiescent current to 30 μ A and 80 μ A respectively. As the load current decreases to a no load condition, the percentage of time that LT3480 operates in sleep mode increases and the average input current is greatly reduced, resulting in high efficiency. The LT3480 has a very low (less than 1 μ A) shutdown current which significantly extends battery life in applications that spend long periods of time in sleep or shutdown mode. For applications that require constant frequency operation even at no load, the LT3480 can be put into

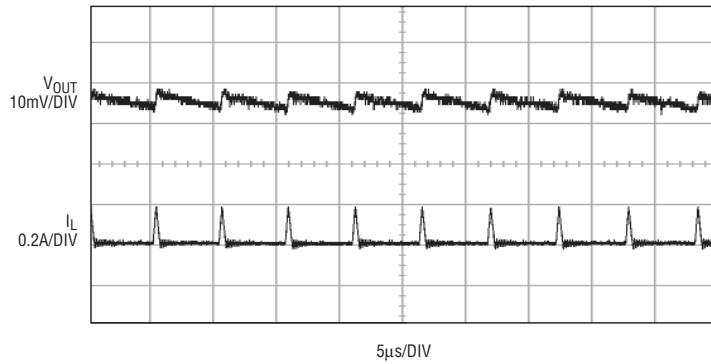


Figure 3. LT3480 Burst Mode operation at 10mA load

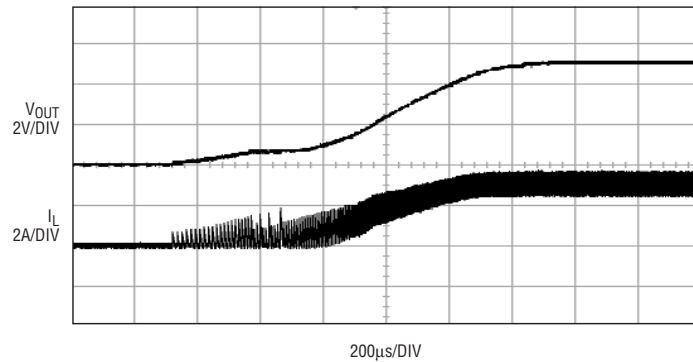


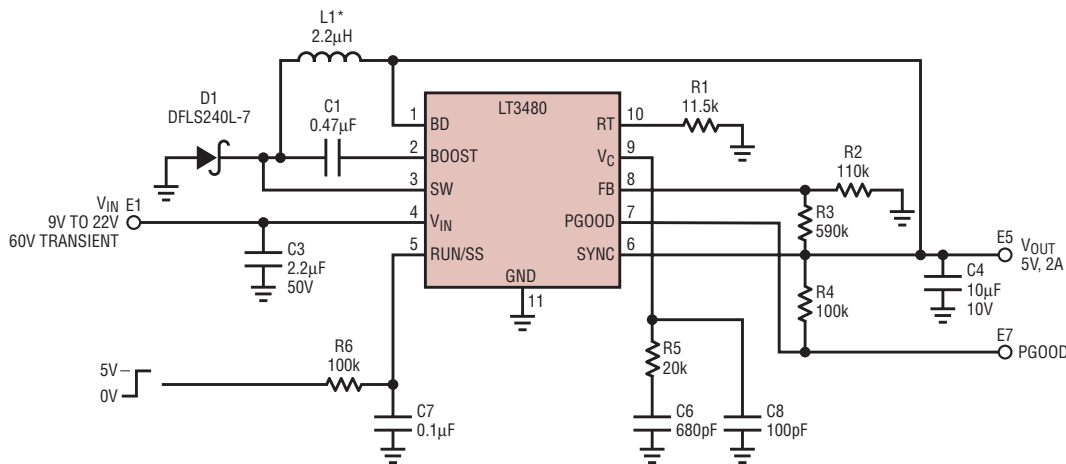
Figure 4. Soft-start of LT3480

forced continuous mode operation by tying the SYNC pin above 2.5V.

6.3V–38V to 5V, 2A DC/DC Converter with All Ceramic Capacitors

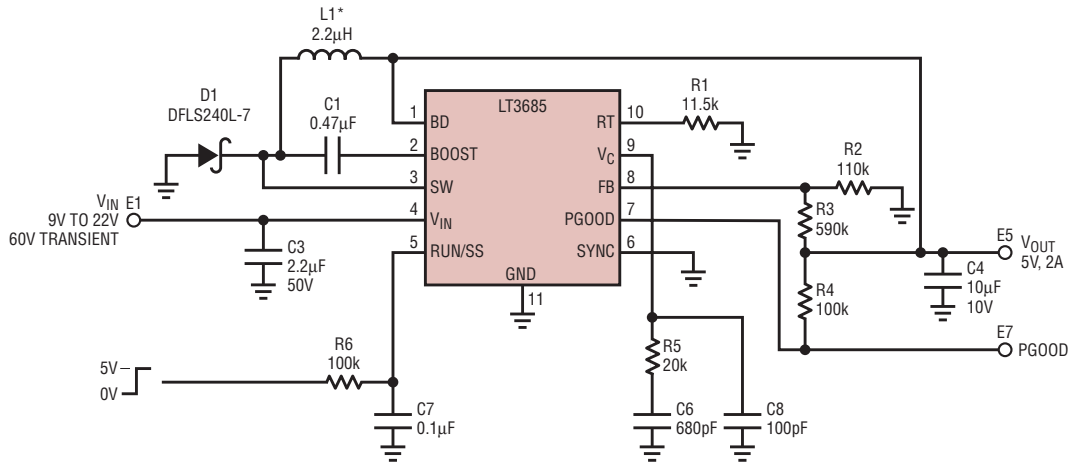
Figure 1 shows the LT3480 producing 5V at 2A from an input of 6.3V to 38V with 60V transient. The circuit is programmed for a 600kHz switching

frequency. Figure 2 shows the circuit efficiency at 12V input. The efficiency peaks at 90% and remains high across the entire load range. The SYNC pin is tied to the ground to enable Burst Mode operation and achieve high efficiency at light load. Figure 3 shows the inductor current and output voltage ripple under single pulse Burst Mode operation at 10mA load. The output



* L1: SUMIDA CDRH4D22/HP-2R2NC

Figure 5. High operating frequency allows the use of small inductors and capacitors. This 2MHz, 9V–22V input DC/DC converter using the LT3480 delivers 2A at 5V output.



* L1: SUMIDA CDRH4D22/HP-2R2NC

Figure 6. A 2MHz 9V-22V input DC/DC converter using the LT3685 delivers 2A at 5V output.

voltage ripple V_{P-P} is less than 10mV as a result of low ripple Burst Mode operation.

An external signal can drive the RUN/SS pin through a resistor and capacitor to program the LT3480's soft-start, reducing maximum inrush current during start-up. Figure 4 shows the start-up waveform.

2MHz, 9V-22V to 5V, 2A DC/DC Converter with All Ceramic Capacitors

Figure 5 shows a step-down DC/DC converter using all ceramic capacitors. This circuit provides a regulated 5V output at up to 2A from an input of 9V to 22V. The high 2MHz switching frequency allows the use of small inductor and capacitors.

In typical automotive battery-voltage applications, high voltage line transients, such as during a load-dump condition, must be accommodated. The circuit shown in Figure 5 can operate through intermittent high voltage excursions to 60V. This converter is an ideal choice for operation near an AM radio receiver because it operates above the broadcast band and the switching noise can be filtered in a predictable manner. The SYNC pin is tied to output to disable Burst Mode operation in order to eliminate AM band interference. The efficiency of this circuit reaches 85%.

The LT3685, similar to the LT3480 without Burst Mode operation, is also

a good candidate for this application. Figure 6 shows the circuit using the LT3685 for this application.

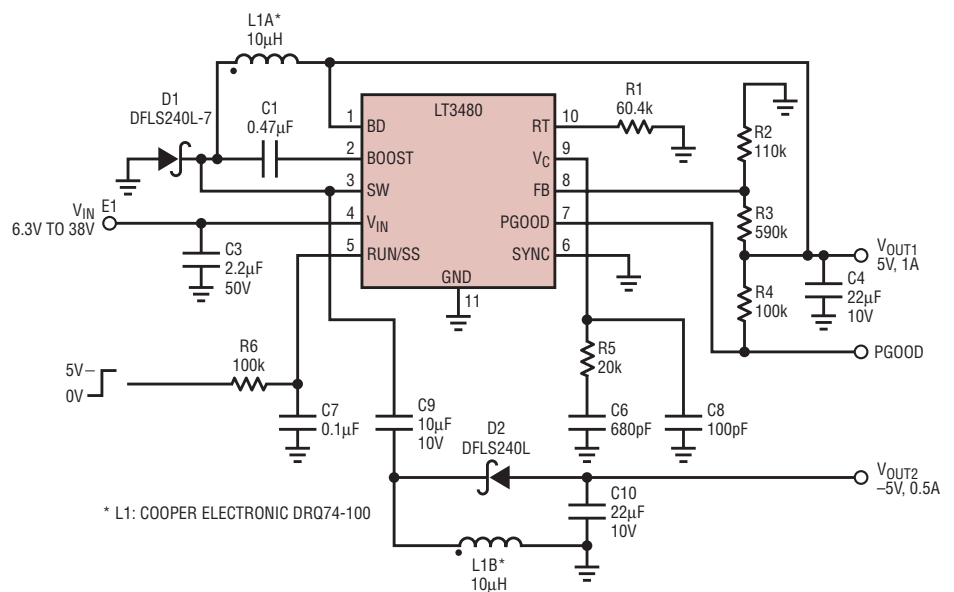
Dual Output Converter

Dual output supplies are required for many applications. The circuit in Figure 7 uses an LT3480 to generate both positive and negative 5V supplies. The two inductors shown are actually two windings on a coupled inductor. The load current on the positive output should be larger than the load on the negative output. With this restriction satisfied, the voltage magnitude of the

negative output tracks the positive output within 5%. For a more complete description of this circuit, see Linear Technology Design Note 100.

Conclusion

The wide input range, low quiescent current, small size and robustness of the LT3480 make it an easy fit in automotive, industrial and distributed power applications. It is highly efficient over the entire load range. Its unique low ripple Burst Mode operation helps to save battery power life while maintaining low output ripple.



* L1: COOPER ELECTRONIC DRQ74-100

Figure 7. A ±5V dual output DC/DC converter. As long as the load on the negative channel is less than the load on the positive channel, the voltage magnitude of the negative output tracks the positive output within 5%.