LINEAR TECHNOLOGY

DESIGN NOTES

36V 2A Buck Regulator Integrates Power Schottky

Design Note 412

David Ng

Introduction

Everyone wants more power in less space. However, the task of designing a power supply is easy to describe but difficult to execute. How does a designer select an optimal set of components that yields the best possible power supply in terms of size, cost and performance? Well, it is easier if the selection is reduced to only a handful of components.

For instance, the LT®3681 reduces parts selection to only a few passive components by integrating all of the power semiconductors necessary to make a buck converter into a single package. Don't think that this high level of integration limits the usefulness of this part. The LT3681 accepts inputs from 3.6V to 34V, provides excellent line and load regulation and dynamic response, and offers a high efficiency solution over a wide load range while keeping the output ripple low during Burst Mode® operation. Furthermore, its frequency is adjustable from 300kHz to 2.8MHz, enabling the use of small, low cost inductors and ceramic capacitors.

A Small, Simple Solution

The LT3681 integrates a wide input voltage range, high performance buck controller, power switch, high side bootstrapping boost diode and a power Schottky diode. All of these attributes are crammed into a tiny but thermally efficient 14-pin 3mm × 4mm DFN package. So, all a designer needs to implement a full-featured buck converter is to add the output LC filter and a few passives.

The most obvious advantage of having the power Schottky diode integrated into the LT3681 is space savings, reducing the amount of board space required by the complete regulator by 15% or more. Moreover, the power Schottky diode has been optimized for the intended operation of the LT3681, so there is no need to agonize over finding the perfect form, fit and function diode for the application. Figure 1 shows a schematic of the LT3681 producing 5V at 2A from an input of 6.3V to 34V and Figure 2 shows the efficiency for a 12V input.

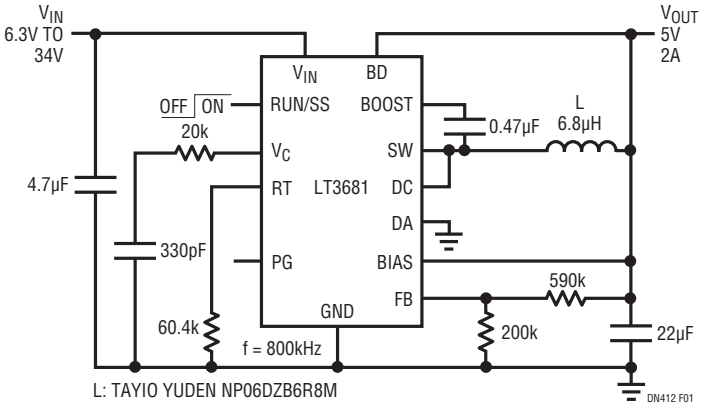

Figure 1. The LT3681 Integrates All of the Power Semiconductors Necessary to Make a Simple 2A Buck Converter

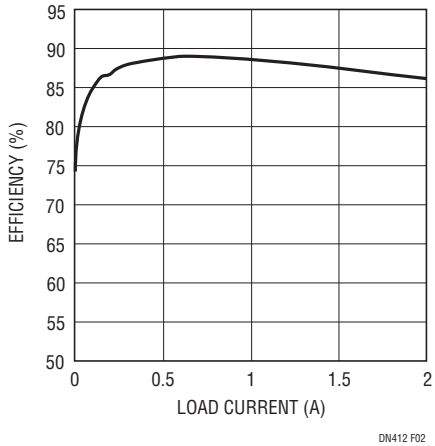

Figure 2. The LT3681 Boasts High Efficiency (12V Input to 5V Output)

Low Ripple and High Efficiency Solution over a Wide Load Range

The LT3681 switching frequency can be programmed from 300kHz to 2.8MHz by using a resistor tied from the RT pin to ground. The LT3681 offers low ripple Burst Mode operation that maintains high efficiency at light loads while keeping the no load output voltage ripple below 15mV$_{P-P}$.

During Burst Mode operation, the LT3681 is able to deliver current in as little as one cycle to the output capacitor followed by sleep periods where all of 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 to only 55µA. As the load current decreases toward no load, the percentage of time that the LT3681 operates in sleep mode increases and the average input current is greatly reduced, so high efficiency is maintained.

Figure 3 shows the low ripple and single cycle burst inductor current at no load for the 3.3V regulator shown in Figures 1 and 2. The LT3681 has a very low shutdown current (less than 1µA), significantly extending battery life in applications that spend long periods in sleep or shutdown mode.

For systems that rely on a well-regulated power source, the LT3681 provides a power good flag that signals when V_{OUT} reaches 90% of the programmed output voltage.

A resistor and capacitor on the RUN/SS pin programs the LT3681's soft-start, reducing the inrush current during start-up. In applications where the circuit is plugged into a live input source through long leads, an electrolytic input capacitor, which has higher ESR than a ceramic capacitor, is recommended to dampen the overshoot voltage. Refer to AN88 for further details.

Frequency Foldback Saves Chips

During short circuit, the LT3681 offers cycle-by-cycle current limit and frequency foldback, which decreases the switching frequency. This increases the off time, reducing the RMS current through the power switch and allowing the inductor current to safely discharge before the next switching cycle begins.

Conclusion

The robust design, small package and high level of integration of the LT3681 make it an excellent choice for a wide variety of step-down applications where a compact footprint and component optimization are critical. The high input voltage rating, high power switch capability and excellent package thermal conductivity adds to its versatility.

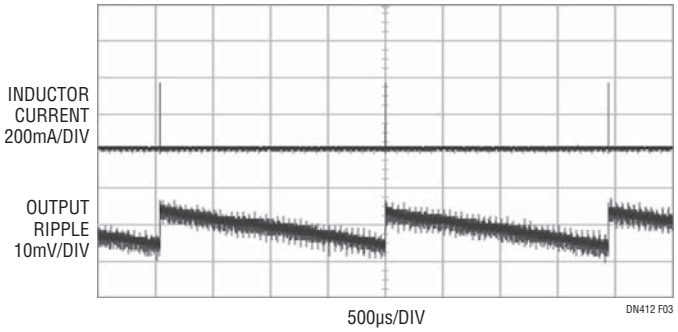

Figure 3. This LT3681 Design Has Only 15mV of Output Ripple, Even at No Load Under Burst Mode Operation

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