Robust DC/DC Step-Down Converter in 3mm × 3mm DFN Resists 60V Input Surges

by Chuen Ming Tan

Introduction

Industrial and test equipment must often run on relatively unregulated 9V-to-24V rails that also support high current and inductive load switching of electromechanical devices. When such devices switch on and off, momentary power surges disrupt power flow, causing voltage fluctuations and large overvoltage spikes on the rail.

The LTC3631, LTC3632 and LTC3642 are robust, monolithic DC/DC step-down solutions that produce a well-regulated supply even in volatile voltage environments. All can operate from a wide input voltage ranges and sustain repetitive 60V surges (see Table 1). The output voltage is immune to large voltage swings in the input (see Figure 1).

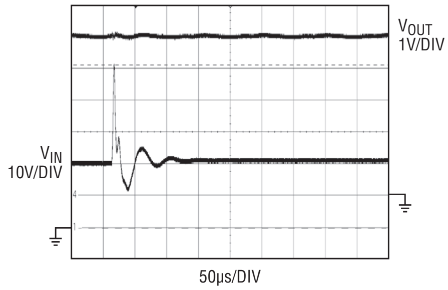

Figure 1. The LTC3642 continues to regulate the output despite a >45V spike on the input.

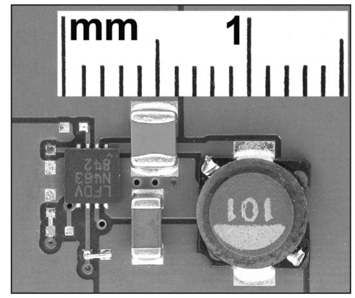

Figure 2. The solution size of LTC3642-3.3/5 in a 3mm × 3mm DFN package

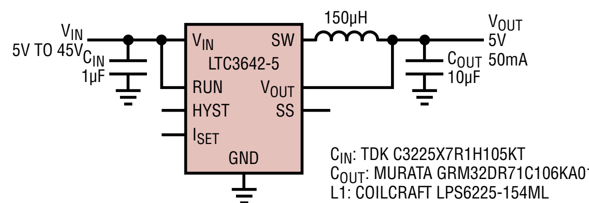

Figure 3. With the LTC3642EDD-3.3/5 only two capacitors and an inductor are required for operation

Compact and Easy to Use

The LTC3642 comes in compact 3mm × 3mm DFN and MS8E packages with integrated MOSFETs, as shown in Figure 2. It is extremely easy to use, requiring no loop compensation. The 3.3V and 5V fixed output versions only need two capacitors and an inductor for operation (see Figure 3).

The constant peak switch current thresholds of these devices inherently protect them from output short circuits. Moreover, each of these devices can reduce its peak switch current threshold such that smaller input and output capacitors can be used.

When operating with a high input voltage source, the LTC3642's RUN pin can be optionally configured to increase its undervoltage lockout (UVLO). Until the input voltage exceeds the UVLO, the input remains disconnected from the load. The RUN pin can be tied directly to the input voltage and can be used together with the hysteresis pin to prevent unwanted UVLO triggering due to noisy input supplies and high voltage coupling in harsh environments. When above the UVLO, the LTC3642 soft starts its output with an internal 0.75ms timer. The duration of the soft-start timer can be increased by adding an external capacitor in the SS pin.

High Efficiency

Unlike a linear regulator, the LTC3642 is a monolithic synchronous buck regulator which does not suffer significant power loss as a result of IR drop between the input and output. High efficiency is also achieved with Burst Mode® operation, which reduces switching activity at light loads to minimize switching losses. Figure 4 shows a fairly constant efficiency curve from light load all the way to full load. During shutdown, this device only draws 3µA even at a maximum input voltage of 45V. With such high efficiency, the LTC3642 is a good fit in battery-operated motorized vehicles,

Table 1. Comparison of monolithic wide input range buck regulators

	LTC3631	LTC3632	LTC3642
Maximum Output Current	100mA	20mA	50mA
Input Voltage Operating Range	4.5V–45V	4.5V–50V	4.5V–45V
Input Voltage Abs Max	60V	60V	60V

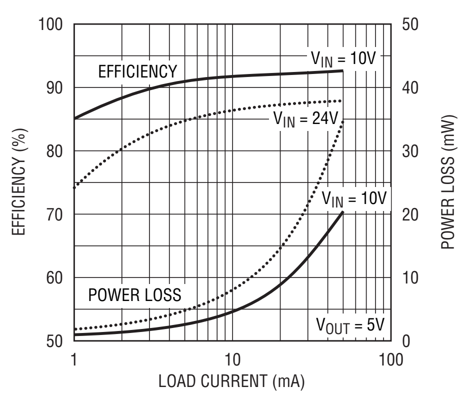

Figure 4. Efficiency for circuit in Figure 3

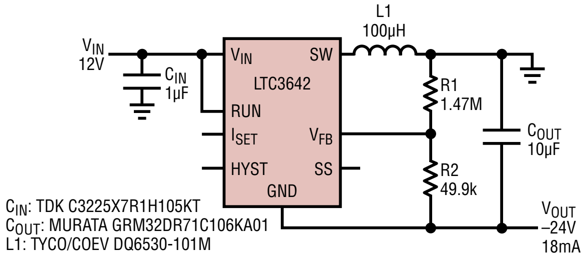

Figure 5. Generating a negative 24V output voltage from a positive 12V input voltage

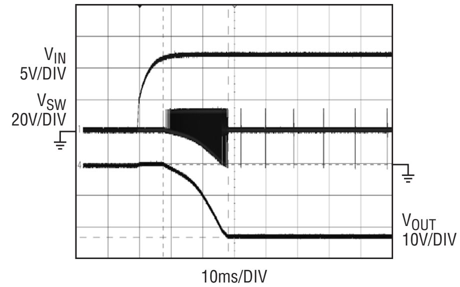

Figure 6. The LTC3642's wide input voltage swing makes it suitable for generating a negative output from positive input voltage.

portable medical instruments and certain automotive applications.

Positive-to-Negative Converter

The LTC3642 can produce a negative output voltage from a positive input voltage without the use of transformers (see Figure 5). In this configuration, the LTC3642 actually operates in an inverting buck-boost mode. Its wide input voltage range, up to 45V, provides sufficient headroom to generate any negative voltage between –0.8V and –40.5V. Figure 6 shows LTC3642 producing a –24V output from a 12V input supply from start-up. The LTC3642 is inherently stable in this configuration with no external compensation components required.

Conclusion

The LTC3642, LTC3631 and LTC3632 are a rugged DC/DC converters for use in applications where a stable voltage output must be produced from poorly regulated high voltage rails. Their compact size and high efficiency make them easy to use in a wide variety of low power applications, including mobile and battery powered devices.

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concern, and extreme accuracy is not paramount. Such applications include clocking microprocessors and microcontrollers, acting as a time base for low speed serial communication protocols such as USB and RS232, digital audio applications, clocking switching power supplies and anywhere a general purpose clock is needed.

Conclusion

When comparing clock power dissipation it is important to consider not just the dissipation of the oscillator itself, but also how the oscillator's features and start-up times effect the dissipation of the entire system. Crystal oscillators not only dissipate more current than other solutions, but can have other start-up and control characteristics that lead to power waste. When the LTC6930's on-the-fly frequency programmability and one-clock-cycle settling time are considered, it is clear that it conserves much more system power than its dissipation specification would indicate

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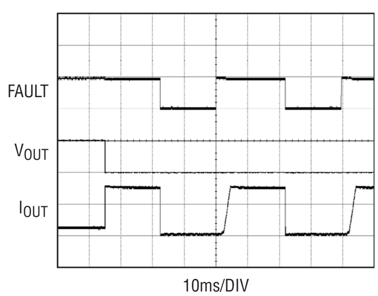
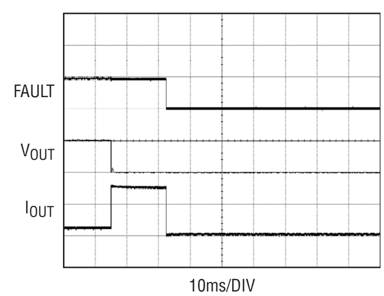
on a pin-selectable setting, the IC can be configured to either periodically attempt to power up (RST pin high, Figure 4a), or remain shut down until power is cycled to the device (RST pin low, Figure 4b). The waveform indicating the fault condition is seen at the Fault pin and is produced by an internal open-drain device whose input is pulled high in the event of a fault. The Fault pin can either be connected to a microprocessor or drive an LED.



4a. RST high: converter attempts power-up every 15ms.



4b. RST low: converter remains shut down until power is cycled.

Figure 4. A fault detection mechanism powers down the converter, providing robustness to output shorts

Conclusion

High conversion efficiency and the ability to detect and handle output shorts make the LTC3529 an ideal solution for either peer-to-peer portable applications or point-of-load board power with robust fault handling. The 1.5MHz switching frequency and highly integrated design of the LTC3529 yield compact solutions with minimal design effort.