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

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).

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

<table>
<thead>
<tr>
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<th>LTC3631</th>
<th>LTC3632</th>
<th>LTC3642</th>
</tr>
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<tbody>
<tr>
<td>Maximum Output Current</td>
<td>100mA</td>
<td>20mA</td>
<td>50mA</td>
</tr>
<tr>
<td>Input Voltage Operating Range</td>
<td>4.5V–45V</td>
<td>4.5V–50V</td>
<td>4.5V–45V</td>
</tr>
<tr>
<td>Input Voltage Abs Max</td>
<td>60V</td>
<td>60V</td>
<td>60V</td>
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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

Figure 4. Efficiency for circuit in Figure 3

by Chuen Ming Tan
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 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.

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

portable medical instruments and certain automotive applications.

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.

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

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