LINEAR TECHNOLOGY

DESIGN NOTES

60V Input Monolithic Converter Powers Critical Circuits without Supercaps or Other Additional Components

Design Note 1040

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Introduction

The LTC3649 is a monolithic step-down regulator capable of operating from an input voltage range of 3.1V to 60V, and efficiently producing a (single) resistor-programmable output voltage at up to 4A of output current. These features alone make it a compelling industrial or automotive supply for output voltages from (V_{IN} – 0.5V) to ground. One unique feature of the LTC3649 is that it is capable of providing power to critical systems when there is a power outage, without any extra components.

Hold-up circuits supply power to critical systems when the main power rail fails, allowing them to perform important housekeeping tasks, such as data retention, for a short period before all available energy

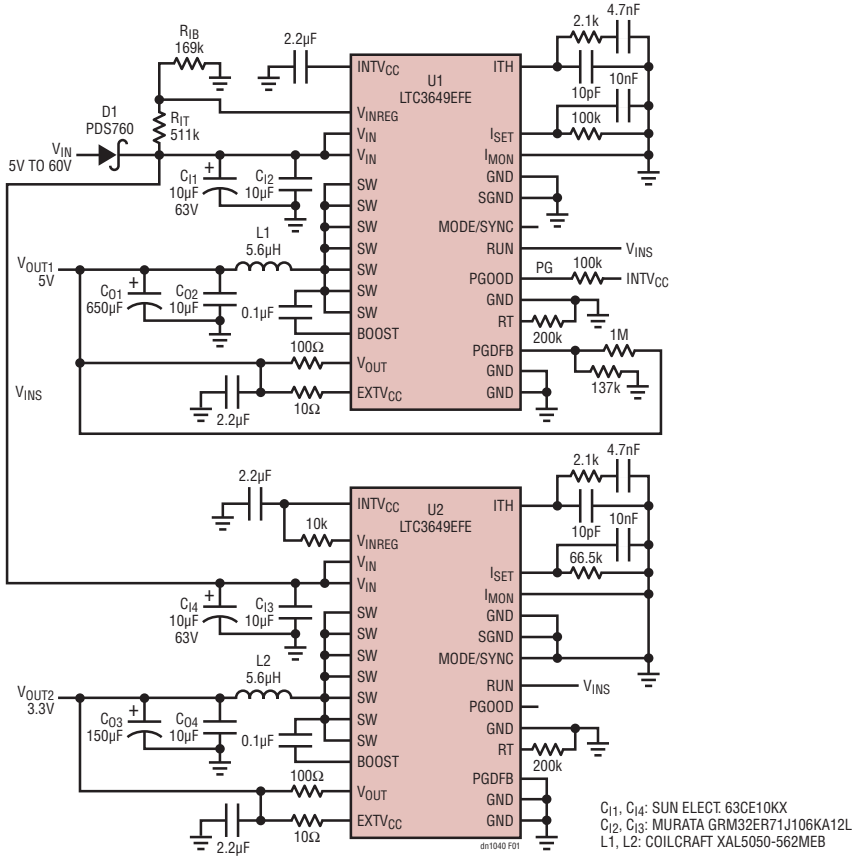

Figure 1. The 5V Output Converter (U1) Provides Hold-Up Power for Protected Load on the 3.3V Output (U2). Note that the Pin MODE/SYNC of U1 Is Left Floating, Allowing the LTC3649 to Enter Boost Mode.

is lost. Typical hold-up solutions employ dedicated controllers and large storage capacitors [1, 2] thus additional cost and complexity is warranted if the critical circuits require significant power and hold-up time. But if the required hold-up energy is relatively low, the LTC3649 can easily perform this task with no additional circuitry.

The dual output converter described herein works as a conventional step-down power supply under normal operating conditions. But during a power interruption, the converter itself becomes the energy source, maintaining the programmed output voltage to critical circuits. To perform this task, U1 becomes a step-up converter when input voltage is disconnected, discharging its output capacitor to provide hold-up energy.

Dual Output Converter and Hold-Up Circuit

Figure 1 shows a hold-up design using the LTC3649. Under normal conditions, the unregulated rail, V_{IN} (V_{INS} via a blocking diode) supplies a converter based on U1 (Converter A). This converter works in buck mode, generating a stable 5V on V_{OUT1}. V_{INS} is connected to a U2-based second converter (Converter B), which supplies 3.3V on V_{OUT2} to a critical load. When V_{IN} fails, Converter A enters boost mode and maintains its programmed output voltage (V_{INS}) by discharging its output filter capacitors C_{O1} and C_{O2}. Resistors R_{IT} and R_{IB} program this voltage level. The PGOOD (PG) signal produced by U1 can be used to communicate the power failure to systems that can disconnect noncritical circuitry to preserve energy. The MODE/SYNC pin is left floating to allow the LTC3649 to enter boost mode.

Figure 2 shows what happens to the LTC3649 in a boost mode. For the first 7ms of the capture, all voltages are stable. At 7ms, the power is turned off; both V_{IN} and V_{INS} begin to decline. When V_{INS} reaches 8V, it stabilizes and the PG signal changes state, signaling

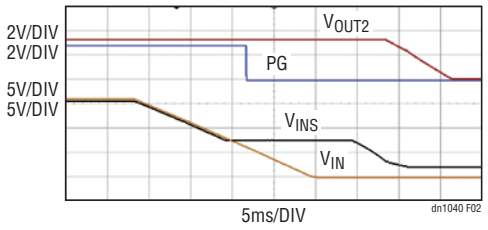

Figure 2. When the Input Voltage V_{IN} Drops, the Converter U1 Boosts V_{OUT1} to Maintain V_{INS} at 8V. V_{INS} Provides Power to Keep V_{OUT2} in Regulation for over 20ms after V_{IN} Drops Out.

the beginning of the V_{OUT1} collapsing. V_{INS} remains at 8V as long as CO1 and CO2 have charge. V_{OUT2} holds constant during the entire process, supplying steady power to the critical load long after the power is interrupted. The LTspice® model of this circuit is available at www.linear.com [3].

Conclusion

LTC3649 is a monolithic step-down regulator with integrated power MOSFETs. It is highly efficient, with low quiescent current, important in many battery-operated systems. It is also highly versatile, with programmable frequency, a wide V_{IN} range up to 60V and an output voltage range down to ground. It simplifies the design of automotive and industrial supplies, especially when its inherent ability as a hold-up circuit is taken into account.

References

1. LTC3110 - 2A Bidirectional Buck-Boost DC/DC Regulator and Charger/Balancer

   http://www.linear.com/product/LTC3110

2. LTC3643 - 2A Bidirectional Power Backup Supply

   http://www.linear.com/product/LTC3643

3. http://www.linear.com/solutions/7412

Data Sheet Download

www.linear.com/LTC3649

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