TECHNICAL ARTICLE

Boost Converter Combines Silent Switcher Technology and Input Disconnect for Performance and Protection

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Abstract

This article introduces a small, powerful, and quiet monolithic synchronous boost converter. It highlights several features of this integrated circuit that enhance its performance and offer customization to meet the requirements of various applications.

Introduction

Traditional synchronous boost converters offer little to no protection against short-circuit events at the output. Due to the boost converter's topology, when the output is shorted to ground, a direct path from input to ground is created, resulting in a large current draw that can be catastrophic to the device. In contrast, this monolithic synchronous boost converter features a short-circuit protection function that can monitor and disconnect the input in the event of a short-circuit, thus protecting the device from potential damage.

The LT8342 integrates 40 V, 9 A power switches with a programmable output voltage of up to 36 V. It also supports a wide 2.8 V to 40 V input voltage range and includes PassThru™ mode operation for conditions when $V_{IN} \geq V_{OUT}$. This integrated circuit (IC) has low V_{IN} pin quiescent current in Burst Mode® operation and can be programmed or synchronized up to 3 MHz, reducing the size of external components and core solution size. The device utilizes Silent Switcher® architecture to minimize electromagnetic interference (EMI) emissions while delivering high efficiency, and it comes in a compact 4 mm × 4 mm LQFN package.

High Performance 24 V, 3 A Supply

Figure 1 shows a 24 V boost application with output short-circuit protection implemented. It can supply a maximum load current of 3 A when the input voltage is above 12 V, and the switching frequency is set to 2 MHz when a 15 kΩ resistor is placed at the RT pin.

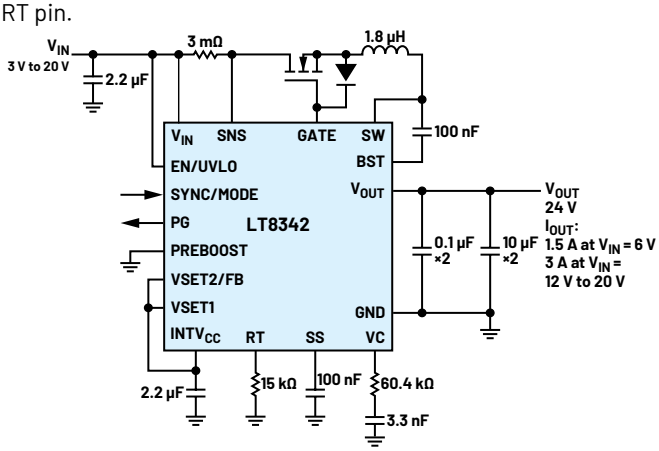

Figure 1. A 2 MHz, 24 V, boost converter with output short-circuit protection.

By configuring the SYNC/MODE pin, this boost converter can operate in either Burst Mode or pulse-skipping mode, depending on the application's needs. Burst Mode provides higher efficiency during light-load conditions, while pulse-skipping mode reduces output ripple. Figure 2 shows the efficiency of the 24 V application operating in Burst Mode when SYNC/MODE = 0 V. Efficiency remains above 70% under light-load conditions and can reach a peak of over 95% at 3 A when the input voltage is 20 V.

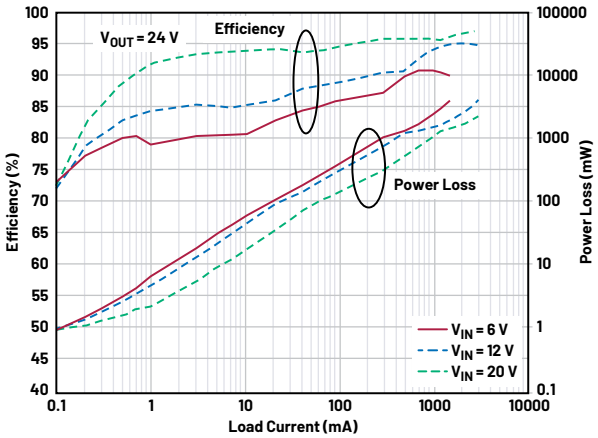

Figure 2. Efficiency and power loss vs. current in Burst Mode (SYNC/MODE = 0 V).

Low I_Q Current

In Burst Mode operation, the LT8342 delivers small single pulses of current to maintain the output voltage, followed by a sleep period. During this sleep period, the V_{IN} pin consumes only 9 µA without short-circuit protection enabled, or 28 µA when short-circuit protection is active. As the load decreases, the device spends a greater percentage of time in sleep mode, improving efficiency at lighter loads. Additionally, when the IC is in shutdown mode, it consumes just 350 nA of input quiescent current.

CISPR 25 Class 5 Emissions Results

This IC features an optional spread spectrum frequency modulation (SSFM) mode, along with the Silent Switcher architecture, to further minimize EMI emissions. When SSFM is enabled by configuring the SYNC/MODE pin, the internal oscillator frequency varies between its programmed value and a value approximately 13% higher. Conducted and radiated EMI results, in accordance with the CISPR 25 Class 5 standards, are shown in figures 3 and 4, respectively. SSFM can also be activated in Burst Mode or pulse-skipping modes to provide both low EMI and high efficiency.

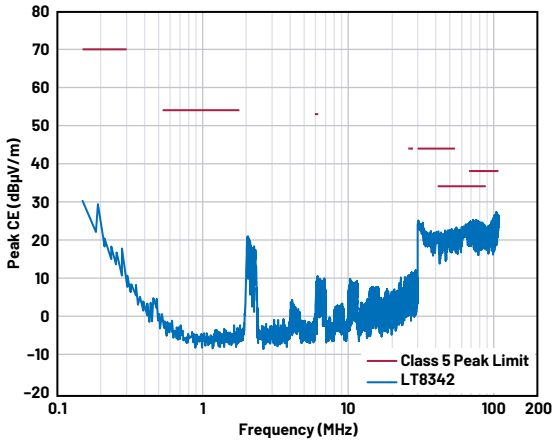

Figure 3. Conducted EMI performance (CISPR 25 Class 5 peak).

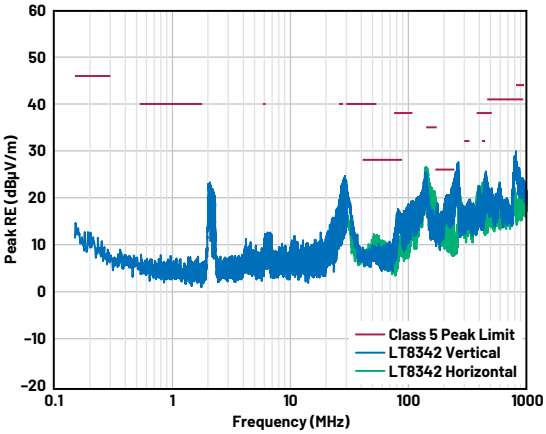

Figure 4. Radiated EMI performance (CISPR 25 Class 5 peak).

Short-Circuit Protection

This converter features an output short-circuit protection mechanism to prevent damage during a short-circuit event. An external sense resistor and an N-channel FET in series with the converter input monitor the current and disconnect the input when necessary. When the current through the sense resistor rises high enough to trigger the voltage threshold of the internal comparator, the IC pulls the GATE pin to ground, turning off the external FET and limiting the short-circuit inductor current. The waveforms in figures 5 and 6 illustrate the typical response of the IC during a short-circuit event at the output.

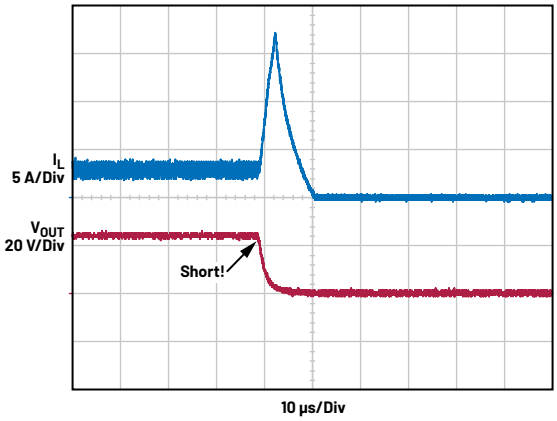

Figure 5. Output short-circuit protection.

An internal hiccup timer counts for 40 ms before turning the external FET back on. If the short persists, the input disconnect will reactivate when the current sense is triggered.

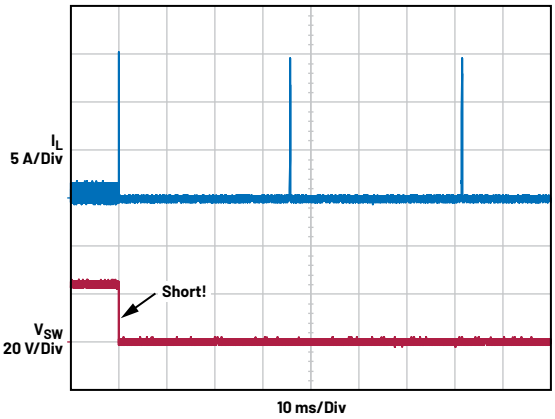

Figure 6. Hiccup during output short-circuit.

PassThru Mode Operation

The LT8342 is an excellent choice for automotive preboost applications where the input voltage of the boost converter is typically above the regulated output voltage. When this condition occurs, the IC enters PassThru mode. The top internal synchronous power switch remains on at 100% duty cycle, while the bottom switch stays off, creating a direct path from the input to the output. The device also enters a low quiescent current state, drawing 12 µA when short-circuit protection is not enabled, or 26.5 µA with the external input disconnect FET. Figure 7 shows a preboost application for stop-start and cold crank, and Figure 8 illustrates its operation when PassThru mode is active.

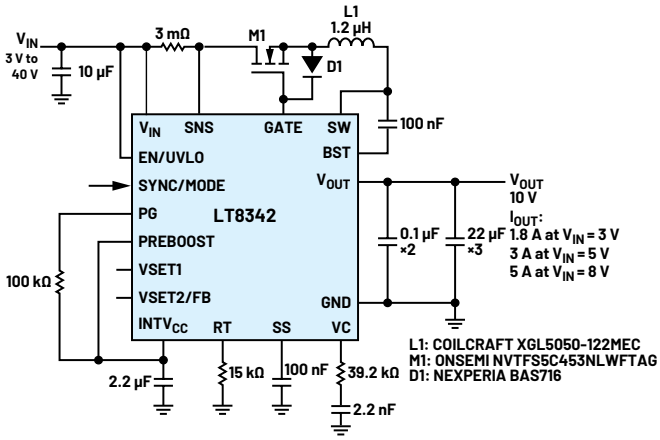

Figure 7. Automotive 2 MHz preboost converter for stop-start and cold crank with 10 V output and short-circuit protection.

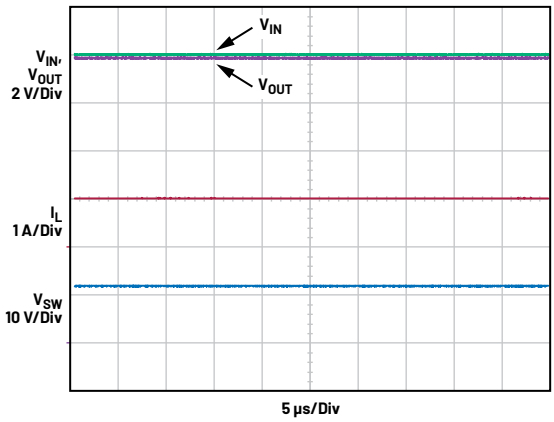

Figure 8. PassThru mode operation, V_{IN} = 12 V, I_{LOAD} = 1 A.

Conclusion

The LT8342 offers a range of features that deliver low noise, low input current, high efficiency, and circuit protection, all in a compact package. With a wide input and output range, programmable switching frequency, low noise, and PassThru mode, this device is ideal for general boost and automotive preboost applications. Burst Mode operation and low input quiescent current enable light-load efficiencies that exceed those of typical boost converters.

About the Author

Michael Wu is a product applications engineer at Analog Devices, Inc. He works in the High Performance Power (HPP) Group, focusing on monolithic buck, boost, and buck-boost topologies. He earned his B.S. and M.S. degrees in electrical engineering from California Polytechnic State University, San Luis Obispo.