42 V, 2 A/3 A Peak Synchronous Step-Down Regulators with 2.5 µA Quiescent Current and Ultralow EMI Emission

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Introduction

The LT8609, LT8609A, LT8609B, and LT8609S are synchronous monolithic step-down regulators that feature a wide 3 V to 42 V input range. This device family is optimized for applications requiring low EMI, high efficiency, and a small solution size—suitable for demanding automotive, industrial, computing, and communications applications. All regulators in this series have the same 2 A continuous, 3 A transient (<1 second) load current capability. Their features are summarized in Table 1.

The LT8609, LT8609A, and LT8609S feature 2.5 µA ultralow quiescent current, which is important for battery-powered systems. With integrated top and bottom N-channel MOSFETs, the regulators exhibit impressive light load efficiency. The LT8609B operates in pulse-skipping mode only, with higher quiescent current than the other devices, and it offers lower ripple during light load operation.

All of these devices can pass CISPR 25 Class 5 radiated EMI regulation, the most rigorous EMI standard for automotive equipment. Furthermore, the LT8609, LT8609A, and LT8609S feature spread spectrum frequency operation to reduce EMI peaks. The LT8609S displays the most impressive EMI performance in this family, based on its proprietary Silent Switcher® 2 technology, described below.

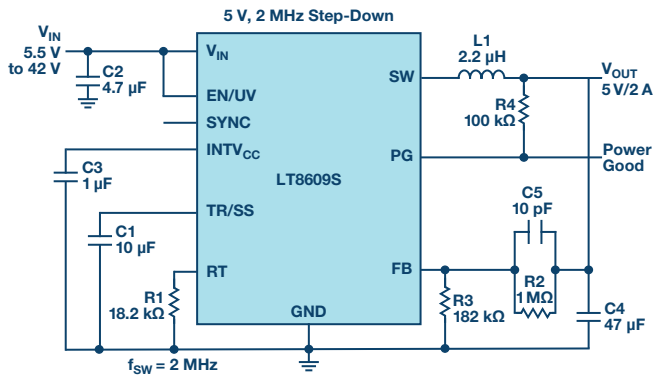

Figure 1. Ultralow EMI emission LT8609S 12 V to 5 V synchronous step-down converter.

5.5 V to 42 V Input, Low EMI, High Efficiency 5 V, 2 A Supply

A 5.5 V to 42 V input to 5 V/2 A output power supply is shown in Figure 1. This solution features a 16-lead LT8609S regulator with a 2 MHz switching frequency. Only a few components are required for the complete solution, including inductor L1 and a few passive components. Figure 2 shows that this solution can achieve 92.9% peak efficiency.

Burst Mode Operation to Improve Light Load Efficiency

During light load operation and no-load standby mode, high efficiency and low idle current are important for battery-powered applications. The LT8609, LT8609A, and LT8609S feature a low 2.5 µA quiescent current in Burst Mode® operation. During light load and no-load conditions, the switching frequency is gradually reduced, greatly reducing power loss while keeping the output voltage ripple relatively low. Figure 2 shows that light load efficiency remains above 85% while the power loss approaches zero at minimal loads.

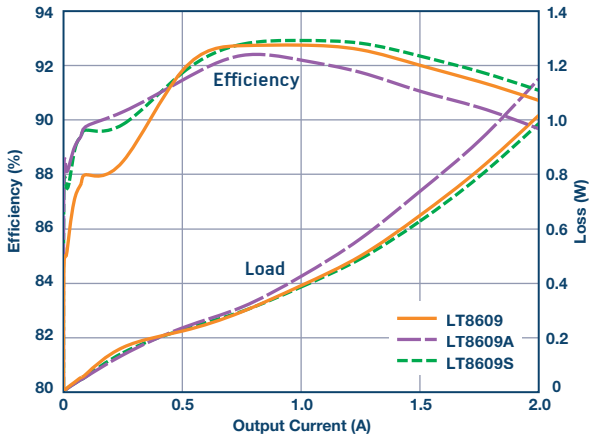

Figure 2. Efficiency vs. load current for LT8609/LT8609A/LT8609S-based 12 V_{IN} to 5 V_{OUT} step-down converter.

High Switching Frequency with Ultralow EMI Emission and Improved Thermal Performance

EMI compliance is a concern in a number of environments, including automotive systems. With integrated MOSFETs, advanced process technology, and up to 2.2 MHz operation, all of the devices in this family can achieve a small solution size while satisfying the most stringent EMI standards. Spread spectrum frequency operation, which reduces EMI peaks, is available in all but the LT8609B. Furthermore, the LT8609S incorporates Silent Switcher 2 technology. Silent Switcher 2 devices feature integrated hot loop and warm loop caps to make EMI performance insensitive to board layout and the number of board layers. A board with fewer layers can be used to reduce manufacturing costs without sacrificing EMI and thermal performance.

Figure 2 shows that the LT8609S features the best peak and full load efficiency of the device family. Figure 3 and Figure 4 show a CISPR 25 EMI and thermal performance comparison of the Figure 1 solution on 2- and 4-layer boards.

Conclusion

The devices in the LT8609 family are easy to use monolithic step-down regulators with integrated power MOSFETs and built-in compensation circuits. They are optimized for applications with wide input voltage range and low EMI noise requirements. Low, 2.5 µA quiescent current and Burst Mode operation make them excellent battery-powered step-down converter solutions. A 200 kHz to 2.2 MHz switching frequency range make them suitable for most low power to micropower applications. Integrated MOSFETs and up to 2.2 MHz switching frequency capability minimize solution size. CISPR 25 scanning results show excellent radiated EMI performance, compliant with the most stringent EMI standards. Silent Switcher 2 technology in the LT8609S makes its performance immune to layout and layer changes, which greatly reduces development and manufacturing costs.

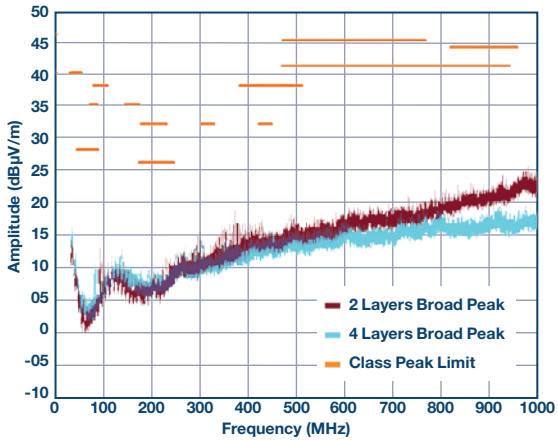

Figure 3. CISPR 25 radiated EMI performance comparison between 2- and 4-layer boards for the circuit in Figure 1.

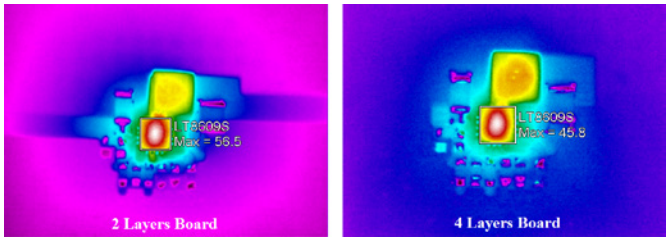

Figure 4. Thermal performance comparison between 2- and 4-layer boards for the circuit in Figure 1.

Part	Package	Performance	Operation Mode
LT8609	10-lead MSE	High efficiency	Burst Mode operation, pulse-skipping mode, spread spectrum mode, sync mode
LT8609A	10-lead MSE	Optimized for both efficiency and EMI performance	Burst Mode operation, pulse-skipping mode, spread spectrum mode, sync mode
LT8609B	10-lead MSE	High efficiency	Pulse-skipping mode
LT8609S	16-lead LQFN	Silent Switcher 2 technology incorporated with best efficiency and EMI performance	Burst Mode operation, pulse-skipping mode, spread spectrum mode, sync mode

About the Author

Dong Wang is a senior applications engineer for power products at Analog Devices who began his career at Linear Technology (now part of ADI) in 2013. He currently provides applications support for nonisolated monolithic step-down converters. Dong Wang has broad interests in power management solutions and analog circuits, including high frequency power conversion, distributed power systems, power factor correction techniques, low voltage, high current conversion techniques, high frequency magnetic integration, and modeling and control of converters. Dong Wang graduated from Zhejiang University in Hangzhou, China with a Ph.D. in electrical engineering. He can be reached at *dong.wang@analog.com*.

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