42 V Monolithic Synchronous Step-Down Regulators with 2.5 µA Quiescent Current and Ultralow EMI

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Introduction

High efficiency, low EMI step-down regulators are found throughout automotive, industrial, medical, and telecom environments, where they power a wide variety of applications from a broad array of input sources. Particularly in battery-powered applications, a significant amount of time is spent in standby mode, requiring all electrical circuits to operate with a low quiescent current in order to preserve battery run times.

The LT8606/LT8607/LT8608 are a series of monolithic step-down regulators optimized for applications with a wide input voltage range, low EMI levels, and small solution sizes. All share the same thermally enhanced 10-lead MSE package and 8-lead 2 mm × 2 mm DFN package, enabling them to fit into tight spaces. They differ in their output current capabilities, as shown in Table 1.

The low I_Q of the LT8606/LT8607/LT8608 is indispensable in battery-powered applications where idle current must be kept low. They feature a Burst Mode® option, which consumes only 2.5 µA quiescent current from the input source even while regulating the output voltage, maintaining battery standby time for as long as possible. The 3 V to 42 V wide input voltage range satisfies the demanding requirements of industrial and automotive applications, which are distinguished by their lack of stable, high quality voltage sources. The devices come in the 10-lead MSE package and also include spread spectrum operation to meet ultralow EMI emission requirements.

Table 1. LT860x Family Feature Comparison

Part Number	Current Level	Package	Operation Mode
LT8606	350 mA	10-lead MSE	Burst Mode operation; pulse-skipping mode; spread spectrum mode; sync mode
		8-lead DFN	Burst Mode operation only
LT8607	750 mA	10-lead MSE	Burst Mode operation; pulse-skipping mode; spread spectrum mode; sync mode
		8-lead DFN	Burst Mode operation only
LT8608	1.5 A	10-lead MSE	Burst Mode operation; pulse-skipping mode; spread spectrum mode; sync mode
		8-lead DFN	Burst Mode operation only

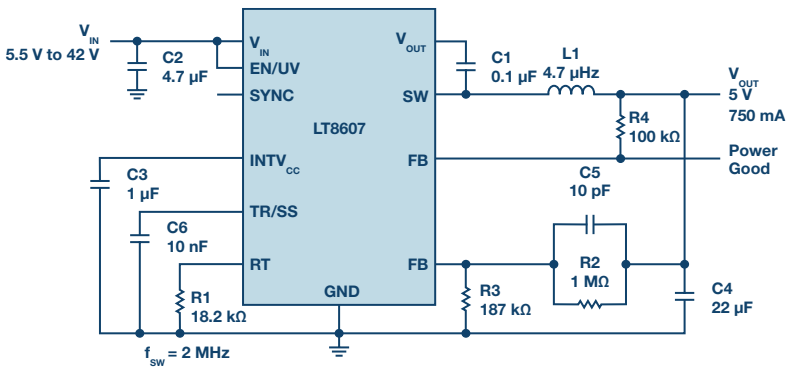

Figure 1. High efficiency LT8607 12 V to 5 V synchronous step-down converter.

Circuit Description and Functionality

Figure 1 shows a 5 V output power supply based on the 10-lead LT8607 regulator. The input voltage extends up to 42 V and the output is set to 5 V at 750 mA with 2 MHz switching frequency. Only a few additional components are required for the complete solution, including inductor L1 and a few passive components. Figure 2 shows that this circuit can achieve 92.5% peak efficiency.

Burst Mode Operation Improves Light Load Efficiency

During light load operation and no-load standby mode, high efficiency and low idle current are very important for battery-powered applications. The LT8606/LT8607/LT8608's 2.5 µA quiescent current and Burst Mode operation option are perfect solutions for these requirements. During light load and no-load conditions, an LT8606/LT8607/LT8608-based converter gradually reduces the switching frequency, which reduces switching power losses while maintaining low output voltage ripple. Figure 3 shows the light load efficiency of the solution shown in Figure 1.

High Switching Frequency with Ultralow EMI Emission

In addition to efficiency, EMI/EMC compliance is demanded in automotive, industrial, computational, and telecom environments. A higher switching frequency allows a smaller solution size, but often at the cost of increased EMI emission. The LT8606/LT8607/LT8608's integrated MOSFETs, built-in compensation circuit, and 2.2 MHz operation minimize solution size, but they also achieve excellent EMI performance, due to advanced process technology. Spread spectrum mode operation of the switching frequency can further reduce EMI emissions. Figure 4 shows the CISPR 25 EMI test result of the solution shown in Figure 1.

Conclusion

The LT8606/LT8607/LT8608 are easy to use monolithic step-down regulators with integrated power MOSFETs and built-in compensation. They are optimized for applications with wide input voltage ranges and low EMI noise requirements. Their 2.5 µA quiescent current and Burst Mode operation option makes them ideal solutions for battery-powered step-down converters, significantly extending battery standby times. The 200 kHz to 2.2 MHz switching frequency range makes them suitable for most low power to micropower applications. Integrated MOSFETs, together with up to 2.2 MHz switching frequency ability, greatly minimize the total solution size. CISPR 25 scanning results show their excellent radiated EMI performance, making them compliant with the most stringent EMI standards.

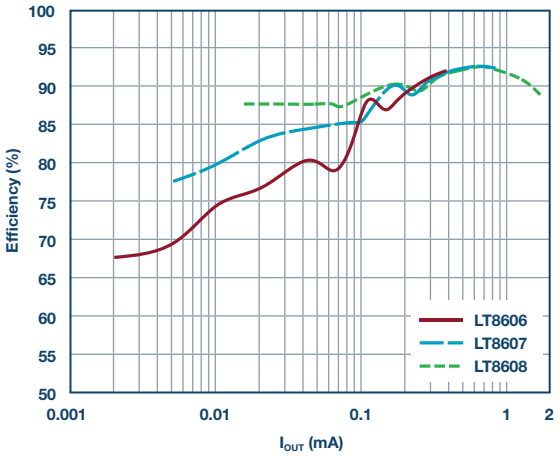

Figure 2. Efficiency vs. load current for LT8606/LT8607/LT8608-based 12 V_{IN} to 5 V_{OUT} step-down converter.

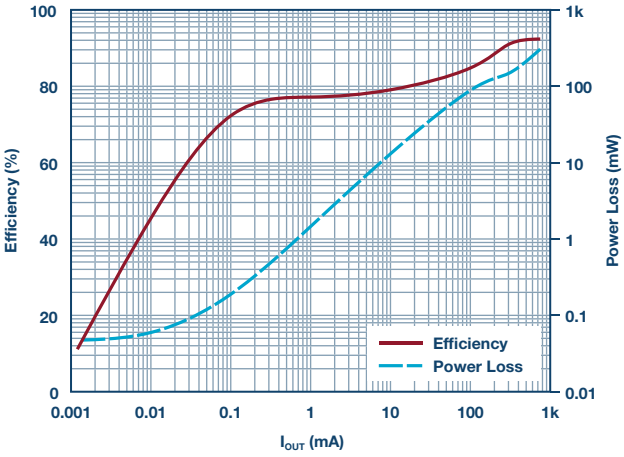

Figure 3. Efficiency and power loss vs. load current for the circuit in Figure 1.

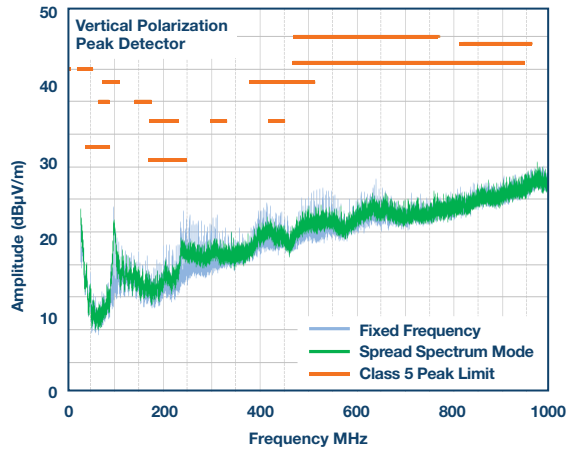

Figure 4. CISPR 25 radiated EMI performance for the circuit in Figure 1.

About the Author

Dong Wang is a senior applications engineer for the Power by Linear™ Group who began his career at Linear Technology (now part of Analog Devices) 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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