Monolithic 65 V, 8 A Step-Down Regulators with Fast Transient Response and Ultralow EMI Emissions

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Introduction

The LT8645S and LT8646S are 65 V synchronous step-down monolithic regulators capable of supporting 8 A outputs. Their Silent Switcher® 2 architecture enables exceptional EMI performance regardless of layout. The LT8646S features RC external compensation to optimize transient responses.

Wide Input Range and High Output Current Monolithic Solution

When designing buck converters for 48 V bus systems, power supply engineers are inclined to choose controller solutions (external MOSFETs) over much smaller monolithic regulators (internal MOSFETs), since few monolithic regulators are able to handle such high input voltages and most are limited to output currents less than 5 A. The LT8645S/LT8646S monolithic regulators break this mold.

The LT8645S/LT8646S's 65 V input, high current monolithic Silent Switcher 2 buck regulators take a wide input voltage range of 3.4 V to 65 V and support output currents up to 8 A. Figure 1 shows a complete 12 V output at 8 A with the LT8645S solution. The LT8645S uses internal compensation, which reduces the number of external components and simplifies the design. The integration of the bypass capacitors further minimizes total solution size. Figure 2 shows the efficiency of this solution reaching 97%.

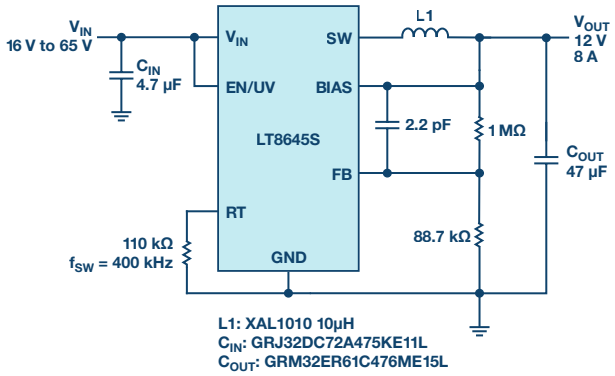

Figure 1. 12 V, 8 A application using LT8645S at 400 kHz.

Fast Transient Response and Ultralow EMI

Only two external components, one resistor and one capacitor at the V_C pin, are required to optimize the LT8646S's transient response for a particular application. Figure 3 shows a 5 V at 8 A output LT8646S solution, and Figure 4 shows the load transient response with optimized compensation.

In this solution, the switching frequency is set to 2 MHz, which allows for the use of a small, 1 µH inductor. The LT8645S/LT8646S can also safely tolerate a saturated inductor during overload or short-circuit conditions due to the high speed peak current-mode architecture. Therefore, the inductor does not need to be oversized to account for overcurrent transients, unless long duration overloads or short-circuits need to be prevented.

Both the LT8645S/LT8646S use a Silent Switcher 2 architecture, which combines the split hot-loop and integrated bypass capacitors. As a result, EMI performance is not sensitive to layout, which relieves the engineer of this design concern in applications requiring ultralow EMI. Figure 5 shows the CISPR 25 radiated EMI test results using the solution shown in Figure 3. With a ferrite bead and capacitor filter, the circuit can pass stringent CISPR 25 Class 5 limits.

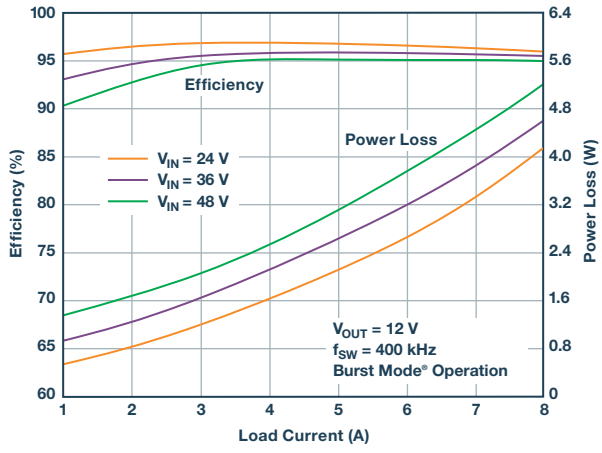

Figure 2. LT8645S 12 V/8 A output efficiency of the Figure 1 design.

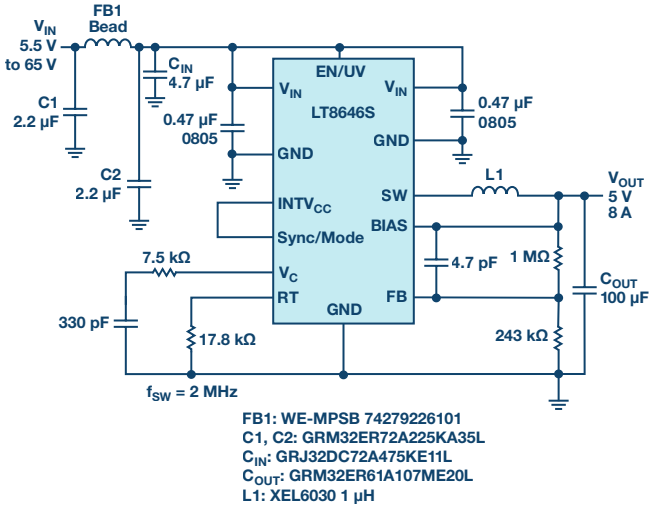

Figure 3. An ultralow EMI LT8646S 5 V, 8 A step-down converter with spread spectrum mode enabled.

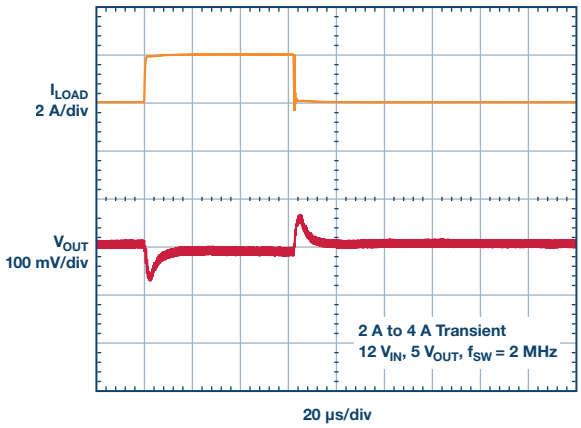

Figure 4. LT8646S 12 V to 5 V, 2 A load step transient of the design in Figure 3 (f_{SW} = 2 MHz).

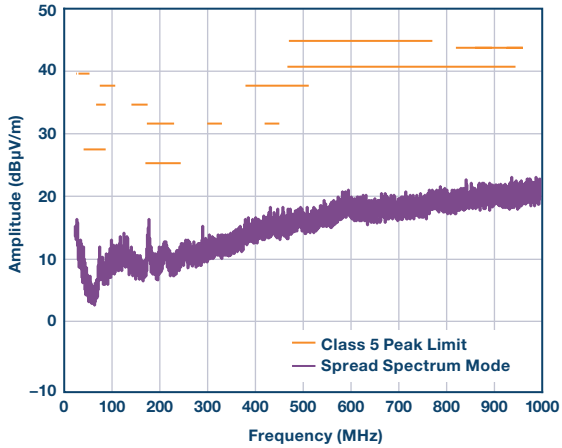

Figure 5. LT8646S CISPR 25 radiated emission test of the Figure 3 design (14 V input to 5 V output at 4 A, f_{SW} = 2 MHz).

Small Minimum On-Time and High Step-Down Ratio

The LT8645S and LT8646S feature a minimum on-time of only 40 ns, enabling them to support high step-down ratios, even at a high 2 MHz switching frequency. For example, converting 48 V to 5 V at 2 MHz requires 52 ns of on-time, which is unattainable by most converters. This step-down ratio would typically require an engineer to settle on a two-stage converter (with an intermediate voltage), but the LT8645S and LT8646S monolithic regulators can perform this conversion stand-alone, which reduces power supply size and complexity.

Figure 6 shows a 1.8 V at 8 A output solution for inputs to 30 V, using the LT8645S operating at 1 MHz switching frequency. The input can go up to the absolute maximum rating of 65 V, if skipping switch cycles is acceptable. When the output is lower than 3.1 V, the BIAS pin of LT8645S can be connected to an external source higher than 3.1 V (that is, 3.3 V or 5 V), to improve efficiency.

Conclusion

LT8645S and LT8646S 8 A synchronous, ultralow EMI monolithic switching regulators are available in a small 6 mm × 4 mm LQFN package. The patented Silent Switcher 2 architecture offers remarkably low EMI emissions, high efficiency, and a compact solution footprint. Inputs can be as high as 65 V. Their 40 ns minimum on-time enables high step-down ratios for direct low voltage outputs, without requiring two-stage conversion.

About the Author

Ying Cheng is a senior applications engineer in Power Products. She graduated from Missouri University of Science and Technology (formerly University of Missouri-Rolla) with a Ph.D. degree in electrical engineering. She has been with Linear Technology (now part of Analog Devices) for six years working on dc-to-dc switching regulators and LDO regulators. She can be reached at *ying.cheng@analog.com*.

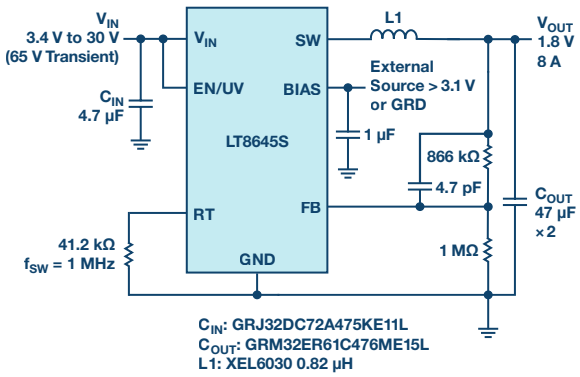

Figure 6. LT8645S 1 MHz 1.8 V/8 A application operates through 65 V input transients.

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