

Design Note

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

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Introduction

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

Wide Input Range and High Output Current Monolithic Solution

When designing buck converters for 48V 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 5A. The LT8645S/LT8646S monolithic regulators break this mold.

The LT8645S/LT8646S's 65V input, high current monolithic Silent Switcher 2 buck regulators take a wide input voltage range of 3.4V to 65V, and supports output currents up to 8A. Figure 1 shows a complete 12V output at 8A with the LT8645S solution. The LT8645S uses

internal compensation, reducing the number of external components and simplifying the design. The integration of the bypass capacitors further minimizes total solution size. Figure 2 shows the efficiency of this solution reaching 97%.

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 5V at 8A output LT8646S solution, and Figure 4 shows the load transient response with optimized compensation.

In this solution, the switching frequency is set to 2MHz, allowing the use of a small, 1μH 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.

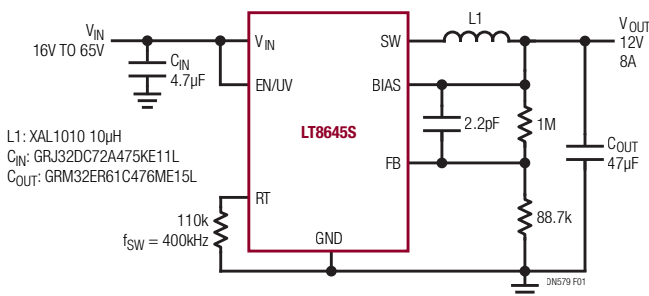


Figure 1. 12V, 8A Application Using LT8645S at 400kHz

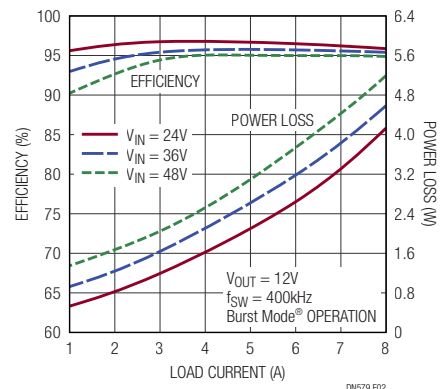


Figure 2. LT8645S 12V/8A Output Efficiency of the Figure 1 Design

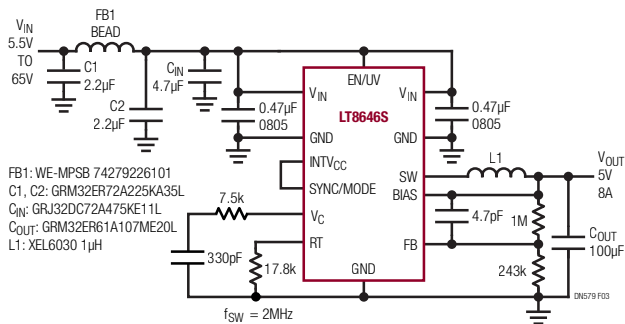


Figure 3. Ultralow EMI LT8646S 5V, 8A Step-Down Converter with Spread Spectrum Mode Enabled

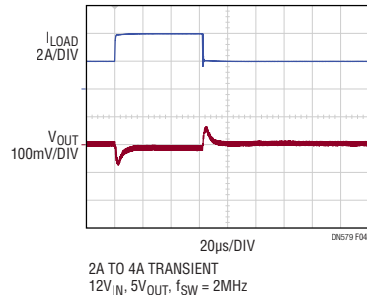


Figure 4. LT8646S 12V to 5V, 2A Load Step Transient of the Design in Figure 3 ($f_{SW} = 2\text{MHz}$)

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, relieving 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.

Small Minimum On-Time and High Step-Down Ratio

The LT8645S and LT8646S feature a minimum on-time of only 40ns, enabling them to support high step-down ratios, even at a high 2MHz switching frequency. For example, converting 48V to 5V at 2MHz requires 52ns of on-time, 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 8646S monolithic regulators can

perform this conversion standalone, reducing power supply size and complexity.

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

Conclusion

LT8645S and LT8646S 8A synchronous ultralow EMI monolithic switching regulators are available in a small 6mm × 4mm 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 65V. Their 40ns minimum on-time enables high step-down ratios for direct low voltage outputs, without requiring two-stage conversion.

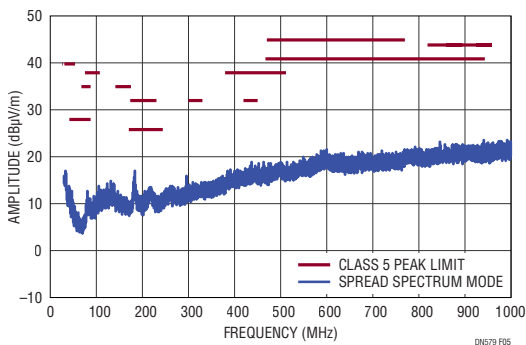


Figure 5. LT8646S CISPR 25 Radiated Emission Test of the Figure 3 Design. (14V Input to 5V Output at 4A, $f_{SW} = 2\text{MHz}$)

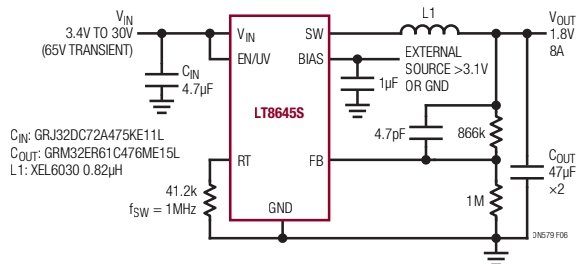


Figure 6. LT8645S 1MHz 1.8V/8A Application Operates through 65V Input Transients

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