Dual-Channel, 42 V, 2 A, Monolithic, Synchronous, Step-Down Silent Switcher 2 Device with 6.2 µA Quiescent Current

Tao Tao, Applications Engineer

The LT8653S is a dual-channel, 2 A, synchronous step-down regulator with a 3 V-to-42 V input voltage range. Silent Switcher® 2 technology enables the LT8653S to simultaneously operate at high frequency and high efficiency with exceptional EMI performance—meeting the demanding requirements of automotive, industrial, computing, and communications environments.

The LT8653S packs two independent regulator channels into a thermally enhanced 3 mm × 4 mm package. Each channel can concurrently supply 2 A of continuous output current, and up to 3 A of current in pulsed load applications. The LT8653S supports Burst Mode® operation, requiring only 6.2 µA of quiescent current with both outputs in regulation, a critical feature for battery-powered systems.

The LT8653S also offers forced continuous mode and spread spectrum frequency modulation (SSFM) operation. SSFM mode lowers peak emissions around the fundamental operating frequency and harmonics by spreading the energy over a wider range of the spectrum.

The LT8653S offers the option of external compensation, which can be used to optimize transient response; alternatively, internal compensation can be used for simplicity. Fixed output options are available with two output voltage select pins that can generate 5 V, 3.3 V, and 1.8 V outputs while eliminating the need for external feedback resistors.

Dual 2 A Regulator with Low EMI and High Efficiency

Figure 1 shows a dual output step-down regulator application with low EMI and high efficiency using the LT8653S. The input voltage range is from 5.8 V to 42 V, and the outputs are 5 V/2 A and 3.3 V/2 A. The switching frequency is programmed at 2 MHz. The internal regulator is supplied from the 3.3 V output through the BIAS pin for lower power dissipation. Burst Mode operation is enabled—SYNC/MODE tied to GND—to optimize efficiency at light load.

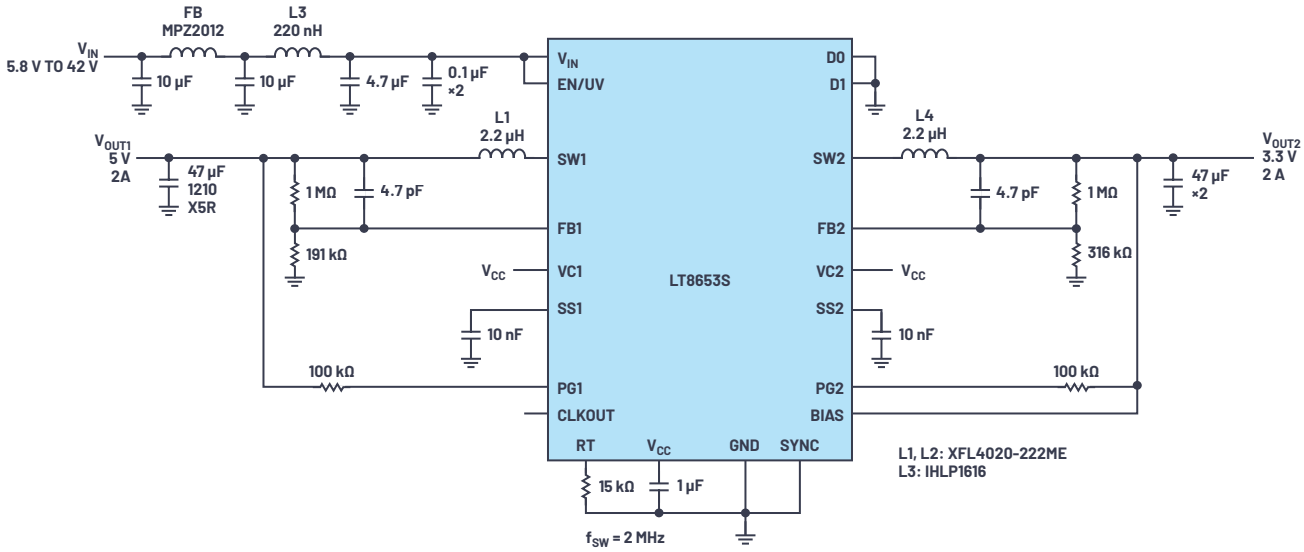

Figure 1. Wide input range, dual-channel, 2 A step-down regulator with high efficiency and low EMI.

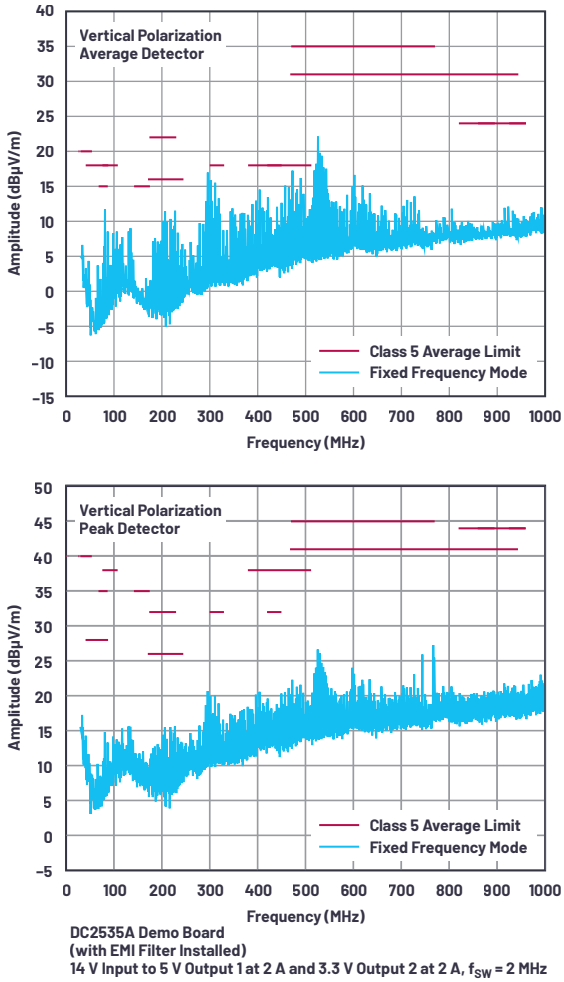

Figure 2. CISPR 25 radiated emission for the circuit shown in Figure 1.

Figure 2 shows the radiated EMI of the regulator in the design of Figure 1, which meets the stringent automotive CISPR 25 Class 5 radiated EMI specification. With LT8653S's switching frequency at 2 MHz, the regulator's peak efficiency at 12 V input and 5 V output reaches 94.8%, and at 24 V input and 5 V, the output only reaches 92.1%.

Internal or External Loop Compensation

To minimize component count, the LT8653S includes internal loop compensation, suitable for most systems—external compensation can be used to minimize output voltage excursions and transient response time for designs requiring optimized load transient performance. Figure 3 shows a dual output regulator designed to optimize the transient response.

Figure 4 shows the 5 V output (V_{OUT1}) responding to a 0 A to 2 A load step. In this case, V_{OUT} deviates less than 80 mV. This fast transient response can be combined with the LT8653S's high initial accuracy to meet tight V_{OUT} tolerance requirements.

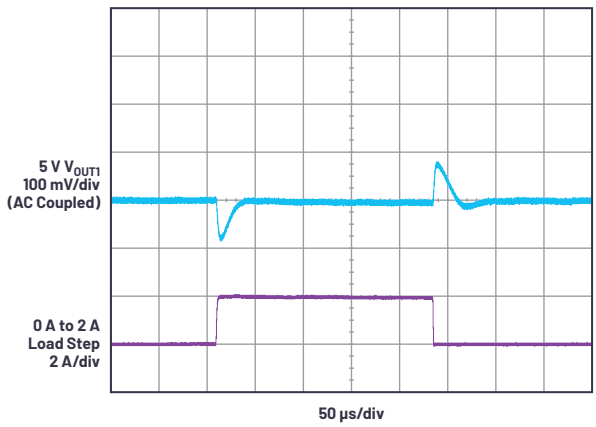

Figure 4. 0 A to 2 A load transient response for the 5 V rail in the circuit in Figure 3.

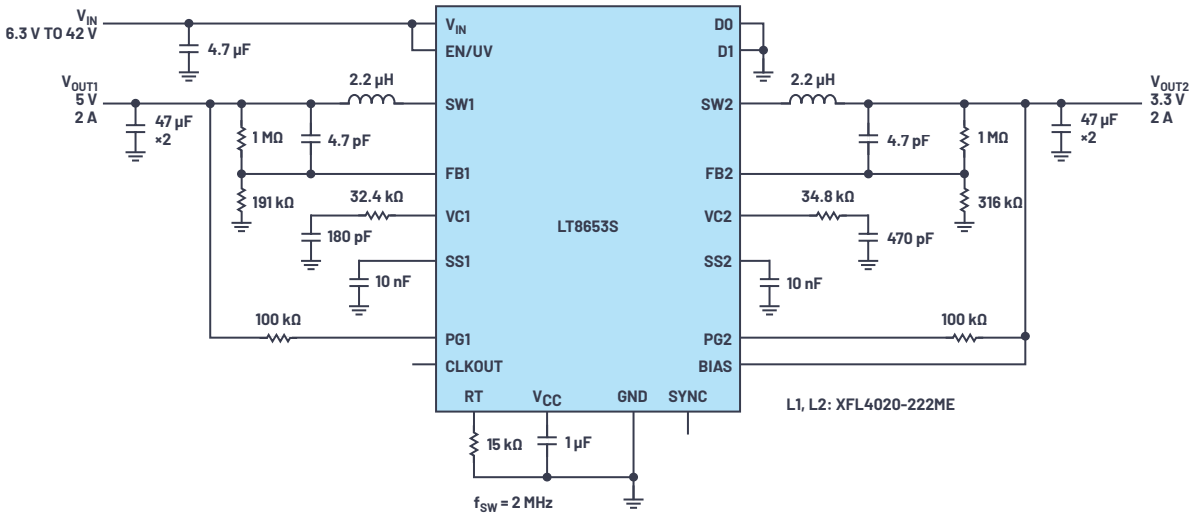

Figure 3. 5 V/2 A and 3.3 V/2 A outputs with fast load transient response.

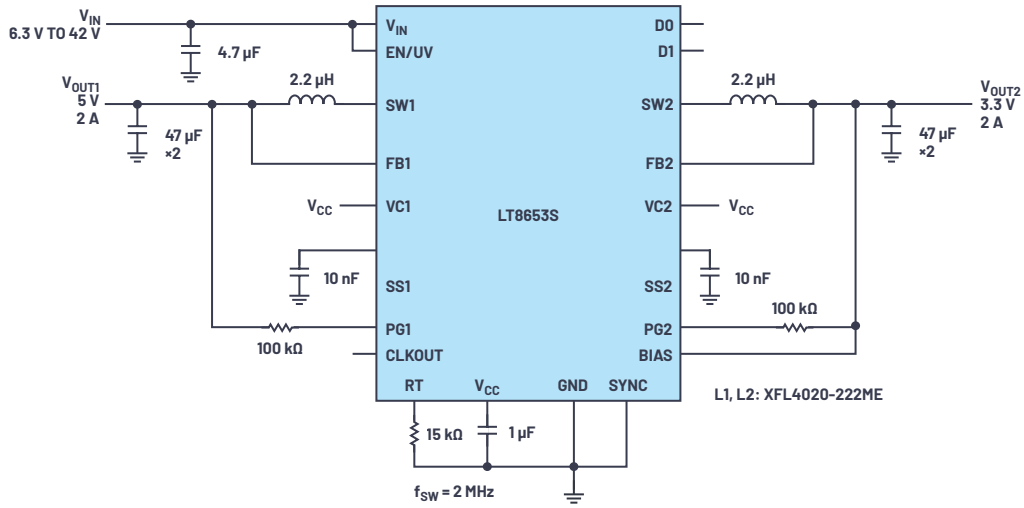

Figure 5. Low part count, dual-channel, 2 A step-down regulator solution.

Fixed Output Voltage Option

Further reductions in component count can take advantage of the LT8653S's output voltage select pins, DO and D1, eliminating the need for external resistors to set the LT8653S output voltage. Depending on the DO and D1 pin combinations selected, an internal feedback resistor divider is enabled, and the FB pin can be connected directly to V_{OUT} to regulate a 5 V, a 3.3 V, or a 1.8 V output. By eliminating the need for an external resistor network, the overall solution can be very small.

The total resistance of the internal feedback resistor divider is 12 MΩ, so no-load quiescent current is well below what is feasible with external resistor dividers. The internal feedback resistor divider yields better regulation than an external divider, where resistor tolerances would affect accuracy. Figure 5 shows a dual output regulator that is optimized for low part count—the 5 V and 3.3 V outputs are set by simply floating the DO and D1 pins.

Conclusion

Silent Switcher 2 technology enables the LT8653S to operate at high frequency while simultaneously providing high efficiency and low EMI emissions. The LT8653S provides a wide input voltage range, low quiescent current, and packs two 2 A regulator channels in a small 4 mm × 3 mm package, reducing part count and solution size. Despite its small size and low external part count requirement, the LT8653S offers design flexibility for a wide range of applications.

About the Author

Tao Tao is a senior applications engineer for power products at Analog Devices, Inc., in Santa Clara, California. He currently provides applications support for step-down switching regulator ICs. Prior to his current role, Tao worked at Intersil Corporation on developing integrated power modules. Tao's interests include high efficiency and high density power converters and regulators, modeling and control of power converters, EMI mitigation techniques, electronic packaging technologies, PCB board design, and solving any other technical problems. Tao obtained a master's degree in electrical engineering from Virginia Polytechnic Institute and State University, Blacksburg, Virginia. He can be reached at tao.tao@analog.com.