Design Note

40V Input, 3.5A Silent Switcher µModule Regulator for Automotive and Industrial Applications

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Introduction

The LTM®8003 is a wide input and output range step-down µModule® regulator featuring the Silent Switcher® architecture. Inputs from 3.4V to 40V can produce outputs from 0.97V to 18V, eliminating the need for intermediate regulation from batteries or industrial supplies. The pinout is specifically designed to be FMEA compliant, so the output stays at or below the regulation voltage during adjacent pin shorts, single pin shorts to ground or pins left floating. Redundant pins enhance electrical connections in the event a solder joint weakens or opens due to vibration, aging or wide temperature variations, such as in automotive and transportation applications.

A complete solution fits a compact space not much larger than the 6.25mm × 9mm footprint of the LTM8003, including the input and output capacitors. The quiescent current of typical 25µA, and wide temperature operation from –40°C to 150°C (H-Grade) make it ideal for applications in automotive, transportation and industrial, where space is tight, the operational environment is harsh, and low quiescent current and high reliability are mandatory.

Figure 1. A Complete Step-Down Solution Is Barely Larger than the 6.25mm × 9mm Footprint of the LTM8003 µModule Regulator

Low Noise Silent Switcher Architecture Simplifies EMI Design

Automotive, transportation and industrial applications are noise-sensitive, and demand low EMI power solutions. Traditional approaches control the EMI with slowed-down switching edges or lower switching frequency. Both have undesired effects, such as reduced efficiency, increased minimum on and off times, and a large solution. Alternative solutions such as an EMI filter or metal shielding add significant costs in required board space, components and assembly, while complicating thermal management and testing.

Our low noise µModule offers a breakthrough in the switching regulator design. The regulator within the µModule package uses a proprietary Silent Switcher architecture to minimize EMI emissions while delivering high efficiency at high switching frequencies. The architecture of the regulator and the internal layout of the µModule are designed so that the input loop of the regulator is minimized. This significantly reduces the switching node ringing and the associated energy stored in the hot loop, even with very fast switching edges. This quiet switching offers excellent EMI performance, while minimizing the AC switching losses, allowing the regulator to operate at high switching frequencies without significant efficiency loss.

This architecture, combined with spread spectrum frequency operation, greatly simplify the EMI filter design and layout, ideal for noise-sensitive environments. Figure 2 shows a simple EMI filter on the input side, enabling the demo circuit to pass CISPR25 Class 5 with plenty of margin, as shown in Figure 3.

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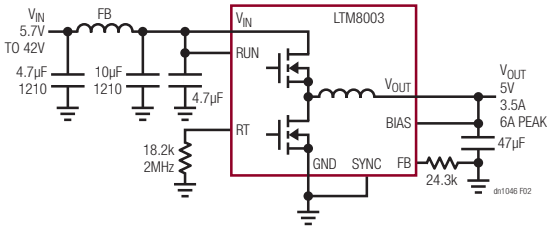
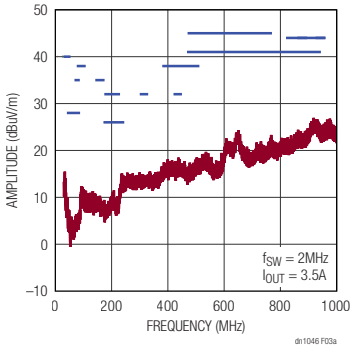


PINS NOT USED IN THIS CIRCUIT: TR/SS, PG

Figure 2. Schematic of a 5V Converter with a Simple EMI Filter at the Input to Pass CISPR25 Class 5

CISPR25 Class 5 Peak Radiated DC2416A Demo Board, V_{OUT} = 5V Spread Spectrum Enabled



CISPR25 Class 5 Average Radiated DC2416A Demo Board, V_{OUT} = 5V Spread Spectrum Enabled

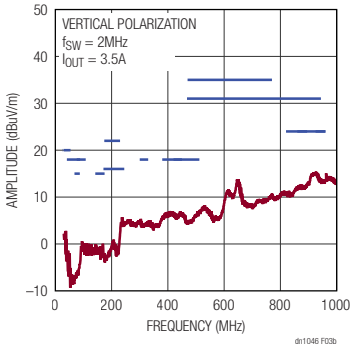


Figure 3. Radiated EMI Spectrum (Vertical Polarization) in 30M to 1GHz Range. V_{IN} = 14V, I_O = 3.5A

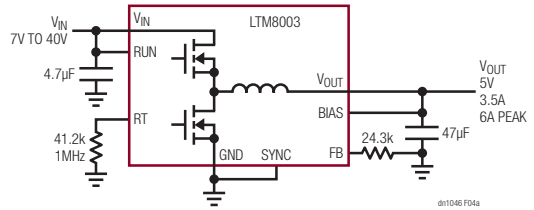
Continuous 3.5A with Peak Current Capability 6A

The internal regulator is capable of safely delivering up to 6A of peak output current, and no extra thermal management—air flow or heat sink—is required for the LTM8003 to continuously support a 3.5A load at 3.3V or 5V from a nominal 12V input. This meets the needs of the battery powered applications in industrial robotics, factory automation and automotive systems.

Wide Operation Temperature Range from –40°C to 150°C

Automotive, industrial and military applications require power supply circuits to operate continuously and safely in ambient temperatures over 105°C or require significant headroom for a thermal rise. The LTM8003H is designed to meet specifications over –40°C to 150°C internal operating temperature range. The internal overtemperature protection (OTP) monitors the junction temperature, and stops switching when the junction temperature is too hot.

Figure 4a shows a 3.5A, 5V solution that operates from a wide ranging 7V to 40V input. The thermal performance at a nominal 12V input is shown in Figure 4b. Typical efficiency is above 92% with a 12V input and 2A load.



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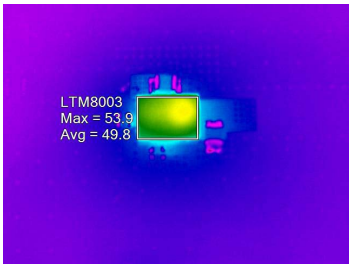


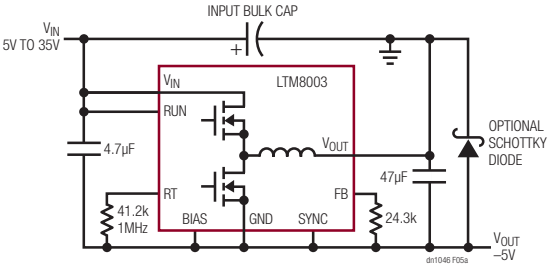
Figure 4. A 5V, 3.5A Solution for 7V to 40V Inputs Using the H-Grade Version, (a) Schematic, (b) Thermal Image ($12V_{IN}$, 3.5A, 25°C)

Negative Output –5V from 3.5V to 35V input

Figure 5 shows a solution for a –5V, 4A output from a nominal 12V input, with a maximum of 35V input. The BIAS pin is should be connected to GND.

Conclusion

The LTM8003 is a 40V, 3.5A step-down µModule featuring wide input and output ranges, an FMEA compliant pinout and low noise Silent Switcher architecture. It is packaged in a compact overmolded ball grid array (BGA) 6.25mm × 9mm × 3.32mm package for simplified manufacturing. Minimal design effort is required to meet the stringent standards posed by harsh operating environments such as industrial robotics, factory automation, avionics and automotive systems.



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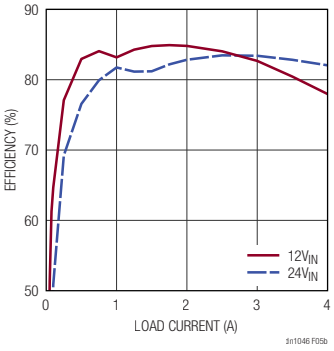

Figure 5. A –5V Supply from a 5V to 35V Input Delivers Current Up to 4A

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