Eliminate EMI Worries with 2A, 15mm × 9mm × 2.82mm µModule Step-Down Regulator

by David Ng

Introduction

"We failed EMI." Those three dreaded words strike fear into the hearts and minds of electronics design engineers. There are four words that are even worse: "We failed EMI again." The psyche of many a seasoned engineer is scarred with dark memories of long days and nights in an EMI lab, struggling with aluminum foil, copper tape, clamp-on filter beads and finger cuts to fix a design that just won't keep quiet. A big part of the problem is the necessary profusion of switching power supplies, which contribute significantly to the radiated system EMI.

The LTM8032 is a DC/DC switching step-down µModule regulator built specifically for low EMI. It is rated for up to $36V_{IN}$, $10V_{OUT}$ at 2A, and features adjustable frequency, synchronization, a power good status flag and soft-start. It is small, measuring only 15mm × 9mm × 2.82mm, integrating the inductor, power stage and controller in a ROHS e3-compliant molded LGA package.

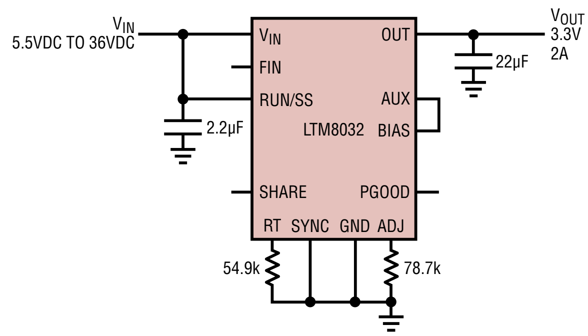

Figure 1. Just two resistors, input and output caps are needed to complete a power supply design with the LTM8032.

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10V/2A Supply Is EN55022 and CSIPR 22 Class B Compliant

Like most other µModule regulators, the LTM8032 is easy to use. As shown in Figure 1, all that is needed for a complete power design are the resistors to set the output voltage and operating frequency, and the input and output caps.

The LTM8032 is test-proven EN55022 and CSIPR 22 class B complaint, tested in an NRTL 5-meter chamber, set up as shown in the photo given in Figure 2. The LTM8032 is mounted on a circuit board with no bulk capacitance installed. The input and output capacitance are the minimum ceramic values specified in the data sheet for proper operation.

The assembled unit is placed atop an all-wood table. The all-wood construction ensures that the test setup does not shield or shadow noise emanating from the device under test (DUT). The power source, a linear lab grade power supply, is on the floor. The load for the LTM8032, with its heat sink, is also on the table top.

Before measuring the emissions from the LTM8032, a baseline measurement is taken to establish the

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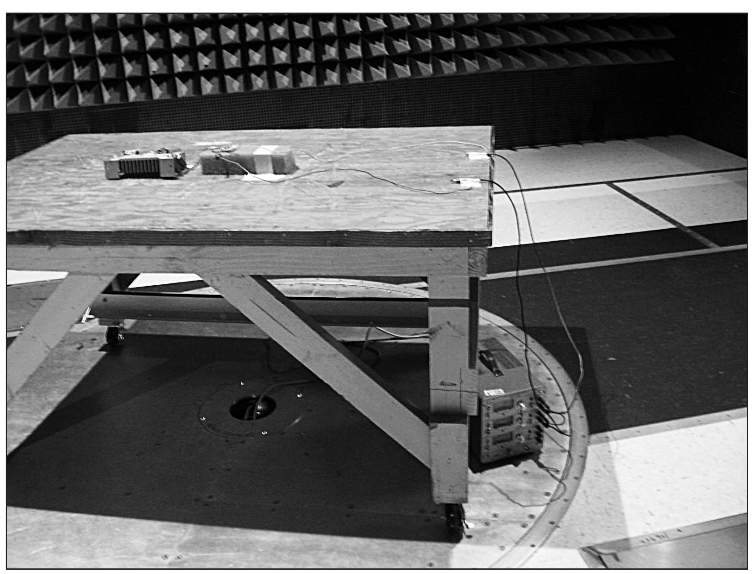

Figure 2. For EMI testing, the DUT is mounted on a circuit board and placed on a wooden table. The power source is on the floor.

is deceptively simple in appearance. In particular, the current step must have an exceptionally fast, high-fidelity transition and faithful turn-on time determination requires substantial measurement bandwidth.

Detailed Measurement Scheme

A more detailed measurement scheme appears in Figure 4. Necessary performance parameters for various elements are called out. A subnanosecond rise time pulse generator, 1A, 2ns rise time amplifier and a 1GHz oscilloscope are required. These specifications represent realistic operating conditions; other currents and rise times can be selected by altering appropriate parameters.

The pulse amplifier necessitates careful attention to circuit configuration and layout. Figure 5 shows the amplifier includes a paralleled, Darlington driven RF transistor output stage. The collector voltage adjustment ("rise time trim") peaks Q4 to Q6 FT; an input RC network optimizes output pulse purity by slightly retarding input pulse rise time to within amplifier passband. Paralleling allows Q4 to Q6 to operate at favorable individual currents, maintaining bandwidth. When the (mildly interactive) edge purity and rise time trims are optimized, Figure 6 indicates the amplifier produces a transcendently clean 2ns rise time output pulse devoid of ringing, alien components or post-transition excursions. Such performance makes diode turn-on time testing practical.[1]

Figure 7 depicts the complete diode forward turn-on time measurement arrangement. The pulse amplifier, driven by a sub-nanosecond pulse generator, drives the diode under test. A Z0 probe monitors the measurement point and feeds a 1GHz oscilloscope.[2, 3, 4]

Diode Testing and Interpreting Results

The measurement test fixture, properly equipped and constructed, permits diode turn-on time testing with excellent time and amplitude resolution.[5] Figures 8 through 12 show results for five different diodes from various manufacturers. Figure 8 (Diode Number 1) overshoots steady state forward voltage for 3.6ns, peaking 200mV. This is the best performance of the five. Figures 9 through 12 show increasing turn-on amplitude and time which are detailed in the figure captions. In the worst cases, turn-on amplitudes exceed nominal clamp voltage by more than 1V while turn-on times extend for tens of nanoseconds. Figure 12 culminates this unfortunate parade with huge time and amplitude errors. Such errant excursions can and will cause IC regulator breakdown and failure. The lesson here is clear. Diode turn-on time must be characterized and measured in any given application to insure reliability.

Notes

1 An alternate pulse generation approach appears in Linear Technology *Application Note 122*, Appendix F, "Another Way to Do It."

2 Z0 probes are described in Linear Technology *Application Note 122* Appendix C, "About Z0 Probes." See also References 27 thru 34.

3 The subnanosecond pulse generator requirement is not trivial. See Linear Technology *Application Note 122* Appendix B, "Subnanosecond Rise Time Pulse Generators For The Rich and Poor."

4 See Linear Linear Technology *Application Note 122* Appendix E, "Connections, Cables, Adapters, Attenuators, Probes and Picoseconds" for relevant commentary.

5 See Linear Technology *Application Note 122* Appendix A, "How Much Bandwidth is Enough?" for discussion on determining necessary measurement bandwidth.

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amount of ambient noise in the room. Figure 3 shows the noise spectrum in the chamber without any devices running. This can be used to determine the actual noise produced by the DUT.

Figure 4 shows the worst case LTM8032 emissions plot, which occurs at maximum power out, 10V at 2A, from the maximum input voltage, 36V. There are two traces in the plot, one for the vertical and horizontal orientations of the test lab's receiver antenna. As shown in the figure, the LTM8032 easily meets the CISPR 22 class B limits, with 20db of margin for most of the frequency spectrum, with either antenna orientation.

Conclusion

The LTM8032 switching step-down regulator is both easy to use and quiet, meeting the radiated emissions requirements of CISPR22 and EN55022 class B by a wide margin.

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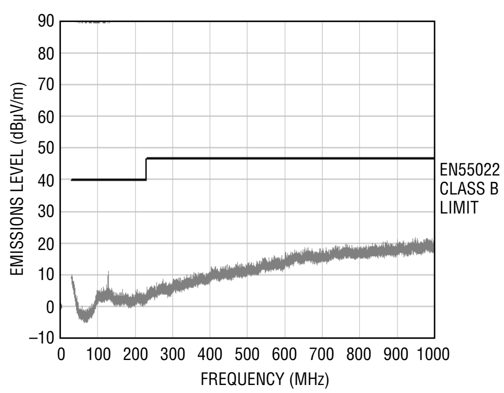

Figure 3. The baseline measurement of ambient noise in the 5-meter chamber (no devices operating)

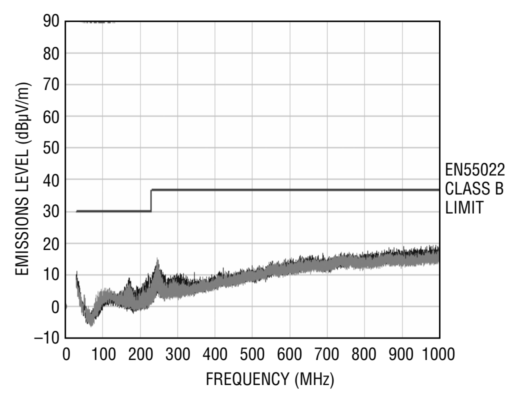

Figure 4. The LTM8032 emissions for 20W out, $36V_{IN}$