High Efficiency Switching Power Conversion Combined with Low Noise Linear Regulation in µModule Package

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Devices with high speed or high resolution functions require clean power. Switching regulators offer efficiency across a variety of input/output conditions, but the typical switcher is hard pressed to deliver the clean, low output noise and fast transient response needed by high data rate FPGA I/O channels or high bit count data converters. In contrast, high performance linear regulators feature low output noise and fast transient response, but can quickly heat up.

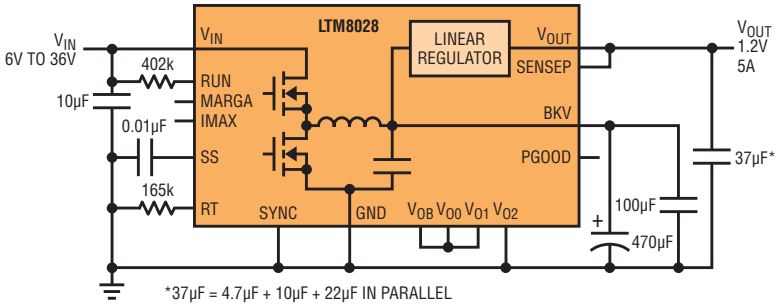


Figure 1. The LTM8028 is a 36V input, UltraFast, low output noise 5A µModule regulator.

The LTM®8028 combines the best of both worlds—a high efficiency synchronous switching converter controlled by an UltraFast™ linear regulator, both integrated into a small, 15mm × 15mm µModule® package. It is available in LGA (4.32mm tall) and BGA (4.92mm tall) lead styles, both of which are RoHS compliant.

The linear regulator controls the output of the switcher to 300mV above the desired output voltage to provide the optimum combination of headroom, efficiency and transient response. The LTM8028 accepts inputs as high as 40V and produces output voltages between 0.8V and 1.8V at up to 5A. A typical 1.2V output application is shown in Figure 1.

Figure 2. In a 12V input to 1.2V output, 5A application, the LTM8028 dissipates less than 4W and heats up by only 45°C.

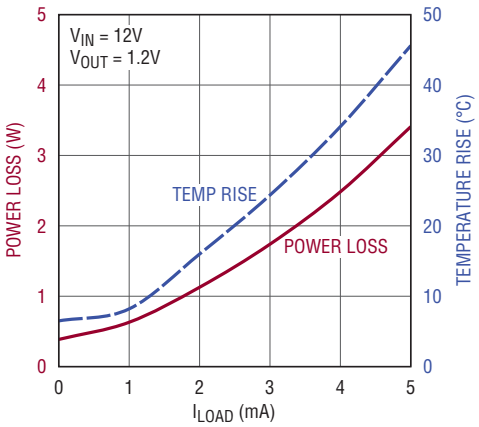


Figure 3. At 1.0V output, the LTM8028 transient response is less than 20mV.

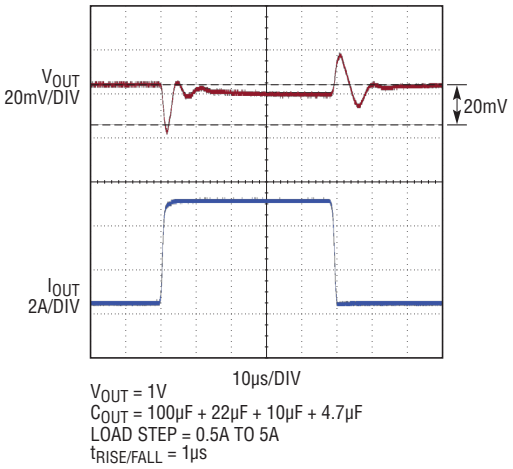
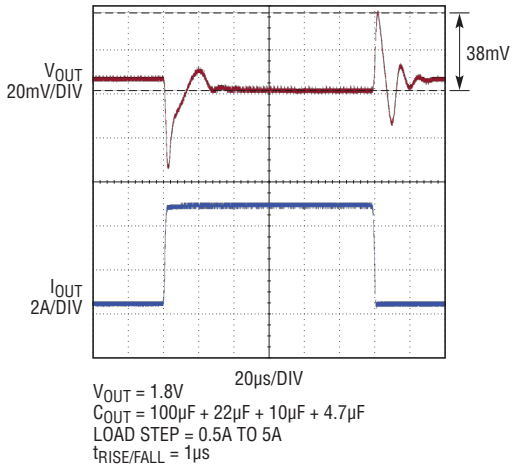


Figure 4. The LTM8028 transient response is only 38mV.



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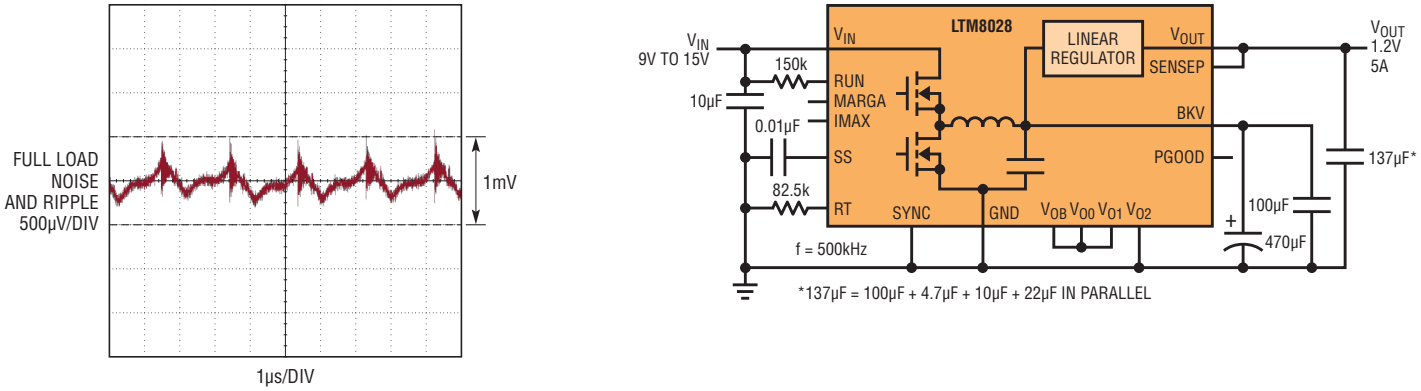
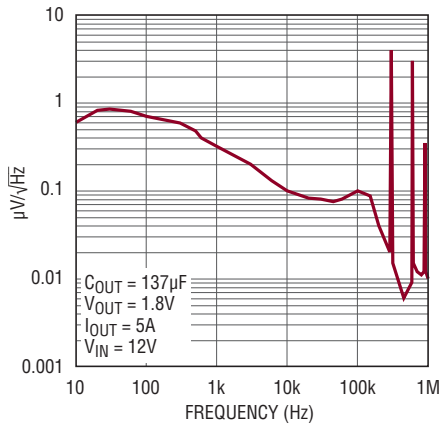


Figure 5. The peak-to-peak switching noise at the output of the LTM8028 is less than 1mV. (Schematic shows the setup used to achieve these results.)

The output voltage of the LTM8028 is set by controlling three 3-state inputs, V_{O0}, V_{O1} and V_{O2}. Applying a voltage to the MARGA pin allows the user to margin the output by as much as ±10%. The current limit may be reduced from the 5A maximum through the IMAX pin, and a PGOOD signal indicates that the output is within 10% of the target voltage.

Figure 6. The output noise spectral density, peaking at only 4µV/√Hz, makes the LTM8028 a good candidate for sensitive data conversion circuits.



A design using a traditional linear regulator providing 1.2V at 5A from a 12V source would burn over 50W and might require expensive heat sinking. The LTM8028, as shown in Figure 2, dissipates a twelfth of that, less at 4W, yielding a typical junction temperature rise of only 45°C.

The heart of the LTM8028 is the high performance linear regulator. Its total line and load regulation below 0.2% at room temp and 1% over its full –40°C to 125°C temperature range. Its UltraFast bandwidth gives the LTM8028 a 10%–90% load step transient response of only 2%. Figures 3 and 4 show the transient response of the LTM8028 when the load steps from 0.5A to 5A at a slew rate of 1A/µs when the device is configured to deliver 1V and 1.8V, respectively.

Even though the linear regulator and the synchronous switching converter are packaged together, high power supply rejection and integrated noise mitigation result in low output noise. Figure 5 shows peak-to-peak noise less than 1mV.[1]

In the frequency domain, the spectral noise content is very low, peaking at 4µV/√Hz at the switching converter's fundamental frequency of 300kHz as shown in Figure 6. This is important when powering high bit count data conversion circuits.

CONCLUSION

When a system design requires low power loss, tight regulation, fast transient response, and low output noise, reach for the LTM8028 µModule regulator. It combines the best features of high performance switching and linear regulators into a single, space efficient package.

Visit www.linear.com/LTM8028 for data sheets, demo boards and other applications information. ■

Notes

1 Measuring low amplitude noise can be tricky. This measurement was made using coaxial cables, impedance matching and a 150MHz HP461A amplifier. This is similar to the setup described in *Linear Technology Application Note 70*, "A Monolithic Switching Regulator with 100µV Output Noise" by Jim Williams, except the measurement here is not bandwidth limited to 10MHz.