

DESIGN NOTES

36V Input, Low Output Noise, 5A μ Module Regulator for Precision Data Acquisition Systems – Design Note 518

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Introduction

Low output noise, fast transient response and high efficiency are just a few of the stringent power supply demands made by applications featuring high data rate FPGA I/O channels and high bit count data converters. The power supply designer faces the difficult task of meeting all of these requirements with as few components as possible, since no single topology easily meets all three.

For instance, high performance linear regulators achieve the required low output noise and fast transient response, but tend to dissipate more power than a switching topology, resulting in thermal issues. Switching regulators, on the other hand, are generally more efficient and run cooler than linear regulators, but generate significantly more output noise and cannot respond as quickly to transients. Power supply designers often resort to combining the two topologies, using a switching regulator to efficiently step down a relatively high bus voltage, followed by a linear post regulator to produce a low noise output. Although it is possible to produce a low noise supply in this way, it requires careful design to achieve high efficiency and fast transient response.

An easier way to reap the benefits of both a linear regulator and a switching regulator is to use the **LTM[®]8028**, which achieves low noise, fast transient response and high efficiency by combining both regulators into a single part.

Integrated Switching and Linear Regulators

The LTM8028 is a 36V_{IN}, 5A μ Module[®] regulator that combines a synchronous switching converter and low noise linear regulator in a 15mm $\times$ 15mm $\times$ 4.92mm BGA package. It operates from an input range of 6V to 36V with an output voltage that can be programmed between 0.8V and 1.8V. The combination of the two converters results in tight tolerance of line and load regulation over the -40°C to 125°C temperature range.

The switching frequency can be adjusted between 200kHz and 1MHz with the RT resistor, or the SYNC

pin can synchronize the internal oscillator to an external clock. The 5A current limit can be reduced by utilizing the IMAX pin. The PGOOD pin can be used to detect when the output voltage is within 10% of the target value.

PCB Trace Voltage Compensation Using SENSEP

The resistance of PCB traces between the μ Module regulator and the load can result in voltage drops that cause a load regulation error at the point of load. As the output current increases, the voltage drop increases accordingly. To eliminate this voltage error, the LTM8028's SENSEP pin can be connected directly to the load point.

Programmable Output Voltage

The output voltage can be digitally programmed in 50mV increments by controlling the LTM8028's 3-state inputs: V00, V01 and V02. Additionally, the MARGA pin can be used for output margining via analog control that adjusts the output voltage by up to $\pm 10\%$.

DC1738A Highlights the LTM8028 Capabilities

A 1.8V output application is shown in Figure 1. The LTM8028 comes in a 15mm $\times$ 15mm $\times$ 4.92mm BGA package and is featured in the demonstration circuit DC1738A, shown in Figure 2.

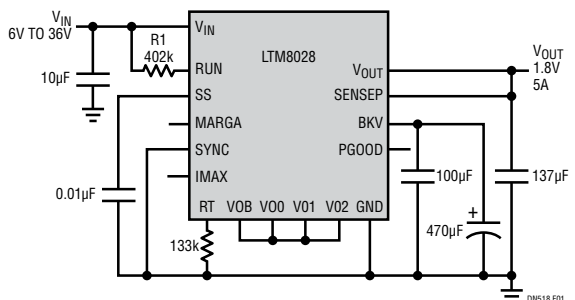


Figure 1. μ Module Regulator Takes a Wide Ranging 6V to 36V Input and Produces a Low Noise 1.8V Output with Up to 5A Output Current

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Noise Test Comparison Using LTC2185 ADC

When powering high speed analog-to-digital converters (ADCs), it is important to use a power supply that is as clean as possible. Any switching spurs that are present on the power supply rail will translate into AM modulation in the ADC output spectrum. The noise performance of the **LTC[®]2185**, a 16-bit ADC, was evaluated to see the difference between using (1) a typical LDO, (2) a typical switching regulator, and (3) the **LTM8028** low noise μ Module regulator. A simplified schematic of the test is shown in Figure 3, where the DUT is represented by either of the configurations.

Figure 4 shows the FFT plots using the three different methods of powering the LTC2185 when sampling a 70MHz tone at 100Msps. The LDO provides a clean power supply, achieving a SINAD of 76.22dB. However, when powered by a typical 250kHz switching regulator, there are spurs around the fundamental with an offset frequency of 250kHz. These are switching regulator spurs that are AM modulated around the carrier

frequency. The sampling process produces 250kHz spurs at baseband. As a result, the SINAD drops to 71.84dB, around 4dB compared to an LDO. This reduces the LTC2185 to nearly 12-bit performance. In demanding applications where tenths of dBs are significant, losing 4dB of SINAD because of a noisy regulator is unacceptable. In addition to degrading the SINAD of the ADC, these spurs may land on neighboring channels or on other signals of interest, making it impossible to receive meaningful data from those channels. With the LTM8028, only a few extraneous spurs exist near the desired frequency and the SINAD performance is only 0.03dB worse than the LDO baseline. The spurious content that was very pronounced in the spectrum of the switching regulator is virtually eliminated. As a result, there will not be any performance degradation of the LTC2185 when using a LTM8028 regulator.

Conclusion

The LTM8028 μ Module regulator combines a linear regulator and a switching regulator to form a DC/DC converter with minimal power loss, low noise and UltraFast[™] transient response, all in a 15mm $\times$ 15mm $\times$ 4.92mm BGA package.



Figure 2. The LTM8028 Makes It Possible to Build a Minimal Component-Count Regulator That Meets Stringent Noise, Efficiency and Transient Response Requirements

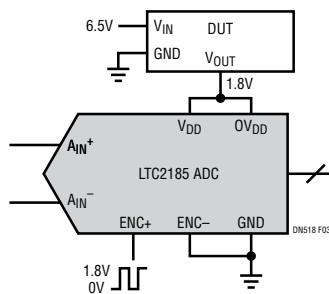


Figure 3. Noise Test Schematic Using Different Supplies to Power 16-Bit LTC2185 ADC

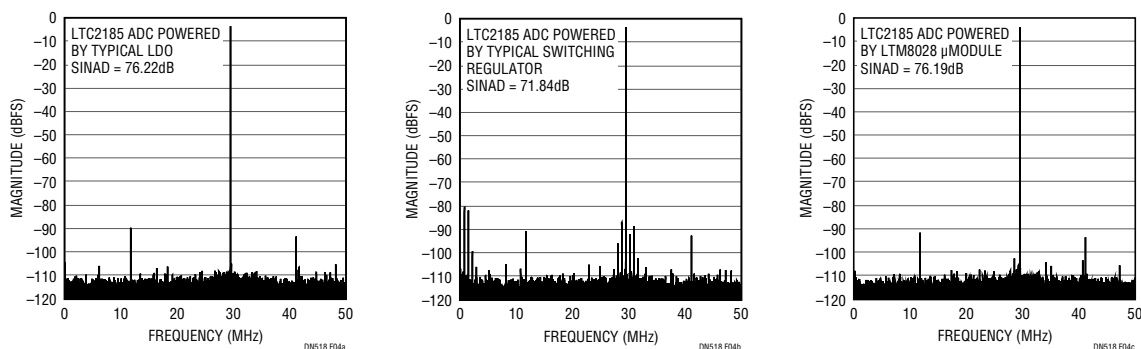


Figure 4. 32k-Point FFT, $f_{IN} = 70.3\text{MHz}$, -1dBFS , 100Msps, Using CMOS Clock Drive

Data Sheet Download

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