Technical Article

Achieving Ultralow Noise Power for Your Most Sensitive Devices

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Abstract

Applications in RF technology and metrology, as well as other fields, need extremely low noise supply voltages. This article explains the traditional design approach vs. a novel, highly integrated approach in generating an ultralow noise power supply for sensitive loads. New technology offers a more compact design and ease of use.

Introduction

RF technology applications (as well as others) require extremely low noise supply voltages. Circuits such as phase-locked loops (PLLs), voltage controlled oscillators (VCOs), and high resolution analog-to-digital converters (ADCs) that are susceptible to interference require low noise power supplies. Any interference on the supply line may influence a signal in the application. To generate extremely clean supply voltages, it is common to use a power train such as the one shown in Figure 1.

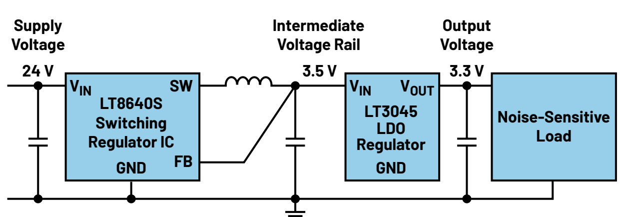

Figure 1. A voltage converter consisting of an efficient switching regulator and a downstream linear regulator.

The switching regulator converts a high supply voltage such as 24 V, to a lower voltage like 3.5 V. This voltage can be used to supply an ultralow noise linear regulator that generates 3.3 V with very low noise at the output. The linear regulator itself has a very low noise level in the region of 0.8 µV rms and a very high power supply rejection ratio (PSRR) of 76 dB (at 1 MHz). This setup reduces the voltage ripple generated by the switching regulator. The design in Figure 1 represents a typical solution used to generate voltages with ultralow noise.

Optimization Possibilities

A multistage discrete design is not easy to accomplish. The switching regulator must be implemented with an optimized PCB layout. Otherwise, the fast-switching transients of the switching regulator will couple into the output voltage as additional interference. To prevent this, it is necessary to place the linear regulator at a sufficient distance from the switching regulator. The result is a supply design that needs a lot of space. Attempts to integrate a switching regulator circuit and a linear regulator for such applications fail due to the coupling of the switching noise onto the final output voltage. However, there is a solution to this problem.

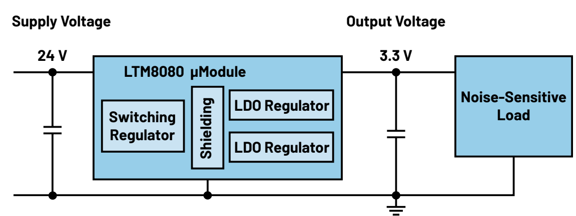

Figure 2. A highly integrated µModule regulator for generating a voltage with minimal noise in a minimal amount of space.

The Solution

Integration of a switching regulator and a linear regulator for noise-sensitive applications can be done with a suitable design. The LTM8080 from Analog Devices' µModule® family provides internal electromagnetic shielding between the switching regulator and integrated linear regulator sections. This built-in barrier absorbs the electromagnetic interference originating from the rapidly switched currents from the switching regulator section. Clean, precisely regulated supply voltages are thus obtained with an ultracompact design. The LTM8080 can generate two different voltages simultaneously and comes in a 9 mm × 6.25 mm package. It contains the switching regulator, including the inductor, and two ultralow noise linear regulators.

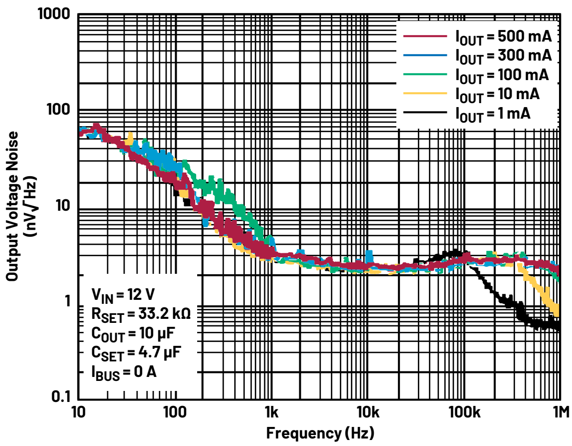

Figure 3. Noise density for different output currents.

Figure 3 shows the noise density for different output currents. An LTM8080 can achieve root mean square (rms) noise levels of less than 1 µV rms (between 10 Hz and 100 kHz). In comparison, a typical value for the voltage of a lithium-ion battery without voltage regulation is 2.7 µV rms (between 10 Hz and 100 kHz). The voltage converter shown in Figure 2, therefore, is not as noisy as a battery voltage.

Conclusion

Additionally, with this solution, the circuit design is extremely simple and does not require a detailed knowledge of the design of a switching regulator and the necessary PCB layout.

The µModule regulator's clever design allows for an ultralow noise power supply with a high integration level and an extremely compact size.

About the Author

Frederik Dostal is a power management expert with more than 20 years of experience in this industry. After his studies of microelectronics at the University of Erlangen, Germany, he joined National Semiconductor in 2001, where he worked as a field applications engineer, gaining experience in implementing power management solutions in customer projects. During his time at National, he also spent four years in Phoenix, Arizona (U.S.A.), working on switch-mode power supplies as an applications engineer. In 2009, he joined Analog Devices, where he has since held a variety of positions working for the product line and European technical support, and currently brings his broad design and application knowledge as a power management expert. Frederik works in the ADI office in Munich, Germany.