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Low-Noise Buck Converters With Ferrite-Bead Compensation Eliminate LDOs

Texas Instruments' TPS62912 and TPS62913 are low-noise switching regulators with integrated ferrite-bead compensation. The offer a low noise of 20 μV_{RMS} for frequencies ranging from 100 Hz to 100 kHz and ultra-low output-voltage ripple of 10 μV_{RMS}, giving engineers the ability to remove one or more low-dropout regulators (LDOs) from their designs, reduce power losses by up to 76% and save 36% of board space, according to the vendor.

Noise in the power supply is a key design challenge in many high-precision test and measurement, medical, aerospace and defense, and wireless infrastructure applications. A traditional low-noise power-supply architecture includes a dc-dc converter; a low-noise LDO and an off-chip filter, such as a ferrite bead. By integrating ferrite-bead compensation, the TPS62912 and TPS62913 use the ferrite bead already present in most systems as an effective filter against high-frequency noise, reducing the power supply output voltage ripple by approximately 30 dB and simplifying the power supply design (see Figs. 1 and 2).

High-precision systems require supply rails with low noise and low ripple to preserve signal accuracy and integrity. The TPS62912 and TPS62913 offer both, along with a power-supply rejection ratio of 65 dB at up to 100 kHz. In addition, this buck converter family has an output-voltage error of less than 1%, which helps ensure tight output-voltage accuracy.

Both converters enable the use of spread-spectrum frequency modulation to further attenuate radio-frequency spurs and allow synchronization to an external clock so engineers can easily meet their signal-to-noise ratio (SNR) and spurious-free dynamic range (SFDR) targets, which are critical in applications such as medical imaging or radar.

Historically, engineers have faced a trade-off between noise and efficiency when powering sensitive analog circuitry. Using a switching regulator on its own would result in too much switching noise, while adding a post-regulator LDO to reduce noise would lead to additional power losses, especially at high load currents.

With a peak efficiency of 97%, the TPS62912 and TPS62913 allow engineers to design for noise filtering without an LDO, reducing power losses by up to 76%—1.8 W in analog front-end (AFE) designs and 1.5 W in designs using a wideband ADC, such as the ADC12DJ5200RF, according to TI. This represents a 20% and 15% increase in efficiency, respectively, when compared to a traditional low-noise power architecture.

By using the TPS62912 or TPS62913 in their designs, engineers can eliminate not only the linear regulator but also the associated passive components, which can save approximately 20 mm^2 of printed circuit board (PCB) area per LDO, according to the vendor. Designs that typically use a single LDO can save 36% of PCB space, says TI. In addition, the integrated ferrite-bead compensation of the buck converters helps engineers reduce the overall dc-dc component count, eliminating two capacitors and two resistors from their designs, to further minimize overall system cost and shorten design time.

Pre-production quantities of the 2-A TPS62912 and 3-A TPS62913 are available now, only on TI.com, in a 2-mm-by-2-mm, 10-pin QFN package. Pricing starts at $1.06 and $1.16 respectively, in 1,000-unit quantities. The TPS62912EVM and TPS62913EVM evaluation modules are available on TI.com for $49.

TI expects both regulators to be available in volume production in the first quarter of 2021. For more information, see TPS62912 product page and the TPS62913 product page. To learn how low-noise buck converters work, read the technical article, "Minimize noise and ripple with a low-noise buck converter."

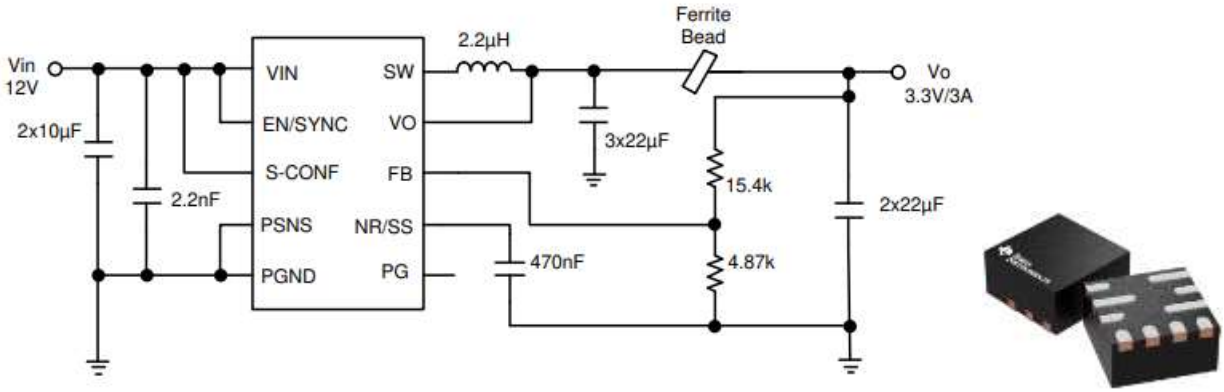

Fig. 1. Engineers can improve efficiency in noise-sensitive applications using members of TI's TPS6291x family of low-noise, low-ripple buck converters. The low levels of noise and output ripple achieved by these regulators means that designers can avoid or reduce the use of low-noise LDO post regulators that are typically employed to clean up the switching regulator's output. Among the design elements contributing to the regulators' noise performance is their integration of loop compensation for an external ferrite bead L-C filter, which is shown in this application schematic. (See Fig 2 for more.) The regulators come in 2-mm x 2-mm QFNs as pictured on the right.

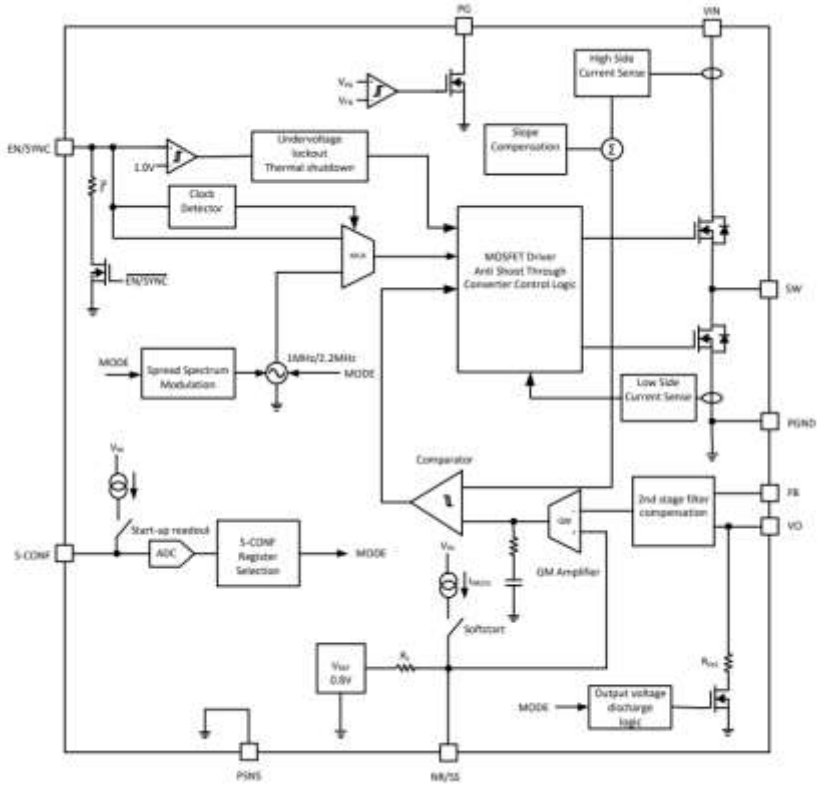

Fig. 2. The TPS6291x low-noise, low-ripple synchronous buck converter is a fixed-frequency current-mode converter. The converter has a filtered internal reference to achieve a low-noise output similar to low-noise LDOs. The converter achieves lower output voltage ripple by using a switching frequency of either 2.2 MHz or 1 MHz and a larger inductance. The output voltage ripple can be further reduced by adding a small second stage L-C filter to the output. This can be a ferrite bead or a small inductor, followed by an output capacitor. Internal compensation maintains stability with an external filter inductor up to 50 nH. To avoid voltage drops across this second stage filter, the device regulates the output voltage after the filter. The TPS6291x family supports optional spread spectrum modulation. When powering ADCs, for example, spread spectrum modulation reduces the mixing spurs. Switching frequency, spread spectrum modulation, and output discharge are set using the S-CONF pin.