Exclusive Technology Feature

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Injecting Noise In Power Supplies Improves Security For Communications Devices

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Switching power supplies are widely used in communication devices such as cell phones, mobile and stationary radio transceivers, and land line phones. In these devices, voice-generated audio signals that pass through audio amplifiers modulate the dc supply voltage and thus they also modulate the switching waveforms that control and regulate switching power supplies. As any switching power supply has some electromagnetic emission at the switching frequency and its harmonics or unwanted derivatives (ringing), the modulating voice-generated information is emitted as well. That means, it's possible for others to electronically eavesdrop on the conversation. This may be a problem for applications requiring a secure communications link.

There is a very simple way of safeguarding the sensitive information that may be contained in these unintended emissions. This method hampers eavesdropping of any emitted signal, can be used with practically any existing switching power supply and is applicable to any device processing information, both digital and analog.

The proposed method uses noise to modulate the power supply switching signal. The noise power and spectrum bandwidth are large enough to efficiently hamper eavesdropping. The noise has an average value equal to zero, so the modulation cannot harm the power supply accuracy. But due to spreading of the emitted spectrum, the noise reduces the spectral power density of the emissions.

To generate the noise, an inexpensive 6.2-V Zener diode can be used. For an efficient noise output it should operate in the area where the up going branch of the characteristic begins. The operating point can be selected as the area where the Zener diode reverse current attains approximately 10 µA. To provide proper noise power it should be amplified 40 dB by a conventional RF amplifier before being applied to modulate the switching signal.

The noise modulation can be performed by injecting noise current into the feedback circuit as shown in Fig. 1.

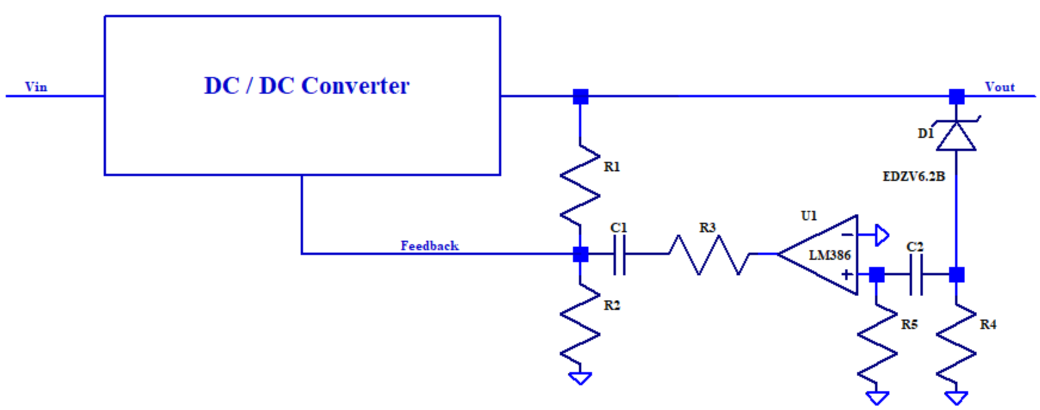


Fig. 1. Connection of the noise generator (Zener diode D1) to a switching power supply.

The power supply feedback loop usually has a bandwidth of around a few kilohertz, which makes this spectrum noise-like deviation acceptable. The noise is injected into the feedback loop through capacitor C1. Zener diode D1 is fed through resistor R4 from the output of the power converter. By setting the D1 operating current I_0 at 10 µA, from the characteristic, shown in Fig. 2, we can easily obtain the R4 value as

$$R4 = (Vout - Vz_0)/I_0$$

If Vout = 12 V, Vz0 = 6.1 and I0 = 10 µA, then R4 = 590 kΩ. A standard value of 560 kΩ will be good enough. To amplify the noise signal, a Texas Instruments RF amplifier, model LM386, is recommended.

Fig. 3 shows simulations of the spectrum of the power supply's switching waveform (as observed at the input to the inductor in the dc-dc converter) without and with the noise modulation applied. There was no audio modulation applied, since an audio signal, due to its non-deterministic structure, is hard to distinguish from noise, and thus the spectrums would be hard to identify. The complete tests employing transceivers have been conducted some time ago and showed a 40-dB suppression of the eavesdropped audio signal across the whole frequency range from 80 Hz to 16 kHz.

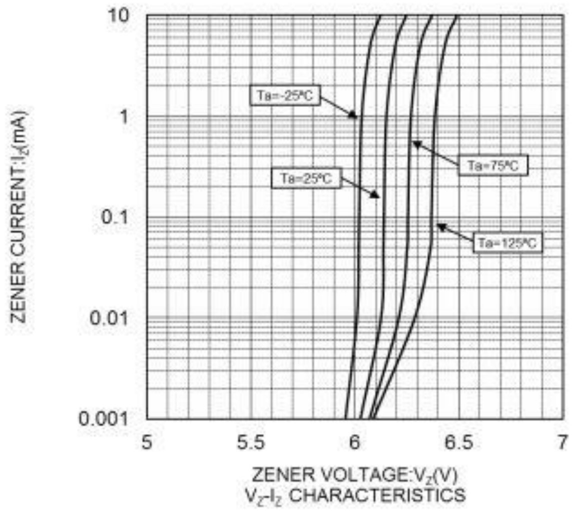
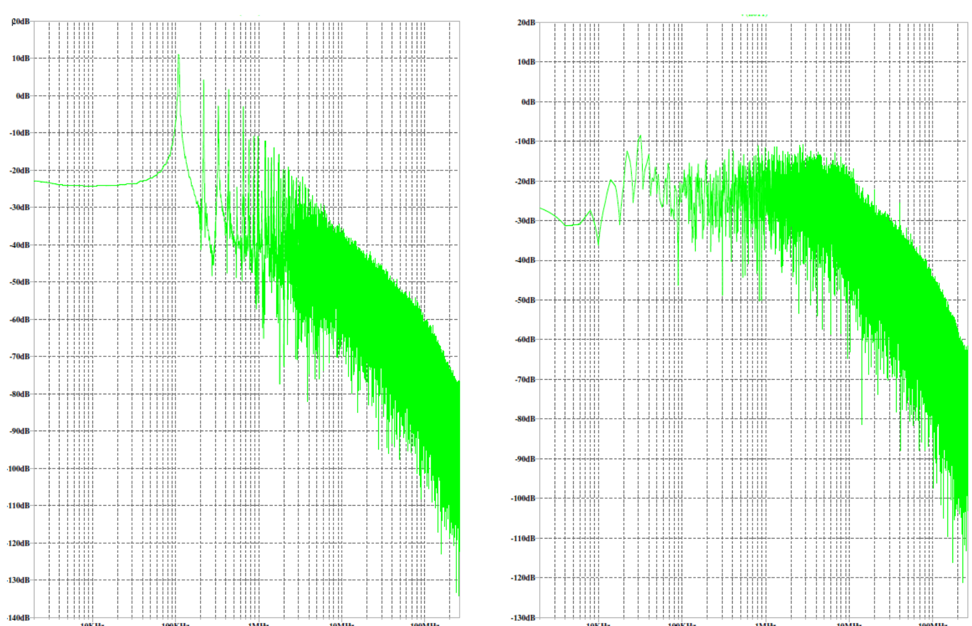


Fig. 2. Zener diode characteristics.



(a) *(b)*

Fig. 3 Simulated spectrum of pulses at the input of the dc-dc converter's internal inductor with no noise modulation (a) and with noise modulation applied (b).

About The Author

Gregory Mirsky, is a senior electrical engineer with Vitesco Technologies, a spinoff of Continental Automotive Systems, in Deer Park, Ill., which he joined in March 2015. In his current role, Gregory performs design verification on various projects, designs and implements new methods of electronic circuit analysis, and runs workshops on MathCAD 15 usage for circuit design and verification.

He obtained a Ph.D. degree in physics and mathematics from the Moscow State Pedagogical University, Russia. During his graduate work, Gregory designed hardware for the high-resolution spectrometer for research of highly compensated semiconductors and high-temperature superconductors. He also holds an MS degree from the Baltic State Technical University, St. Petersburg, Russia where he majored in missile and aircraft electronic systems.

Gregory holds numerous patents and publications in technical and scientific magazines in Great Britain, Russia and the United States. Outside of work, Gregory's hobby is traveling, which is associated with his wife's business as a tour operator, and he publishes movies and pictures about his travels online.