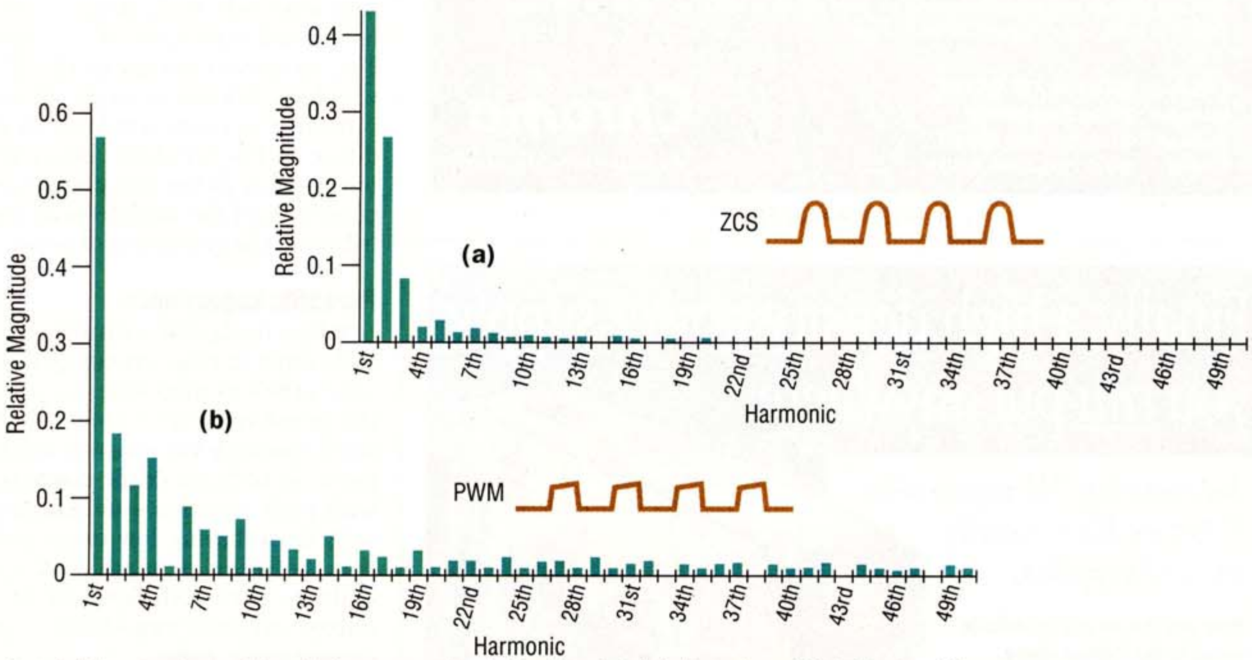
ELECTRONIC PRODUCTS

Noise management in dc/dc converters

Zero-current switching devices produce less harmonic and parasitic noise, suiting them for noise-sensitive applications



In a dc/dc converter module using zero-current-switching topology (a), the pulse width is fixed and the repetition rate is variable, whereas in a module using pulse-width modulation (b), the opposite is true.

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The introduction of switch-mode high-density dc/dc converters radically redefined standards for size, performance, and reliability. These power components, commonly referred to as bricks, gave power system designers unprecedented design and development flexibility.

But these converters exhibit fast voltage and current-switching transients that generate both conducted and radiated noise. Therefore, it is important to understand how converter topologies relate to generated noise.

Converter topologies

Available dc/dc converter modules use different topologies, none of which is superior to all others in every respect. Of the primary classes of topologies, however, quasiresonant zero-current switching (ZCS) produces significantly less conducted noise than a traditional board-mounted pulse-width-modulated (PWM) converter.

For those applications that require very low conducted noise or are very noise sensitive or those where space is simply not available for extensive filtering, bricks that use the inherently low-noise quasi-resonant zero-current switching topologies should be considered.

The low-noise performance of the ZCS converter is largely determined by the power train topology. The zero-switching converters have sinusoidal current waveforms that produce less harmonic noise. In addition, the more-continuous current waveforms produce less excitation of the parasitic elements, resulting in far less parasitic noise.

In a module using a quasiresonant topology, the pulse width is fixed while the repetition rate is variable, and in a module using pulse-width modulation, the opposite is true—the repetition rate is fixed and the pulse width is variable (see *figure*). Each topology generates characteristic noise spectra.

The ZCS design, however, has significantly lower high-frequency components associated with the leading and falling edges of the current waveform because it is essentially a half-wave rectified sine wave. The spectral content of the ZCS waveform is lower in amplitude and contained in a narrower band. In addition to the topology, other features—such as the transformer and packaging of the module—can contribute to the generation of noise.

Parasitic capacitance

When designed with the input and output in close proximity to ensure efficient magnetic coupling, the transformer can introduce electrical coupling via parasitic capacitance. In addition, dc/dc converters with high isolation—as compared with those having low or no isolation between primary and secondary—have both lower input-to-output parasitic capacitance and, consequently, noise.

The high di/dt's associated with PWM topologies can cause the excitation of construction-method parasitics. Components like diodes and MOSFETs dissipate heat so they are mounted on an insulating substrate, which in turn is mounted to the aluminum baseplate of the module.

Because of the close spacing for thermal considerations, there is capacitance from the diode or the FET to the baseplate. That construction facilitates heat removal, but also increases parasitic capacitance, thereby increasing the coupling of noise. By carefully controlling the geometries, the parasitic capacitance and noise coupling can be minimized. EP