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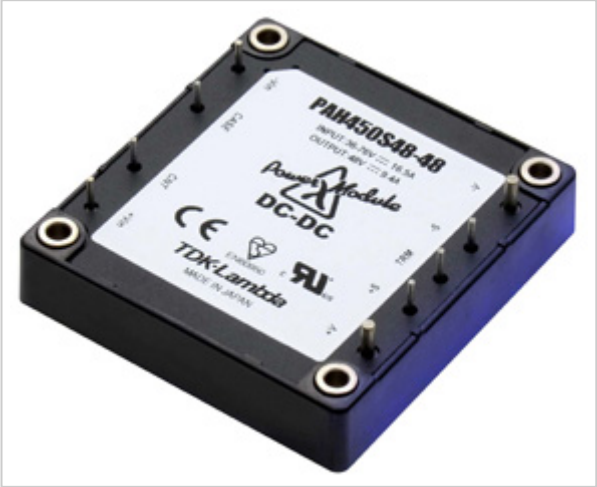
Applications of DC-DC converters For Base Station RF Power Amplifiers

When a DC-DC converter is in proximity to the Power Amplifier (PA) in an RF transmitter, regardless of whether it is located at the top or at the base of the antenna tower, the switching action of the converter is a potential source of RF interference. Many features of TDK-Lambda's PAH450S series of power modules provide safeguards against this. For example, the sealed casting of this module effectively acts as a containment shield for radiated EMI generated by the converter that could be sensed and amplified by the RF PA. Conducted EMI is also a concern, with the chief sources being conducted EMI from the converter input back onto the supply bus, and voltage ripple on the converter's output being coupled into the PA.

To suppress conducted EMI, RF Power Amplifier customers generally design their own input filters. Guidelines for conducted emissions standards generally stop at 30 MHz, while the typical frequency range for the PAs is between 800 MHz to 2 GHz. Therefore, these standards are mainly directed at guarding against potential interference with other RF equipment sharing the PA's power bus. This precaution can be compared to warning pacemaker patients about staying away from microwave ovens; the risk may be slight, but the consequences can be drastic.

The compact size (half brick) of TDK-Lambda's PAH450S dc-dc converter provides a high power density suitable for driving analog PAs in integrated modules for base-station applications.



Regarding external interference, as well as the potential interference from the converter's output voltage ripple, while general guidelines are applied to prevent RF interference, this risk is also minimized by the fact that the RF and power converter frequency domains are significantly different. Therefore, with careful design practices, RF interference from the converter is not a major concern, though as converter's switching frequencies increase it may become a significant design issue.

In addition, thermal issues represent a significant challenge in the design of transmitters, especially in a combined PA/converter module. In configurations where the converter and the RF PA are co-packaged as a single module and installed at the top of the tower (alternative configurations keep the complete RF transmit stage at the base of the tower), even modest gains in efficiency can have tremendous performance advantages.

For example, an improvement in converter efficiency from 90% to 92% can lead to total heat reductions of up to 20% in the combined module. The less heat produced by the converter, the more RF output power that can be generated by Power Amplifier, which is usually the driving parameter for the transmit path.

Packaged in a standard half-brick case, these DC-DC converters are available with 28V or 48V outputs, and reach efficiencies up to 92%. Digital power control might seem to hold the potential to introduce further single-digit percentages in gained efficiency. However, our customer's tell us, to emulate the equivalent operation of an analog control loop operating at 1MHz (for example), the clocking frequency of a digital controller would have to be significantly higher, which could then hasten the arrival of higher RF interferences with the RF PA in future systems.

Other advances, mainly in RF power device technologies such as SiC and GaN semiconductors, will have a greater impact on the overall efficiency of transmitters than digital power control. For now, converters with analog control such as the PAH450S series represent a solid option for powering analog PAs.

Power supplies needed for the PAs of next-generation base station applications are also faced with several other requirements. These include the ability to withstand extreme ambient temperature swings, compact size, and a wide output adjustment range to allow the user to optimize the amplifier's performance. TDK-Lambda's PAH450S series of 450 W dc-dc converter modules are designed to meet these demands. For

example, many cell repeaters are configured as three separate single-pole antennas, each 2 ft to 3 ft tall, mounted in a triangular configuration on a 200 ft to 300 ft tower. Each pole typically has a separate RF PA and dc-dc converter. A power bus is routed up the tower, and the wide input range spanned by the 48V version of the converter (36V to 76Vdc) is highly tolerant of the voltage drop that can occur along the length of the power bus, which can range from 6V to 7Vdc.

Posted by Power Guy