

Coreless Buck Converter Module Provides Efficient Point-Of-Load Power In MRIs And Particle Accelerators

[Powerbox](#)'s coreless technology platform is designed to power medical and industrial equipment operating in very high magnetic field environments such as magnetic resonance imaging (MRI) scanners and particle accelerators. Using the latest in high-frequency switching topologies and digital control with proprietary firmware to optimize efficiency and voltage regulation, Powerbox's GB350 buck-converter module is the first building block in its category that can operate safely when exposed to high radiation magnetic fields of 2 to 4 Tesla. The GB350 delivers an output power of 350 W and when higher power levels are required it can be paralleled using an interleaving mode thus reducing EMI (see the figure—it shows three modules paralleled.)

The GB350 is a multiphase buck converter with four interleaved phases. Each phase switches at 600 kHz, resulting in an output frequency of 2.4 MHz, which allows for easier filter and enables fast transient response. While the 600-kHz switching frequency is relatively low for a coreless inductor approach (recall Semtech's [SC220](#) 20-MHz buck regulator), according to Powerbox's Patrick Le Fevre, this choice of switching frequency was needed "to keep the EMI in a controlled spectrum." The unit also includes EMI shielding to lower radiated emission of the buck converter.

In its standard platform, the GB350 delivers a nominal current of 50 A and preset output voltages of 6.8, 3.3 or 1.6 V. As part of the Powerbox Custom Power Solution toolbox, other output voltages are available on request. In addition, there are several "variants" of the GB350 with different form factors.

While the company uses the term "standard" in describing the modules, the GB350 is more of a custom product than an off-the-shelf type. There's no data sheet per se, says Le Fevre and "all the projects for medical applications are 99.99% customized to fit the specific system." While the GB350 has been successfully applied in the MRI application, use of the GB350 in a particle accelerator application is still in the prototype stage, according to Le Fevre. But he adds that "our technology platform qualified and tested above the limits originally required" by a customer for the particle accelerator application.

Medical and industrial applications such as MRI scanners and particle accelerators (PAs) generate high magnetic fields to induce the RF energy required to activate the hydrogen nuclei in the case of imaging, or to accelerate particles in physics research and industrial equipment. Modern MRI systems usually generate 1.5 to 4 Tesla, making conventional power supplies using ferrite material for inductor and transformer cores useless due to inductance saturation as a result of the MRI magnet disturbing the energy transfer.

In such applications, to prevent parasitic saturation, power supplies are traditionally positioned outside the shielded operation room. Installing the power supplies remotely requires long cables with subsequent power losses, and it is also a big challenge to power the latest generation of measuring equipment that require stable and tightly regulated voltages under fast transient load conditions.

To reduce energy consumption and to guarantee the level of quality required by integrated equipment, systems manufacturers are now integrating local power supplies near the load. However, placing equipment directly in the radiated magnetic field requires an innovative power solution known as "coreless power units" and a state-of-the-art switching power stage.

Designed to respond to this demand and to guarantee the highest efficiency and tightly regulated output voltage under any load-condition, Powerbox's GB350 coreless power unit is fully controlled by a digital processor that manages the complete power unit from switching parameters (e.g. dead-time and duty-cycle optimization) to output voltage characterization. To guarantee a high level of flexibility for changing application requirements as well as software upgrades, the GB350's microcontroller can be programmed with optimized configuration files downloaded through the digital interface.

"Combining the latest technology in digital power and very advanced coreless energy transfer, the GB350 is an important component of the Powerbox Custom Power Solution toolbox," said Tomas Isaksson, chief technology officer at Powerbox. "With more than 3,500 custom power projects delivered to market, it is very important to rely on a strong platform portfolio, reducing time to market in demanding applications such as medical magnetic resonance imaging."

As part of Powerbox's Custom Power Solution Toolbox, the GB350 and products based on that technology are tested, verified and qualified in accordance to end customers' specifications.

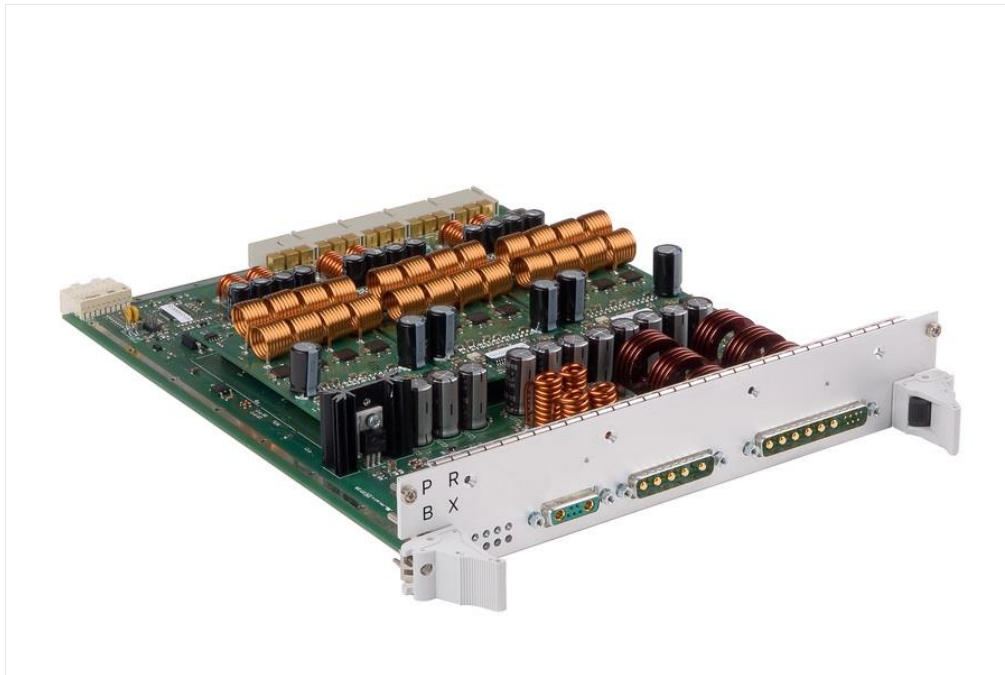


Figure. Powerbox's GB350 buck-converter module delivers an output power of 350 W while operating in the presence of high radiation magnetic fields of 2 to 4 Tesla. Target applications include MRI scanners and particle accelerators. Shown here is a three-phase coreless power supply that parallels three GB350 modules.