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Controller Accelerates Prototyping Of Wide-Bandgap-Based Power Converters

Imperix's B-Box 4 is described as the highest-performance Rapid Control Prototyping (RCP) system available for power electronics. Featuring a proprietary architecture optimized for low-latency operation, the controller delivers unrivaled control loop speeds and signal fidelity, according to the vendor. Thanks to such high performance, leveraged from the easy-to-use Cockpit software, the device is said to significantly accelerate experimental prototyping activities in both industrial and academic research environments (see the figure).

As SiC and GaN semiconductors are pushing switching frequencies beyond 200 kHz, legacy RCP architectures—developed in the era of millisecond-scale automotive control and kilohertz-scale industrial drives—are facing inherent bottlenecks, creating a performance ceiling that has become a hard limit for innovation. According to Imperiz, the B-Box 4 shatters this barrier, offering a high temporal resolution and low round-trip latency, characteristics that are key for research with wide-bandgap converters.

With the B-Box 4, the platform natively supports code generated from engineering software such as MATLAB/Simulink or PLECS, with performance figures that were previously achievable only through custom FPGA-based implementation. "With the B-Box 4, we are enabling researchers to obtain the same results from the CPU in one minute as previously from the FPGA in one hour," says Nicolas Cherix, head of engineering at Imperix.

The key to the B-Box 4's performance advantage lies in its I/O interfaces, which are fully dedicated to power electronics. In particular, the advanced analog frontend outperforms that of standard industrial targets by over one order of magnitude, says the vendor.

While competing platforms typically limit sampling rates to 1 to 2 Msps, the B-Box 4 samples all analog inputs simultaneously at 20 Msps. This captures the full high-frequency content of current ripple or medium-frequency waveforms, as opposed to conventional strategies that only retrieve one or two samples per PWM period. This significantly improves immunity to noise and perturbations, but also permits the direct visualization of waveforms without extra instrumentation.

Thanks to this oversampling, the B-Box 4 is not only a control system but also an agile monitoring and debugging tool, usable directly from the readily available measurements, at no extra cost.

The system offers a PWM resolution of 250 ps. This ultra-fine granularity is critical for ultra-fast switching applications, especially for techniques relying on phase shift control such as within medium-frequency converters.

From the sampling instant to the moment the PWM parameters are effectively updated, the B-Box 4 can execute the control loop of simple systems in under 2 µs, directly from the CPU. This makes automated code generation perfectly compatible with advanced performance requirements, says Imperix.

For engineers seeking performance beyond even this benchmark, programming the FPGA always remains possible—at no extra cost—by leveraging the embedded AMD UltraScale+ 7EV, which offers Kintex-grade programmable logic. The device also happens to be the largest FPGA programmable using a free Vivado edition.

In addition, the B-Box 4 is fully integrated into a comprehensive ecosystem of products designed to accelerate prototyping in power electronics. High-performance, factory-calibrated current and voltage sensors, alongside ready-to-use power modules, are available to quickly implement all sorts of laboratory prototypes. These products offer plug-and-play connectivity with the controller, while the most recent ones even support auto-configuration.

For industrial applications, guaranteed code portability with the B-Board PRO enables a seamless transition to a smaller, cost-effective and product-embeddable controller variant.

The B-Box 4 is available for shipping. For technical details, benchmarks and pricing, see the RCP Controller B-BOX 4 page.

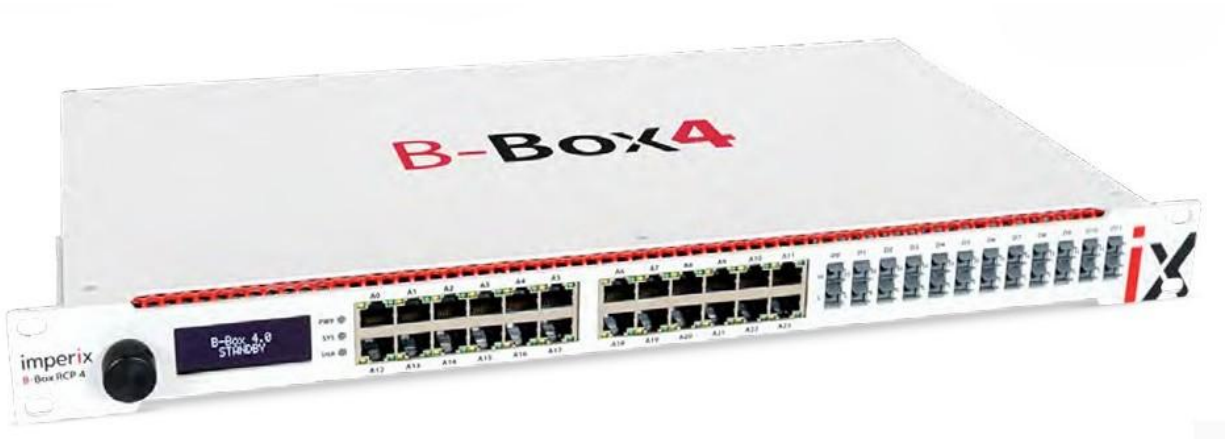

Figure. Thanks to its low latency CPU+FPGA architecture and bare-metal implementation, the B-Box 4 offers computing performance that was previously only obtainable with advanced custom implementations (such as on FPGAs). Total control delays down to 2 to 2.5 µs are now achievable, even with graphical programming approaches based on Simulink or PLECS.