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IVR Delivers 4.5 A/mm² In Chip-Scale Module

Ferric's Fe1766 is an integrated voltage regulator (IVR) designed to deliver high current density and fast transient response close to advanced SoCs. The device is a single-output, 16-phase interleaved buck converter with a fully integrated powertrain, including power inductors (Fig. 1). By placing high-bandwidth regulation closer to the processor load, including through vertical power delivery for kilowatt-class AI processors, the Fe1766 helps meet rapidly changing current demands while reducing voltage droop, voltage guardband requirements, and power-delivery footprint (Fig. 2).

As the vendor explains, for AI and LLM workloads, those improvements can translate into lower watts per token, better energy efficiency, or additional performance headroom. Its digital interface provides complete power management and monitoring with fast and precise voltage control, fast transient response times, and high bandwidth regulation.

In addition, its high switching frequency powertrain includes high-performance FETs and capacitors that drive the industry's most advanced power inductors, says the vendor, all in a single device. According to the vendor, its tiny size delivers the best-in-class current density; reducing board area, layout complexity, and component count.

Key specs and features include:

•90% peak efficiency for 1.8-V to 0.75-V conversion at 96-A output, and 89% efficiency at 160-A output, indicating nearly flat efficiency across high-load operating conditions

•Wide loop bandwidth of 5 MHz

•True point-of-load sensing

•Ganged operation of up to 64 devices for 10,000-A output

•Automatic phase shedding

•Input voltage, output voltage, output current and temperature telemetry

The system-level value of these specifications comes from their effect on voltage margin. With a conventional voltage regulator solution, the output of the regulator may be set to 800 mV to account for voltage droop under load transients. However, with the faster reaction time and reduced droop of the Fe1766, a user may be able to set the output to 720 mV (Fig. 3). Since dynamic processor power scales roughly with the square of voltage, reducing the rail from 800 mV to 720 mV could lower dynamic power by approximately 19%, says the vendor.

The actual system-level savings will depend on workload, leakage, frequency, and how much of the processor power is supplied by that rail. But for AI processors operating at hundreds or thousands of watts, even a portion of that savings can translate into lower energy per token, reduced cooling demand, improved datacenter TCO, or additional voltage headroom for higher performance, according to Ferric.

The Fe1766 also provides protection functions such as UVLO, OVP, OCP, and OTP fault response, a 1-MHz PMBus-compliant serial interface and a 50-MHz AVS bus-compliant serial interface enabling dynamic voltage scaling (DVS). The regulator is offered in a µLGA package with nickel-gold-plated pads.

According to Noah Sturcken, founder and CEO of Ferric, the Fe1766 achieves twice the output current density of the Fe1736 which was released last year. (See "APEC 2025: Industry Crafts Vertical Power Delivery Solutions For AI Processors".) The Fe1736 also achieves higher efficiency at max output versus the Fe1736—close to 90% at 160 A.

As another point of reference, according to Sturcken, voltage regulator solutions using integrated power stage modules from Infineon offer 2 A/mm² while achieving efficiency percentages in the low 80s. The '1766 switches at tens of megahertz per phase and with all phases interleaved, ripple frequency is effectively in the hundreds of megahertz, adds Sturcken.

The improved performance of the '1766 versus the '1736 mainly reflects the additional time spent optimizing the company's technology. Sturcken attributes the performance gains in the '1766 to subtle improvements in

the inductors, switches, decoupling caps and the design of the power delivery network at the input of the converter.

According to Sturcken, the '1766 enables customers to finally apply IVRs while improving both performance and economics. He adds that customers are saying they want this. "With conventional [lateral] power solutions, customers are resorting to spreading out instructions to the processor to avoid the voltage droop that crashes the processor."

The Fe1766 is sampling to AI processor developers. For more information, see the website or contact Ferric.

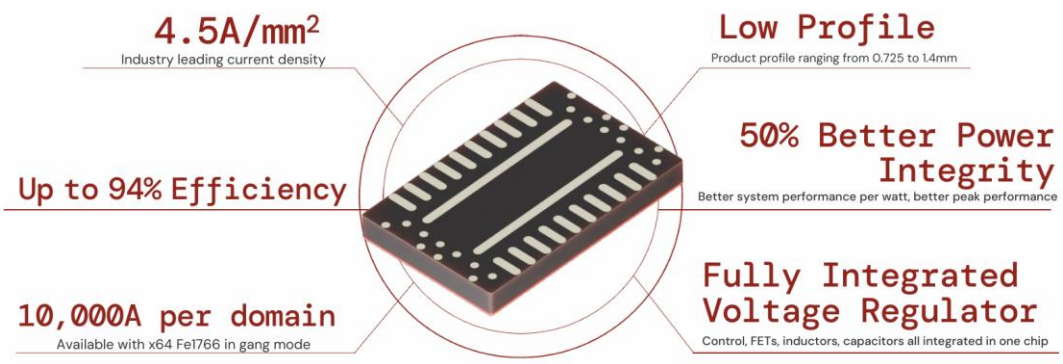

Fig. 1. The Fe1766 is a single-output, 16-phase interleaved buck converter with a fully integrated powertrain. A single module can deliver 160 A continuously, but up to 64 devices can be ganged together to deliver 10,000 per voltage rail.

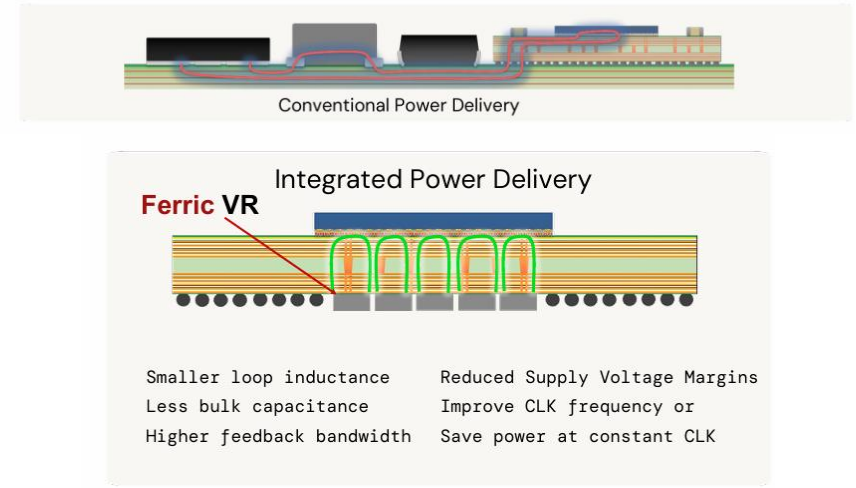

Fig. 2. Comparing the power path for a conventional VR solution with lateral power delivery to that of the Fe1766 IVR with vertical power delivery.

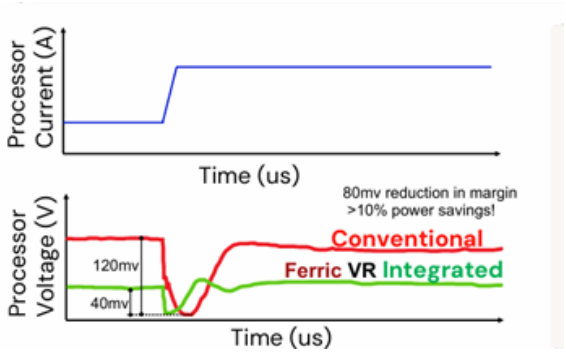

Fig. 3. Comparing the voltage droop of a conventional VR solution with lateral power delivery to that of the Fe1766 IVR with vertical power delivery.