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Two-Stage Conversion Redefines Distributed Power Architecture

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A two-stage power conversion architecture aimed at 48V systems has been gaining momentum with an intermediate voltage bus.

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The proliferation of multiple point-of-load (POL) converters on a board, as well as the drive toward lower voltages and higher currents, has further refined the distributed power architecture (DPA) popular in telecom and networking systems. As a result, a two-stage power conversion architecture aimed at 48V systems has been gaining momentum with an intermediate voltage bus. Because the POL can typically accept relatively wide input voltage and provides the needed regulation, this scheme does not require a tightly regulated intermediate voltage. Its popularity has attracted major power semiconductor players and module makers to join this fray.

While there is no one choice for the second-level distribution bus, which can range from 5V to 12V, the 8V unregulated bus is being touted as the optimum voltage. There are many factors, including cost and efficiency, guiding the selection of the intermediate bus. At the recent APEC 2003 in Miami, Fla., a paper entitled "Emerging On-Board Power Architectures," by Bob White of Artesyn Technologies, showed that 6V to 8V was an optimum range as far as the efficiency of POL dc-dc converters was concerned. If overall efficiency was taken into consideration, the same paper argued that 7V to 9V was an optimum range.

However, some argue that 12V bus offered a better tradeoff when it comes to minimizing distribution losses, as well as those in the POL converters. Many dc-dc converter manufacturers offer bricks with 12V output for 48V systems. And many voltage regulator modules functioning as POLs accept 12V input. Favoring 12V intermediate voltage bus solution, module maker SynQor has generated an isolated converter family, labeled BusQor, to provide unregulated 12-isolated Vdc intermediate bus to power myriad non POL regulators. Tailored for 48V systems,

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it can deliver up to 240W output power. Other 12V intermediate bus backers include Broadband Telecom, Datel, and Cherokee International. But, Datel also favors other voltages. However, Datel is not fixed on one voltage (**Fig.1**). Bob Leonard, Datel's marketing manager, suggests that depending on the applications, the optimum intermediate voltage can be determined. Hence, Datel is developing a number of product lines to address a variety of intermediate voltage buses.

Taking such factors into consideration, International Rectifier is betting on 8V intermediate bus voltage. As per IR's data sheets, 8V bus enables lower distribution losses as compared to 3.3V bus for the same power levels. Distribution losses can be reduced by approximately 82% for the same on-board power. Likewise, in comparison to 12V bus, the 8V bus cuts switching losses in the POL. Investigating iPOWIR data sheets, an 8V input voltage reduces power loss by 6.5% to 9%.

Toward that end, the power semiconductor giant has launched a new dc bus converter chipset as a complete front-end solution for a two-stage DPA architecture. It is targeting traditional 48V input, 150W board-mounted power converters. Delivering a 6:1 step down ratio, IR's seven-piece chipset solution slashes board space by more than half when compared to traditional quarter-brick form factors, and 25% compared to eighth brick format (**Fig.2**, on page 64). To ease design complexity and BOM costs, the dc bus converter chipset reduces component count in isolated converters from approximately 50 to 20. According to Carl Smith, IR's marketing manager for networking and telecom products, "The dc bus converter chipset architecture removes the need for a output at the intermediate stage, eliminating expensive feedback." Smith added that the chipset yields a dc bus converter that maximizes efficiency and power density, while achieving substantial reduction in parts count and size.

Unregulated Intermediate Bus

Comprising IR2085S control IC, two primary-side IRF7493 and two secondary-side IRF6603 HEXFET power MOSFETs, the primary-side bias IRF7380 and the secondary-side gate clamp IRF9956, the chipset delivers a nominal unregulated 8V at 20A at greater than 96% efficiency for POL converters (see the **table**).

At the heart of this dc bus converter chipset is the primary side control IC IR2085S. In a single SO-8 package, it combines a programmable 500-kHz oscillator operating at 50% fixed duty with a 100-V half-bridge driver IC with built-in soft-start circuitry. The integrated soft-start capacitor gradually increases duty cycle from 0% to 50% for 5 milliseconds to limit inrush current during startup. The controller maintains equal pulse widths for its high- and low-side MOSFETs throughout the startup sequence. To prevent transformer imbalance during operation, the low- and high-side pulses for the half-bridge are matched to within ± 25 ns. Other salient features of the controller include ± 1 A gate drive

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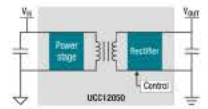


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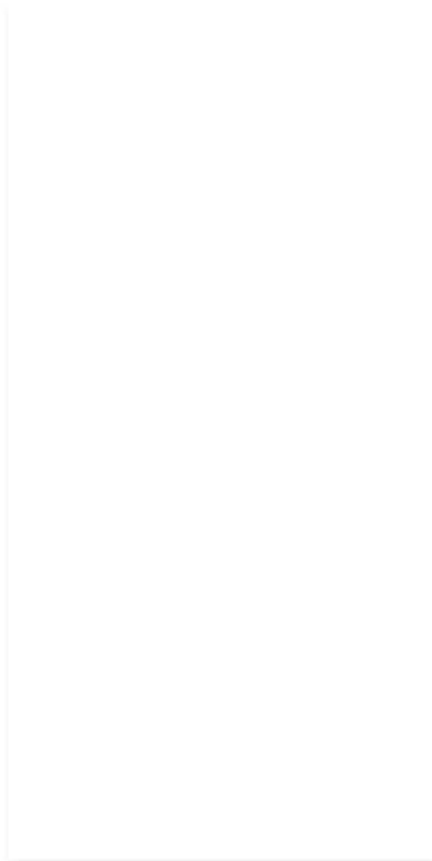
Only two external are required to independently adjust switching frequency and dead time. In addition, the controller employs novel high-voltage, high-frequency level shift technique with high dv/dt immunity to prevent unwanted turn-on of the lower MOSFET in the half-bridge enable faster switching speed.

On the primary side, the control IC drives the architecture's half-bridge consisting of two 80V-rated IRF7493 power MOSFETs. Housed in SO-8 packages, the MOSFET features low $R_{DS(on)}$ with a maximum of 15m Ω at 10V gate-source voltage. It offers a total gate charge of 31 nC. And 12 nC gate-o-drain charge for fast switching performance.

On the secondary side, two 30V-rated IRF6603 MOSFETs, each in a DirectFET package to minimize packaging resistance and inductance, are used in a self-driven synchronous-rectification topology. These thermally enhanced FETs feature an $R_{DS(on)}$ of 3.9m Ω (max) at 10V gate-source voltage. To deliver maximum current capability and efficiency, the IRF6603 offers a thermal resistance of 1°C/W.

While dual 80V MOSFET IRF7380 offers biasing voltage for the primary side control IC, the dual 30V MOSFET IRF9956 on the secondary side provides a 7.5V gate clamp for the synchronous rectification MOSFETs. Both, the IRF7380 and IRF9956 come in SO-8 packages.

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Sampling now, the dc bus converter chipset is slated to ramp up production next month. Meanwhile, the supplier has also readied an evaluation board, which demonstrates conversion efficiency of over 96% at 20A load current (**Fig.3**). In lots of 10,000, each chipset is priced at \$7.67.

International Rectifier, El Segundo, Calif., www.irf.com

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