Power Conversion

New Technologies and Business Strategies Merge to Meet Power Designers' Needs

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With the onset of the new millennium, unprecedented demand for power in all of its forms has spurred the creation of more options and choices for power architects than ever before. While the component power concept that broke new ground when it challenged traditional approaches is now mature, the power train architecture, enhanced for 2nd Generation DC/DC converters, continues to be the foundation for new products and new technologies.

2nd Generation products provide higher power density, improved heat and noise management, higher reliability and enhanced manufacturability.

Nevertheless, in the new e-business environment, new products and new technologies are not sufficient. New business strategies — embodied in software as expert systems — are needed to provide tools that give power designers more flexibility and control over the design and manufacture of their power solutions. Expert systems are facilitating and integrating design, ordering and manufacturing processes, enabling designers to have not just more control, but real-time control.

Power Train Architecture

The Zero Current Switching/Zero Voltage Switching (ZCS/ZVS) architecture largely determines the Vicor DC/DC converter attributes of high-efficiency, low-noise, robustness, high-power density and low-cost. What's more, the 2nd Generation of the ZCS/ZVS power train topology is at the heart of such new and unique benefits for the design engineer as wide output voltage trimming range and a fault-tolerant current-sharing architecture.

The unusually wide output voltage trimming range of +10 percent/-90 percent offers designers exceptional flexibility. A 12 Vout module, for example, can provide a trim range of 1.2 V to 13.2 V, while a module with 5 V, 400 W output can provide 3.3 V, 2 V, 1.2 V or even 0.8 V at 80 A. Wide output voltage range also offers designers the ability to create non-standard output voltages and to minimize the number of different models that must be purchased and stocked. For one-time resetting of the output voltage to a known value, fixed resistor trimming is useful. A typical example of this would be an application involving two similar output voltages, such as 5 V and 5.2 V, where it is advantageous to stock only one model type.

The power train topology also enables a number of features that simplify application in a redundant parallel array. The most significant of these include the ability to self-arbitrate the leadership role and a unique fault tolerant master/slave current share control scheme for power expansion and fault-tolerant applications.

In this current share control scheme, a synchronous pulse is used as a current-sharing signal that simplifies current-sharing control by synchronizing the high-frequency switching of each converter. It eliminates the need for current-sensing or current-measuring devices on each module, and, unlike some other current-sharing methods, load regulation is not compromised. A pulsed signal also makes AC-coupled single-wire paralleling possible. This gives designers the option to add capacitors or transformers between PR pins, providing DC-blocked coupling. Such coupling prevents certain failure modes internal to a single module from affecting the other modules in the array, thus providing an increased level of fault tolerance.

Technologies and Products

New technologies and products include 2nd Generation control and switching technologies (integrated in silicon),

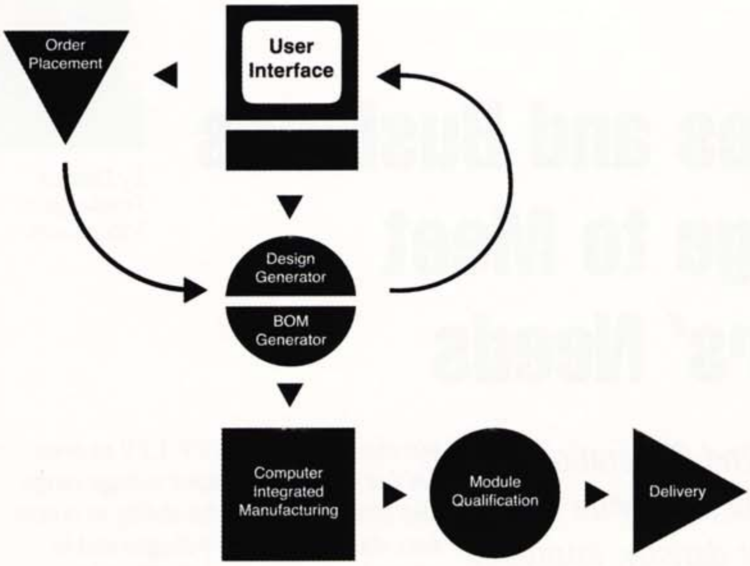

Figure 1. VDAC (Vicor Design Assistance Computer) Overview Diagram

the continued expansion of 2nd Generation converter families, and new accessory modules. In addition, a new power conversion architecture, called PowerStick™, was recently introduced to address the need for low profile, high density, board-mounted DC/DC converters.

Among the new benefits provided by the 2nd Generation were higher power density, improved heat and noise management, higher reliability and enhanced manufacturability. One of the keys to achieving these objectives was full integration of the control circuitry in silicon and the use of the space saved for improving the power processing components. The control functions and active circuitry were packaged into two integrated circuits that occupy a volume of only of a cubic inch, reducing the total component count from 113 to only 35. The resultant reduction of the total parts contributes to a reduction in cost per watt up to 50 percent.

In concert with the maturation of the component power approach is the availability of a broad and growing suite of complementary accessories that allow the building block concept to flourish. AC front ends, EMI filters, output filters, heat sinks, sockets, common mode chokes, differential mode chokes and Y capacitors make it easy to create a stable, reliable power system design.

The PowerStick is a new power conversion architecture that was specifically designed to address the market for low-profile, high-density, board mounted DC/DC converters. Featuring an above-board height of only 0.35″ and a footprint as small as 2.28″ × 0.5″, these converters deliver up to 75 W per module and up to 900 W in fault tolerant arrays. Innovative through-the-board mounting results in an effective power conversion density of 188 W/in^3. A wraparound aluminum body, available in a variety of options, provides integral cooling in a broad range of applications and thermal environments, allowing designers to achieve peak power density within the 0.35″ low-profile. All members of the family maintain the complete feature set of 2nd Generation converters. And, because they are environmentally sealed and encased in aluminum, they offer superior ruggedness, reliability, electrical shielding and noise performance.

Software Technologies/Strategies

Hardware technologies are important, but the real leverage comes from having complementary software (or expert systems) strategies that impart more control to the power designer. One example is VDAC (Vicor Design Assistance Computer), an Internet-based expert system for real-time automated design of DC/DC converters for users. This, and other expert systems, interact with CIM (computer integrated manufacturing) systems to give designers real-time feedback and control over the design and production of the finished product.

VDAC incorporates a web-based front end (see Figure 1) which, when used by the customer, activates the major elements of the system: back-end business systems, design generator, BOM (Bill of Materials) generator, automated manufacturing, test and delivery. In the front end, power designers enter design parameters (such as input voltage range, output voltage set point, output power and operating temperature) and mechanical variations (including package size, baseplate style and pin/interconnect option). Once all parameters are selected, the design's feasibility is checked. For a design to be determined feasible, the design generator must find at least three valid designs; if less than three designs are generated, an alternative solution is recommended. At this point a unique part number, price and delivery can be returned to the designer and stored in a password-protected account so that the product can be ordered at any time.

If a designer chooses to go forward and place an order for the unique DC/DC converter that complies with all of his/her specifications, a whole series of electronic behind-the-scenes steps occur. The first is that the design generator, in conjunction with the automated BOM database, is run "open loop". For the feasibility check, it was stopped after three valid designs were generated; now it will generate all valid designs. It is not uncommon that more than 2,000 designs are generated. Although each of these designs is feasible and incorporates available parts, the design generator will evaluate and rank each design and select the optimal. In the design selection process, component availability and qualification are, of course, taken into account.

The BOM, test parameters, test limits and work instructions are electronically fed to the CIM (Computer Integrated Manufacturing) system to direct the production of the product on fully automated manufacturing lines. These assembly lines are a closed-loop manufacturing process that ensures product consistency, repeatability, and traceability. The final element of the family of expert systems required to produce an optimal product quickly, predictably, and cost effectively is DIVA (Device Introduction Verification and Analysis). DIVA is an automated test system used to electrically and thermally qualify DC/DC converters.

When the design has completed the DIVA qualification test, the product is shipped to the customer, normally within six weeks from the time of ordering. At this time, the power designer has received a "custom" product without the long lead times and high costs normally attributed to custom products.

Reprinted from **ECN** March, 2001

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