

## Component Power Solves Unique Military Problems

Instead of designing custom power supplies, military users can turn to modular component power supplies that are more cost-effective. There are even interactive design tools for semi-custom DC/DC power components available on the Internet.

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The power needs for the military and defense markets have been, and will continue to be, unique, perhaps even more so than for many electronic OEM applications. In the commercial world the preferred solution for a unique requirement—especially when high quantities are involved—has traditionally been the custom power supply. But, a custom power solution means long lead times, high initial non-recurring costs, the high risk of a new, unproven design, and an inherent inflexibility to change.

Military and defense applications, however, often do not have sufficient quantities over which to amortize the cost, nor do they have the ability to tolerate the time and expense associated with the qualification effort needed to verify the power unit over environmental, quality, thermal, and noise performance metrics. Still, manufacturers have striven to meet these unique power requirements while avoiding the downsides of a custom solution by offering a multiplicity of power component-based solutions. In general, they fall into three classes:

- Power modules with discrete components
- Configurable power solutions
- Quasi-custom power solutions

### Power Modules with Discrete Components

As in the commercial marketplace, high-density component power and distributed power have earned acceptance in military and defense applications where high performance, reliability and low cost are critical. DC/DC converter modules (Figure 1) are power components, commonly referred to as “bricks”, that are available in a range of sizes and formats (for example, half bricks, quarter bricks, and so on). Manufacturers of high-density DC/DC converters are providing power system architects with a wide range of choices.

These converters—usually characterized by high-frequency operation, allowing them to achieve their small size, high-power density, and efficiency—come in thousands of combinations of input voltage, output voltage, and power level. Such a modular DC/DC converter, in combination with discrete components, can satisfy many unique power requirements. Because each module is a proven performer, pre-qualified with its own agency approvals, designers using these converters enjoy an advanced starting point toward a finished power supply.

Typical input voltages shown in Table 1 include 12, 24, 28, 36, 48, 50, 72,

150, 270, 300 and 375 VDC, although only a few manufacturers address such a wide range. Typical output voltages shown in Table 2 include 1.8, 2, 2.5, 3.3, 5, 12, 15, 24, 28, and 48 VDC. Contributing to the ability of power components to satisfy even unusual output voltage requirements, most DC/DC converters



Figure 1

DC/DC converters come in a number of physical sizes and a wide range of input and output voltages and power levels that, when combined with discrete components, satisfy a multitude of requirements. Shown in the photograph are 2nd generation DC/DC converters in three sizes (full-, half-, and quarter-brick).

## On The Rugged Side

Nominal Input	Range (DC)	Typical Application
12 VDC	8 V – 15 V	Industrial; Transportation
24 VDC	18 V – 36 V	Telecom remote; Industrial
28 VDC	16 V – 40 V	Defense, airborne & ground mobile
36 VDC	21 V – 56 V	Telco central office; Industrial
48 VDC	36 V – 72 V	Telco central office
50 VDC	40 V – 60 V	Distributed power from 48V supply
72 VDC	55 V – 100 V	Transportation
150 VDC	100 V – 200 V	Off line 120 Vac; Transportation
270 VDC	160 V – 400 V	Defense, airborne
300 VDC	200 V – 400 V	Off line, autoranging
375 VDC	250 V – 425 V	Off line, PFC

**Table 1**  
Traditional Input Voltages

Output Voltage (DC)	Application
24 & 48 V	Telecommunication bus distribution
28 V	Aircraft bus distribution
12 & 15 V	Common analog voltages
1.8, 2.0, 2.5, 3.3 & 5 V	Popular logic voltages

**Table 2**  
Traditional Output Voltages



**Figure 2**

One example of a configurable power supply is this power factor corrected AC/DC switcher which provides up to 2,400 Watts and as many as 16 isolated outputs.

can be trimmed, some as much as -90 to +10% of the nominal output.

In the beginning, designers had to supplement the capabilities of modular DC/DC converters by using discrete components to implement auxiliary power system features such as AC/DC rectification, filtering, power factor correction, and so on. That option is still open to them, but now, specialized accessory components are increasingly available. Together with the DC/DC power components, these matched, compatible accessories—such as filters, holdup capacitors, heat sinks, and AC front ends—allow users to quickly assemble complete power systems by selecting and interconnecting standard, modular parts to meet their design requirements.

Compatible front-end accessories, for example, provide a number of performance features such as input transient

protection, EMI filtering and inrush current limiting. In addition, they have international agency approvals and can accommodate the wide range of input source voltages necessary to reach worldwide defense markets.

DC/DC converters intended for military use typically satisfy U.S. Department of Defense (DoD) definitions for non-development items (NDI) and commercial off-the-shelf (COTS) equipment. They meet key military performance specifications for input power quality (MIL-STD-704, -1275, -1399), EMI levels (MIL-STD-461), environmental requirements (MIL-STD-810, -202), and component derating (NAVMAT-P-4855-1A). Full encapsulation of the “brick” package enables the modules to meet severe environments of humidity, fungus, salt fog, explosive atmosphere, acceleration, vibration, and shock.

### Configurable Power Solutions

As with the power components, configurable power supplies are flexible pre-designed power solutions. Using configurable power supplies usually provides the fastest solutions because pre-configured chassis are already on the shelf, ready to be populated with application-specific modules. They are also very cost-effective with no NRE and are inherently low risk.

In a typical package configuration (Figure 2), the designer selects the chassis appropriate to their input requirements and the total power level needed. A wide variety of slide-in DC/DC converter module cards are available with configurable output voltages and currents. Module cards can be easily added or replaced, allowing the user to alter the system to meet changing or expanding needs. Individual module cards can provide up to 600 Watts of power and can be combined in parallel for even higher powers. Complete systems may be configured at the factory or, in many cases, on-site by the user.

Another configurable solution, specifically designed for military applications, meets the conducted emissions and susceptibility requirements of MIL-STD-461 and offers complete input transient, surge and spike protection to MIL-STD-

1275 and MIL-STD-704. Additionally, the system provides input reverse polarity protection and input over/undervoltage lockout, providing additional safeguards against potentially damaging abnormal line conditions.

### Quasi-Custom Power Solutions

Complete turnkey custom power solutions are provided by manufacturers and value-added resellers who make it their business to design, develop, and manufacture complete power solutions using high-density DC/DC converter modules. These manufacturers use component power in a modular, building-block design approach that offers low cost, quick turnaround, and reliable performance. Because they employ power components at the heart of the design, they are here termed quasi-custom power solutions rather than full custom power solutions.

The use of standard high-density DC/DC converters and other modular components rapidly satisfies the basic power system functions. The balance of the effort quickly shifts to the system level mechanical, electrical and thermal design elements required to effectively integrate the component-based power system into the specific application.

An excellent example of a complete quasi-custom power solution is shown in Figure 3. This 28 VDC input, 168 Watt

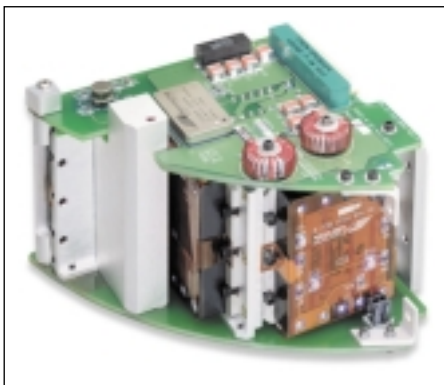


Figure 3

Quasi-custom power solutions also employ the full range of available power components, but this approach is completely unrestrained with respect to unique features, form-factor, and packaging.

## Interactive Design Tools Simplify DC/DC Converter Design

The VDAC (Vicor Design Assistance Computer) consists of a family of expert systems including (Figure 1) Design Generator, BOM (bill of materials) Generator, Computer Integrated Manufacturing, and Module Qualification.

Power designers enter design parameters (inset in Figure 1)—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, at least three designs must be possible; if the design is determined not to be feasible, 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 place an order for a DC/DC converter, the Design Generator, in conjunction with the BOM database, determines up to 2000 potential

designs. Although each of these designs is feasible and incorporates available parts, the Design Generator then ranks each design based on performance characteristics and selects the optimum design. In the design selection process, component availability and qualification are, of course, taken into account. The bill of materials, 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.

The CIM automated assembly line is a closed-loop manufacturing process that ensures product consistency, repeatability, and traceability. The final element of the family of expert systems is module qualification. Module qualification is performed on dedicated ATE and consists of the measuring and recording of all critical parameters over line, load, and temperature. When the design has completed qualification tests, the product is shipped to the customer.

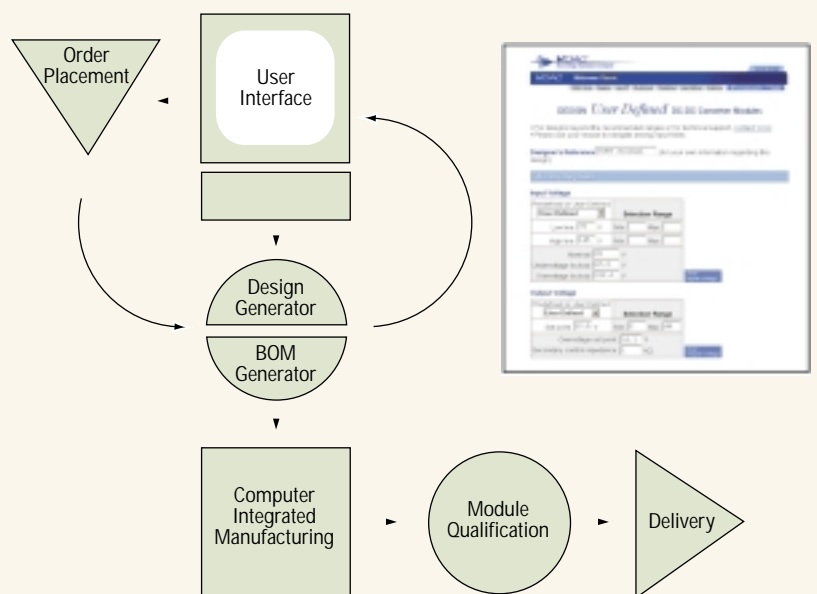


Figure 1

VDAC (Vicor Design Assistance Computer) Overview Diagram.

## On The Rugged Side

output DC/DC power supply utilizes two standard converter modules and one input filter attenuator module. It powers logic circuitry for a missile guidance and control system.

### **New Paths to Unique Solutions**

The three levels of integration discussed so far are the prevalent approaches to achieving unique, cost-effective power solutions with minimum risk. A few manufacturers, however, are implementing new ways to achieve custom designs without incurring the penalties of long lead times or added cost.

One web-based system, for example, enables customers to specify on-line, and verify in real-time, the performance and attributes of custom DC/DC converters (see sidebar: Interactive Design Tools Simplify DC/DC Converter Design). This expert system accepts user-specified converter performance requirements and generates an optimal design utilizing an extensive database of pre-qualified components. This design is downloaded directly into a computer-integrated manufacturing (CIM) system. By offering a

direct link into the mass customization capabilities of an automated design and manufacturing environment, this system frees power specifiers from having to compromise between standard products—which only partially meet their needs—and custom engineered products, with their long cycle times and performance uncertainties.

Another automated design tool for configurable power supplies allows customers to specify, verify, and order—online and in real-time—configurable power supplies. They can choose from available input voltages, output configurations, thermal features, mechanical configurations and an optional power-up/power-down sequencing feature to design custom power solutions—all at standard lead times and standard prices.



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