The Dissolution of Standard Vs Custom Component Power Constraints

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Traditionally, most OEM power system requirements have been met by custom power supplies designed and built using discrete components to serve a specific application. While that approach is still common, power component based systems are making inroads and will likely dominate in the next ten years. But power components are available only in a finite number of input voltages, output voltages, power ratings, package sizes (see Figure 1) and feature sets. Power engineers have been constrained — plagued might not be too strong a word — by manufacturer distinctions between “standard” and “custom” power component specifications. A custom power component product carries the same penalties and risks as the traditional discrete design: non-recurring charges, long lead times, and the uncertainties of a new, unproven product.

Figure 1. High-density DC-DC converters (bricks) come in full-, half-, and quarter-brick packages. The smallest module shown here measures 2.28 x 1.45 x 0.5 in (57,9 x 36,8 x 12,7 mm) and has a maximum output power of 150 Watts.

Nevertheless, the power system needs of electronic OEMs continue to be unique, and power components solve an increasing number of contemporary problems — fueling demand for custom solutions within the context of component power.

What's the Problem?

The major product specifications that define a power conversion component as a "standard" or a "custom" are the nominal input voltage, the operating input voltage range, the output voltage set-point, and the maximum output power of the module.

Input Voltages. Power component manufacturers have traditionally offered a defined set of input voltages designed to address specific application segments (see Table 1) within the electronics market.

While these input voltages address a significant cross-section of requirements, the limitations placed on engineers by the operating ranges often cause hardships. Spikes on the line that exceed the maximum input voltage rating can cause module failure. Low inputs due to line sags or low battery voltages can cause the output from the module to drop or can shut down the module completely.

Table 1. Traditional Input Voltages

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

Extending an input range often necessitates a major re-design of the converter, leading to non-recurring engineering charges and long product development times, and would probably restrict the maximum available output power of the module. Also, any change made to the input voltage range can negatively impact the line regulation performance, especially with respect to the module's input transient response specification.

Output Voltages. As with input voltages, DC-DC converter output voltages have been traditionally offered as a finite set of "standards" (see Table 2).

Table 2. Traditional Output Voltages

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

With this set of standard output voltages, many system requirements can be met. However, an application may require a slightly higher or lower output voltage to compensate for voltage drops to the load, to power a unique set of semiconductors, or to distribute a unique bus voltage.

Such output voltage requirements can often be achieved by output voltage trimming using an external resistor trim network. Trimming the output of a DC-DC converter, however, can produce undesirable effects, such as reduced efficiency and instability in the converter's control loop.

Alternatively, the converter manufacturer can change the output voltage set-point by making an internal modification — called a "modified standard" or "semi-custom" design — to the device. Most manufacturers typically entertain such requirements only when the potential for significant volume exists, and even then, charge for non-recurring engineering. Moreover, these "modified standard" designs often prove to be more challenging to design and manufacture than the converter company originally anticipated, causing unexpected delays in product qualification and delivery as well as performance compromises.

Output Power. Just as power component manufacturers offer standard input voltages and output voltages, companies likewise offer standard output power ratings. And because there is a direct relation between output power and the input voltage range and output voltage of the converter, any change made to these parameters usually affects the maximum output power capability of the device. As a result, most power converter companies have substantial "holes" in their product lines. Component manufacturers often don't offer certain input/output combinations or, if they do, offer them only at particular (usually reduced) power levels.

Dissolution of Standard Vs Custom

A number of trends impinge on the issue of standard versus custom. Fast time to market, a significant advantage for component power, continues to increase in value. Other trends in the marketplace include increasing pressures for lower prices, higher reliability and greater availability. Perhaps the most significant trend of all, however, is the growing application of intelligence in the design and production process. These and the pervasive use of the Internet — all in the face of undiminished demand for custom solutions — are some of the reasons for and the basis of new expert systems that will lead to the dissolution of standard versus custom component power constraints.

The complete dissolution of the distinction between standard and custom is at hand. Mass customization of optimal products is possible using databases of actual hardware platforms and components in combination with the automated factory. Intelligence and engineering experience accumulated with each hardware platform can be distilled into a set of algorithms that assess and compare each viable solution to a customer requirement.

Such expert software systems are already being used to impart more options 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 computer integrated manufacturing systems to give designers real-time feedback and control over the design and production of the finished product.

VDAC consists of a family of expert systems including Design Generator, BOM (bill of materials) Generator, Computer Integrated Manufacturing (CIM), and Module Qualification.

Power designers enter design parameters (see Figure 2) — 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 output at least three valid designs; 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.

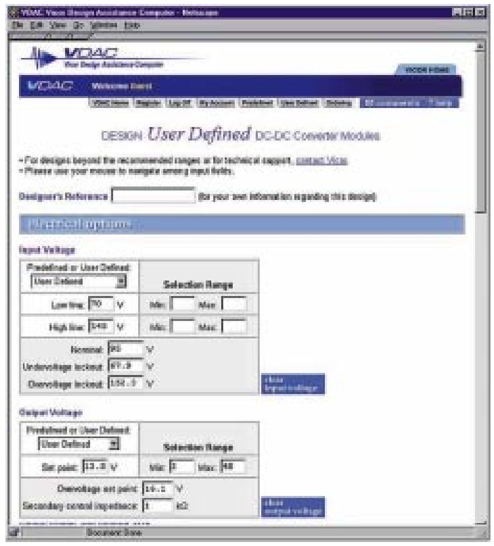

Figure 2. On-Line Product Specifier tool responds to parameters specified by the designer.

If a designer chooses to place an order for a DC-DC converter, the Design Generator, in conjunction with the BOM database, determines all valid designs which, in some cases, can be up to 2,000 unique variations. Although each of these designs is feasible and incorporates available parts, the Design Generator will rank each design based on performance, reliability and thermal characteristics and will select the optimal design. The bill of materials, test parameters, test limits and work instructions are electronically fed to the CIM system to direct the production of the product on fully automated manufacturing lines.

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 major parameters over the full range of line, load, and temperature. When the design has successfully completed qualification tests, the product is shipped to the customer.