

# Power Supplies & Converters

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# ATE, DPA, and Bricks: An Auspicious Alliance

By Robert Marchetti

Automated testing continues to become more complex and sophisticated to keep pace with the systems that must be tested. Similarly, power systems manufacturers are introducing new technologies, improved products, and even new architectures for the same reasons. Nevertheless, the proven combination of distributed power architectures and bricks continues to serve the automated test equipment marketplace well.

Distributed power architecture (DPA) is important in ATE applications because — unlike, for example, a centralized power architecture — it enables the converter to be placed close to the

load. Such an arrangement minimizes noise, eases regulation, gives greater dynamic performance, avoids inductance problems associated with long leads, and minimizes the need for sense lines. With DPA (Figure 1), the ability to partition the load improves thermal management (more surface area for cooling with more modules), provides higher reliability, and helps to lower noise.

The development of high-density bricks (Figure 2), which actually enabled the emergence of distributed power architecture (DPA), also brought some brick-specific advantages to ATE systems such as isolated, regulated power at the point of load. Typically, power in a DPA system

or be mounted on cold plate rather than resort to the use of fans, notorious for their lower MTBF and consumption of valuable space.

## Simplified thermal management

ATE is becoming extremely dense with tight board spacing that requires, in turn, low-profile power converters that often produce more heat in a smaller space.

The efficiency of bricks is not only higher than discretized but predictable, which contributes to simplified thermal management. Design considerations include using innovative cooling or thermal management techniques and optimizing efficiency. Brick baseplate designs, mentioned earlier, simplify removal of heat with cold plates or heatsinks. Careful designers observe also that some converters have peaky efficiency curves, achieving best efficiency only in a narrow band, e.g., 80% of full load while other converters have efficiency curves that are flat across the full operating range, e.g., 40% to 100% of full load. And, of course,

DPA partitions the load, spreading the heat more evenly through the system.

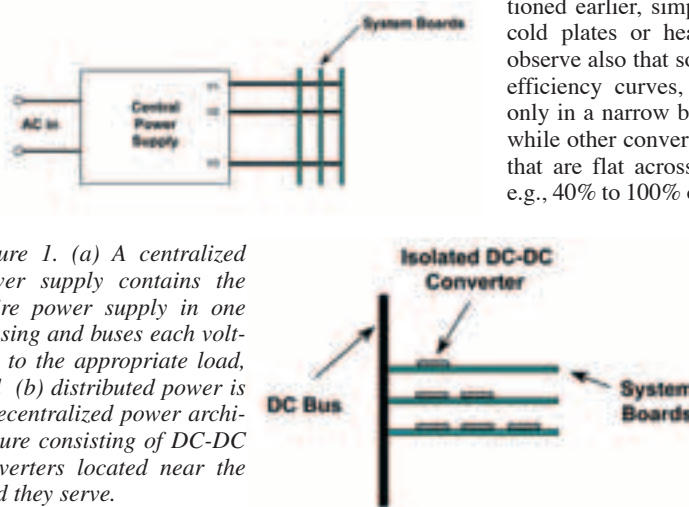
## Low noise

All DC-DC converters generate common mode, differential mode, and radiated noise, and many ATE applications are especially vulnerable to

noise.

Noise (electromagnetic interference, or EMI) can vary widely among DC-DC converters from supplier to supplier and topology to topology. The reasons for this are diverse, but they include fundamental differences in the way noise is produced. A major difference, for example, between fixed frequency pulse-width modulated (PWM) and variable frequency zero-current, zero-voltage switching (ZCS/ZVS) converters is the noise generated by the switch. Among other reasons (because ZCS/ZVS converters have sinusoidal waveforms rather than square waveforms), the lack of sharp edges and lower harmonic content results in much less excitation of the parasitic elements, resulting in far less noise.

Figure 1. (a) A centralized power supply contains the entire power supply in one housing and buses each voltage to the appropriate load, and (b) distributed power architecture consisting of DC-DC converters located near the load they serve.



is distributed on a 48-Volt bus. On-board isolated DC-to-DC converters are matched to the load requirement. This helps with dynamic response and eliminates the problems associated with distributing low voltages (and the concomitant high current) around the system.

The combination of distributed power architecture and high-density bricks significantly contributes to satisfying the needs of automated test equipment in terms of less rack and floor space, simplified thermal management, low noise, fast transient response, and multiple power sources.

## Less rack and floor space

The introduction of high-density power components — bricks — brought unprecedented flex-

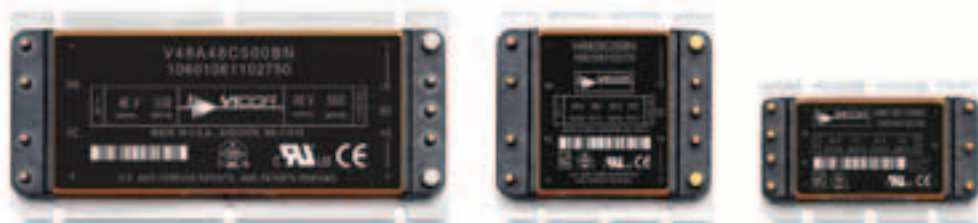


Figure 2. High-density DC-DC converters come in thousands of combinations of input voltage, output voltage, and power level. The smallest module shown here measures 2.28 x 1.45 x 0.5 in (57.8 x 36.8 x 12.7 mm) and has a maximum output power of 150W.

ibility and creativity to power system development with options to implement power architectures never before possible. High-density power components simplified the design of distributed power solutions, but they also put more power in smaller packages.

Not unlike those who design many other electronic systems, designers of ATE systems strive to minimize rack and floor space. High-density bricks help achieve such design objectives with more power per cubic inch than any other power device.

Generally, because the bricks — as well as their associated AC-DC front ends and filters — are highly engineered and often use high switching frequencies, they result in power solutions with higher efficiencies than discrete designs. Efficiency means more power in the same space without compromising effective thermal management. In many situations, because of the baseplate design, modular designs can use heatsinks

provide detailed application notes and offer the assistance of a knowledgeable, experienced and easily accessible applications engineering staff.

In addition, some DC-DC converter suppliers also offer AC front ends and EMI filters as modular accessories. These filters not only save time; they are a means of risk prevention as well. The EMI filter is designed to work with the supplier's converter modules, and, assuming proper layout, the combination is certified to meet the specified EMC directives.

## Fast transient response

Some ATE systems have demanding transient response requirements that are difficult or impossible for a power converter. In fact, most power converters are severely challenged to meet such requirements. The transient response of some DC-DC converters vary significantly and should be evaluated carefully if the application requires demanding transient response.

In a centralized power architecture, accurate voltage regulation to loads at varying conductor lengths from the supply can be very difficult and expensive to accomplish effectively. Long conductor paths add inductance that slows transient response to rapidly varying loads.

Shorter conductor paths in distributed power architectures greatly reduce inductance and improve transient response. With DC-DC converters located close to the load, output voltage regulation is much simpler.

## Multiple power sources

A typical ATE system might use several power supplies, each requiring different power and/or performance requirements. Some tests require that the test system be capable of changing voltages quickly, others need high accuracy for precision trimming needs, while others need only simple DC power requirements.

While the availability of thousands of bricks make it easy to meet ATE system needs, high-density power components also simplify partitioning and provide additional advantages. Some modern converters, for example, can be trimmed or programmed from 10% to 110% of their output voltage set point using fixed resistors, potentiometers, or voltage DACs. A 12Vout module, for example, can provide a trim range of 1.2V to 13.2V, while a module with 5V, 400W output can provide 3.3V, 2V, or 1.2V at 80A.

In some cases, this wide output voltage trimming range can be exploited to achieve creative design solutions. Voltage margining, for example, is used to provide functional and parametric test for design verification and production final test. Resistors can be varied using solid-state switches under control of the system to adjust the output voltage +10% and -10% to check system margin levels.

With such a wide range of output voltage, it is conceivable not only that all of the converters in a distributed system have the same footprint and pinout, but also that they have the same nominal output voltage as well.

With distributed systems, the level of partitioning is unrestricted. It is possible to go from card-level conversion to one module powering several cards. Generally, certain tasks — such as thermal management, hot-swapping, and mechanical design — become simpler as the number of load partitions increases. In addition, if the load is partitioned to the card level, power system assembly is easier, and the DC supply bus design is simplified.

## Low cost

Any designer of power solutions for automated test equipment is certain to be challenged to reduce the cost of testing, if not to reduce system cost. Bricks and DPA are not known for being low-cost solutions. Nevertheless, the use of DPA and bricks can significantly reduce design costs, time to market, and improve reliability, factors that should be considered in the total cost of a power system.

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