

Disaggregated DC/DC Converters: A Growing Trend?



by Robert Marchetti, Vicor Corp.

In the early 1980s, the introduction of modular, high-density, DC/DC power converters enabled the popularity of Distributed Power Architecture (DPA) which overcame some of the problems of centralized power systems.

These modular converters, now called bricks, delivered — and they are still delivering — all of the functions of a classic DC/DC converter: isolation, voltage transformation and regulation at the point of load. When the number of on-board voltages increases, however, DPA solutions naturally require more bricks, replicating full converter functionality and exacting a penalty in terms of board space and cost. Perhaps more significant, the power conversion topologies used in conventional DPA bricks are not typically up to meeting the transient response requirements of today's demanding loads.

The Intermediate Bus Architecture (IBA) was introduced to address some of the problems of DPA. It disaggregates the DC/DC converter functions by using an isolated Intermediate Bus Converter (IBC) to transform the input bus voltage to provide a common voltage from which a number of niPOL (non-isolated Point-of-Load) buck regulators may be powered to regulate their respective loads. Because the niPOLs are inexpensive, IBA improved on the DPA power distribution architecture from a cost and complexity perspective for contemporary systems in certain end markets.

A second DC/DC converter architecture takes decoupled functionality a step further. Factorized Power Architecture (FPA) breaks power conversion into flexible and scaleable power building blocks. One is a current multiplier module that provides transformation and isolation. Another module provides a regulated non-isolated

output voltage — a 'factorized bus' — from an unregulated input source.

A third disaggregated DC/DC converter is a new modular power platform that incorporates the technical attributes underlying FPA and the robust packaging of the brick. Using this new brick, one of the most useful attributes of disaggregated DC/DC converters — their design flexibility — is demonstrated by considering various configurations of the two elements to produce cost-effective power solutions. The robust "brick-like" package is specifically designed for efficient thermal management.

Depending on the requirements for voltage regulation, load current, system cost and other factors, the two brick modules facilitate a range of design configurations that include multiple outputs,

high power arrays, high-current/low voltage, high voltage and separation of regulation and transformation for optimal board space utilization and thermal management. One brick, the voltage transformation module (VTM) is a current multiplier, and it provides voltage transformation

and isolation. The other, the regulator module (PRM), provides regulation. Both are shown in Figure 1.

Figure 2 shows a few of the ways designers can use these new bricks. The simplest configuration of the regulator module and current multiplier, as shown in Figure 2a, provides DC/DC conversion with the current multiplier providing isolation and transformation at the point of load. The PRM, which can be collocated with the VTM or located a distance away from the VTM, provides regulation. In a variation of this simplest configuration, shown in Figure 2b, the output voltage of the VTM can be controlled with a choice of methods. The local-loop control method, connected to A, regulates the Factorized Bus voltage. The adaptive-loop control method, connected to B, improves regulation to within 1 percent. The remote-loop control method, connected to C, improves regulation to within 0.2 percent.

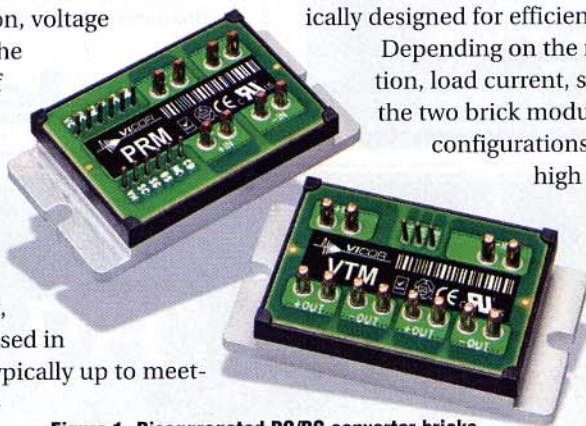


Figure 1. Disaggregated DC/DC converter bricks.

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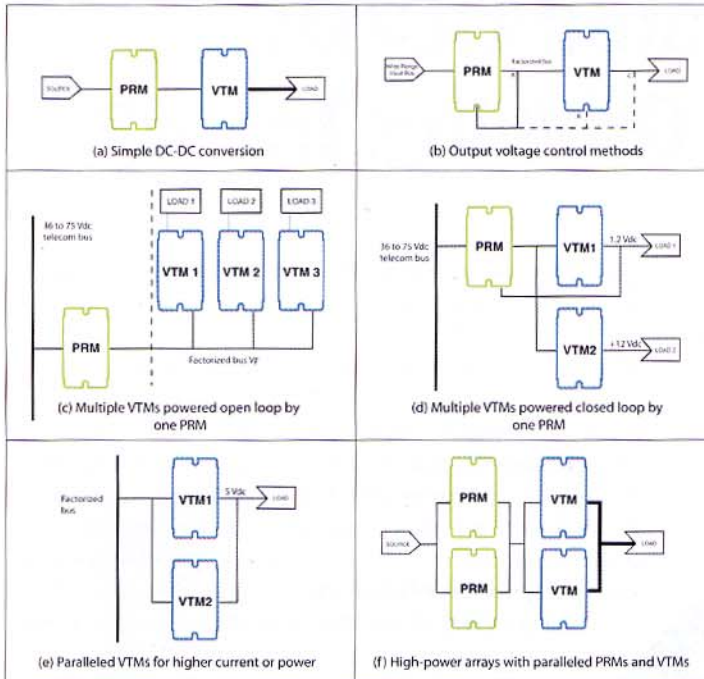


Figure 2. Decoupled functionality increases power designer flexibility.

In another configuration, Figure 2c shows a low-cost, high-density power system that uses one PRM to power multiple VTMs in open loop to generate multiple supply voltages. It is also possible to operate one of the VTM's closed loops, as shown in Figure 2d, with the PRM for the tightest voltage regulation at that load. The voltage regulation of the other VTMs will follow that of the VTM operating closed loop.

As shown in Figure 2e, VTMs can be paralleled for applications requiring higher current or power. Likewise, PRMs can be paralleled, as with VTMs in Figure 2f, to create high power arrays such as multi-kilowatt power systems.

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