Configuring the BUS CONVERTOR MODULE (BCM) with low power niPOLs

This Application Note describes basic design practices for using Vicor's Bus Converter Module (BCM) as an Intermediate Bus Converter (IBC), providing a bus voltage to non-isolated Point-of-Load converters (niPOLs).

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The focus of this article is on power systems of 300W or less (multiple BCM configurations will accommodate higher power levels). Let's first review the differences between a Distributed Power Architecture and an Intermediate Bus Architecture. Figure 1 shows a typical distributed architecture in which a 48V bus provides power to dc-dc converters. Depending on the application, this distribution system may have some drawbacks.

Multiple isolated dc-dc converters duplicate the isolation function and consume an excess of valuable pcb real estate. If niPOLs are used, their efficiency in converting 48V to voltages of 5V or less is typically in the 70% range.

Figure 2 shows an Intermediate Bus Architecture (IBA) in which the 48V bus is again used, in this case to power a Vicor 48V to 12V (K=1/4)BCM. The K=1/4 refers to the fixed ratio or voltage transformation ratio of the BCM. The IBA approach has some advantages over the 48V distribution scheme shown in Figure 1, but this advantage can be application dependent.

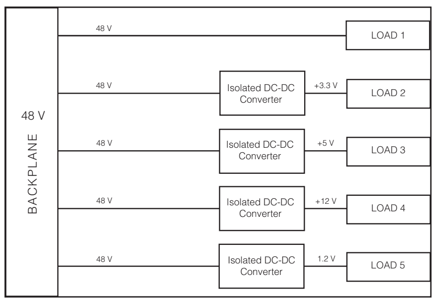

FIG.1 Typical distributed power architecture.

The niPOLs within IBA forego isolation and high-ratio voltage transformation in order to improve cost effectiveness and they depend upon a nearby bus converter to supply isolated power at a low voltage.

The 48V to 12V (K = 1/4) BCM can be placed at the power entry point on the board. This will provide safety isolation from the higher 48V backplane voltage as well as free up board space at the point-of-load. The system architect needs to take into account the lowest BCM input voltage and the negative impedance of the niPOLs when determining the number of niPOLs a BCM can drive. This precaution is necessary to ensure that the BCM will not be in current limit during startup or low line conditions.

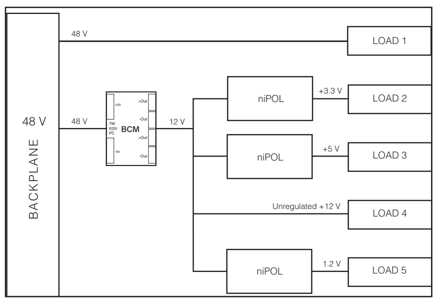

FIG.2 Typical intermediate bus architecture.

Summary

IBA separates the dc-dc converter functions of isolation, transformation, and regulation and allocates them to two devices. In figure 3, the BCM provides voltage transformation and isolation, and the niPOL converter provides the tight load regulation. High system efficiency is maintained because of the exceptionally high conversion efficiency of the BCM along with the reduced stepdown ratio required by the niPOL. Efficiency above 95% for the BCM is realized because the BCM does not regulate output voltage, it provides a fixed-ratio output. IBA systems use less board space than an isolated brick converter solution by eliminating multiple isolation barriers included in isolated converters.

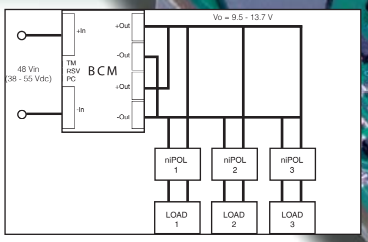

FIG.3 The input range to the BCM is 38 – 55Vdc which corresponds to an output range of 9.5 – 13.7Vdc.

The small size of niPOL converters complement today's high density packaging designs, with vertical-mount versions presenting a very small footprint while making effective use of forced-air cooling. Fast load transients are handled effectively by the niPOL converters since the niPOL can be placed very close to the load. This also reduces the possibility of noise injection in other circuit functions on the same board. If appropriate consideration is given when partitioning the system loads for operation from niPOL converters, power up sequencing may be tailored to each circuit section or load device. Additionally, there can be fewer board layers because multiple voltages no longer need to traverse the entire board. BCMs inherently support current-sharing, allowing parallel operation without additional control circuitry or interconnects. The BCM uses a new power conversion technology called Sine Amplitude Conversion (SAC), which provides the capability of realizing higher efficiency, greater power density of 1095 W/in3 (compared to 168 W/in3 in a quarter brick) and faster transient response.

Pictured is a comparison of a typical open frame quarter-brick to Vicor's BCM.

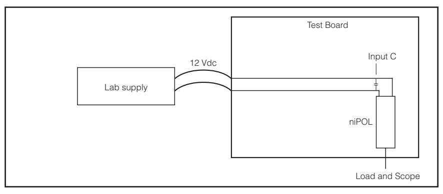

FIG.4 Test set up 1 with niPOL and recommended input capacitance of 680 μF.

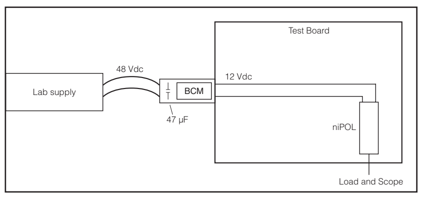

FIG.5 Test set up 2 with BCM and 47 μF of input capacitance.

Faster transient response means that less energy storage is required downstream. The BCM power train offers a unique capacitance multiplication feature. The effective output capacitance is 16x the input capacitance when a BCM with K of 1/4 is used. This means significantly less capacitance need be added downstream of the BCM. Since energy stored

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