使用48V分布式电源架构解决汽车电气化难题

Phil Davies

轿车、卡车、公交车及摩托车制造商都在快速为其车辆实现电气化，以提高内燃机的燃油效率，减少二氧化碳排放。电气化选择很多，但大多数制造商都没有选择完全混合动力总成，而是选择 48 伏轻度混合动力系统。轻度混合动力系统除了有传统 12V 电池之外，还新增了一款 48V 电池。

这可增加 4 倍的电量 (P = V • I)，用于催化式排气净化器等重负荷。48V 系统可为混合动力发动机供电，在节省燃油的同时，更快、更平稳的加速，以提高车辆性能。额外的电源不仅可为转向、刹车以及悬架系统提供支持，而且还可增加新的安全、娱乐及舒适特性。

引入 48 伏轻度混合动力系统，一旦完成设计，会有很大的优势。克服对长期存在的 12 伏供电网络 (PDN) 进行改造的犹豫可能是最大的挑战。改变供电通常需要必须进行大量测试的新技术，而且可能还需要能够按汽车产业的高安全性及高质量标准供电的全新供应商。

但数据中心行业在转向 48V PDN 的过程中发现，这样做的优势远远超过了转换成本。对于汽车产业来说，48V 轻度混合动力系统带来了快速推出排放更低、行驶里程更远、油耗更低的全新车辆的途径。此外，它还可为提高性能特性并减少二氧化碳排放提供令人振奋的全新设计选项。

如何最大化 48V 供电网络

增加 48V 电池，为更重的动力总成及底盘系统负载供电，可为工程师提供各种选项。现在有一个增加系统的选择，可以直接处理 48V 输入，也可以保留泵、风扇和电机等原有 12V 机电负载，无需通过稳压 DC-DC 转换器将 48V 转换成 12V。为了管理变革与风险，现有轻度混合动力供电系统逐渐增加 48V 负载的同时，仍使用大型集中式数千瓦 48V 至 12V 转换器，将整个汽车的 12V 电源提供给 12V 负载。然而，这种集中式架构不仅没有完全利用 48V PDN 的优势，而且也没有利用现在可用的高级转换器拓扑、控制系统与封装的优势。

Figure 3
Standard DC-DC converter is 94% efficient

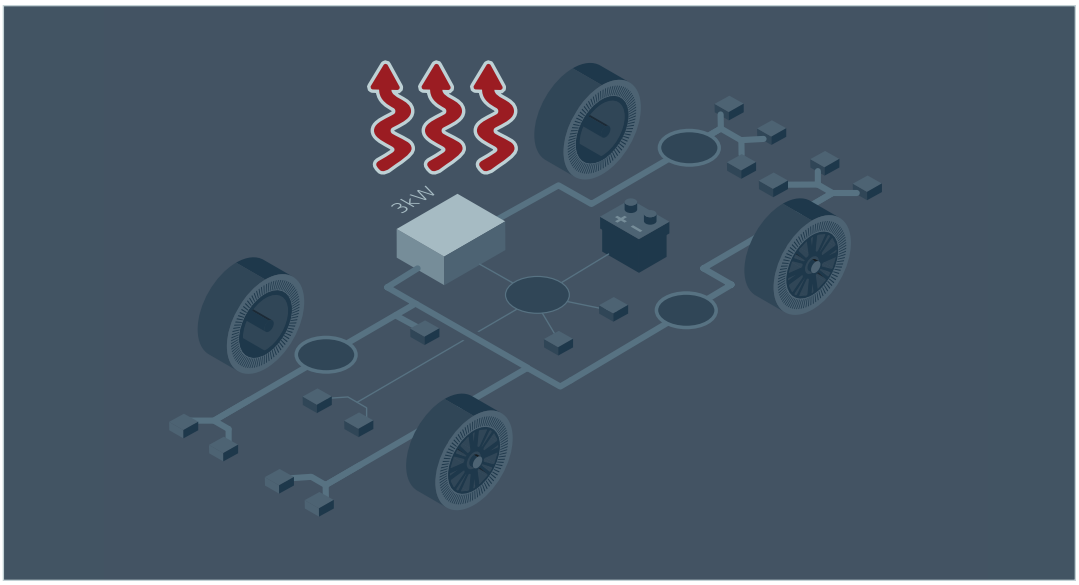
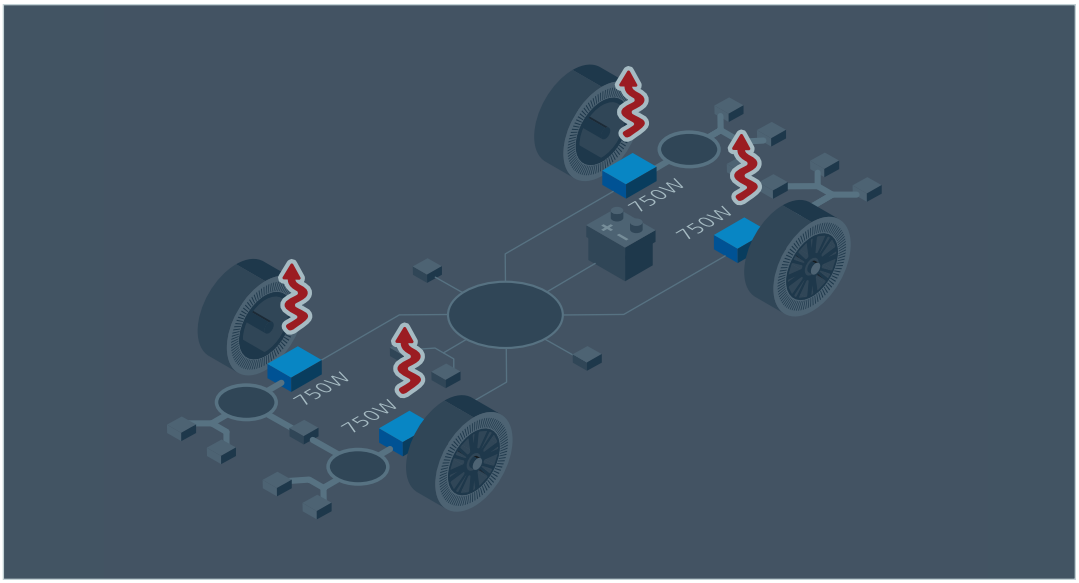


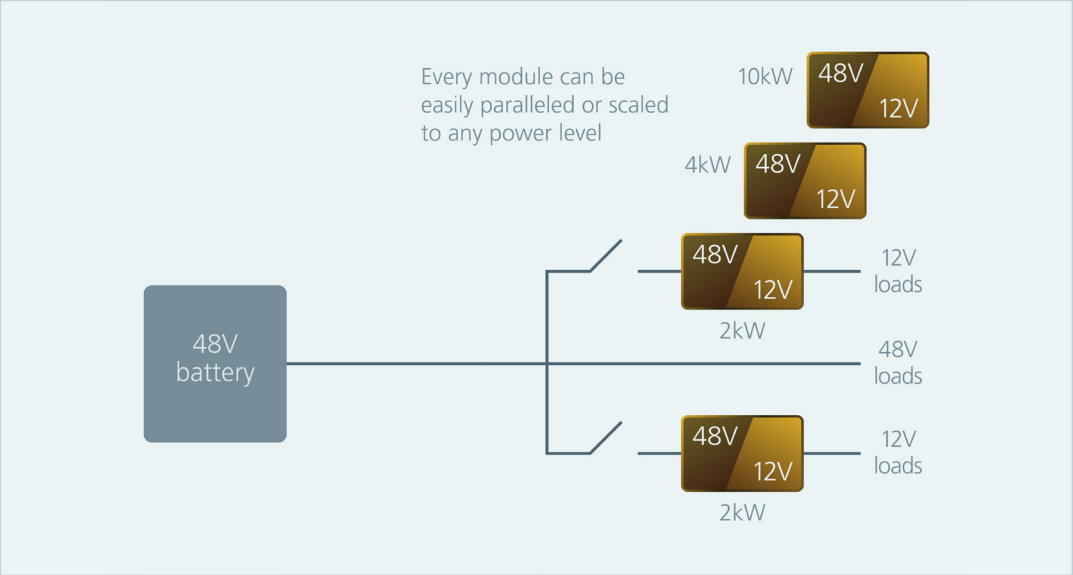
Figure 4
Vicor DC-DC converter is 98% efficient



Modular component benefits for decentralized architectures

A modular approach to a decentralized power delivery (Figure 5) is highly scalable.

Figure 5
A modular approach to a hybrid electric vehicle

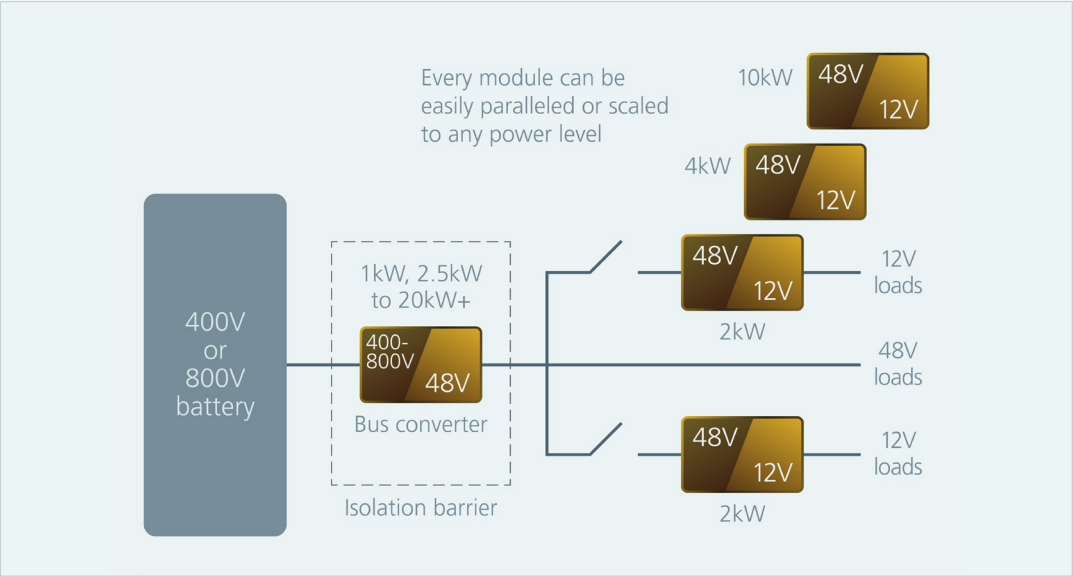


The 48V output from the battery is distributed to the various high-power loads in the vehicle, maximizing the benefits of lower current (4x) and lower losses (16x) resulting in a physically smaller and lower weight PDN. Depending on a load power analysis of the various distributed loads, one module can be designed and qualified for the right power granularity and scale to be used in parallel arrays.

In this example, a 2kW module is shown. As noted, the granularity and scalability are system dependent. By using distributed modules instead of a large centralized DC-DC converter, N+1 redundancy is also possible at a much lower cost. This approach also has advantages if load power changes during the vehicle development phase. Instead of implementing changes to a full ground-up custom power supply, engineers can either add or eliminate modules. Another design advantage is reduced development time as the module is already approved and qualified.

Implementing a decentralized, modular 48V architecture in higher voltage battery systems

Figure 6
A modular approach to a fully electric vehicle



In the case of pure electric vehicles or high-performance hybrid cars, high-voltage batteries are used due to the high power demands of the powertrain and chassis systems. A 48V SELV PDN still has significant benefits for OEMs, but now the power system designer has an additional challenge of a high-power 800V- or 400V-to-48V conversion.

This high-power DC-DC converter also requires isolation but not regulation. Better voltage regulation is one benefit of decentralizing the placement of 48V-to-12V converters. By using regulated PoL converters, the high-power upstream converter can use a fixed-ratio topology. This is extremely beneficial due to the wide input-to-output voltage range of 16:1 or 8:1 for 800/48 and 400/48, respectively (Figure 6). Using a regulated converter over this range is very inefficient and presents a large thermal management problem.

It would be very difficult and costly to decentralize this high-voltage isolated converter due to safety requirements in distributing the 400V or 800V. However, a high-power centralized fixed-ratio converter can be designed utilizing power modules instead of a large silver box DC-DC converter.

Power modules of the right level of granularity and scalability can be developed and then easily paralleled for a range of vehicles with differing powertrain and chassis electrification requirements. Vicor fixed-ratio bus converters (BCM®) are also bidirectional, which supports various energy regeneration schemes. Due to the Sine Amplitude Converter (SAC™) high-frequency soft-switching topology, BCMs achieve efficiencies over 98%. They also feature power densities of 2.6kW/in^3, which significantly reduces the size of the centralized high-voltage converter.

Conclusion

Vicor is a supplier to the automotive market, delivering the most advanced and innovative 48V solutions. A decentralized modular approach to automotive power delivery architectures simplifies complex power delivery challenges, increasing performance, productivity and time to market. A leader in 48V power conversion, Vicor is constantly innovating power delivery architectures, power conversion topologies, control systems and packaging.

Contact Us: http://www.vicorpower.com/contact-us

Vicor Corporation
25 Frontage Road
Andover, MA, USA 01810
Tel: 800-735-6200
Fax: 978-475-6715
www.vicorpower.com

email
Customer Service: custserv@vicorpower.com
Technical Support: apps@vicorpower.com