

使用 48V 分散式電源架構解決汽車電氣化難題

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轎車、卡車、公車及摩托車製造商都在快速為其車輛實現電氣化，以提高內燃機的燃油效率，減少二氧化碳排放。電氣化選擇很多，但大多數製造商都沒有選擇完全混合動力總成，而是選擇 48 伏輕度混合動力系統。輕度混合動力系統除了有傳統 12V 電池之外，還新增了一款 48V 電池。

這可增加 4 倍的電量 ($P = V \cdot I$)，用於催化式排氣淨化器等重負荷。48V 系統可為混合動力引擎供電，在節省燃油的同時，更快、更平穩地加速，以提高車輛性能。額外的電源不僅可為轉向、剎車以及懸吊系統提供支援，而且還可增加新的安全、娛樂及舒適特性。

引入 48 伏輕度混合動力系統，一旦完成設計，會有很大的優勢。克服對長期存在的 12 伏供電網路 (PDN) 進行改造的猶豫可能是最大的挑戰。改變供電通常需要進行大量測試的新技術，而且可能還需要能夠按汽車產業的高安全性及高品質標準供電的全新供應商。

但資料中心產業在轉向 48V PDN 的過程中發現，這樣做的優勢遠遠超過了轉換時所付出的成本。對於汽車產業來說，48V 輕度混合動力系統帶來了快速推出排放更低、行駛里程更遠、油耗更低的全新車輛的途徑。此外，它還可為提高性能特性並減少二氧化碳排放提供令人振奮的全新設計選項。

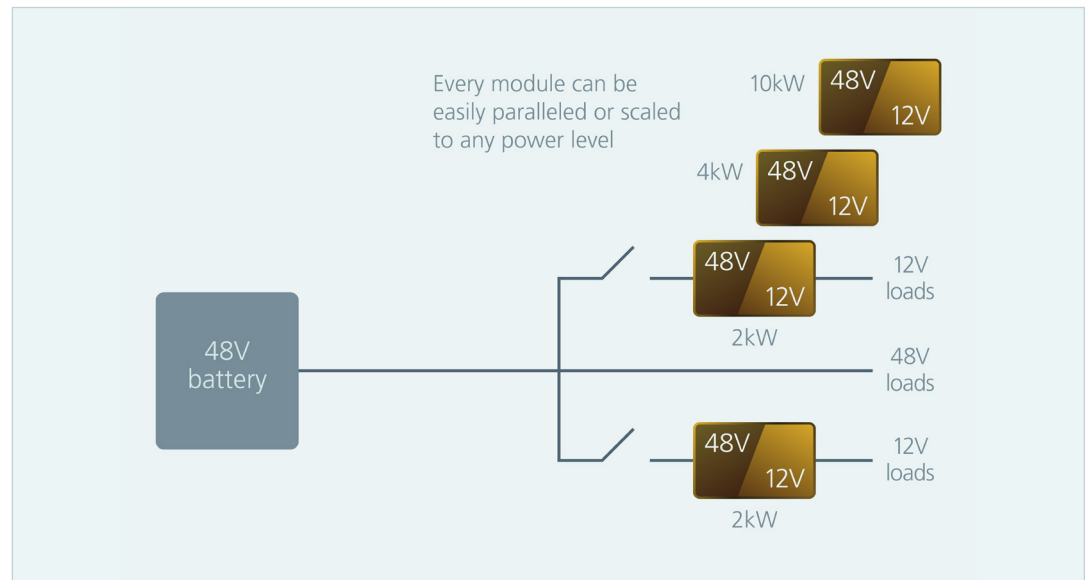
如何最大化 48V 供電網路

增加 48V 電池，為更重的動力總成及底盤系統負載供電，可為工程師提供各種選項。現在有一個增加系統的選擇，可以直接處理 48V 輸入，也可以保留泵、風扇和馬達等原有 12V 機電負載，無需透過穩壓 DC-DC 轉換器將 48V 轉換成 12V。為了管理變革與風險，現有輕度混合動力供電系統逐漸增加 48V 負載的同時，仍使用大型集中式數千瓦 48V 至 12V 轉換器，將整個汽車的 12V 電源提供給 12V 負載。然而，這種集中式架構不僅沒有完全利用 48V PDN 的優勢，而且也沒有利用現在可用的高階轉換器拓撲、控制系統與封裝的優勢。

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

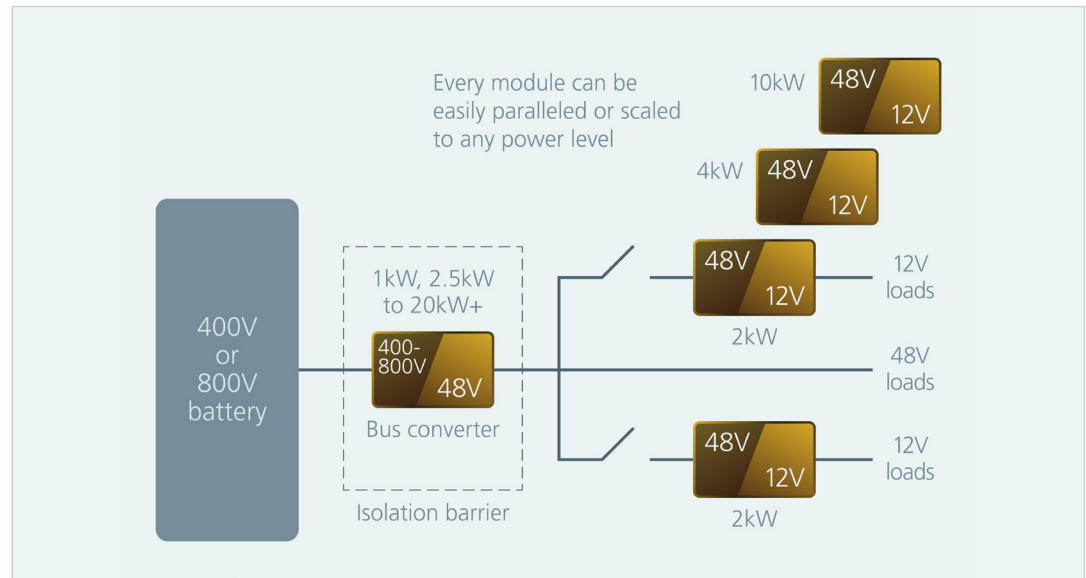


The 48V output from the battery is distributed to the various high-power loads in the vehicle, maximizing the benefits of lower current (4x) and lower losses (16x) resulting in a physically smaller and lower weight PDN. Depending on a load power analysis of the various distributed loads, one module can 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/in³, 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.

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