Vicor 电源模块的核心技术以及工业应用分享

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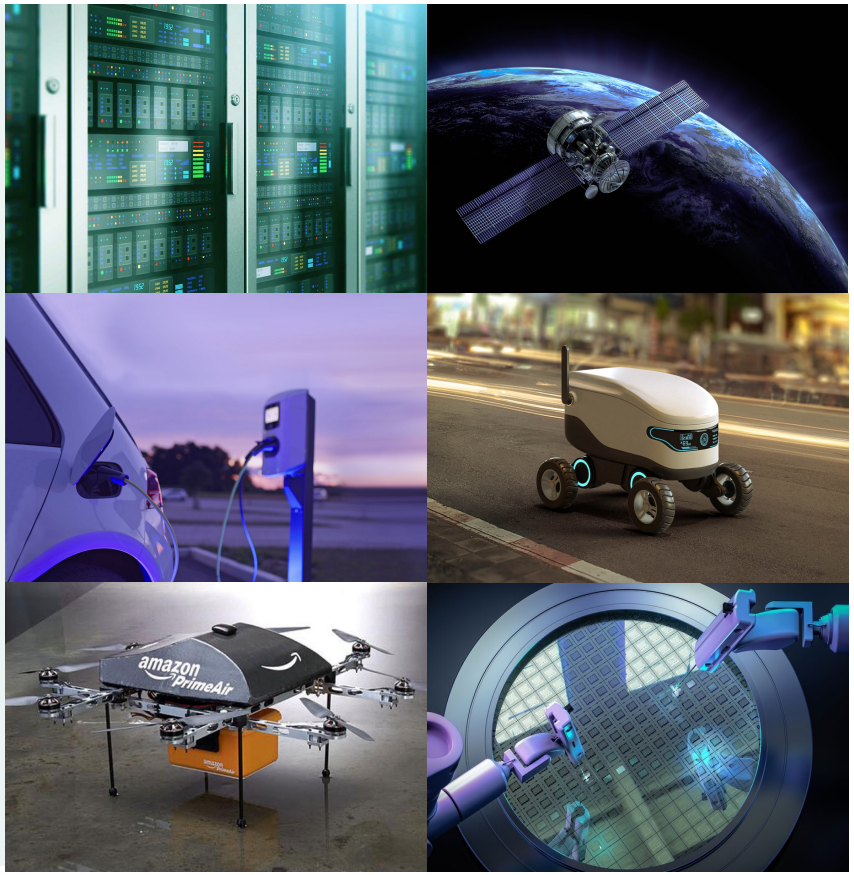
如何设计更好的电源架构
Design Power Supply network structure

- Vicor 在工业应用领域的案列分享
- 电源方案的种类和优缺点对比
- Vicor 产品的优势，灵活性，可扩张性的介绍
- Vicor 核心技术分享以及拓扑结构
- Vicor 产品的封装形式，制造工艺以及热处理方式

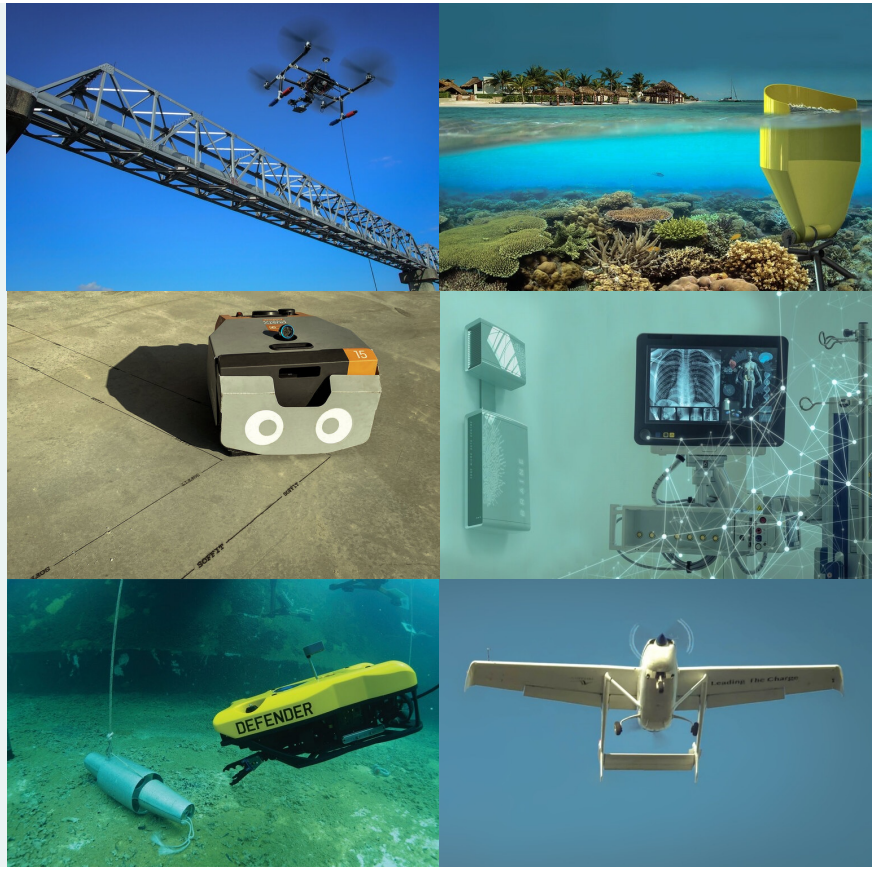
Vicor 使命

我们正在通过创新设计模块电源解锁
改变世界技术的潜能

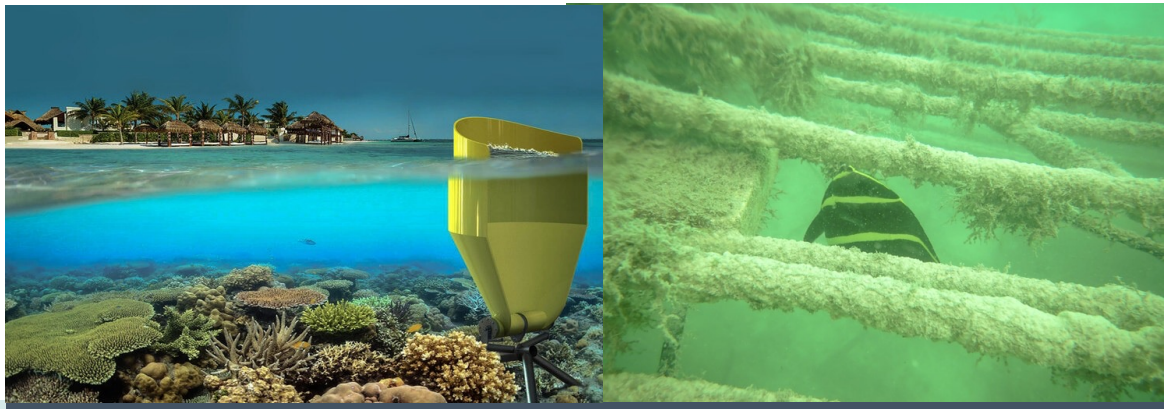


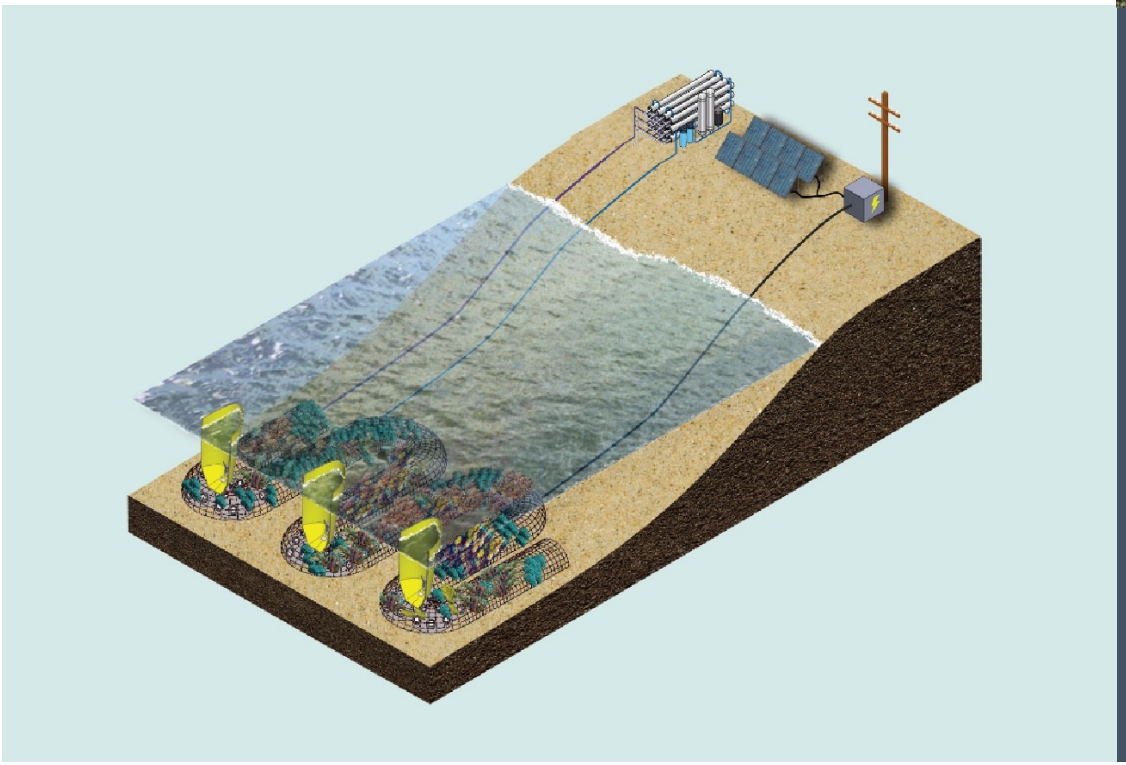
使命宣言

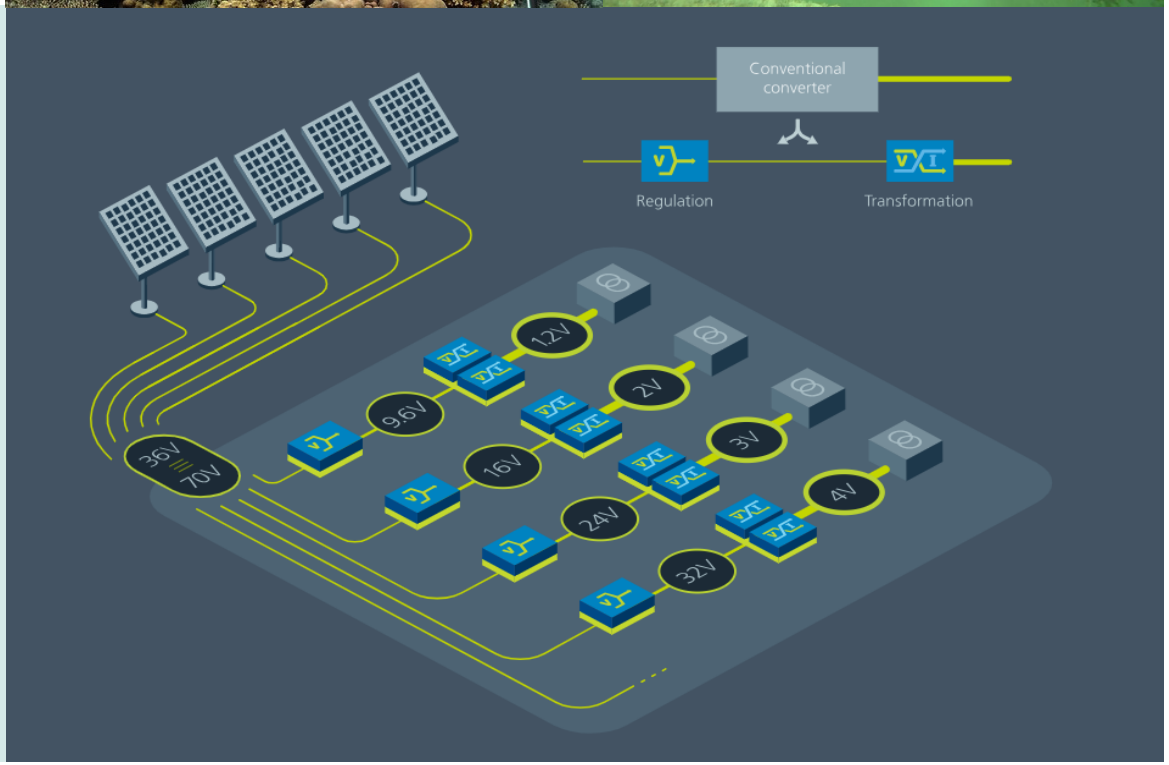
通过易于部署的模块化电源解决方案能帮助客户实现创新，这些解决方案在高性能计算，汽车，工业以及航空航天和国防市场中提供最高密度和最高效的供电网络



新能源助力珊瑚礁再生的应用







什么是供电网络或 PDN (Power Delivery Network)?

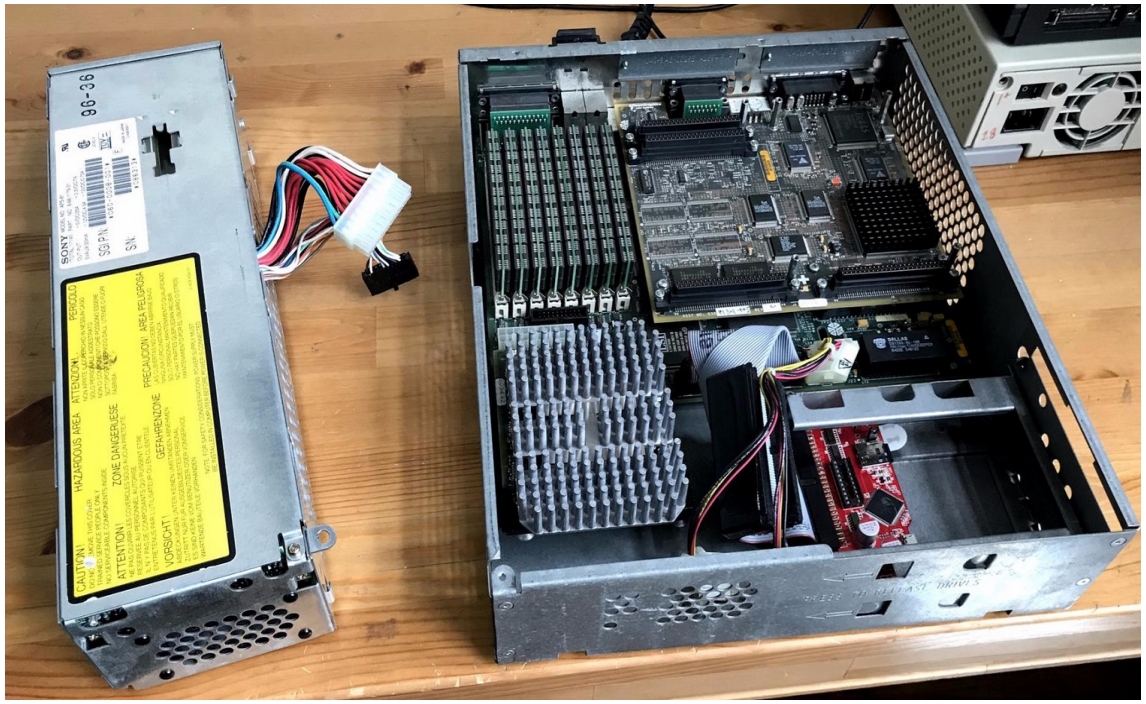
供电网络 (PDN)旨在为系统内从大功率电源到各种负载提供特定级别的电压和电流。你的选择很重要。

电源设计解决方案：

- Silver box成品电源
- 分立器件设计
- 模块化设计

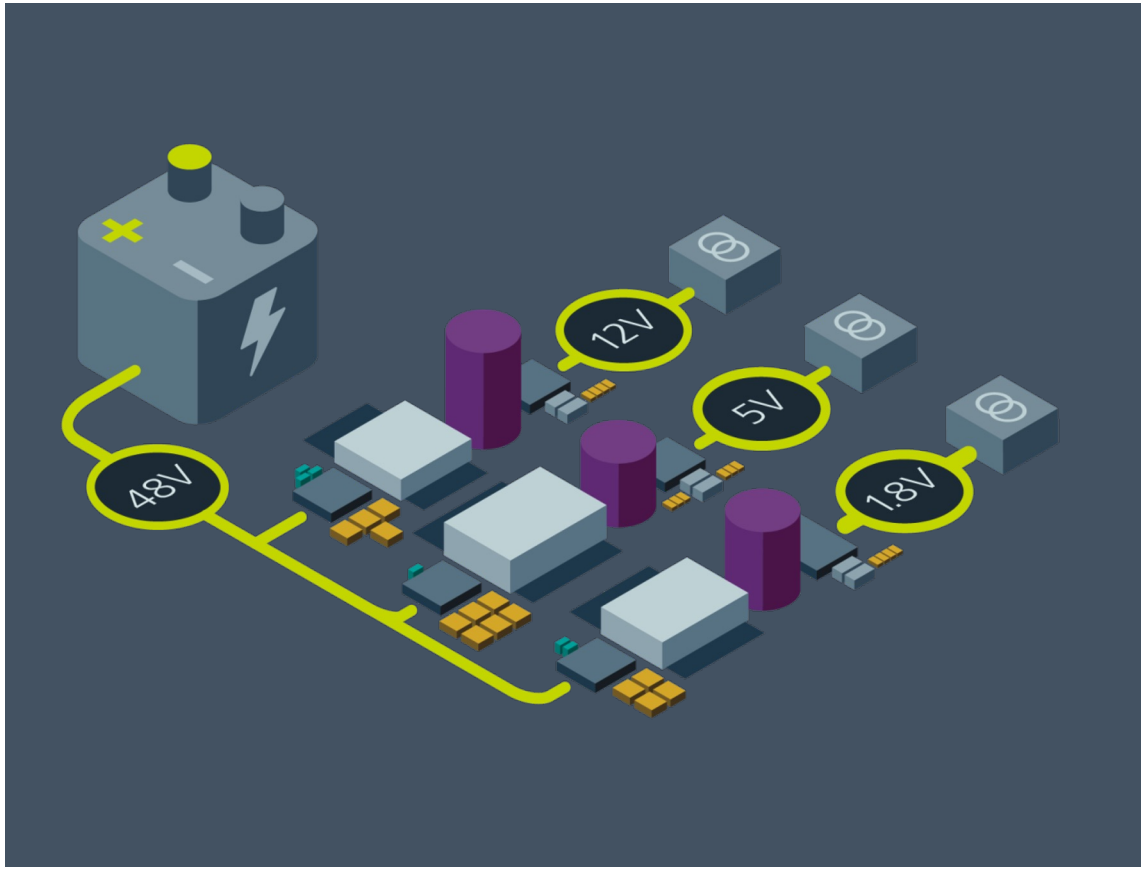
Silver box 解决方案：简单，但很有限

- 即大又重还死板
- 固定输入/输出接口
- 没有灵活性
  - 无法修改设计参数（输入、输出）
  - 需要保留一个大的空间来容纳所需面积
- 没有可扩展性
  - 无法修改设计以适应客户规格的变化



分立器件解决方案：精确，但不易调整

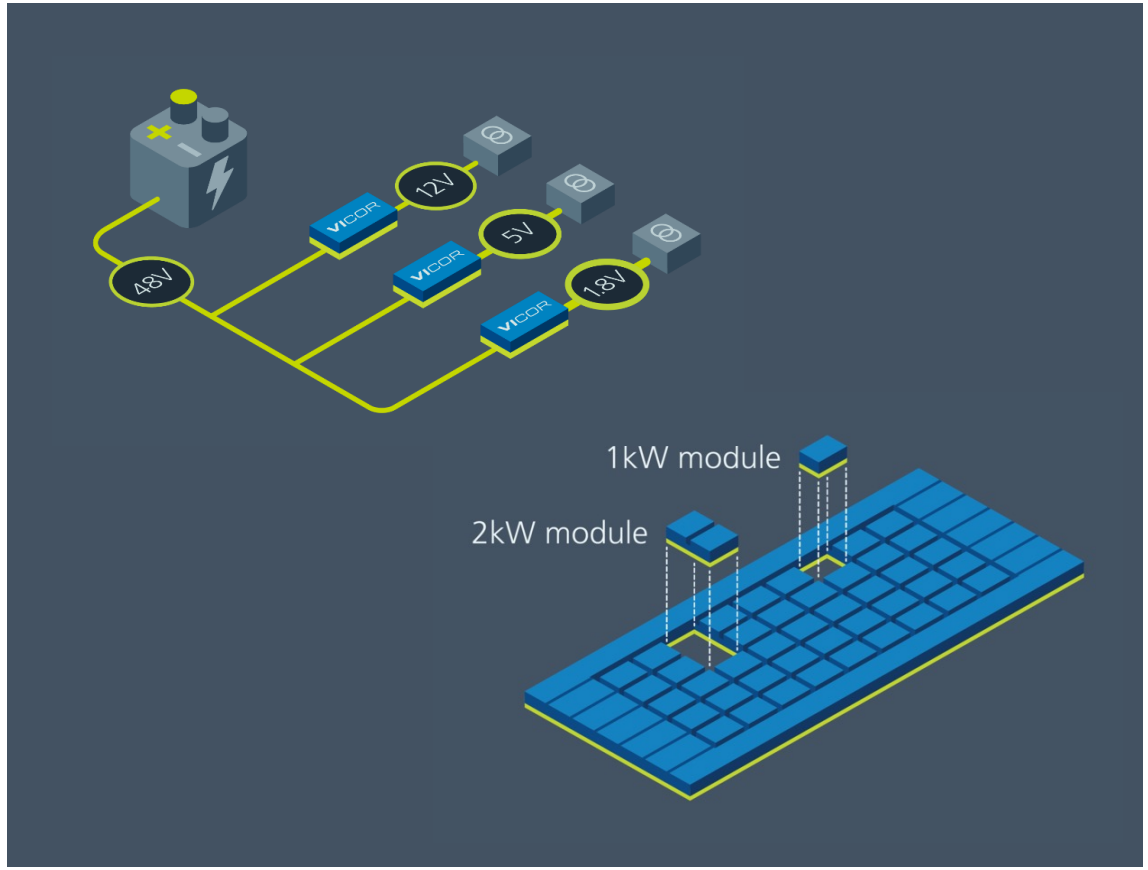
- 设计复杂性
  - 需要大量的设计工作和测试
  - 更长的设计，集成时间
  - 多物料清单 (BOM)
- 难以扩展
  - 需要重新设计这个系统并重新验证
- 缺乏设计灵活性



模块化解决方案：功率密度，可扩展

模块化供电网络：

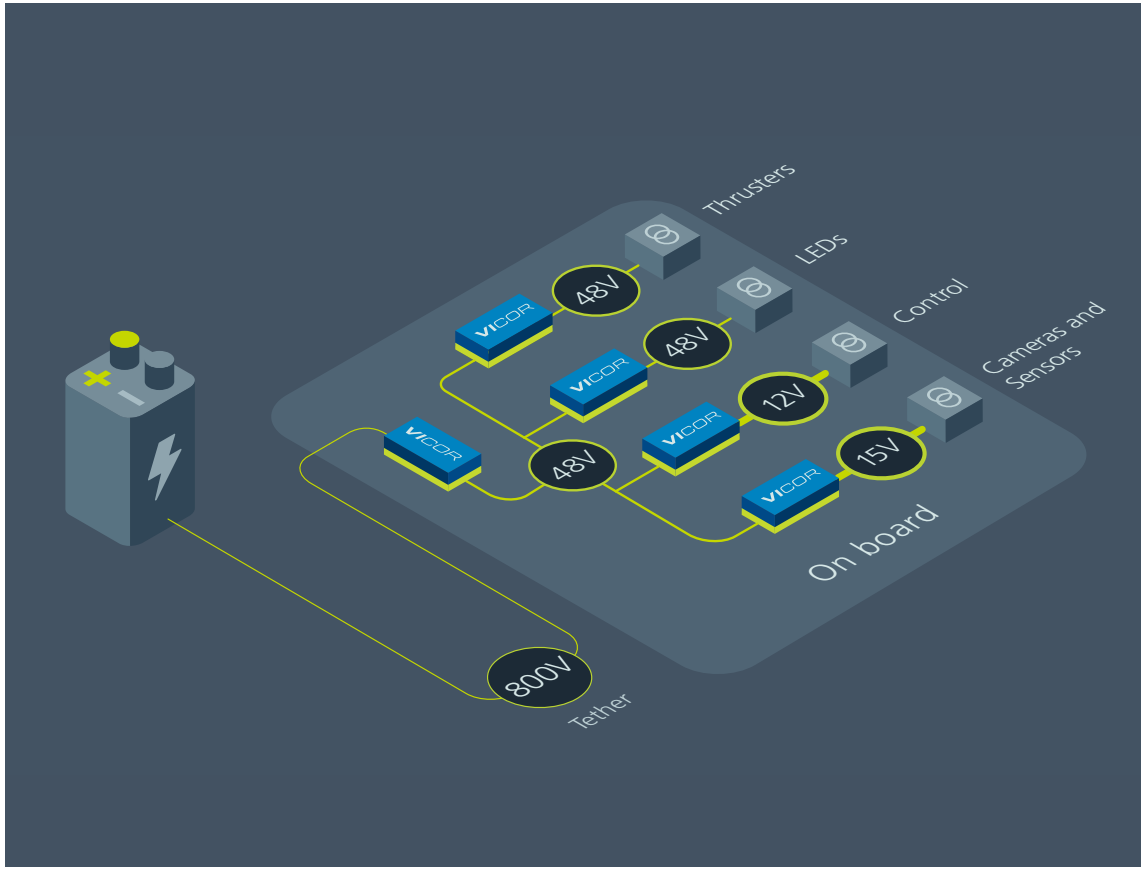
- 需要最少的设计、工程资源
- 易于设计，支持更快的上市时间
- 通常需要更少的零件，换言之需要更少的BOM,更低的风险
- 经过测试和认证就可供使用



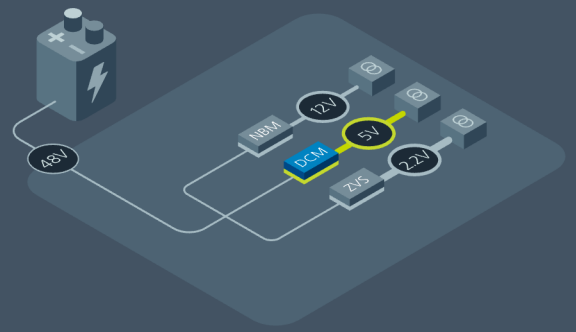
尽早考虑电源以优化您的设计

尽早考虑供电网络：

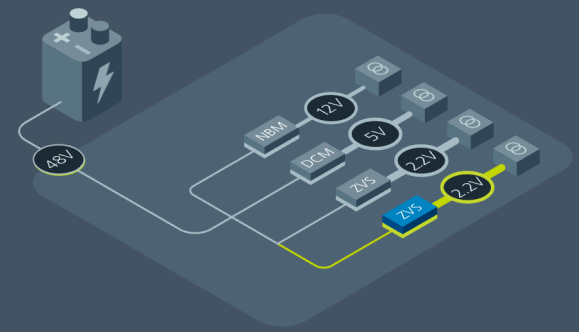
- 提高整个系统的性能
- 优化系统尺寸，重量
- 降低系统成本
- 最大限度地减少供应链的复杂性，降低风险



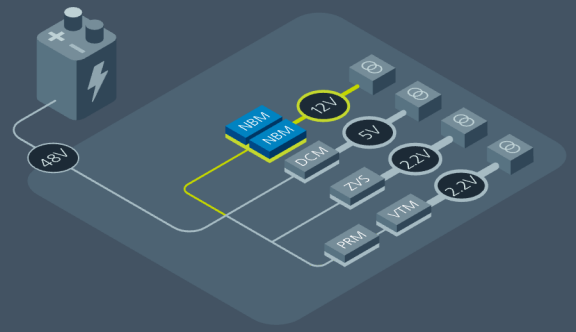
模块供电网络的灵活性和扩展性



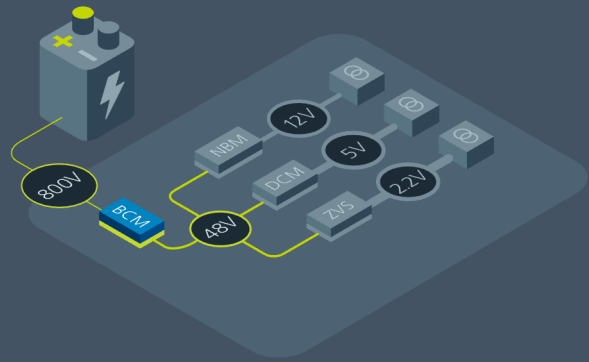
Replace modules when power needs change



Add another module to support an additional load



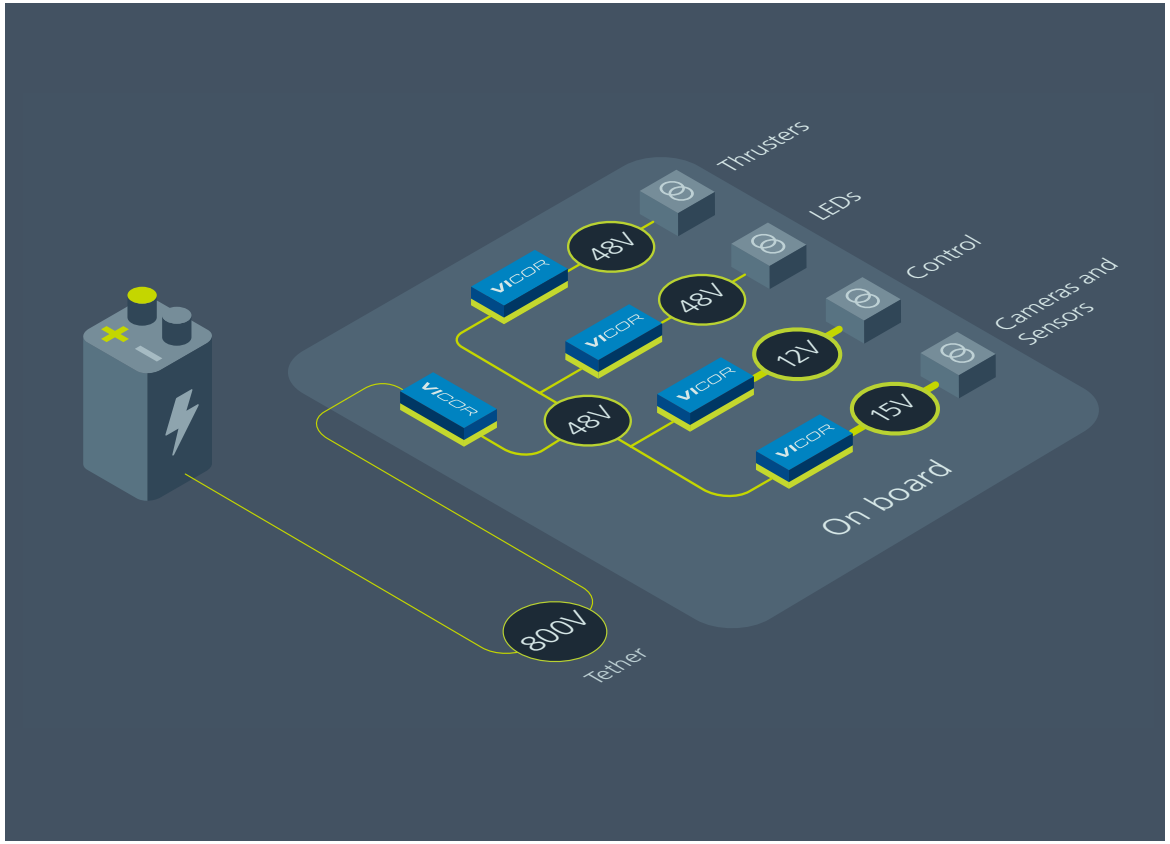
Double the power at a load with a second module



Create a SELV bus from a high-voltage source

可扩展的 PDN

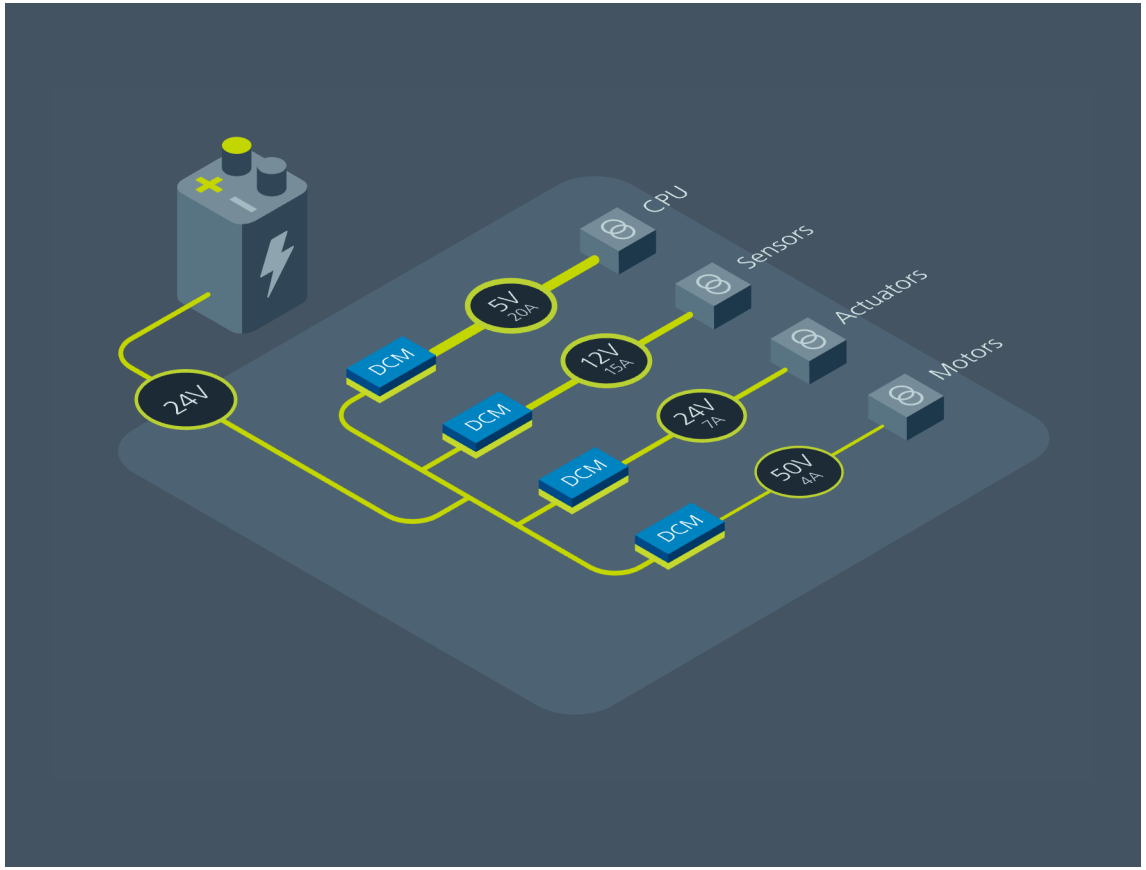
- 负载可由非隔离降压或升降压转换器供电
- 48V 总线连接到负载，每个负载都有自己的转换器



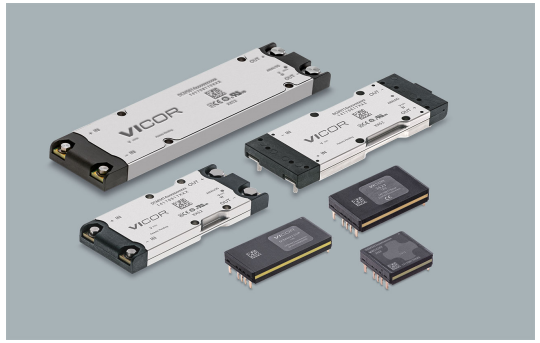
从12V 总线电压升级到 48V 总线的好处

使用 48V 的好处：

- 功率密度大幅度提升
- 转化效率提高
- 增加负载能提

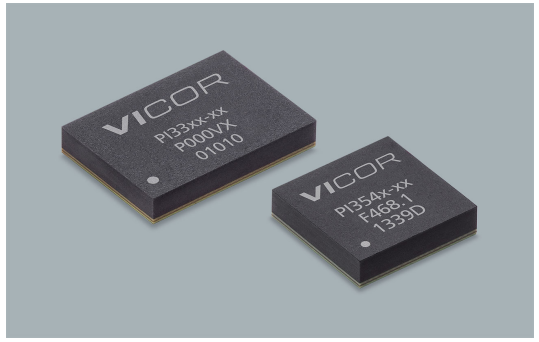


BCM®, DCM™ 和 ZVS 稳压器系列



DCM 系列

BCM 系列



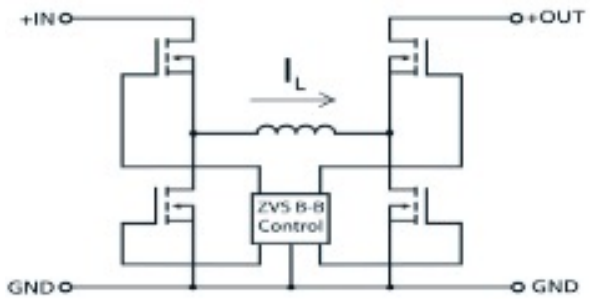
ZVS 降压稳压器系列

PI37xx ZVS 升降压稳压器系列

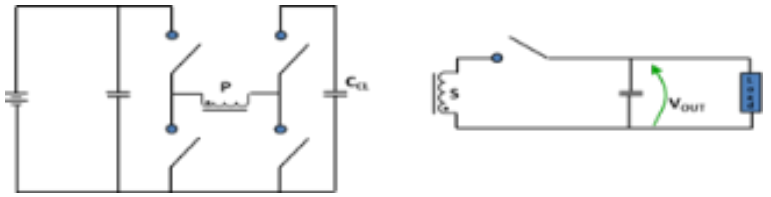
Vicor 关键技术-创新拓扑结构

Vicor 如何实现高功率, 高效率，更轻重量

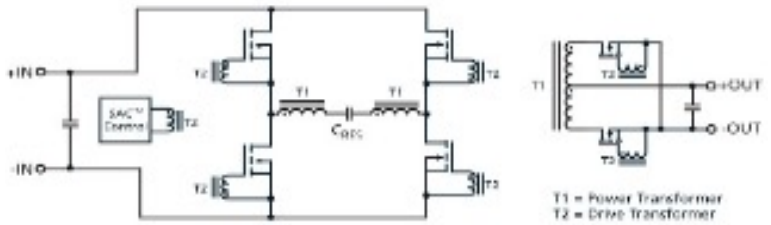
- 拓扑结构
- 高频开关
- 平面磁性设计
- 半导体集成
- 模组化，3D 封装
  - 特有包装设计
  - 卓越的散热和 EMI 特性
  - 设计灵活性



ZVS Regulator
Non-isolated,
DC-DC regulator

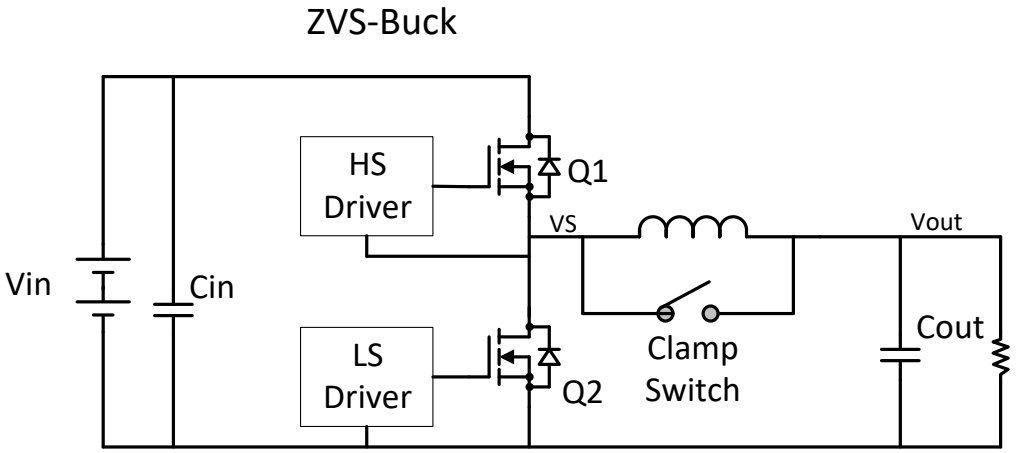


Double-Clamped
ZVS (DC-ZVS)
Isolated, regulated,
DC-DC or AC-DC
converter



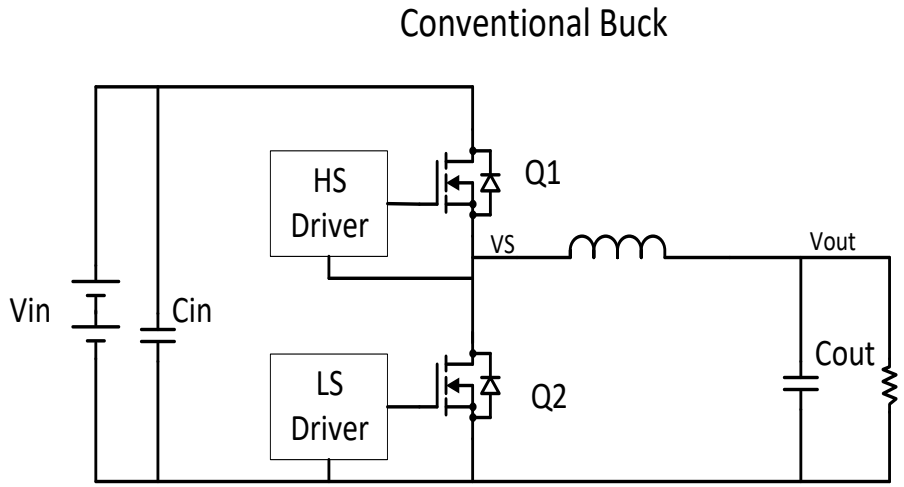
Sine Amplitude
Converter (SAC)
Isolated, fixed-ratio,
DC-DC transformer

Power Train 对比



ZVS Buck Topology

- High frequency operation up to the maximum Vin
- ZVS resonant soft turn on (higher efficiency, lower noise)
- Clamp switch preserves ZVS energy
- Negligible body diode conduction
- Small output inductor (fast dynamic response)
- Low switching and gate drive losses

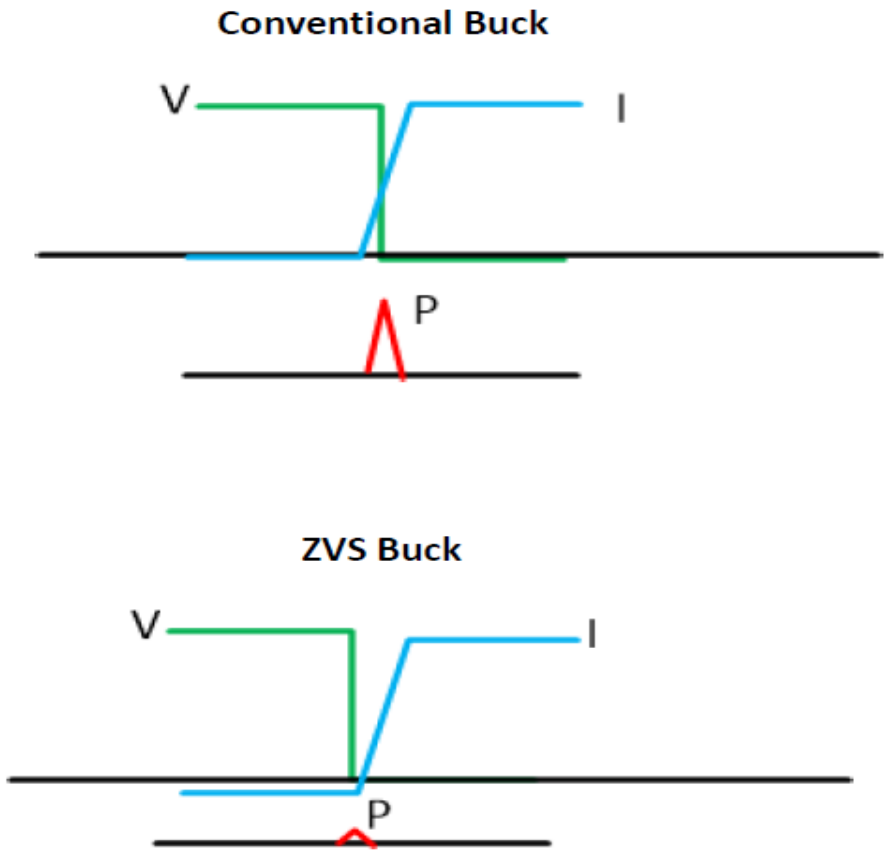


Conventional Buck Topology

- Lower frequency operation (limited by switching losses)
- Hard switching (ringing) with high losses
- Longer body diode conduction
- Larger output inductor
- Higher gate drive losses

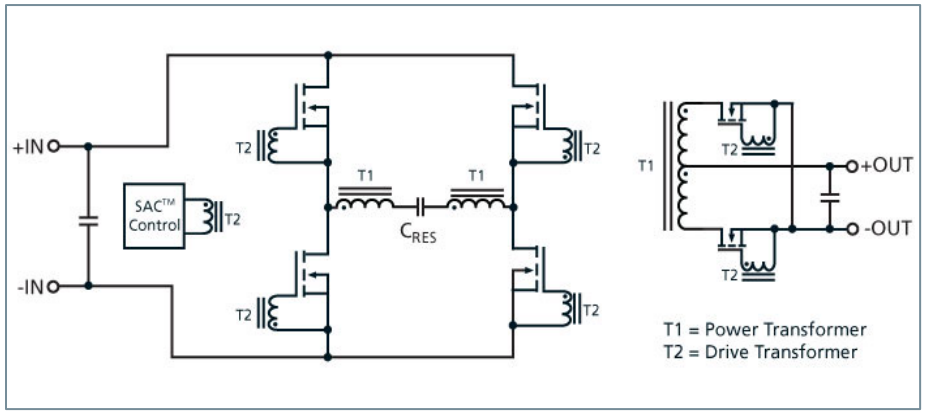
零电压开关 Zero-Voltage Switching

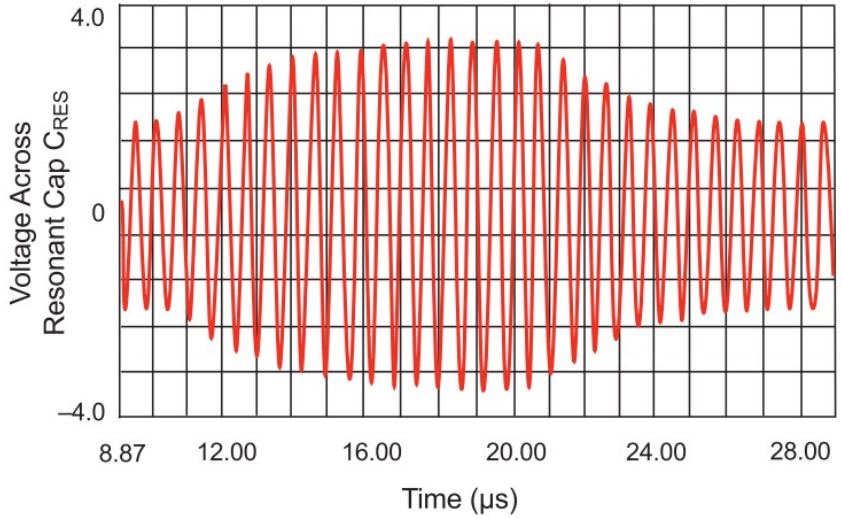
- 零电压开关是一种在 MOSFET 在导通之前将电流反向流动以均衡 DS 两侧电压的技术
- 这大大减少或消除了开关损耗
  - 使开关频率提高 4 倍（或更多），从而减少磁性元件尺寸
  - 减少高电压转低电压的损耗
- ZVS 用于所有 Vicor 电源产品



正弦振幅转化器(Sine Amplitude Converter）拓扑结构

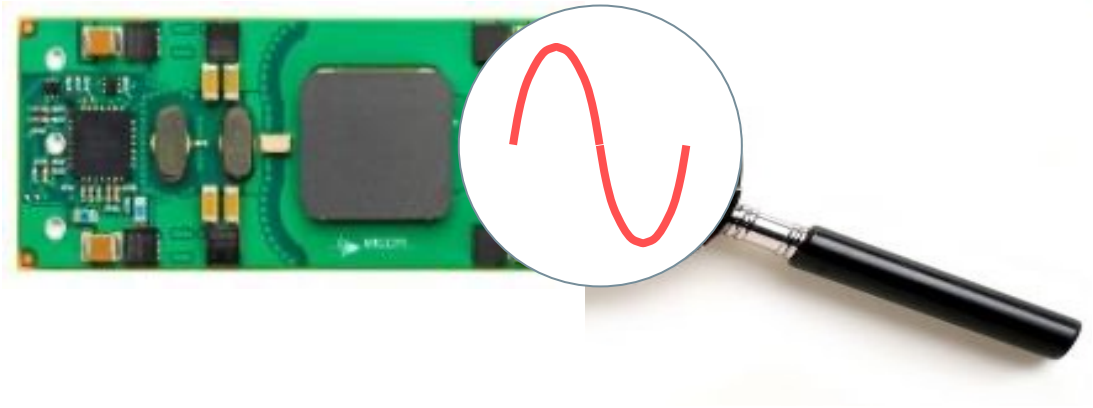
- SAC 拓扑结构是 BCM 和 VTM 模组核心位置的动态，高效能引擎。
- SAC 是基于变压器的串联谐振拓扑结构，在等于初级侧储能电路谐振频率的固定频率下工作，初级侧的开关 MOSFET 锁定为初级的自然谐振频率，在零交叉点开关，从而消除开关中的功耗，提高效率，显著减少高阶杂讯谐波的产生。
- 初级谐振回路是纯正弦波曲线，减少谐波分量，提供更干净的输出杂讯频谱。由于 SAC 的高工作频率，可使用较小的变压器来提高功率密度和效率。





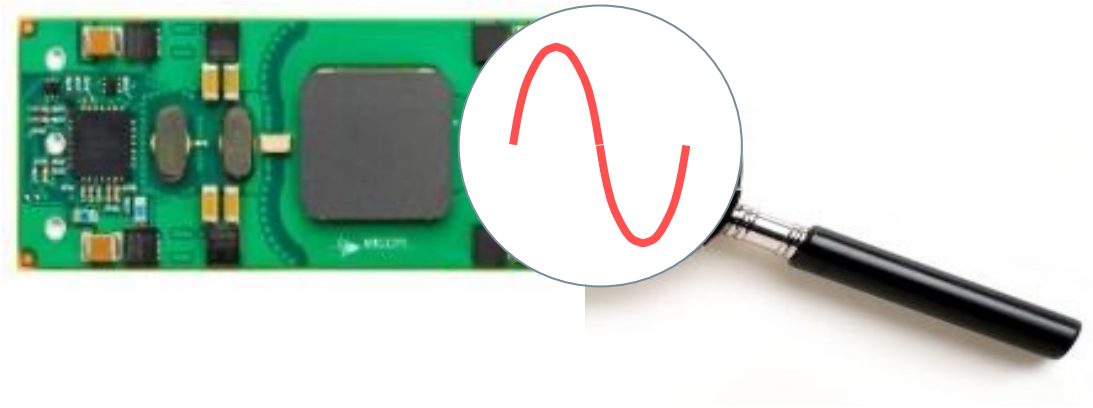
SAC Topologies – Always Sinusoidal Current (必定是正弦振幅)

- Fast transient response (快速响应) :
  - Resonant tank will naturally let current flow and output voltage settle within few switching cycles
- Reduced EMI (减少EMI) :
  - Very narrow spectrum 噪声频谱狭窄
- Bidirectional (双向传输) :
  - Power can be processed from input to output or vice versa across the entire converter bandwidth
- Optimal filtering (容易滤波) :
  - No harmonics below switching frequency, and very few above



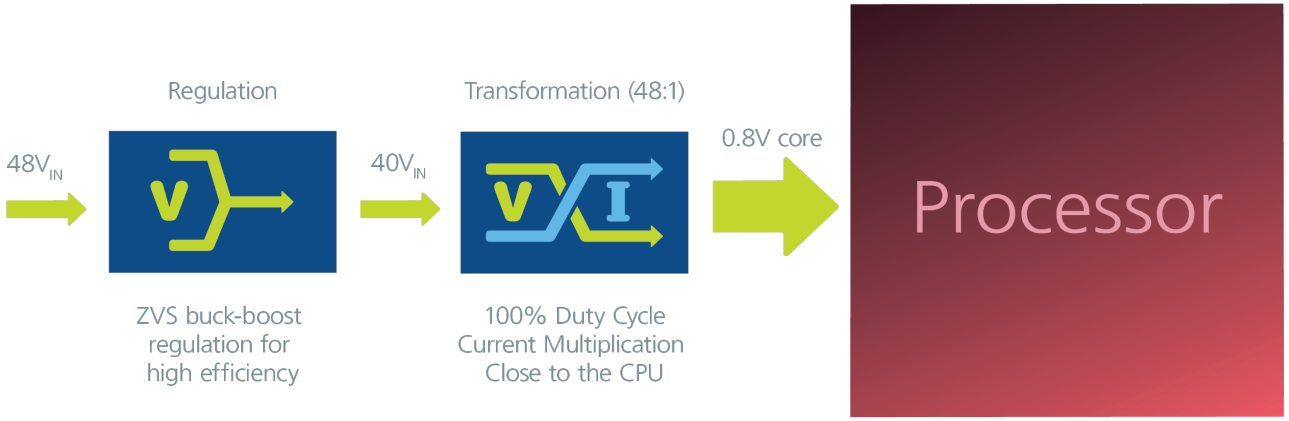
SAC Topologies – Always Sinusoidal Current (必定是正弦振幅)

- Zero-voltage, zero-current switching (零电流、电压开关)：
  - All transitions, every cycle
- Enables components with higher figure of merit
(可以使用更高品质的零件)：
  - Reduced de-rating guidelines
- No switching losses (没有开关损耗)：
  - Switching frequency not limited by power switches 'losses
- Low peak to average current and voltage ratios
(低"峰值/平均"电流或者电压比例:
  - Most efficient use of silicon switches



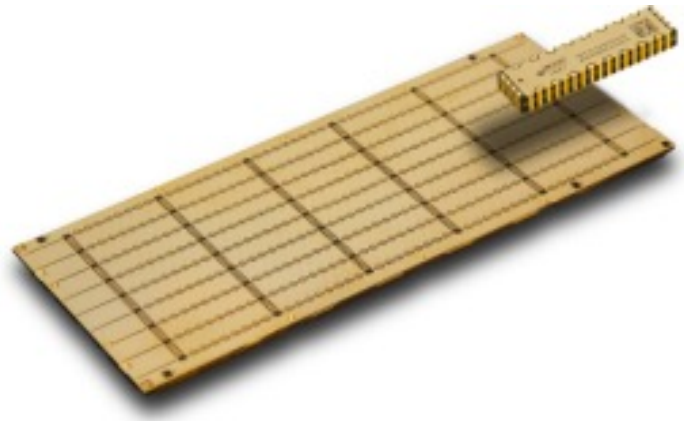
Factorized Power Architecture（分比式架构）

- Regulation stage first
  - Keep input and output of regulator stage as close as possible to ideal (1:1)
- Transformation at the point of load (current multiplication)
  - Minimize impedance of current multiplier
- Soft switching topologies:
  - Minimize noise
  - Enable High Switching frequency (1-3MHz)
  - Enable high-power density

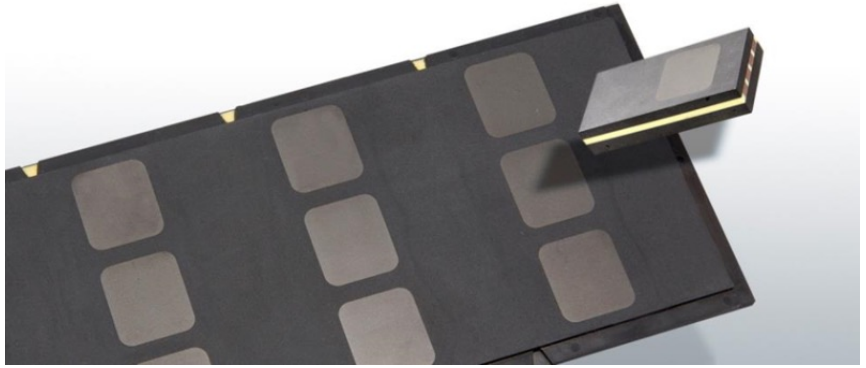


Vicor 模块电源的封装形式和散热处理

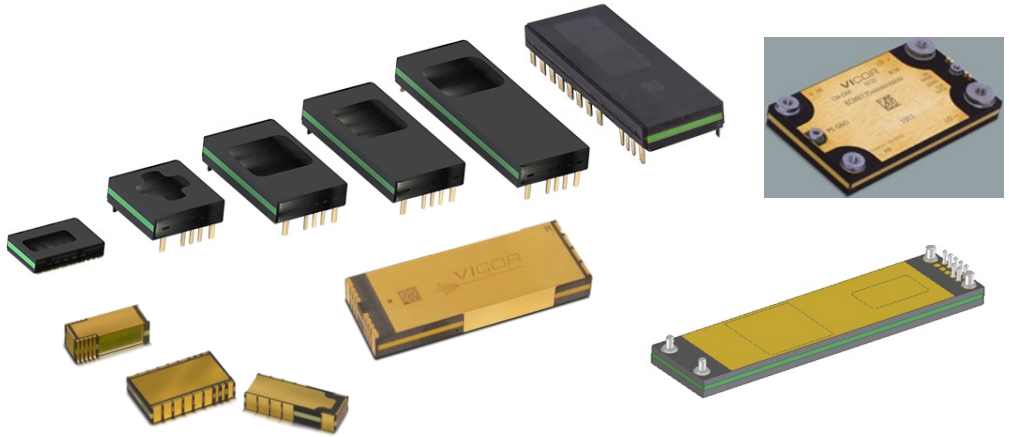
SM-ChiP panels



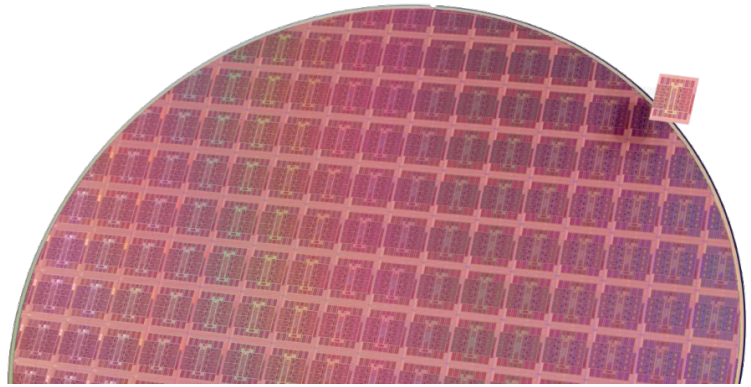
ChiP panels



IC-based controllers low component count, higher reliability

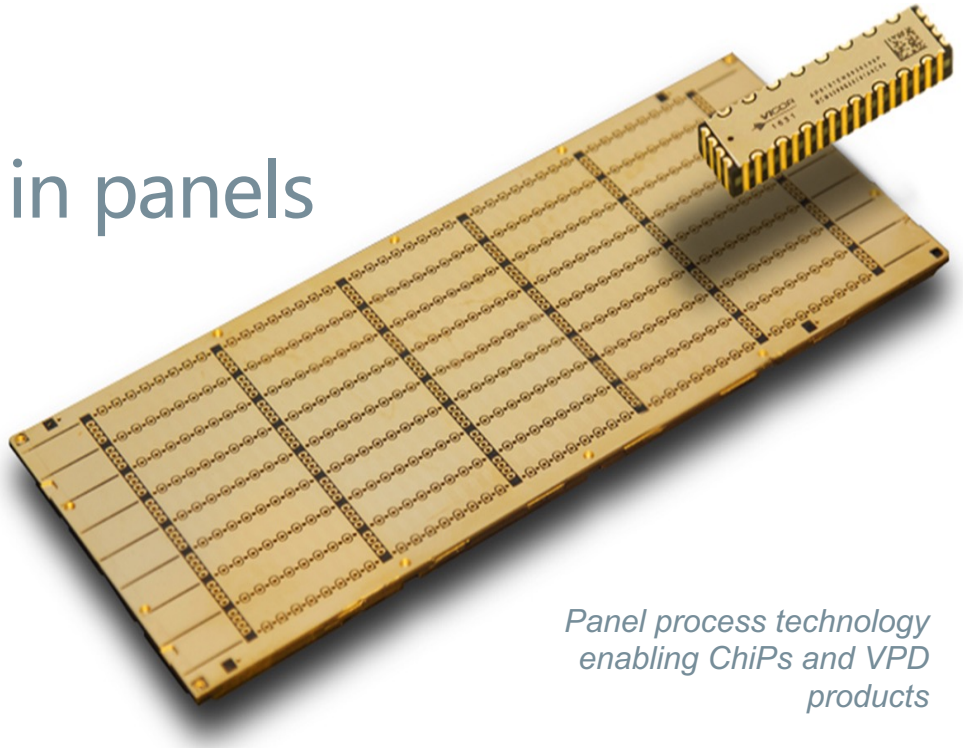


Semiconductor wafers



可扩展的制造工艺 ChiPs*

- Power modules fabricated as ChiPs in panels
  - Thickness: up to 8mm
  - Width: up to 71mm
  - Length: up to 184mm
- Up to 327 ChiPs per panel
- Scalable cost structure
- 3D connectivity within molded plated modules with optional multiplicity of layers
  - >1.9 million units shipped

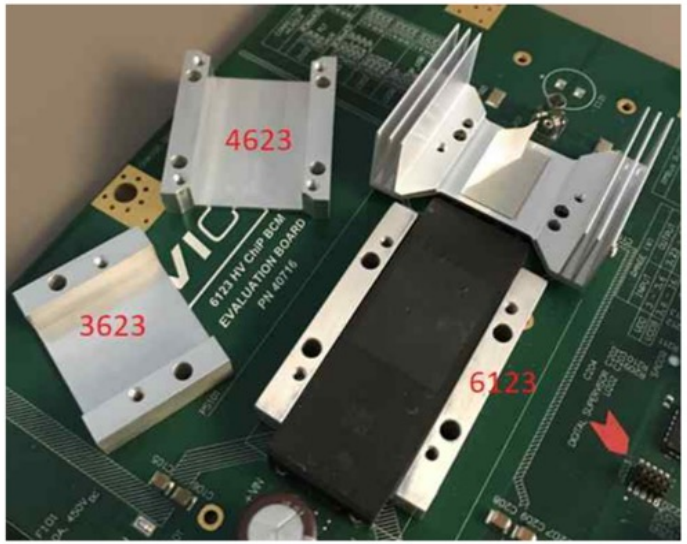


Panel process technology enabling ChiPs and VPD products

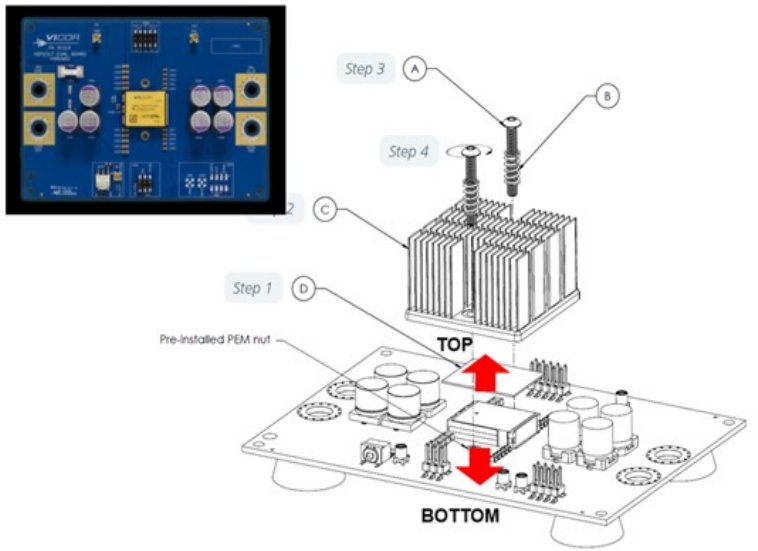
*Vicor IP to package technology

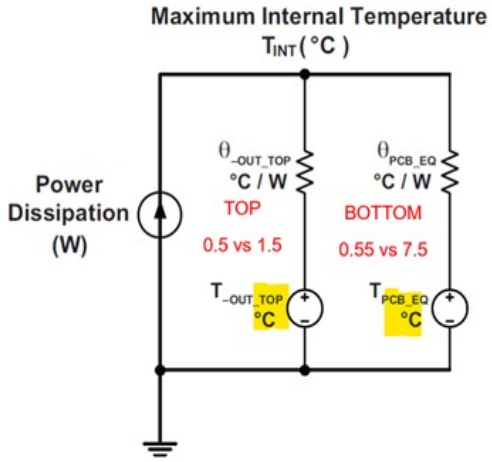
热处理方案

- 针对 VIA BCM 模块, 直接把模块和散热器或者金属外壳靠在一起就可以了，如果采用双面散热就更完美
- ChiP BCM 模块, Vicor 有推荐的散热器，采用双面散热
- Vicor 热传导器



Thermal Performance – 双面散热 SM ChiP





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