


UAV eBook

A better way to power today's advanced UAV platforms

VICOR

Contents

UAV eBook Introduction

The use of UAVs and drones is increasing rapidly. Whether it's providing arial images that change the way we see the world, delivering lifesaving supplies, or monitoring situations to keep us safe, they are becoming an everyday sight. The growth of UAVs is also being driven by new applications, with both commercial and defense UAVs requiring more functionality to meet these needs.

UAV performance is a combination of range, flight time, payload capacity, and the ability to maintain fast communications. These characteristics often conflict, as increasing levels of power are required increase range and payload capacity, but adding that power will also add weight and take up valuable space. Whether it's a tethered drone, a vertical take-off and landing (VTOL) drone, or a high-altitude long-endurance (HALE) drone, UAV developers are looking for ways to achieve highly efficient, lightweight and compact power solutions.

> "This eBook will help engineers developing UAVs to find a better way to distribute power in their designs."

This eBook will help engineers developing UAVs to find a better way to distribute power in their designs. The book includes several technical articles that describe how innovative power distribution networks (PDNs), and novel power modules can reduce the size and weight of the power system while increasing performance. You will also find case studies explaining how UAV industry leaders have leveraged these techniques to deliver results in real-world applications.

To help you begin the design, you'll also find several applications notes and links to sophisticated online tools that will allow you to benefit from these novel power modules without a time-consuming learning curve.

As the number of UAVs and drones that are deployed grows, it's likely that the range of applications – and the demands put on the UAVs – will continue to increase. Optimizing the power distribution networks in your UAV designs is a key part of ensuring you can enable larger, complex and more power-hungry payload without compromising on range and flight time.

Case studies

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Case study:
Wireless battery charger

One wireless charger for all UAVs

Customer's challenge

As UAV fleets reshape logistic, delivery and inspection industries the demand for more efficient and flexible charging solutions is increasing. At the same time more autonomy requires the elimination of human intervention. Targeted at aerial, mobile, marine and industrial robots this customer, **WiBotic**, wanted to develop a wireless charging station that avoided unreliable mechanical connectors and intelligently adjusted its output to meet the needs of different UAVs' onboard batteries. The key goals were:

- Charger output voltage adjustable to accommodate a wide range of batteries
- Low losses over full output voltage adjustment range
- Compensate for voltage drops in long input cabling to charger

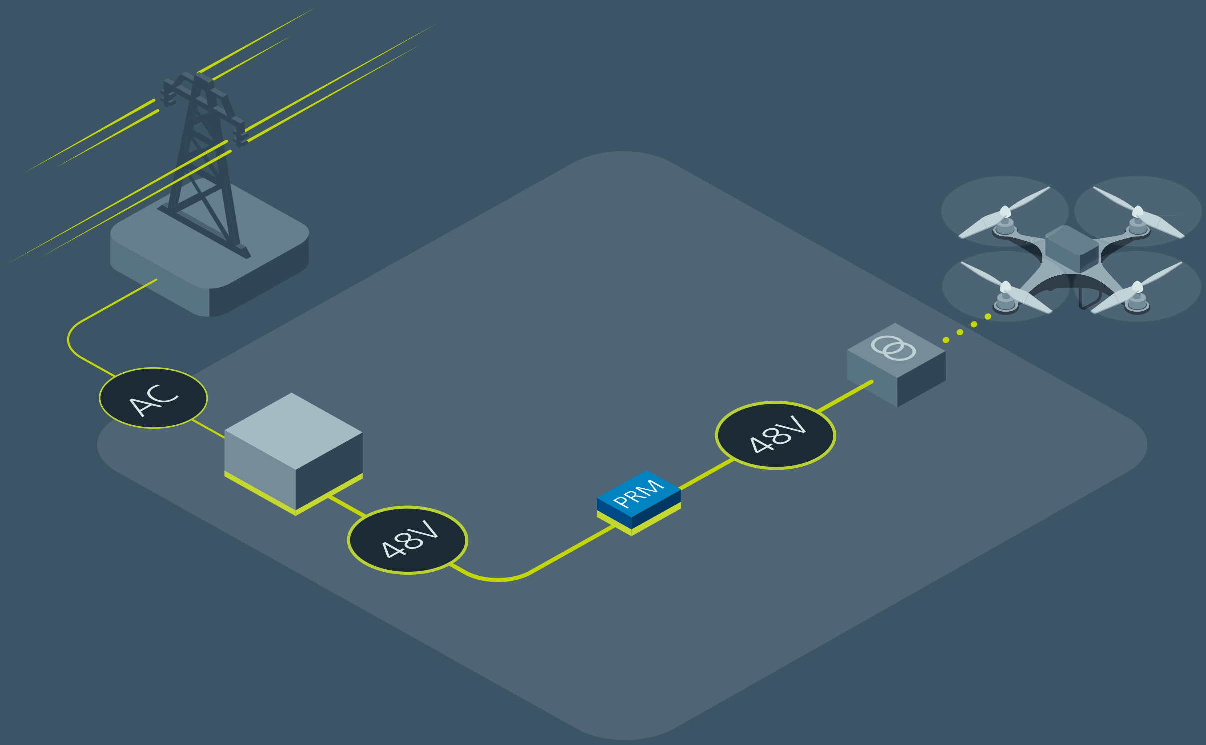
The Vicor solution

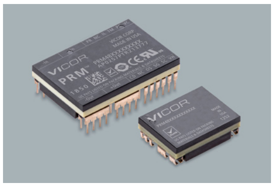
An external AC supply provided the nominal 48V power to the charging station. The voltage varied due to losses in the long cable, which a PRM buck-boost module then regulated. The output voltage and current of the PRM could be varied to match the wide range of battery types of the visiting robots. Key benefits were:

- Extremely wide output voltage adjustment (20 – 55V)
- Highly efficient over full adjustment range (>97%)
- Uniquely capable of handling of wide differences in input and output voltage (up to 10:1)

Vicor PRM regulator provides great flexibility in accommodating wide input and output voltages

Power delivery network: A PRM buck-boost module regulated the widely varying input voltages, providing a precisely regulated output, adjustable over a wide range to suit each robot's battery requirement. To analyze this power chain go to the **Vicor Whiteboard** online tool.





PRM regulator modules

Input: 48V (36 – 75V)

Output: 48V (5 – 55V)

Power: Up to 600W

Peak efficiency: Up to 97%

As small as 22 x 16.5 x 6.73mm

vicorpower.com/prm

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Case study: Hydrogen powered UAV (Doosan)

Lightweight, small converters maximize flight time

Customer's challenge

Extending the operational range of small (<25kG) UAVs has proved challenging using Li-Ion technology as the power-to-weight performance of these batteries typically limits flight times to below 30 minutes. By miniaturizing hydrogen fuel cell technology Doosan has been able to develop a 2.6kW fuel cell solution that is lighter (typically half the weight) and has a higher power density (typically double) compared to conventional LiPo solutions. Employing this technology in a UAV, the designer's key goals were:

- Flight duration and range quadrupled using the hydrogen fuel cell (>2hrs duration)
- Significantly reduce power supply weight and maximize space on-board for payload
- Minimize chance of failure over the sea, requires a highly reliable power solution

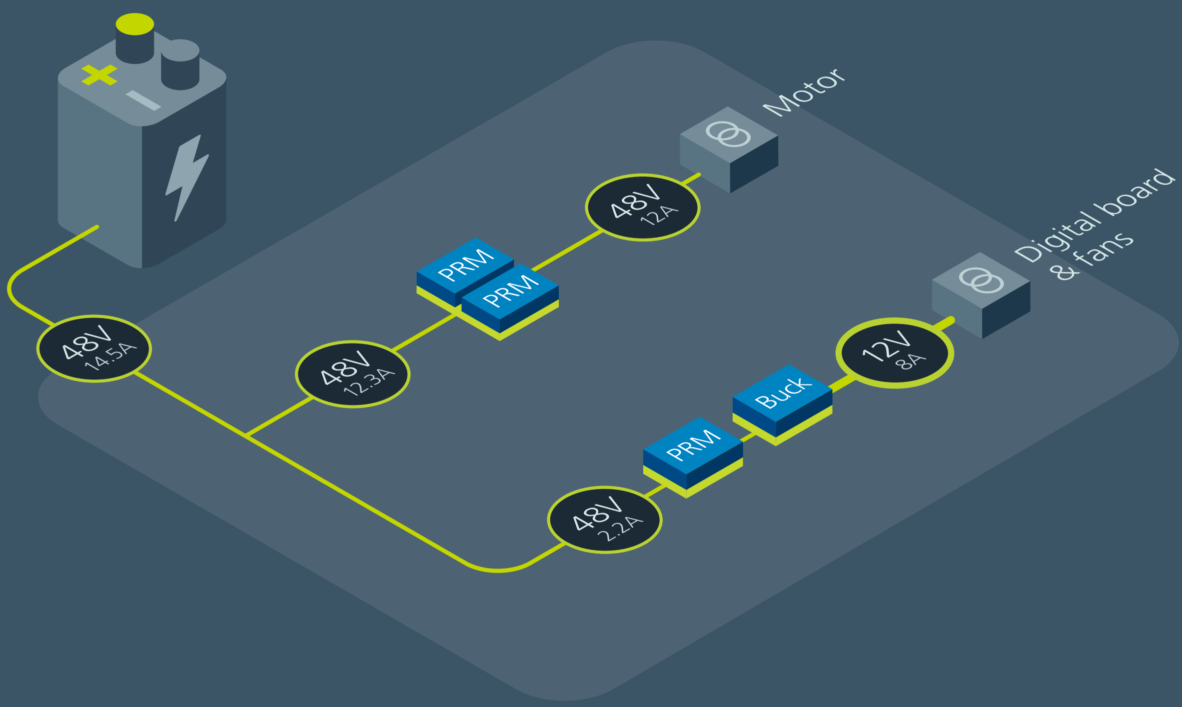
The Vicor solution

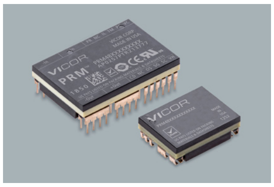
To maximize UAV performance the power distribution network for the rotor motors and electronics should save weight for the payload while keeping conversion losses low. Hydrogen fuel cells typically have a widely varying output dependent on their state of charge and load current. In this case the cell voltage varied from 40 to 74V and the stable 48V 580W rail required for the motors was provided by an array of two PRM regulators. Key benefits were:

- Highly power dense components, PRMs provide 400W in 13.6g and a package 32.5 x 22 x 6.7mm
- ZVS switching topology provides highest efficiency, PRM regulators achieve 97.4%
- Highly integrated power components for highest reliability

Low weight, small power components extend flight time

Power delivery network: The widely varying 40 – 74V output from the hydrogen fuel cell was stabilized for the 48V 580W rotor motor supply by an array of two PRM regulators. The 12V 100W rail for the on-board electronics was provided by a half-chip PRM that regulated the fuel cell output and was followed by a ZVS Buck regulator that converted the 48V PRM output to 12V. Efficiency of the complete power distribution network was 97% and the weight was only 35g, just 10% of a comparable brick solution. To analyze this power chain go to the **Vicor Whiteboard** online tool.

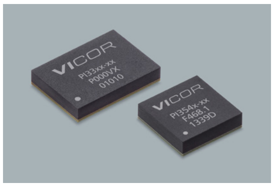




PRM regulator modules

- Input: 48V (36 – 75V)
- Output: 48V (5 – 55V)
- Power: Up to 600W
- Peak efficiency: Up to 97%
- As small as 22 x 16.5 x 6.73mm

vicorpower.com/prm



ZVS buck regulators

- Inputs: 12V (8 – 18V), 24V (8 – 36V), 48V (30 – 60V)
- Output: 1 – 16V
- Current: Up to 22A
- Peak efficiency: Up to 98%
- As small as 7 x 8 x 0.85mm

vicorpower.com/buck

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Case study: Modular multi-purpose ROV (VideoRay)

Flexible solution enabled by modular power

Customer's challenge

For optimum maneuverability and to offset the drag from ocean currents, 1kW of thruster power is required over the tether of an underwater ROV, yet the tether needs be light and thin. When used in very deep water, to maximize performance, this manufacturer further reduced the tether diameter by powering the ROV from an onboard 48V battery. This eliminating the weight of the power cables, enabling the tether to be used only for communication purposes. Modularity of the ROV power solution was a key goal so the platform could be quickly reconfigured for different use cases. Key goals were:

- Adapting to different power sources required a flexible power solution
- Free up space onboard for payload
- Eliminating down time and associated costs requires a highly reliable solution

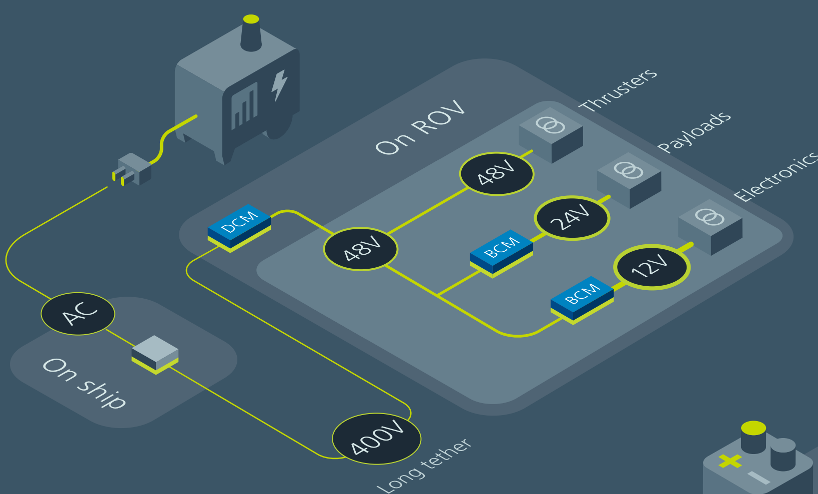
The Vicor solution

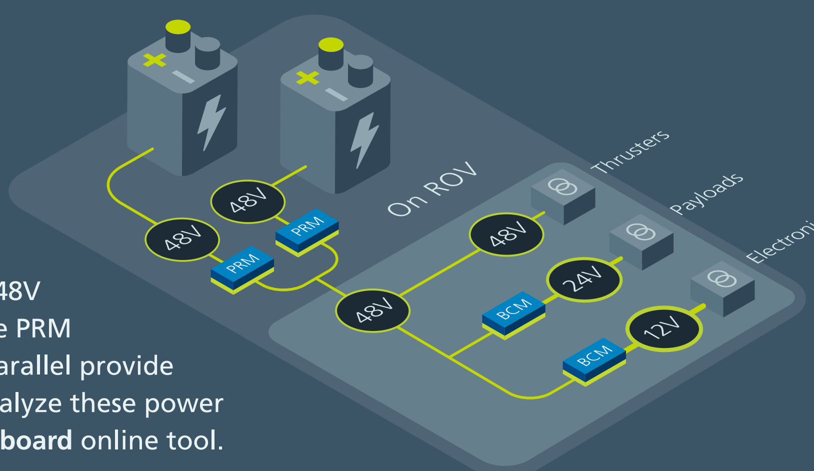
For the tethered option an array of three 400V input DCM DC-DC converters deliver an isolated, stable, 48V rail. For the ROV configuration powered by internal batteries three highly efficient PRM regulators are used to provide each of the redundant 48V rails.

- Modular power components that can be changed to meet diverse requirements
- Highly dense solution occupies just 25% of the space required for a brick-based solution
- Rugged, highly integrated power components for high reliability (>1.85M hours MTBF)

Flexible power components optimize conversion for multiple use cases

Power delivery network: On the ship the AC supply is rectified to provide the 400V DC tether voltage. On the ROV, the tether voltage is isolated and regulated to 48V by an array of three DCM DC-DC converters. The regulated 48V rail directly powers the thrusters and two BCM DC-DC transformers with 95% efficiency provide the 24V and 12V outputs for onboard loads.





When, for redundancy, the ROV is powered by two 48V batteries, two arrays of three PRM regulators with outputs in parallel provide the stable 48V output. To analyze these power chains go to the **Vicor Whiteboard** online tool.

DCM converters

Input: 9 – 420V

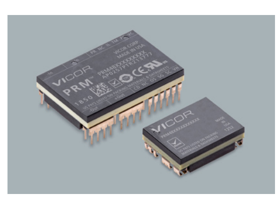
Output: 3.3, 5, 12, 13.8, 15, 24, 28, 36, 48V

Power: Up to 1300W

Peak efficiency: Up to 96%

As small as 24.8 x 22.8 x 7.2mm

vicorpower.com/dcm



PRM regulators

Input: 48V (36 – 75V)

Output: 48V (5 – 55V)

Power: Up to 600W

Peak efficiency: Up to 97%

As small as 22 x 16.5 x 6.73mm

vicorpower.com/prm

BCM bus converter modules

Inputs:	36 – 60V	38 – 55V
200 – 330V	200 – 400V	240 – 330V
260 – 410V	330 – 365V	360 – 400V
400 – 700V	500 – 800V	

Output: 2.4 – 55V   Current: Up to 150A

Peak efficiency: Up to 98%

As small as 22.0 x 16.5 x 6.7mm

vicorpower.com/bcm

Technical articles

The following is a summary adapted from the article "Hydrogen Fuel Cell-Power Drones" by Maurizio Di Paolo, published in EE Times.

Hydrogen fuel cell power extends drone range by 4x

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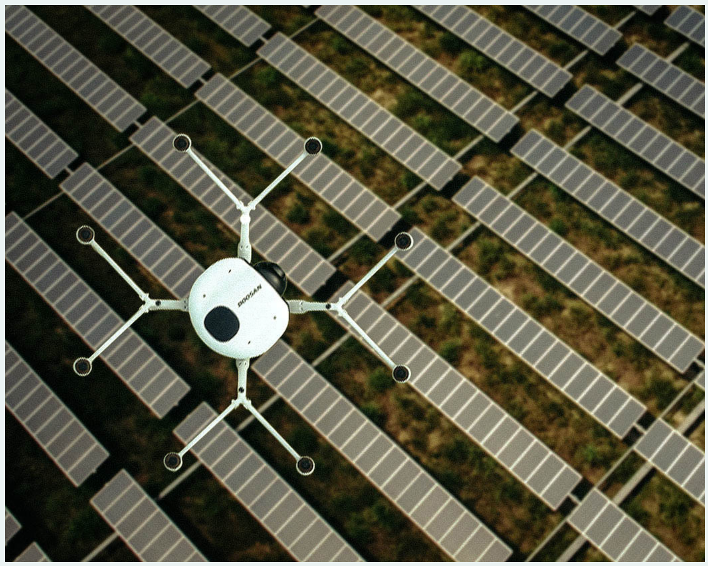
Power delivery networks (PDNs) based on high-density power modules from Vicor are enabling the use of hydrogen fuel cells in drones, where size, weight and efficiency are critical. New hydrogen power technology is paving the way for mobile robot development with extended range and load capacity. Doosan Mobility Innovation (DMI) has now successfully used hydrogen-powered drones to **deliver humanitarian aid** in remote locations that require up to two hours of flight time.



Example of solar panel inspection
(Source: Doosan Mobility Innovation)

In addition to delivering humanitarian aid, the long run-time of DMI's drones allows them to be used for commercial monitoring. DMI has demonstrated this by monitoring the vast area of one of Korea's largest solar power plants where conventionally powered drones would have required more than six battery changes.

Achieving success was dependent not only on the innovative DMI approach to hydrogen power, but also on the use of Vicor high-performance, high-density power modules to deliver power from the fuel cell battery to the various loads within the drone.

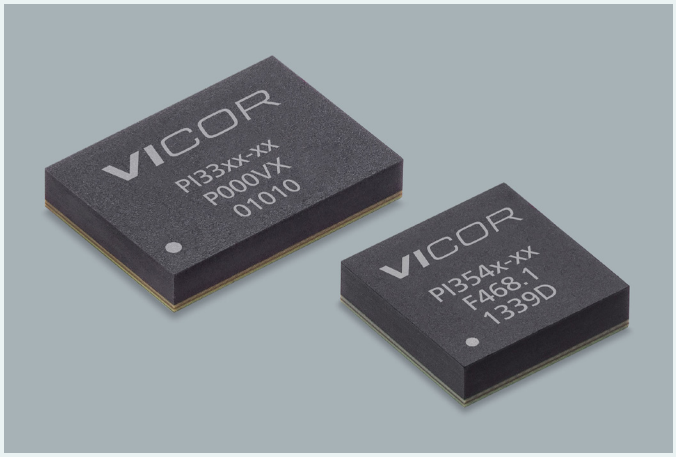
Vicor optimizes power management using a 48V power delivery network

A power delivery network (PDN) is the design of power elements, wires and harnesses that delivers power from the source to the loads in a system. The choice and architecture of a PDN is a system-wide decision and has a significant impact on the drone design and its capabilities. DMI, working with Vicor, chose to use a 48V system which is quickly becoming a standard in many applications to improve efficiency and reliability.

The 2.6kW DP30 power supply system used by DMI has two main groups that supply power to the drone rotors and controllers for the two stacks. Due to the wide range and variable output voltage of the DP30 power supply, from 40 to 74V, the output power units operate at 48V, 12A for the motors and at 12V, 8A for the control circuits and fans. The structure is supported by a **Vicor PRM™ buck-boost regulators** and a ZVS buck regulator (**PRM48AF480T400A00** 400W buck-boost regulator/**PRM48AH480T200A00** 200W buck-boost regulator).

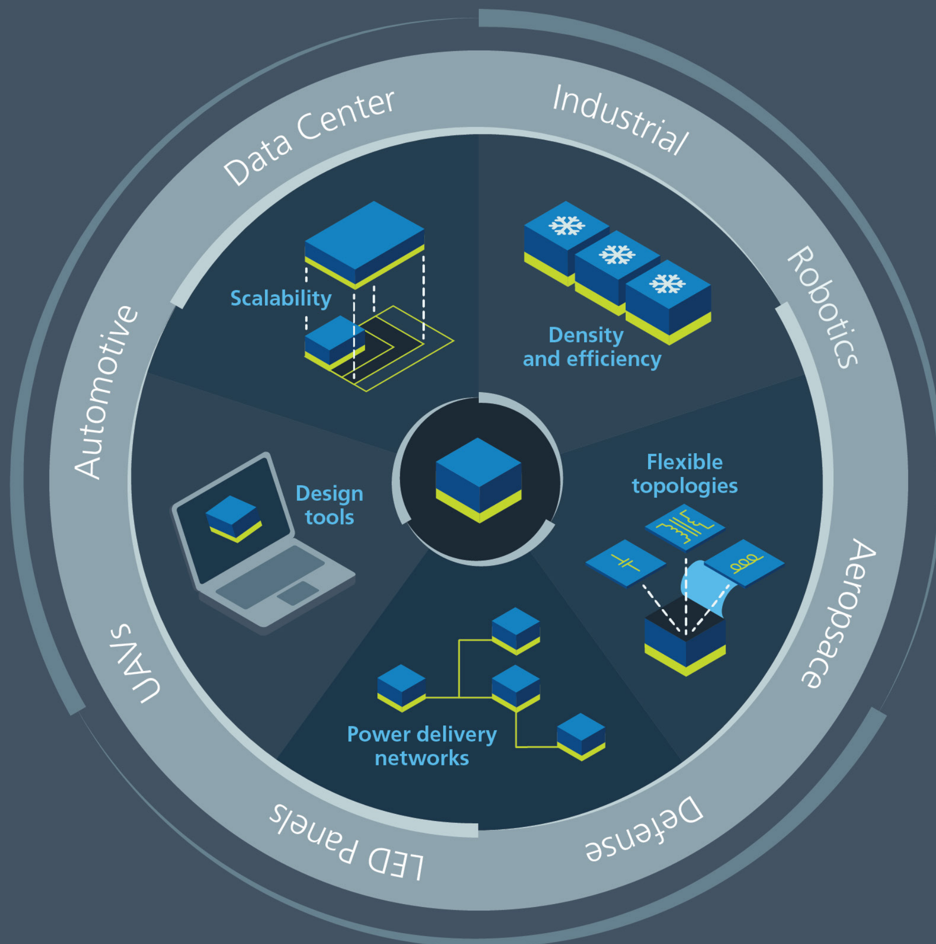
"Wide range of fuel cell voltage and the hybrid connection to the conventional Li-Po battery is the key configuration of our power management system. By doing that, it allows the lithium batteries to automatically charge by Fuel Cell when needed, or discharge when Fuel Cells need additional power when the drone is operating. Thermal management is important to hydrogen fuel cell, and we have an inner cooling fan to regulate the heat," said Jiwon-Yeo.

The increased flight time, coupled with rapid refueling, opens a wide range of new business possibilities for companies using drones for offshore platform inspection, search and rescue operations, high-quality aerial photography, precision agriculture, deliveries and more.



ZVS Buck switching regulators

ZVS Buck switching regulators offer board-level designers maximum power density and flexibility for high-efficiency point-of-load DC-DC regulation. The integration of a high performance Zero-Voltage Switching (ZVS) topology increases point-of-load performance, providing best-in-class power efficiency up to 98%. The ZVS Regulators are highly integrated with control circuitry, power semiconductors and support components, in a high-density System in Package (SiP). The device can also be configured to operate in constant current mode.



Article by Robert Gendron, VP Product Marketing

Power of the module

VICOR

Eliminate intermediate energy storage in EV power architectures

Introduction

Vicor has established a power module capability spanning product design, manufacturing, simulation and selection tools. This capability allows Vicor to enable power systems designers to quickly and easily deploy high-performance power delivery networks (PDNs) from the power source to the point-of-load (PoL) for end systems extending across many different industries such as automotive, AI/data center, defense and aerospace, LED lighting, etc.

This modular power component approach signifies a new standard within the power industry, addressing the increasing power needs of modern, high-performance end systems with a methodology that also provides other power system benefits such as reduced power system footprint, high efficiency and faster time-to-market.

The need for power modules

Power delivery networks are rapidly changing within many end systems across many industries today. The power requirements for these different systems vary widely from each other and require a wide portfolio of modules to enable the maximum flexibility for a modular power component methodology to be employed. The range of modular power solutions Vicor provides include:

- AC-DC and DC-DC modules
- Power levels from 50W to over 50kW
- Currents from a few amps to 1,000A+
- Voltages from sub-1V to over 1,000V
- Isolated and non-isolated converters and regulators
- Regulated and fixed-ratio converters
- Board-mount, chassis-mount and surface-mount power module packages

> "Utilizing power modules follows the practice and benefits of a mass customization capability."

In addition to the above, there are also different control features such as telemetry, compensation and programability, plus any industry/safety certifications that can be required. To effectively support different PDNs in different industries with an optimized solution, a comprehensive power module approach in needed. Utilizing power modules follows the practice and benefits of a mass customization capability. Mass customization enables the ability to offer unique PDNs optimized for different end systems while benefiting from common design and manufacturing processes. Common, scalable design and manufacturing processes also offer advantages in faster time-to-market, reliability, technology risk and cost management. The key elements of this power module approach are:

Modular power component design methodology

The modular power component design methodology is the ability for the end designer to select, configure, optimize and source a unique power delivery network comprised of different power modules.

Power module design

The power modules themselves are assembled within a common manufacturing process and can easily be configured by utilizing:

- Flexible power switching topologies and control systems
- Configurable and scalable packaging

Modular power component design methodology

Multiple PDN designs are enabled by a large power module portfolio offering a range of functionality, scalability and performance. Selecting the optimized power modules for different power delivery architectures out of the portfolio and building the highest performing PDN is possible with the **Power System Designer** and **Whiteboard tools** (Figure 1). These tools provide an environment to analyze different architectures and modules optimized for overall performance, cost or size considerations. The modular power component design methodology—supported by a large power module portfolio and tools for selection and optimization — is the more visible element to the Vicor power module approach since customers use it to interface with Vicor daily. It is the second element of power modules, the power module design itself, that is not as visible to customers — but it is equally important to providing the benefits of mass customization.

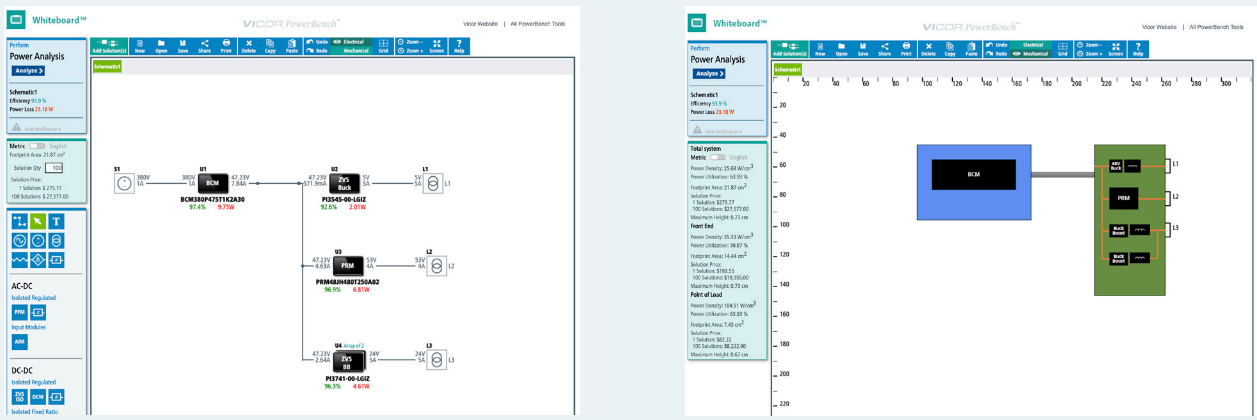


Figure 1: Example of a power delivery network designed and optimized using the Vicor Whiteboard tool

Flexible switching topologies

Vicor has innovated flexible switching topologies that can adapt to the various power conversion functions and needs. Topologies vary in their functionality, and one or more can be used within a power module. The Sine Amplitude Converter (SAC™) topology is one of the most common topologies and can be quickly configured to different power requirements, primarily by means of changes to the FETs and planer magnetics within the module design. The use of flexible switching topologies allows for quick development time and low risk for new power modules optimized to meet specific application needs.

Configurable and scalable packaging

Vicor developed the CM-ChiP™ common package technology to maximize power module density and thermal performance. The CM-ChiP package is a 3D package with an internal mid-plane substrate that enables component placement on both the top and bottom sides. Package thermal impedance is equal

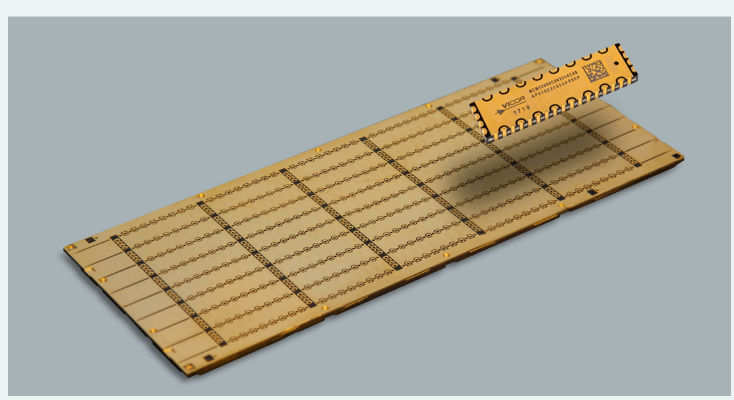


Figure 2: Panel fabrication process enabling configurable CM-ChiP packaging

from the top and bottom sides of the package, allowing for dual-sided cooling if desired. Exterior plating options provide flexibility for shielding options and terminal connections, which include surface-mount, pinned and chassis-mount terminations. No tooling is required for different form factors or terminal connections. By using the CM-ChiP common package technology, a faster time-to-market and a higher level of performance predictability can be achieved in new power module designs.

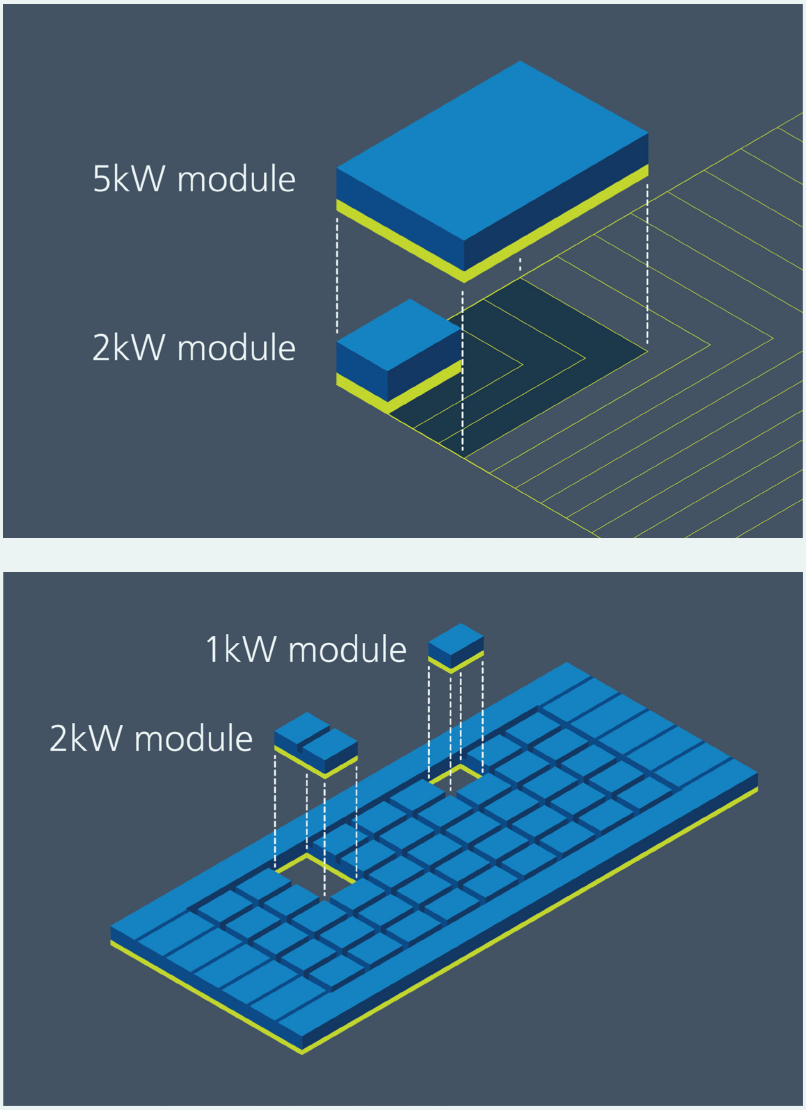


Figure 3: Scaling approaches with the panel fabrication process: linear scaling (top) and integer scaling (bottom)

The CM-ChiP is fabricated within a panel fabrication process, which is similar to a wafer fabrication process (Figure 2). Both processes enable multiple modules or devices to be fabricated from a single panel or wafer, standardized on a fabrication line. The panel can accommodate various module form factors with the largest possible module utilizing the full panel. A critical element to mass customization, the panel fabrication process shifts the manufacturing focus away from conventional fragmented, single-component package support and yield-enhancement efforts towards panel-level efforts that encompass all products.

Flexibility within the PDN architecture and design includes the ability to parallel most power modules for increasing system power demands. In addition, Vicor can increase module power delivery by scaling the power module itself to a larger size. Scaling can be accomplished by module linear scaling, increasing the power capability by modifying the core module design to a higher power level. Another scaling option is integer scaling where 2x, 3x, 4x power capability is possible by singularization of more than one base module from the panel (Figure 3).

Advanced modular power delivery network examples

When artificial intelligence (AI) processor power system designers wanted to maximize their processor performance on an AI accelerator card, they turned to Vicor. Power performance requirements for the processor called for the delivery of 500A+ at a sub-1V level (Figure 4). In addition, the power delivery network needed to fit within the industry-standard Open Compute Platform OAM card, pushing the power density limits of conventional multiphase buck regulators.

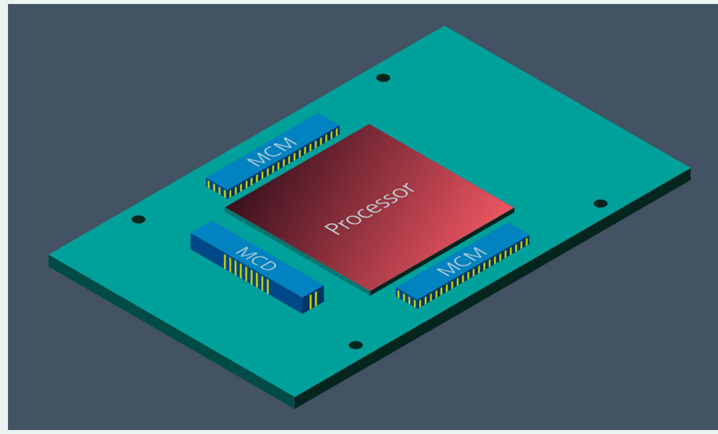


Figure 4: Power delivery network for advanced AI processors delivering 500A+ at sub-1V

Vicor configured a SAC-topology-based module, the MCM4609 with a K factor of 1/48, to fit within the north and south sides of the AI processor with dimensions of 46 x 9 x 3.2mm (Figure 5). Each MCM4609 provides 325A, or 650A continuous in total at sub-1V levels to the processor. The MCM4609s receive a drive signal from the MCD4609 module completing the power delivery network. The AI PDN provides unparalleled density and proximity to the processor minimizing PCB losses.

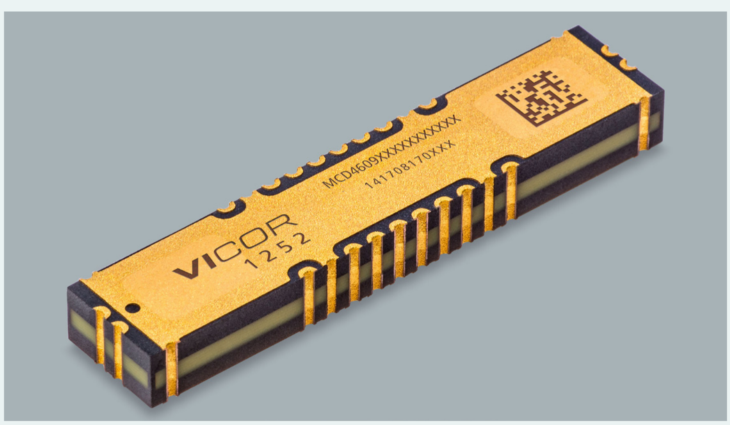


Figure 5: MCM4609 power module for AI processor power delivery

Similar to the AI processor need, when approached to develop a high-density electric vehicle (EV) battery PDN, Vicor was able to quickly configure a SAC-topology-based module to meet those needs (Figure 6). EVs require a 48V rail to support non-motor loads within the vehicle from the primary battery in addition to requiring a chassis-mounted package. Conventional solutions to provide 48V from the 800V battery in an efficient and lightweight manner were limited.

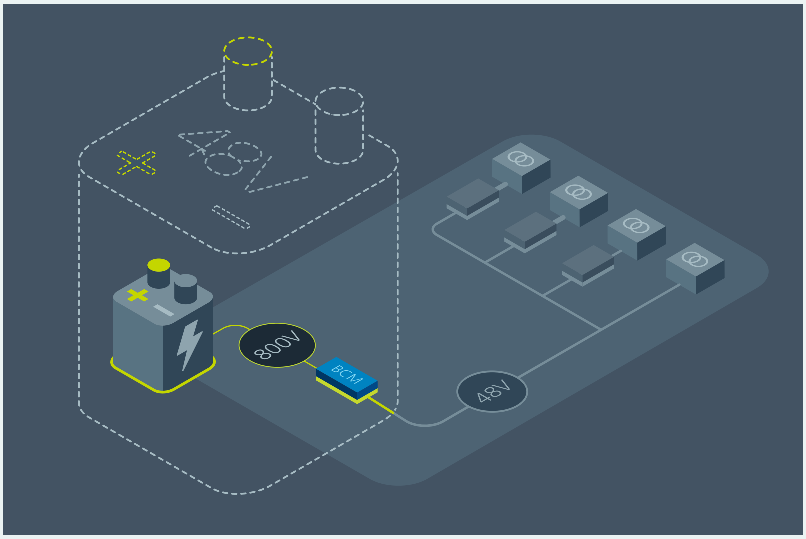


Figure 6: Power delivery network for 800V EV battery power conversion

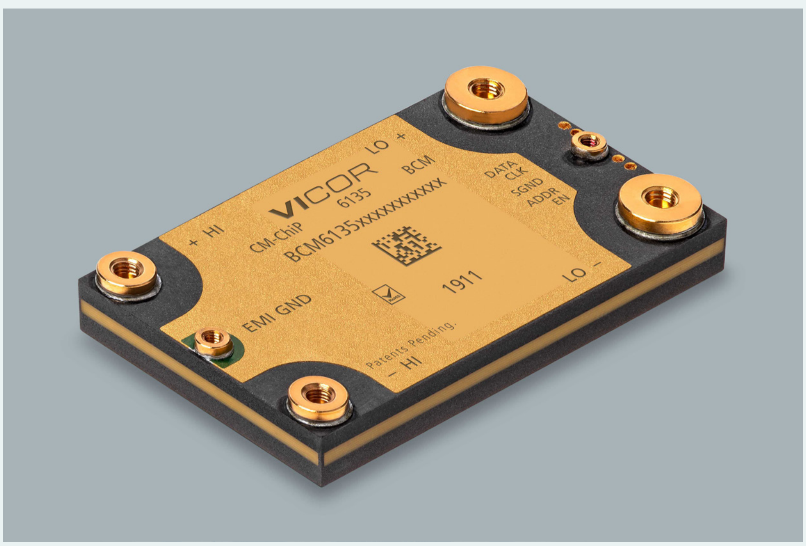


Figure 7: BCM6135 power module for EV battery voltage conversion

Vicor therefore developed a SAC-topology-based module with a 1/16 K factor within a larger CM-ChiP (compared to the AI MCM4609) to accommodate higher power and chassis mounting. The power module, BCM6135, provides $800V_{IN}$ to $48V_{OUT}$ at 80A (or 3.8kW of output power) conversion at over 97% efficiency in a 61 x 35 x 7.4mm CM-ChiP package (Figure 7). Additional power modules downstream of the BCM6135 support regulated 12V and 48V rails to complete the PDN. The high-density and high-efficiency attributes of the BCM6135 and downstream power modules enable a reduced weight and higher-performing EV battery conversion.

The following is a summary adapted from the article "Overcoming Tethered UAV Challenges with a High-Voltage, Compact Module-based Power Delivery Network" published by EE Times

Overcoming tethered UAV challenges with a high-voltage, compact, module-based power delivery network

VICOR

Robotic and unmanned vehicle (UV) fleets are reshaping the future of automation and production. Continuous improvements in productivity are being driven by extended range and increased uptime that are reliant on fleet maintenance, particularly the charging process. One of the top costs and inefficiencies today is the need for human intervention in the charging process; therefore, UAV and automated robotics developers are looking for ways to make further improvements in power density and efficiency to lighten loads and extend battery life.

Efficient power delivery with reduced footprint and weight.

Realizing such improvements requires reconsideration of the power delivery network (PDN) and the use of high-density power modules instead of traditional, all-in-one power supplies.

Tethered drones are a growth market for UAVs because of the need for extended uptimes and increased load capabilities for applications such as surveillance and communications. Ispagro addresses this market in an innovative way by retrofitting existing, market-leading small drones from manufacturers such as DJI and Parrot. Retrofitting existing UAVs allows Ispagro to rapidly address evolving market needs in a cost-competitive manner.

However, these battery-operated, small drones have limited payloads and uptimes. So adding a tether extends uptime and provides fail-safe operation for safe landing via onboard battery in case of power failure, tether, damage, etc. The tether, however, does add more challenges for the UAV designer who must accommodate the 50m tether cable and aerial units within a tight 400gm payload limit.

Heavy-gauge tether limits range and performance

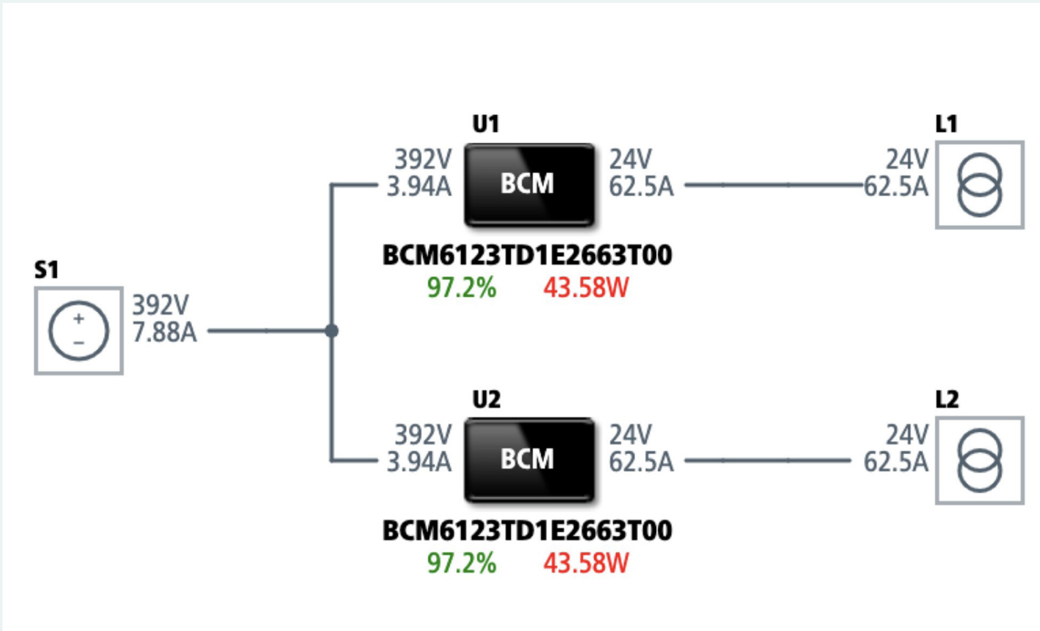
The biggest challenge is to reduce the weight of the tether. A heavier tether will require more power to maintain flight times. More weight will also limit the height and range of the drone. High-power DC-DC conversion would typically require a bulky power supply because they are sending lower voltage power up the tether.

Best power design for tethered drones

The best way to alleviate heavy tethers is to send high-voltage power up the tether and convert down to the load levels at the other end. High-voltage power can travel more efficiently than low-voltage via a thinner-gauge cable, which is lighter and more efficient. To minimize weight of the flying drone, small fixed-ratio bus converter modules are used to efficiently convert high voltage (400 – 800V) to loads (20 – 50V). The Vicor BCMs can achieve 98% peak efficiency and continuous efficiency of 95%.

Vicor BCMs reduce cable weight by 30 – 40%

High-density and lightweight power modules are ideal for this application, enabling lower input currents and thinner and lighter tether cables. The weight saved from the tether cable can be used to maximize payload to improve the functionality and capabilities of the UAV. Newer versions with high-capacity drones also need the power conversion to happen inside drone, and lightweight, high-performance power modules are necessary to fit into the system.



BCM modules can be paralleled with inputs powered from different sources because they are isolated transformers. BCM modules mounted close to each other and cooled equally will also equalize power dissipation.

Vicor high-density, high-efficiency power modules address Ispagro's challenges. The **BCM family of fixed-ratio converters** offer the highest efficiency and highest power density for use in onboard power conversion. BCMs are available in many combinations of input and output voltages to accommodate a wide range of payload applications, and they can be easily paralleled to **simplify development of UAV platforms**.

The combination of high efficiency and light weight of Vicor BCMs enables tether cable weight reduction of 30 – 40%. BCM modules can be paralleled with inputs powered from different sources because they are isolated transformers. BCM modules mounted close to each other and cooled equally will also equalize power dissipation. This further reduces amount of space needed, simplifies thermal management, and increases the power available to the drone and its payload.

The Vicor modular solution delivers high efficiency, high power and scalability

BCM® bus converter modules

The Vicor PDN solution is compact and lightweight due to industry-leading high power density. Ispagro was able to meet higher power requirements with a simple 2-module solution using fixed-ratio BCMs. This solution achieves 98% peak efficiency and continuous efficiency of 95% with high MTBF. As Ispagro increases power requirements, these BCMs can be swapped out for other BCMs or paralleled as needed with minimal additional development.

BCM bus converters are high-density, high-efficiency, fixed-ratio (non-regulating) isolated DC-DC converter modules. BCMs are available in a ChiP™ package or a VIA™ package, which simplifies cooling as well as providing integrated PMBus® control, EMI filtering and transient protection. The family extends from 800V to 48V inputs with various K factors to suit a wide range of applications and markets. Based on the Vicor proprietary Sine Amplitude Converter (SAC™) topology, high-voltage BCM ChiPs are able to reach peak efficiencies of 98% and achieve power densities up to 2,400W/in^3.

Application notes

This section provides information on select Vicor products used in robotics and links to their online application notes for key implementation details and considerations to note when designing a power delivery network.

Single DCM

- A DCM™ DC-DC Converter Module contains isolation, regulation, thermal management, and fault monitoring all in one single module. The DCM is applicable to a variety of industries and military applications due to its wide input voltage range, high output power, high density, and high efficiency. This single DCM has two available packages: Converter housed in Package (ChiP) and Vicor Integrated Adapter (VIA™) package.

Paralleling DCM

- When an application calls for more power than can be delivered by a single DCM, parallel DCMS can be utilized. Paralleling DCMs is rather straightforward, since the operation of each DCM in an array is nearly identical to that of a single DCM circuit. In a parallel circuit, each DCM operates on its own load line, depending on its share of the load. Because of this, having parallel DCMs allows for the same load line to be remapped over a higher current range, with no derating.

Reverse-mode SAC

- Sine Amplitude Converters (SACs) are symmetrical power processing systems which function as a close approximation to an ideal power converter. When a SAC is placed in reverse mode, the source is applied to the SAC™ secondary power port. The SAC delivers a voltage boosted according to the K factor associated with the particular module, which it presents to a load connected across its primary power port.

Filtering Considerations

- An Intermediate Bus Converter (IBC) is a very efficient, low profile, isolated, fixed-ratio DC-DC converter based on the Vicor's patented Sine Amplitude Converter (SAC). The IBC exhibits low levels of noise and has a very wide bandwidth with high efficiency. To guarantee optimal performance of the IBC, a filter can be applied. Here you can learn about filter considerations and approaches to best fit your IBC.

Thermal Management

- Proper thermal management is important for Vicor VIA and ChiP™ package converters because it provides improved module and system MTBFs, smaller size, and lower product life-cycle costs. Vicor provides guidelines for achieving effective thermal management.

Application notes

Paralleling PRM

- Pre Regulation Modules (PRM™) and Voltage Transformation Modules (VTM™) solutions leverage the advantages of Factorized Power Architecture™ for high power, low voltage, isolated and non-isolated point of load applications. Factorized Power Architecture uses PRMs or buck-boost regulators and VTMs or current multipliers at the point of load, to provide a complete DC-DC solution.

Paralleling BCM

- Vicor BCMs are power components that provide voltage transformation, current multiplication and isolation for designs that require high power density, high efficiency, small size and low weight. A BCM® steps down its input voltage by a range of ratios and provides galvanic isolation. BCMs support a broad range of output voltages and power levels. The robust VIA package also provides integrated PMBus communication and EMI filtering. These flexible modules can be easily paralleled into higher power arrays.

Series-output BCM

- BCMs support a broad range of output voltages and power levels. BCM outputs can be connected in series to achieve higher Voltage output. Vicor BCM products offer benchmark performance in a small, cost-effective package. Utilizing Vicor resonant Sine Amplitude Converter™ (SAC) topology, BCMs leverage high-frequency Zero-Voltage Switching (ZVS) and Zero-Current Switching (ZCS) to deliver unmatched efficiency and power density with low noise and fast transient response.

Constant Current (charger)

- Vicor's VI-200/VI-J00 and Maxi, Mini and Micro family DC-DC converters are voltage regulating devices, but their wide trim range makes it possible to use them as efficient high-power current sources. Current regulation can be implemented through the addition of an external control loop and current-sense resistor.

Tools

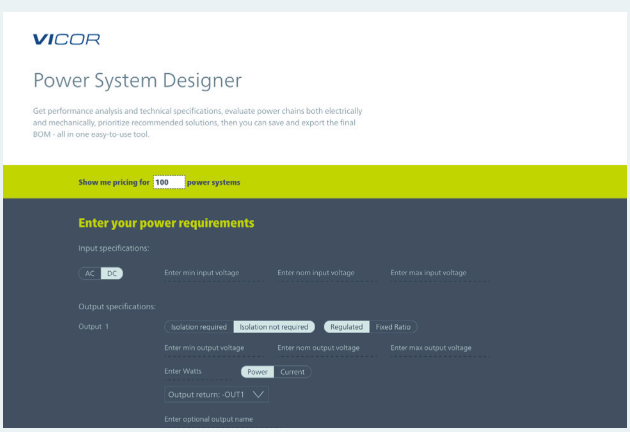
This section outlines Vicor tools that provide novice and experienced engineers a digital workspace where they can design and test power module solutions to best fit their application needs.

Power System Designer

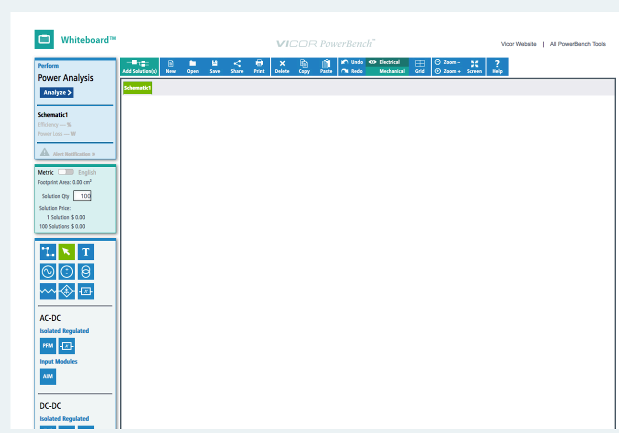
- The Power System Designer is a user-friendly software which both novice and experienced system designers can utilize to architect end-to-end power delivery networks. This tool harnesses Vicor’s Power Component Design Methodology to produce optimized solutions without time consuming trial and error. The Power System Designer also provides a service which is up to 75% faster than traditional methods and allows users to export the final BOM.

Whiteboard

- Whiteboard is an online tool with an easy-to-use workspace where users can analyze and optimize the performance of different power chains. Users are able to find the best solution for their application needs using Vicor’s high density, high efficiency power modules. In addition, users can set operating conditions for each component of the power design and get loss analysis for individual components and the system overall.



Power System Deisgner



Whiteboard

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