Powering Innovation eBook

Volume 1:
Saving the environment

VICOR

Contents

Introduction

Technological breakthroughs to protect and preserve the environment

Our customers develop breakthrough end applications designed to improve the quality of the air we breathe and restore the delicate ecosystems that protect communities and livelihoods across the globe. These innovations include harnessing the immense power of ocean waves to create clean renewable energy, building new coral reefs quickly to prevent coastal erosion, and electrifying modes of transportation to reduce the amount of greenhouse gasses released into our atmosphere. These companies rely on highly efficient power delivery networks to enable their innovations.

Powering innovation

For over 40 years Vicor has been at the forefront of power solutions with groundbreaking architectures, packaging, and advanced manufacturing. Our high-performance power modules are the most compact, power-dense, and efficient power solutions. As a result, our customers have been able to leverage our patented technologies to solve the toughest power challenges and unleash the true potential of their products.

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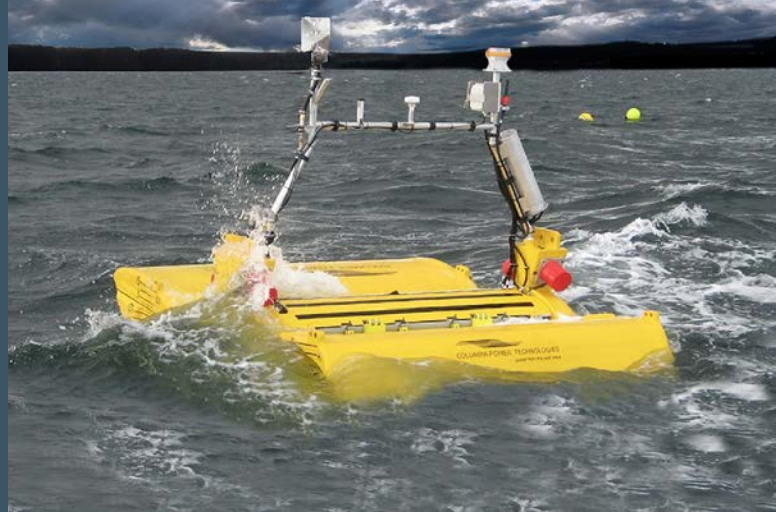
Case study: C-Power renewable autonomous offshore power system



Ocean waves are renewable energy to power marine applications

Customer's challenge

Oceanographic exploration and research are inherently challenging because of unpredictable and often risky environmental conditions. Power management is a critical component of any off-shore venture to ensure successful missions by delivering a robust power supply to essential systems and extending time at sea. The key goals for C-Power were:

- Ultra-wide 30:1 input range to adapt from calm waters to tumultuous storms
- Dynamically controllable output voltage for a range of applications
- A power supply that was compact in size and lightweight

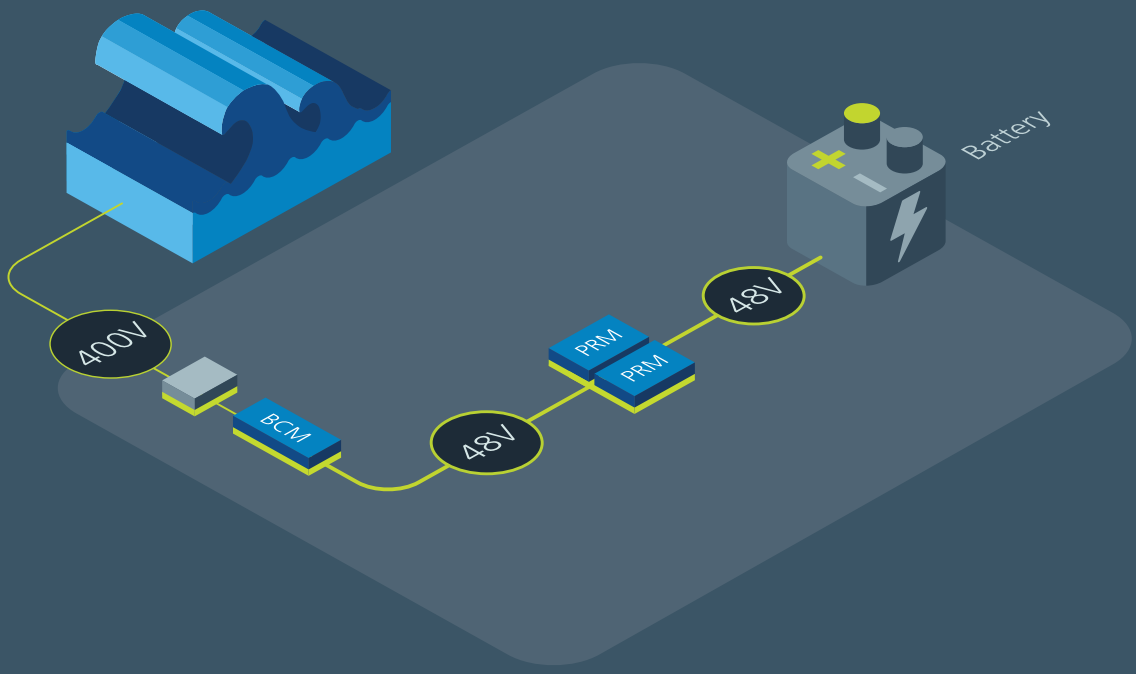
The Vicor solution

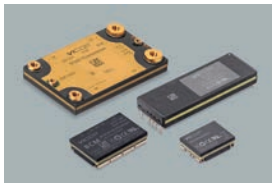
The Vicor Power Systems (VPS) design team developed a highly dense and efficient solution that operated across the ultra-wide 30:1 input range and delivered the dynamic control of the output voltage caused by varying wave energy input while offering external override control of the output. The Vicor BCM® and PRM™ architecture provides the stable, constant current from the highly variable power pulses coming from SeaRAY's onboard generator, caused by turbulent and unpredictable ocean waves. Key benefits were:

- Achieving greater power efficiency up to 90%
- Reliable, stable and safe constant current despite highly variable power pulses
- Minimal EMI and noise in the power output

Delivering high efficiency, precise control and low EMI

To achieve high efficiency, a BCM® fixed-ratio bus converter and PRM™ regulator modules were used to efficiently convert wave energy and provide controlled power. Previous conversion was around 50% using discrete power components. By incorporating the BCM and PRM power delivery network, Vicor was able to increase efficiency up to 94%.

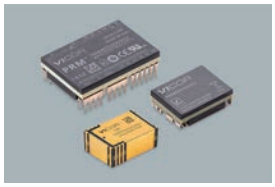




BCM® bus converter

Isolated fixed-ratio
Input: 800 – 48V
Output: 2.4 – 55.0V
Current: Up to 150A
Peak efficiency: 98%
As small as 22.0 x 16.5 x 6.7mm

vicorpower.com/bcm



PRM™ regulator

Non-isolated regulated
Input: 48V (36 – 75V)
Output: 48V (5 – 55V)
Power: Up to 600W
Peak efficiency: 98%
As small as 22.0 x 16.5 x 6.73mm

vicorpower.com/prm

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Case study: CCell coastal protection

Combating coastal erosion by restoring and growing coral reefs

Customer's challenge

CCell Renewables is a marine engineering company that is combating coastal erosion and enhancing marine ecosystems by restoring and growing new coral reefs on a large scale through the electrolysis of seawater. Renewable energy is inherently unpredictable and delivers widely varying supply voltages which complicates conversion and regulation in the power delivery network. The key goals for CCell were:

- Long power delivery distance
- Precise load voltage regulation
- Ability to handle a wide range of input voltages

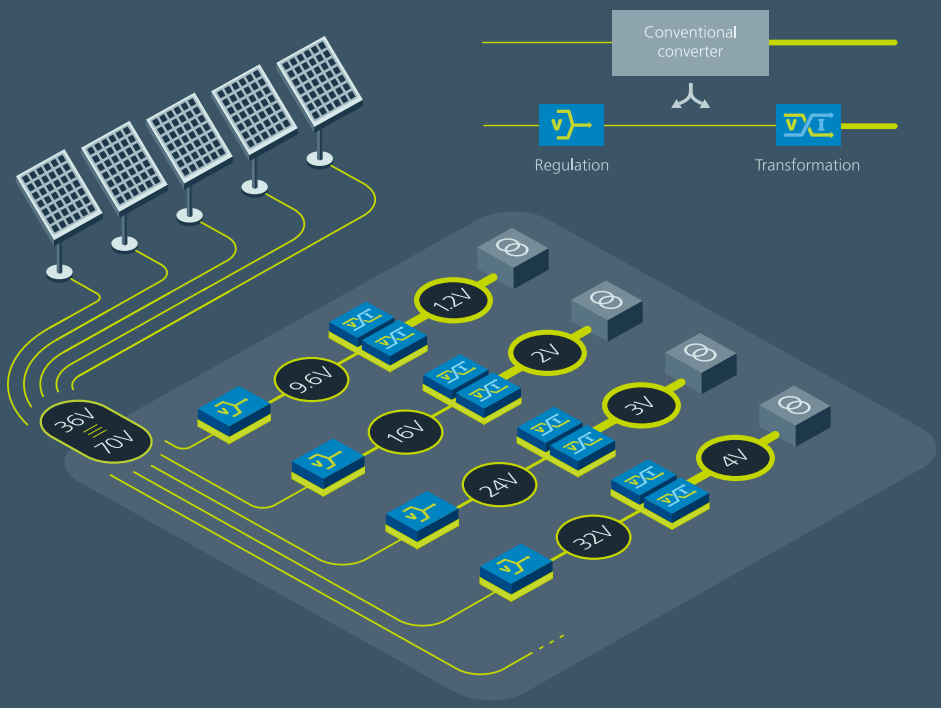
The Vicor solution

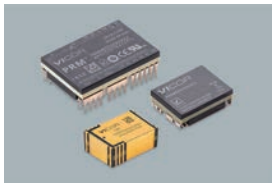
CCell's reef growing system deposits calcium carbonate (limestone) on large steel frames which function as anodes and cathodes (electrodes) and give the new reef its early structure. The technique helps to dramatically accelerate limestone growth which is the foundation for a strong and healthy coral reef ecosystem. Factorizing the DC-DC function into two modules, a PRM™ regulator and a VTM™ current multiplier, the power delivery network is optimized for regulation and conversion. Key benefits were:

- Mangement of the wide input voltage derived from renewable energy sources
- Able to deliver a precise output voltage needed for optimum coral growth
- High efficiency

Factorized Power optimizes regulation and conversion

By using Factorized Power Architecture (FPA™) the DC-DC function can be split into two modules, a PRM™ regulator and a VTM™ current multiplier. The PRM buck-boost regulator operates over a wide input voltage range and has a zero-voltage switching (ZVS) topology, delivering very high efficiency, and power density. The VTM is a fixed-ratio resonant converter with high current density. The PRM tightly regulates the voltage required for the reef and the VTM handles the down-conversion and current delivery to the electrodes.





PRM™ regulator

Non-isolated regulated

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Output: 48V (5 – 55V)

Power: Up to 600W

Peak efficiency: 98%

As small as
22.0 x 16.5 x 6.73mm

vicorpower.com/prm

VTM™ current multiplier

Isolated fixed-ratio

Input: 0 – 60V

Output: 0 – 55V

Current: Up to 130A

Peak efficiency: 97%

As small as
22.83 x 8.52 x 4.9mm

vicorpower.com/vtm

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Case study: Lightning Motorcycles electric bikes

Making a global impact and setting record breaking speeds for electric bikes

Customer's challenge

Motorcycle electrification is challenged by stringent standards for a minimum range of 100 miles and charge times under one hour for 70 miles of range. Electric motorcycles require an extremely power-dense and reliable power delivery network that mitigates electrical noise (EMI) and manages a wide range of battery voltages while negotiating rugged, unpredictable conditions. The key goals for Lightning Motocycles were:

- Dramatically extend range and decrease charge times
- Compact and lightweight solution
- Capable of handling the different voltage input ranges from different battery chemistries

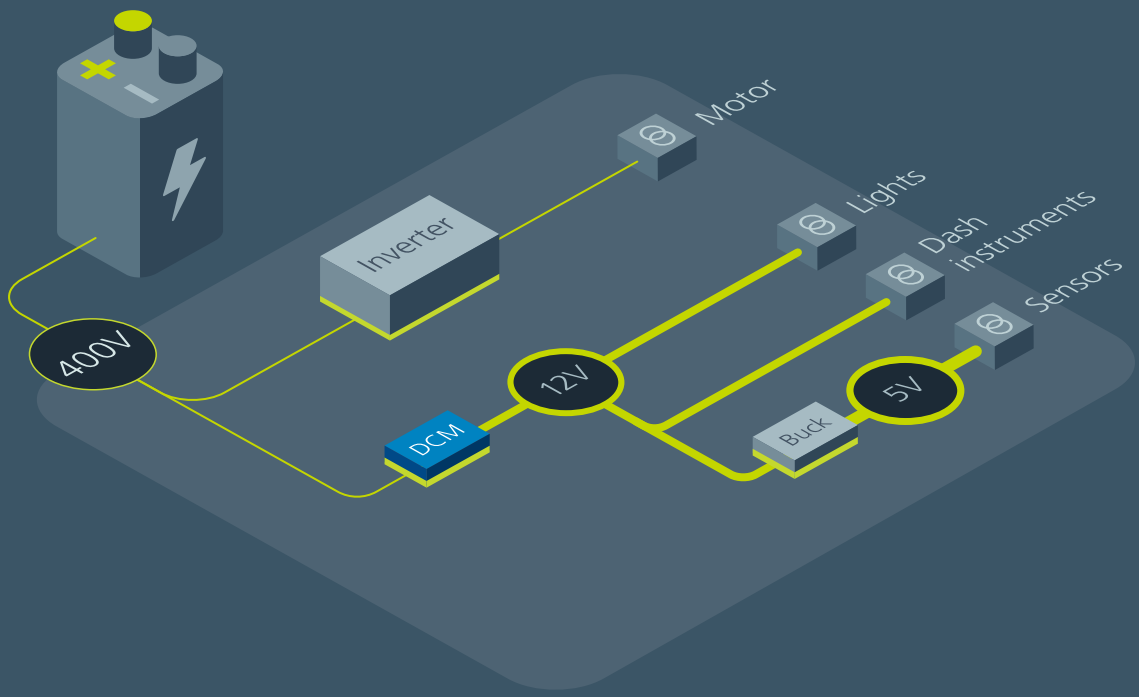
The Vicor solution

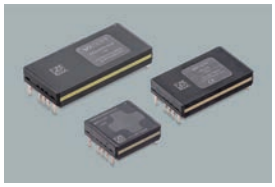
To achieve peak operational performance of world-class electric motorcycles, Lightning turned to Vicor for the smallest and most power-dense solution with the widest input range that offers flexibility to switch between Lithium-Iron-Phosphate packs, which provide 200 – 400V, and Nickel-Manganese-Cobalt or Nickel-Cobalt-Aluminum Oxide chemistries, which typically range between 250 – 420V. Key benefits were:

- Safely converts high-voltage power (400V) to SELV (12V)
- DCM™ best-in-class power density
- The integrated module packaging offers a more robust solution that can handle extreme environmental conditions

Power dense and compact power modules safely convert high voltages to 12V supply

Vicor DCM™ power modules convert the high voltage battery down to 12V to power the bike's control electronics including dash instrumentation, lighting, and sensors. The DCM4623 is a power-dense, lightweight and cost-effective DC-DC converter that generates a clean 12V supply from a very wide high voltage input range. The input range of the DCM4623 is wide enough to support different voltages from commonly used battery chemistries.





DCM™ DC-DC converter

Isolated regulated

Input: 9 – 420V

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

Power: Up to 1300W

Peak efficiency: 96%

As small as 24.8 x 22.8 x 7.21mm

vicorpower.com/dcm

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Case study: Ampaire hybrid-electric aircraft

Air travel powered by eco-friendly high-efficiency electric systems

Customer's challenge

Escalating concern over rising carbon dioxide (CO_2) emissions is driving worldwide demand for more pure electric and hybrid electric vehicles. While automotive has led this charge, the airline industry is ramping quickly and is analyzing the cost/performance benefits of electric-powered aviation. If air travel costs can be driven down, it can expand air travel to under-serviced or remote geographies. The key goals for Ampaire were:

- A DC-DC converter with a wide input range
- A compact and lightweight power solution to keep the plane as light as possible
- High efficiency and simplified thermals

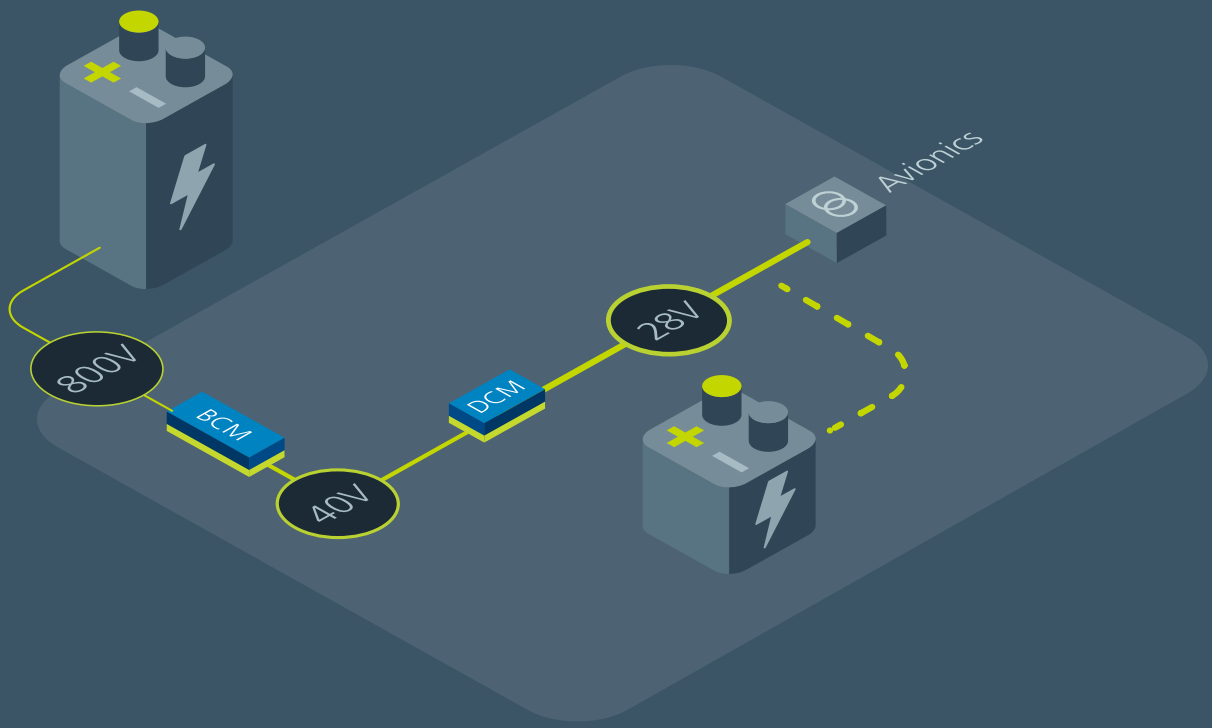
The Vicor solution

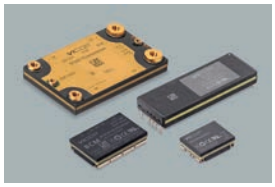
The modularity of the Vicor solution enabled Ampaire to achieve key design advantages compared to bulky 'silver box' power supplies. These technology advantages were complemented by Vicor proven military-grade quality and reliability. In the highly-regulated aviation technology domain, this helps streamline validation and certification cycles. This ease of certification will prove to be a great asset as Ampaire transitions from its current hybrid powertrain architecture to a fully electric propulsion system. Key benefits were:

- Modularity and scalability
- Lightweight power modules
- Higher efficiency to extend flight times and range of operation

2-stage modular solution

The power conversion and regulation is done in two stages, to optimize the efficiency and power density and to simplify thermal management. A fixed ratio bus converter module (BCM®) is used to isolate and down-convert the high voltage battery, then followed by (stage 2) a low voltage DC-DC converter to regulate the output of the bus converter to 28V.





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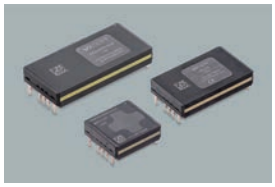

DCM™ DC-DC converter

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Power: Up to 1300W

Peak efficiency: 96%

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vicorpower.com/dcm

Other Powering Innovation eBooks

Volume 2: Protecting and saving lives

Our customers develop innovative solutions designed to offer security, necessary resources in time of need, and in some cases preserving life. These systems include Autonomous Security Robots (ASR) which offer 24/7 mobile advanced security monitoring to hydrogen and electric-powered drones that can assist first responders establish vital local and long-range wireless communications quickly and deliver critically needed supplies to remote hard-to-reach locations. Beyond the frontline support, edge computing systems can help coordinate rescue efforts and deliver data to medical robots to assist doctors during medical procedures. These companies depend on the most advanced and reliable power delivery networks to enable these lifesaving applications. Download the eBook.

Volume 3: Changing what's possible

Our customers are constantly challenging the limits of what is possible. From battery-operated robot layout assistants on construction sites to AI-enabled undersea remotely operated vehicles (ROVs) their achievements are only limited by their imagination. They have gone as far as to change the fundamental principles of electricity with the introduction of digital electricity making it easier, cheaper, and safer to install and use. The common thread shared among these world-changing applications is the need for a power delivery network that is capable of supporting the advanced functionality and performance these systems deliver. Download the eBook.

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