

Powering Innovation eBook

Volume 2: Protecting and saving lives

VICOR

Contents

Introduction

Innovative solutions that protect and deliver lifesaving materials and services

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.

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: Fukaden communications tethered drone

Enabling life-saving communications amid natural disasters

Customer's challenge

Responding quickly to natural disasters and restoring uninterrupted wireless communications is important to establish a supply line of essential services and materials such as drinking water, food, electricity, and medical supplies. This enables first responders to support the time-critical needs of victims and helps ensure their safety. The absence of reliable mobile communication frustrates and hinders restoration efforts putting everyone's lives at risk. The key goals for Fukaden were:

- Compact high-density power modules optimize available design space and weight
- Handling higher input voltages to reduce cable weight
- Lower EMI to support clearer communications

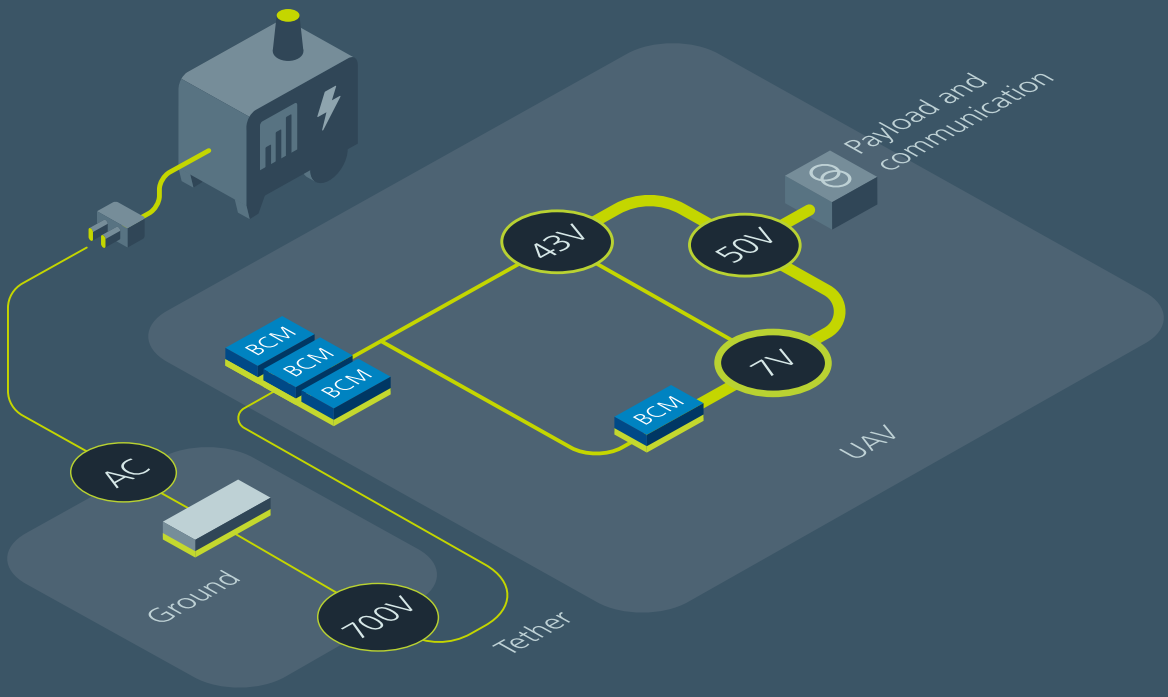
The Vicor solution

Fukaden's drones require power that ranges from 1kW to 5kW. Fukaden was able to minimize the size and weight of the tether cable by using higher voltage power, which reduced current. To support the added weight of the communication base station Fukaden deployed higher voltage (700V), a thinner tether, and used three high voltage Vicor BCM® fixed ratio converters in parallel. This delivered the extra power needed to support, payload, duration, and communication services. Key benefits were:

- High levels of integration and efficiency in the smallest form factor
- Up to 776W/in^3 power density
- Vicor power modules provide integrated EMI filtering

Higher voltage enables lighter and thinner cable

Fukaden's communication station requires up to 9kW. Using higher voltage power (DC 700V), thinner cabling, and an array of three Vicor BCMs® in parallel Fukaden was able to easily scale the power to deliver better performance. In this **power delivery network**, the drone can fly for 92 hours and maintain a communication area diameter of 10km.



BCM bus converter modules

Input: 800 – 48V
Output: 2.4 – 55.0V
Current: Up to 150A
As small as 22.0 x 16.5 x 6.7mm

vicorpower.com/bcm

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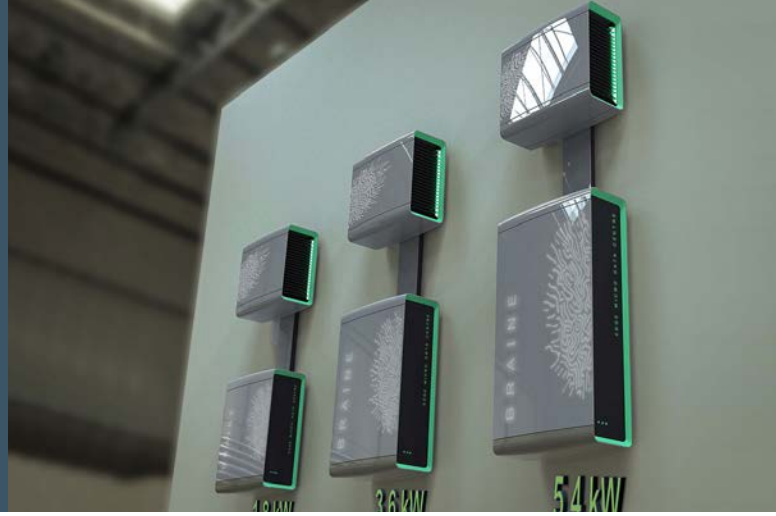
Case study: HIRO edge computer networking



Enabling next-generation brain surgery via edge computing

Customer's challenge

Edge computing is vital in realizing the full potential of artificial intelligence (AI), machine learning, and the Internet of Things (IoT). Applications like autonomous driving, smart buildings, robotics, and healthcare rely on rapid response times from AI computers needed close to the devices. Powering the fast-growing edge computing is an enormous challenge that requires advanced processors coupled with equally robust and compact power delivery networks. The key goals for HIRO were:

- The need for higher power density to maximize processing capability
- Thermally efficient solution that is reliable in harsh environments
- Easily scalable design to support network expansion

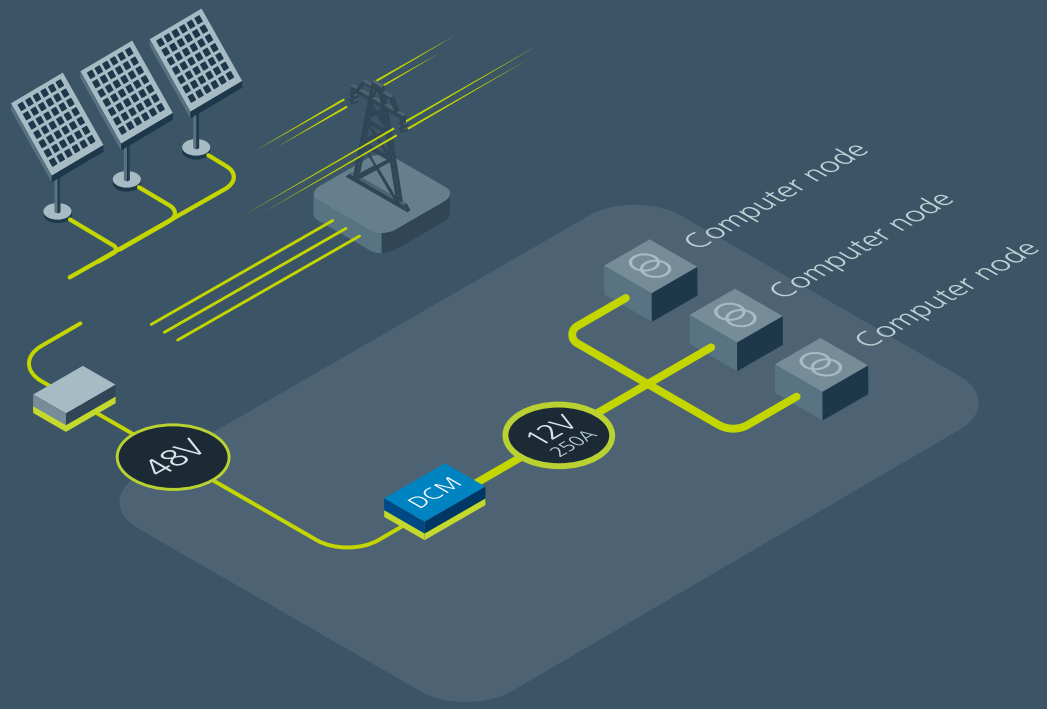
The Vicor solution

Efficient power conversion is achieved by running $48V_{DC}$ power distribution, instead of $12V_{DC}$. The higher voltage reduces I^2R power losses by 16X across the power delivery network (PDN). High-density, high-efficiency DCM power modules contribute to HIRO's solid-state, thermally adept, compact, energy-efficient EMDC designs. Legacy solutions using standard® COM Express® modules can draw approximately 3kW within one 3U chassis. Converting this power efficiently is paramount to EMDC performance. Key benefits were:

- Modular design enables flexibility and scalability
- High efficiency modules maximize available power and minimize power losses
- Compact, planer surface modules can be convection cooled

Power density and efficiency drive scalable, high-performance edge computing

The DCMs™ provide 48V to 12V conversion, offering flexible cooling options and world-leading volumetric power density. This flexibility also lends itself to renewable energy opportunities.



DCM3717
DC-DC converter

Input: 54V (40 – 60V)

Output: 12.2 (10.0 – 13.5V)

Power: Up to 750W

36.70 x 17.30 x 7.42mm

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Case study: Doosan Hydrogen powered UAV

Delivering life-saving humanitarian aid in times of distress

Customer's challenge

Extending the operational range of small (<25kG) UAVs has proved challenging using Li-Ion technology as the power-to-weight performance typically limits flight times to below 30 minutes. By miniaturizing hydrogen fuel cell technology Doosan developed a 2.6kW fuel cell solution that is lighter (typically half the weight) and has a higher power density (typically double) compared to conventional battery solutions. The 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
- Reliability to minimize chance of failure over the sea

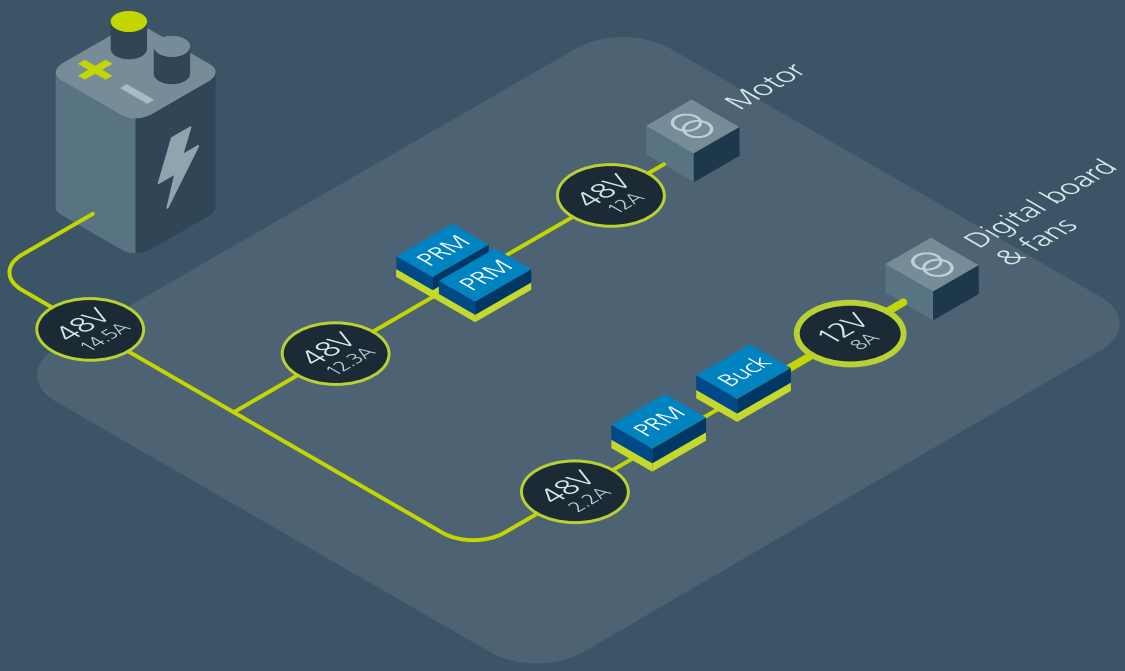
The Vicor solution

To maximize performance the power delivery 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 provide 400W in 13.6g
- Zero-Voltage-Switching topology provides 97.4% efficiency
- 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: Knightscope autonomous security robots

Deterring crime and minimizing risk to security personnel

Customer's challenge

Knightscope autonomous security robots (ASRs) provide improved surveillance and safer interdiction by proactively spotting potential threats and mitigating risks to security personnel. They have an expansive array of features and capabilities such as LIDAR, GPS, sonar, IMUs, 4K cameras and high-fidelity audio must be powered efficiently inside a sealed system. The key goals for Knightscope were:

- Highly efficient to extend run time
- Capable of managing high-temperature operations
- Supporting a variety of point-of-load voltages

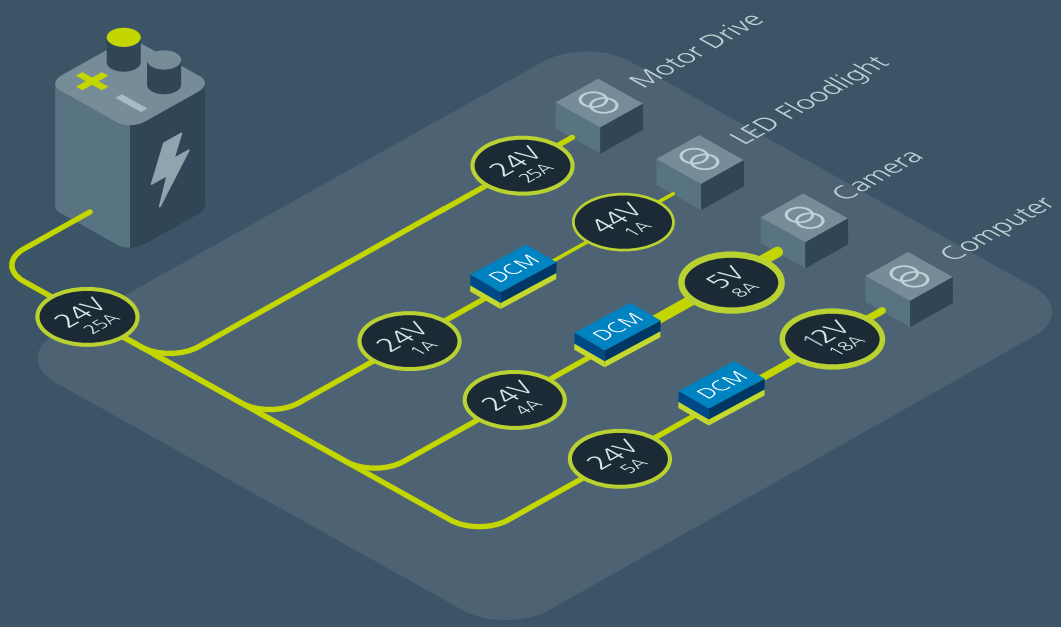
The Vicor solution

Vicor modules power a variety of point-of-load voltages. Knightscope chose the DCM3623 because of its unique ChiP™ (Converter housed in Package) design. It is thermally adept and very power-dense. The power density of the Vicor DCM™ also helps with routing the wiring and cable assembly and increasing battery efficiency, performance, and runtime. Key benefits were:

- Improved power density and efficiency extend the run time
- DCM offers advanced packaging and topologies to manage thermal loads
- The DCM can be paralleled easily to accommodate additional system expansion

High efficiency power for a ventless, sealed system

The intense level of computing, communications, and sensing places a tremendous load on the ASRs' **power delivery networks**. Power components must be compact and highly efficient. Cooling has a big impact on efficiency and performance. Because the ASRs have no airflow nor venting, Knightscope needed a pure conduction-cooled solution. The Vicor DCM3623 is well suited for this application because of its thermally optimized packaging, and topology. The DCM™ power modules can be paralleled to deliver higher power if needed making this an easily scalable solution for future designs.



DCM3623 DC-DC converters

Input: 9 – 154V

Output: 3.3 – 53V

Power: Up to 320W

36.38 x 22.8 x 7.26mm

vicorpower.com/dcm

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Case study: Dragonfly Pictures unmanned multirotor aerial relay (UMAR) tethered drone

Tethered drones revolutionize remote communications

Customer's challenge

As today's navies become more sophisticated, the demand for more reliable communications and intelligence, surveillance, and reconnaissance (ISR) has grown. To withstand the harsh weather conditions, the industry has turned its attention to vertical lift-off tethered drone technology. This new technology has the potential to achieve all the desired objectives but still has challenges to overcome like time of flight, stability, and survivability. The key goals for Dragonfly Pictures were:

- Tether diameter must be kept thin for reduced weight
- Power density must be high to support higher voltage inputs
- Low EMI to improve quality of communication signal

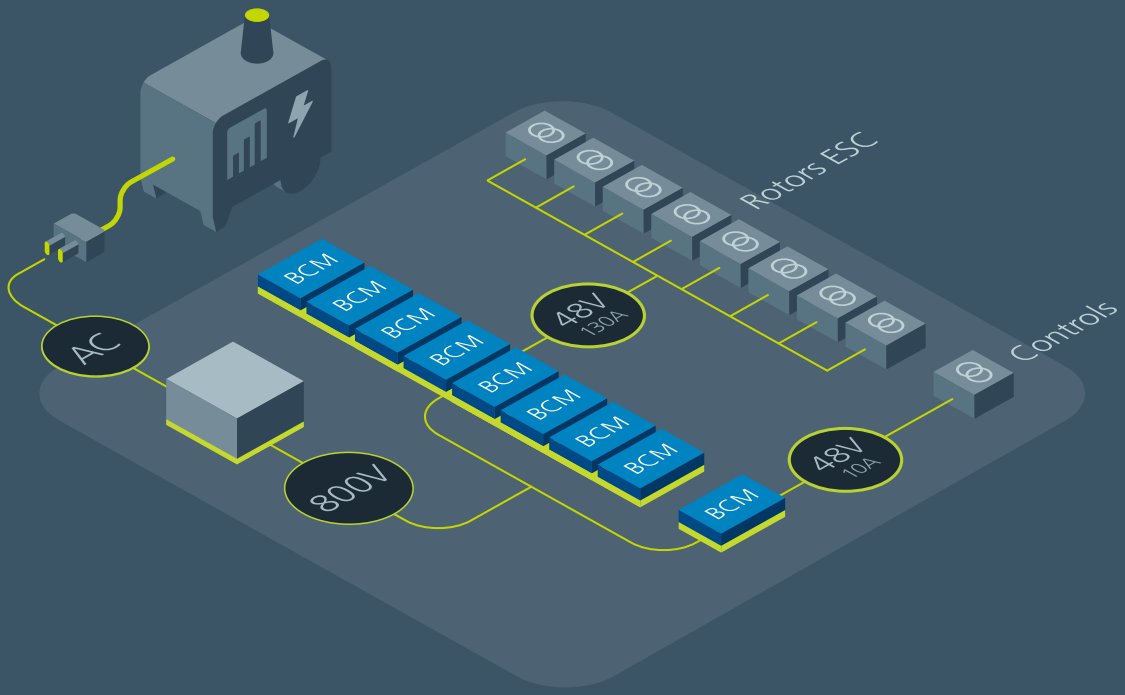
The Vicor solution

The DPI Unmanned Multirotor Aerial Relay (UMAR) tethered drone can provide 400+ hours of non-stop uptime and operations – at altitudes up to 500 feet. To achieve this, power needs to be delivered from the host vessel to the drone at extremely high voltage (500 – 800V) and low current to enable the use of the thinnest, lightest tether enabling greater drone mobility and larger airborne payloads. Also, high-voltage conversion must be achieved in the smallest possible footprint and lightweight profile. Key benefits were:

- High-power density enables smaller form factor and lower weight
- Higher voltage inputs deliver higher efficiency enabling longer flight times
- Low-noise power topologies support lower EMI and clearer communications

Power solutions enabling the thinnest, lightest tether

The Vicor high-voltage BCM4414 VIA low-profile modules used within its UMAR tethered drone enable high-efficiency power conversion (98%) from 800V to 50V. The compact footprint of the **power delivery network** is critical in achieving an extremely power-dense board configuration. There are eight Vicor BCMs® arrayed to power the DPI UMAR's eight independent rotors, with the ability to share power among the rotors in parallel for increased redundancy. The integrated filtering capability within the Vicor BCMs helped to minimize EMI noise.



High-voltage BCM4414 bus converter

Input: 500 – 800V
Output: 31.3 – 50.0V
Current: Up to 35A
110.6 x 35.5 x 9.4mm

vicorpower.com/bcm

Other Powering Innovation eBooks

Volume 1: Saving 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.
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 autonomous self-driving long haul trucks and 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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