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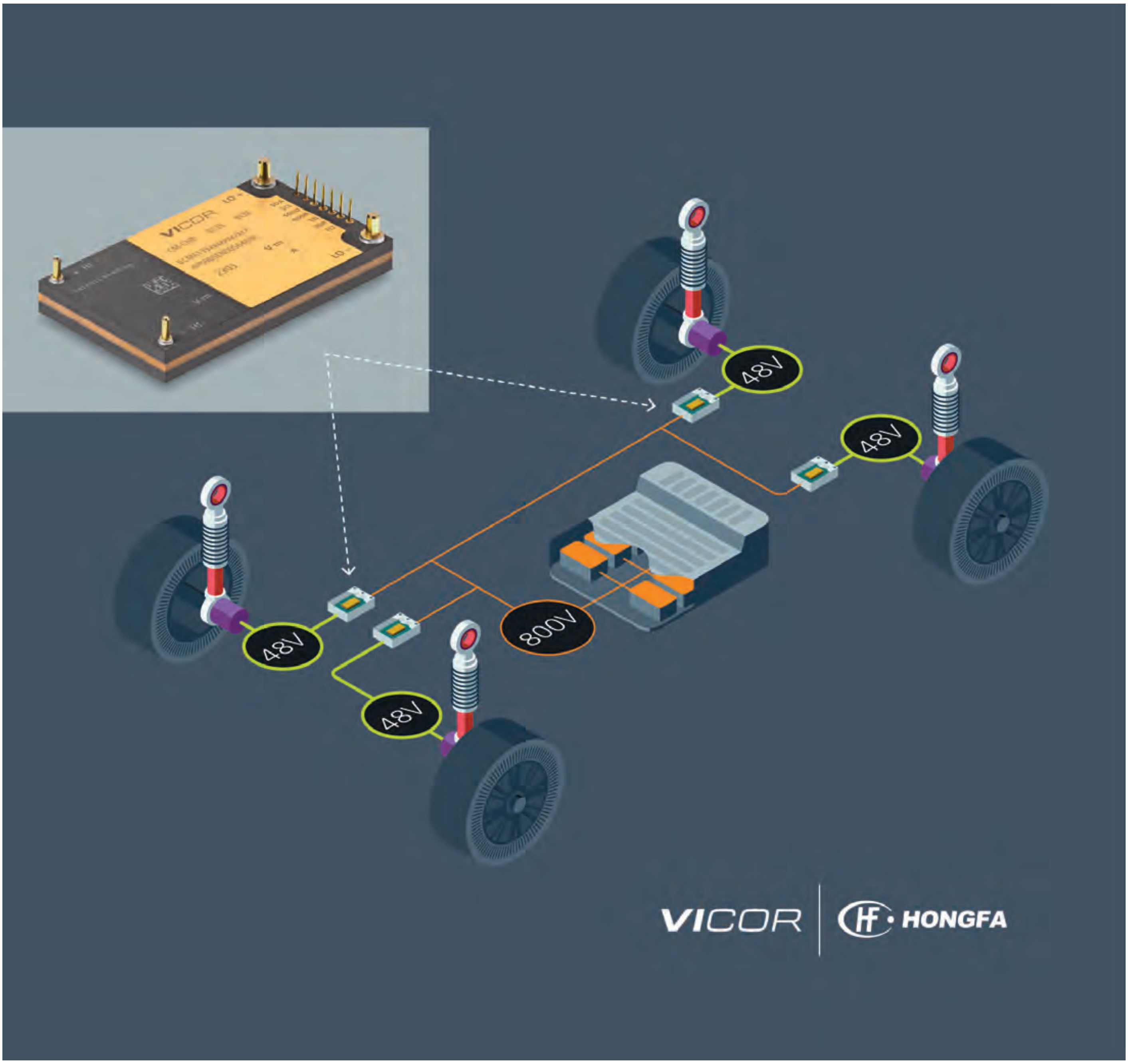
# 48V POWER INFUSION

Active suspension approaches on-ramp to more markets after 48V power infusion

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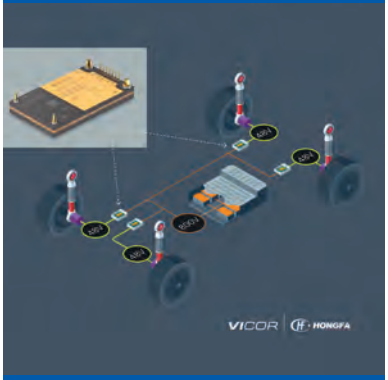
## FEATURE STORY




## Active suspension approaches on-ramp to more markets after 48V power infusion

Hongfa solves age-old power challenge with 48V architecture and high-density power modules

More details on page 8.

# European response to edge AI challenges: Rutronik adds Axelera AI to its portfolio


With Axelera AI, Rutronik Elektronische Bauelemente says it is expanding its franchise portfolio to include a European pioneer in the field of AI inference at the edge. The Dutch company develops cutting-edge hardware and software solutions, targeting applications where energy efficiency, scalability, and real-time processing are paramount. Its Metis platform, based on RISC-V and digital in-memory computing, offers outstanding performance with lower energy consumption – positioning itself as a viable alternative to existing GPU-based solutions.

With the Metis AIPU and the Voyager SDK, Axelera AI has created a platform that can implement machine learning models for Vision AI significantly faster, easier, and more cost-effectively than conventional cloud-based or GPU-centric architectures. Applications include automated checkout monitoring in retail, industrial security monitoring, and intelligent traffic control.

"We're working to establish a serious alternative to the current market leader, Nvidia, in the embedded market," explains Anja Schaal, Senior Manager Product Marketing Boards & Storage. "With Axelera AI, our customers benefit from a significantly more attractive cost-benefit ratio and an optimal computing power-to-energy consumption ratio. Especially in the edge environment, specialized hardware with an innovative design is needed – and that's exactly what Axelera delivers."

At the heart of the partnership is the vision of democratising artificial intelligence at the edge, making it independent of expensive cloud solutions or complex GPU setups. Rutronik is leveraging Axelera AI's technological strengths: Digital In-Memory Computing (D-IMC), a proprietary RISC-V dataflow architecture, and an SDK that significantly simplifies integration for developers.

Rutronik also offers full -service project support for companies that do not have their own AI teams or want to minimise development risks through its partner network, for example with COMI.

The European Innovation Council Fund's investment in Axelera AI underlines the company's potential and its importance for the European technology location.

"With Rutronik, we have found an experienced and strongly positioned distribution partner across Europe who shares our vision: to make artificial intelligence at the edge accessible, efficient, and less dependent on non-European platforms. In addition to its strong market presence, we particularly value Rutronik's deep technological understanding in the embedded and AI sectors – an ideal basis for jointly implementing innovative solutions for demanding edge applications and strategically developing our roadmap," explains John Wilkins, Global Director of Channel Sales at Axelera AI.

With this partnership, Rutronik reaffirms its role as a leading embedded and AI distributor in Europe and offers its customers access to pioneering technology – "Made in Europe".

**www.rutronik.com**

# Molex Introduces AirBorn 3U VPX Power Supply, Extending Innovation of Award-Winning 6U

Molex, a global electronics leader and connectivity innovator, has announced it has introduced the AirBorn 3U VPX Power Supply, delivering clean power in a smaller form factor to unlock capacity in space-constrained aerospace, defence and commercial applications. As the latest innovation from AirBorn, a Molex Company, this newest VPX model is built on the robust architecture and award-winning innovation of the AirBorn 6U VPX Power Supply. The new 3U version has been engineered to offer unparalleled reliability and efficiency for the most challenging operational environments.

"AirBorn's line of VPX power systems sets new standards for power density and efficiency, based on our decades of experience developing, testing and deploying highly reliable power solutions for the aerospace and defense industry," said Mike Cole, SVP and President, Aerospace and Defence Solutions, Molex. "With the new 3U VPX Power Supply, we continue to overcome the most formidable physical and electrical challenges in power supply design."

## Reducing Design Complexity and Costs

The company says AirBorn's patent-pending VPX Power Supply family optimises size, weight, power and cost (SWaP-C) while meeting VPX and VITA 62 open architecture and performance requirements. Approximately one-third the size and weight of the 6U VPX Power Supply, the new SOSA-compliant 3U power system has been designed to achieve a maximum output of 1,000 watts and offers out-of-the-box compliance with MIL-STD-1275 and MIL-STD-461 CE101/CE102 conducted emission test


requirements. Adherence safeguards sensitive electronics from extreme voltage variations inherent in military ground vehicles, while saving time, effort and cost in product design, testing and qualification.

Additionally, the 3U VPX Power Supply incorporates AirBorn's advanced internal filtering to meet stringent EMI/RF requirements. Integrated EMI suppression capability is designed to meet MIL-STD-461-conducted EMI emission requirements without external filtering. A testament to AirBorn's proven power engineering expertise, this unique functionality mitigates interference at the source to reduce signal degradation, lower crosstalk and enhance data transmission rates.

"For customers building highly compact 3U VPX systems, the opportunity to leverage an 'all-in-one' power supply that handles power conversion and EMI filtering on a single printed circuit board is very compelling," said Scott Poole, director, Design and Development Engineering at AirBorn. "We apply extensive engineering expertise and special processes to develop highly efficient power engines capable of achieving low noise switching, clean conducted emissions, ultra-clean output voltages and versatility in parallel VPX cards."

### Meeting Bigger Power Demands in Smaller Footprints

The AirBorn 3U VPX Power Supply is well positioned to deliver continuous operation in rigorous conditions common for military ground vehicles, which can create voltage spikes and surges. When space is at a premium, the new 3U VPX model can safeguard essential onboard systems and applications, such as Low Earth Orbit (LEO) satellites, unmanned aerial vehicles (UAVs), industrial automation, robotics and AI-driven distributed systems. This transfer of military-grade ruggedization and reliability to other applications and industries will be universally appealing to engineers and systems integrators committed to ensuring flawless power delivery and seamless systems integration of sensitive electronics.

**www.molex.com.**

# Navitas Powers Xiaomi's Next Generation GaN Charger


**Navitas Semiconductor, an industry leader in next-generation GaNFast gallium nitride (GaN) and GeneSiC silicon carbide (SiC) power semiconductors, has announced that Xiaomi's next-generation 90W GaN charger will be powered by Navitas' GaNSense Control ICs.**

**Reportedly the world's smallest 90 W charger, the company says this ultra-compact, high-power-density form-factor measures just 34 × 45 × 34 mm and weighs only 65 grams—approximately half the size and a third the weight of typical GaN chargers.**

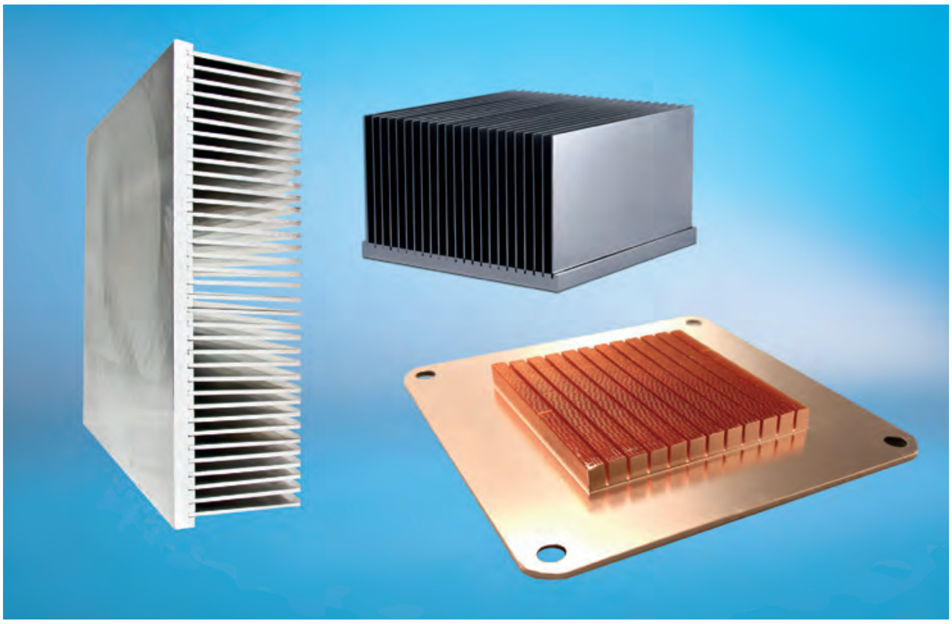
**The charger integrates Navitas' NV9580 GaNSense Control power IC on the primary side and the NV9701 synchronous rectification controller IC on the secondary side. The GaNSense Control family combines 4th generation GaN power with high-frequency control functionality. It provides all the benefits of a monolithically integrated GaN power FET and GaN drive, plus a controller and protection features in a single surface-mount package for high-density, high-efficiency chargers, adapters, and auxiliary power designs.**

**GaNSense Control ICs are said to deliver the highest-frequency operation to minimise system size and weight. Integrated features such as lossless current sensing, high-voltage start-up, and elimination of VDD inductor reduce component count and increase system efficiency. With transient voltage breakdown up to 800 V and no PCB hotspots, Navitas' GaNSense Control ICs can deliver best-in-class efficiency in the smallest form factor.**

**"The launch of Xiaomi's 90W GaN charger marks a new milestone in our long-standing collaboration with Xiaomi," said Charles Zha, SVP and APAC GM of Navitas. "Combining the innovation of GaNSense Control ICs and Xiaomi's leading system expertise, we have delivered a new benchmark for ultra-portable fast-chargers. Navitas will continue our partnership with Xiaomi to continue future innovations with our GaN technology."**

**https://navitassemi.com/**

# Power electronics require efficient cooling



Electric vehicles, renewable energies, digitalisation, automation – the trend toward electrification is growing in applications where reliability and durability are crucial. This also increases the demand for high-performance cooling solutions. Below CTX specifies three factors that are important for high-efficiency heat sinks.

The most important requirement for effective cooling solutions is a sufficiently large surface. This enables fast heat dissipation in power electronics, and is why classic heat sinks are equipped with fins – the narrower and more numerous, the better. Typical manufacturing processes are extrusion and die-casting. In these processes, a forming tool is used to create the structures necessary for heat dissipation, in large quantities.

The second efficiency factor is low thermal resistance. This can be achieved at the location where the fins are connected to the base plate. CTX adapts production-related transitions by means of CNC machining. Alternatively, the skived fin process can be used to pare the fins from a metal block. This produces very fine fins that remain connected to the heat sink base with no transitions.

Finally, the choice of material is also crucial. Although copper offers the highest thermal conductivity (up to 400 W/mK), it is used only rarely due to its high price and weight. Aluminum is less expensive, lighter, and has a thermal conductivity of 180 to 235 W/mK, which is optimal with the right engineering and manufacturing process. One example is cold forging. This process produces an extremely homogeneous and dense material structure. As a result, the thermal conductivity of the heat sink is higher than that of the feedstock.

CTX Thermal Solutions overs one of the leading product ranges for heat sinks in Europe. In addition to standard heat sinks, the company also manufactures application-specific cooling solutions.

**www.ctx.eu**

# Bourns Introduces Shielded Power Inductor Series with Metal Alloy Powder Core Capable of Handling High Currents with Very Low DCR

**Bourns, a global manufacturer and supplier of electronic components for power, protection, and sensing solutions, has announced its SRP3220A Series Shielded Power Inductors. Designed with Bourns' uniquely-formulated metal alloy powder core, the series can handle high currents up to 11 A without saturating, and supports reliable operation in high-temperature environments. These automotive grade, AEC-Q200 compliant power inductors feature a high heating current rating and shielded construction that minimises magnetic field radiation. The capabilities delivered with the SRP3220A Series also help enhance performance, thermal stability and meet demanding automotive temperature requirements making Bourns' latest power inductors a cost-effective and efficient power management solution for a growing range of automotive systems.**


**https://bourns.com/**

# Active suspension approaches on-ramp to more markets after 48V power infusion

## Hongfa solves age-old power challenge with 48V architecture and high-density power modules

Vehicle electrification still grabs the lion's share of automotive technology headlines, but active suspension systems are transforming the driving experience for millions of car owners. Joining the ranks of anti-lock brakes, lane-departure warnings and back-up cameras, active suspension technology, which is currently found only in luxury vehicles, is on the fast track to enter the mid-range auto market.

Xiamen Hongfa Electroacoustic Co., Ltd. (Hongfa), one of the world's largest manufacturers of power relays, has been advancing the automotive market for nearly three decades. Hongfa specializes in automotive power management and distribution, and they are squarely focused on the future of EVs and how to support better electrification in power systems. Hongfa relays are foundational to electric vehicle design and are enabling breakthrough developments where 48V networks are replacing 12V systems to improve efficiency and reduce vehicle size and weight. Hongfa is infusing its electrical hardware, software and structural design expertise to propel the next generation of xEVs.

Among other innovations Hongfa has designed the highest performance and smallest active suspension power system on the market (Figure 1). Their bold, innovative design projects to soon make this long-time high-end feature common among mid-range vehicles, improving the ride and safety for more drivers.

### 48V and evolutionary power technology drive smaller systems and better performance

Active suspension systems are highly complex. They use a network of sensors, electromechanical actuators and sophisticated software to adjust vehicle suspension in real time. This results in better handling, a smoother, safer ride and reduced road noise even under the worst road conditions—from navigating suburban potholes to a rural dirt road.

Appreciating what Hongfa has achieved requires understanding the active suspension in its infancy. Starting in the 1970s active suspension used complicated electromagnetic solutions which strained the capabilities of 12V battery power systems. It required four 200-pound electromagnetic motors— adding an extra 800lbs to the vehicle, limiting mass adoption.

### Top technical challenges facing active suspension PDNs

Generally, there are two options for the active suspension system power delivery network (PDN). First, the system can be connected directly to the high-voltage battery, which is the current standard for plug-in hybrid vehicles. Here, active suspension is linked directly to the car's 800V battery, which is efficient and enables energy recuperation through regenerative charging. However, this architecture requires the OEM to run heavy, expensive high-voltage cables all around the car.

Alternatively, active suspension can be achieved via the lower-voltage bus, which is either 12V or the increasingly popular 48V. Within the low-voltage option, systems can either rely on an intermediary battery or use DC-DC converters to step down the high-voltage battery rail for use in active suspension.

For the latter, the technical revolve around:

1. **Small system size**. Today's active suspension systems require 10 – 15kW of power, which traditionally requires a very large and heavy DC-DC converter to support this power level.
2. **Rapid regenerative DC-DC converter speeds.** Achieving energy recuperation in active suspension systems requires very dynamic,

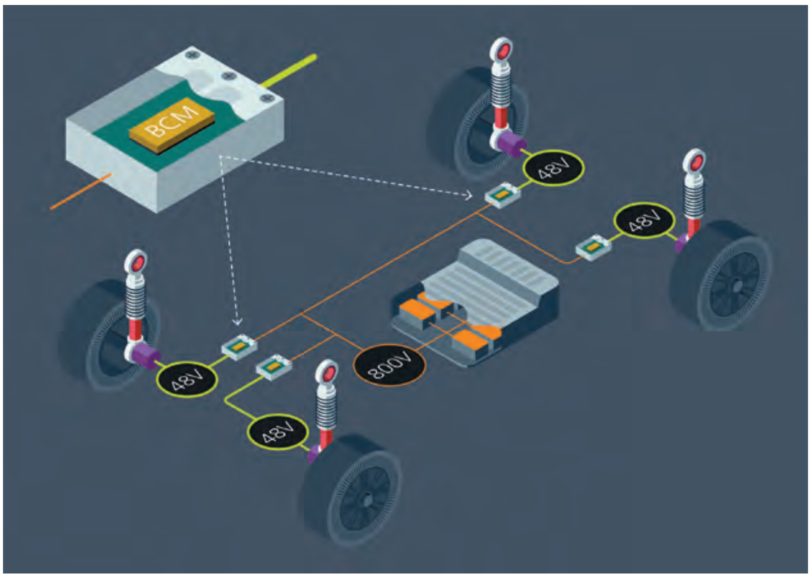



**Figure 1 Hongfa has designed the smallest and lightest active suspension power delivery network on the market by combining a 48V architecture and high-density power modules. Four Vicor fixed-ratio BCM6135, 800V-to-48V DC-DC bus converters are used to convert high voltage to 48V and route power to each wheel. The BCM6135 is bidirectional and provides the fastest transient response of any DC-DC converter. This symmetrical switching speed enables optimal energy regeneration when directly linked to the DC-DC converter.**

bidirectional power switching capability. It's imperative that the direction of the current change rapidly for top performance in each direction.

3. **Fast transient response times.** A DC-DC converter with high slew rate is critical for active suspension. With anything less, a battery or supercapacitors must be added to compensate for inadequate transient performance.

The Hongfa approach to solving these tough system challenges was to rely on the benefits of a 48-volt PDN without an intermediary battery. The main challenge was that, even while some conventional DC-DC converters can deliver power without the need for an intermediate battery, they face a tradeoff in that they are bulky and lack the fast response time required to meet the regenerative demands to recoup and store power.

### Hongfa uses Sine Amplitude Converter Technology to address top technical challenges

Alternatively, Vicor bidirectional, fixed-ratio 800V-to-48V DC-DC bus converters provide the fastest transient response of any DC-DC converter. They also have industry-leading power density and efficiency and are designed specifically for a 48V-centric power delivery architecture. Their advanced planar packaging simplifies thermal management systems design further reducing overall footprint and weight. Unique among DC-DC converters, they offer symmetrical performance with their ability to buck or boost with the same level of power (Figure 2).

This feature, which is essential to deliver optimal power regeneration for active suspension, is a result of proprietary Vicor Sine Amplitude Converter (SAC™) technology. The SAC uses a zero-current and zero-voltage soft-switching technique and fixed switching frequency in excess of 1MHz to provide fixed-ratio DC-DC conversion. The SAC output voltage ($V_{OUT}$) is proportional to its input voltage ($V_{IN}$) at no load per Equation 1.

$$V_{OUT} = K \cdot V_{IN} \qquad (1)$$

In Equation 1, K is commonly referred to as the transformation ratio and is defined as the ratio of output voltage and input voltage. K is a fixed value for a given model of SAC.

In bidirectional mode, a single SAC can be deployed with the intent that once excited, the module is to deliver power in either the forward or reverse direction, depending on the way in which the SAC is being actively driven at a given instant in time. Such performance is essential to deliver optimal power regeneration for active suspension.

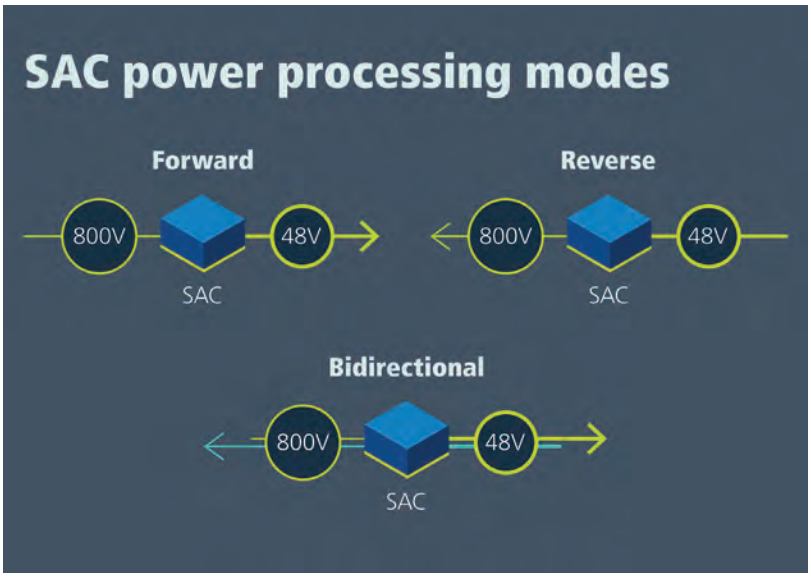



**Figure 2 Sine Amplitude Converter (SAC) -- with TM SAC™ application topology options.The SAC operates as forward, reverse or bidirectional power converters which have isolation barriers set between their primary and secondary power ports. The gray bar represents the SAC inbuilt galvanic isolation barrier between the input and output power ports**

Linking active suspension directly to the main battery with a bidirectional power converter enables top energy recuperation. Similar to how a spring absorbs and releases energy, active suspension uses regenerative shock absorbers to collect kinetic energy that is returned to the battery. While this can be done with a conventional bidirectional DC-DC converter, few manufacturers can design a system with the performance necessary for transient response, peak power slew rate (about 8 million amps per second), and power efficiency to manage the bidirectional power flow between the converter and battery power source (Figure 3).

Fully capitalizing on these advantages, Hongfa has designed and developed a compact system that includes CAN communication, high-voltage protection and EMI filtering. Their innovative mechanical assembly optimizes thermal dissipation within a very compact footprint.

In the regenerative active suspension application, the 800V battery sources current when the vehicle travels over smooth road surfaces, and the suspension actuation motor is the 48V load. When the vehicle traverses a bumpy road, the linear motors in the suspension system momentarily become generators (compression), increasing the voltage on

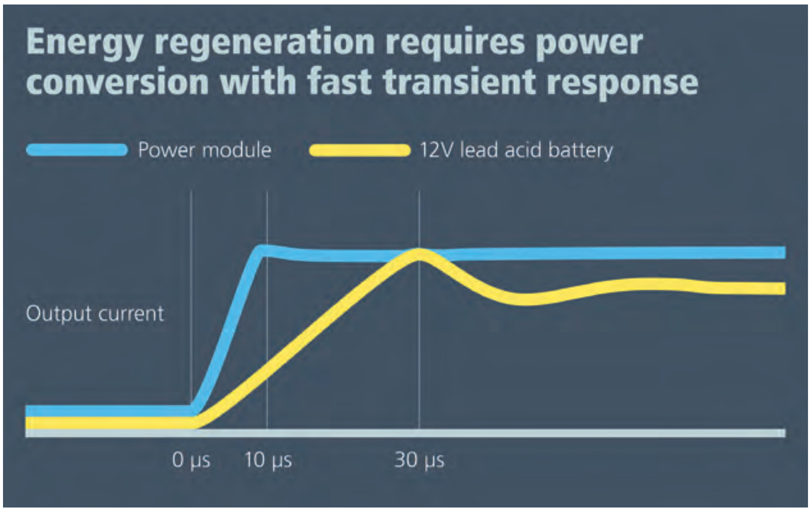



**Figure 3 Vicor BCM6135 DC-DC converter di/dt is 8 million amps per second, offering an unrivaled slew rate which is essential to support optimal energy recuperation and storage for the Hongfa active suspension system.**

the low side of the converter which is then multiplied by the conversion ratio of the converter (in this case 16/1) increasing the voltage on the input side above the 800V battery voltage. This difference in voltage reverses the direction of current flow without internal loop controller intervention. The 800V battery then momentarily becomes the load (rebound) and recovers energy by charging through its battery management control system.

Once the displacement from the bumpy road has subsided, the bus converter will once again step down the 800V battery and supply current to the suspension linear motors – all without intervention from the vehicle's onboard processors.

## Hongfa introduces smallest active suspension power supply using power modules and 48 volts

For Hongfa, active suspension design is defined by the need to balance size and weight against the requirement for higher efficiency, improved EMI and thermal performance. These system requirements brought Hongfa and Vicor together on the development of an 800V-to-48V DC-DC converter to build the ultimate active suspension system.

The Hongfa solution leverages the Vicor power density advantage to create compact (197 x 201 x 71mm) 5kW power supplies for each actuator. The system can process up to 6kW of peak power in either direction. The design of the converter is greatly simplified by using a pair of Vicor BCM6135 bus converters operating in parallel, instead of several hundred discrete components.

The converter is optimized to work with 800V battery systems and has an operating range of 420 to 920V. With liquid cooling it can deliver up to 100A of current with 97.3% efficiency. The system housing volume is under 1.8l and total system weighs in at 2.6kg, providing a major weight reduction (Figure 4).

"When it comes to active suspension, our OEM customers require a DC-DC converter with a response rate measured in milliseconds," said Mr. Peter Li Research & Development Director at Hongfa, "otherwise, additional battery support is needed. Vicor BCM6135 power modules enable the competitive performance we need."

Together Hongfa and Vicor have collaborated to develop the smallest active suspension system today – almost half the size of the nearest competitor – that delivers the industry's fastest power conversion response.

At the low end of its operating voltage range the guaranteed peak power rating of the BCM6135 model is 3.1kW for 20ms with a 25 percent duty cycle (Figure 5). As Hongfa can attest, developing an active suspension power system is complex: worst-case road surface profiles, cooling methods, size, weight and cost constraints can vary enormously.

"Vicor power modules not only deliver the performance we need but they also significantly shorten our development time and have made designing this type of system much easier for us," said Mr. Li at Hongfa.

The combination of 48V and high-density power modules are enabling new levels of innovation in automotive electrification — reducing space, weight and delivering superior performance. The BCM6135 is critically important to delivering top performance for high voltage

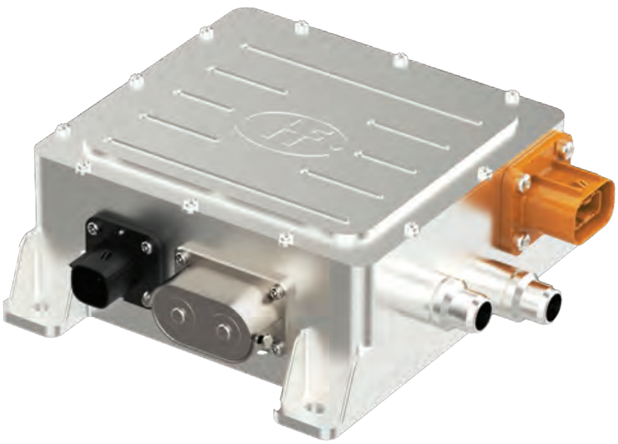


**Figure 4 The Hongfa active suspension system (Power System Specs HF3661 800V-48V DC-DC System) is liquid cooled and is the most compact on the market, weighing 2.6kg and measuring 197 x 201 x 71mm.**

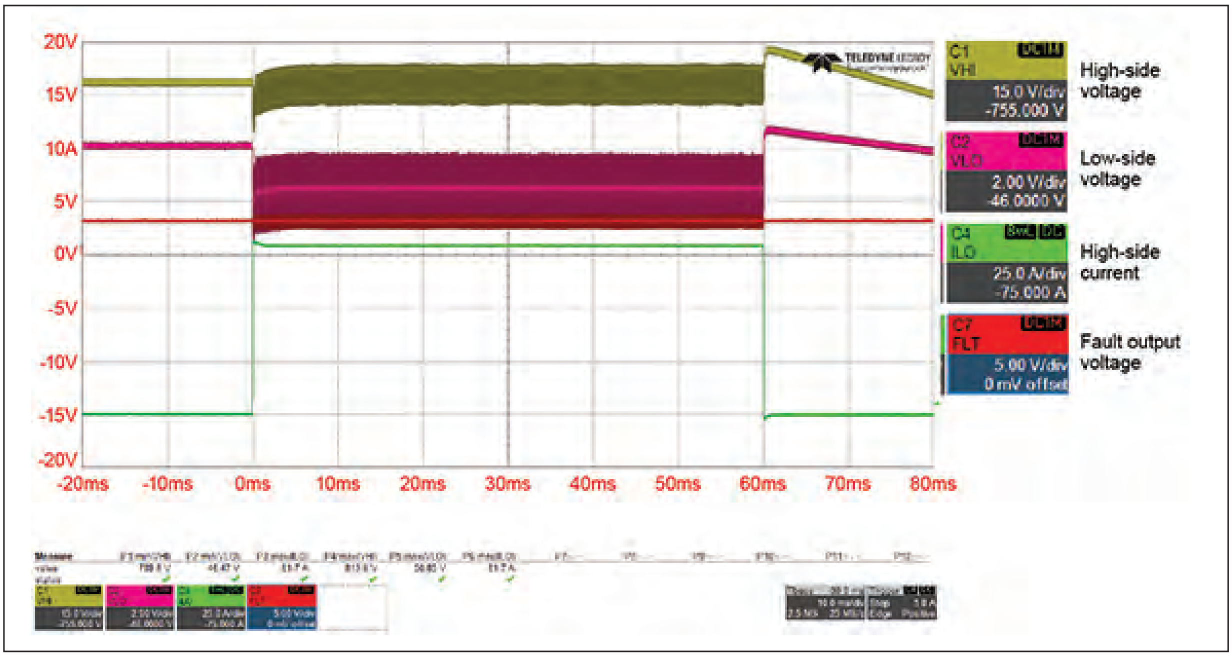



**Figure 5 In laboratory testing, a BCM bus converter with a 16:1 transformation ratio was provided an 800V input to produce a 50V output. Without an attached heat sink, the module outputted a peak current of 90A. Even though the module is rated for only 3.1kW, it was able to support peak output power of 4kW in testing.**

to SELV conversion (Figure 6) . No other DC-DC converter can match the size, transient speed and bidirectional switching performance of the BCM. It stands alone in this capacity and offers an enormous size advantage versus every other converter.

This infusion of power electronics technology has solved a decades-old active suspension power system design problem. Together Hongfa and Vicor are delivering the smallest and highest-performing active suspension system on the market. This is just the beginning for Hongfa and Vicor as they partner to advance automotive electrification.

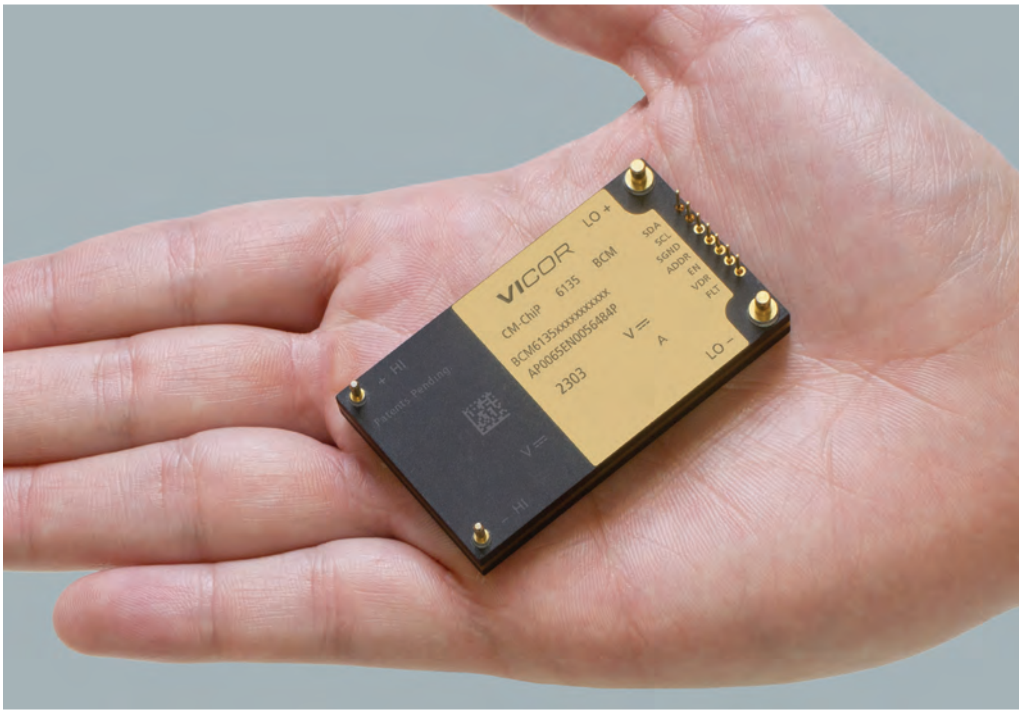



**Figure 6 Inherently bidirectional, the BCM6135 rapid current transient response rate of 8 million amps/second is a perfect match for the power profiles of active suspension and power regeneration in electrified vehicles. The BCM6135 is a 95% efficient 3.5kW peak power bus converter that converts 800V from the traction battery to 48V.**

# Flipping human motion detection on its head

Automatic object detection is growing ever more sophisticated, yet the accurate detection of humans still poses unique challenges. Omron's Gabriele Fulco explores what it is that makes humans so difficult to reliably detect, and how successfully navigating these obstacles could usher in a new era of productivity.

**Efforts to mimic human vision to** identify objects are nothing new. The first digital image processing technologies were first developed in the 1960s, and have been constantly refined and improved ever since. Recent advances in AI have served to intensify these efforts further. Achieving a computer-based vision system that can not just match but exceed the accuracy and understanding of human vision combined with a human brain has been notoriously difficult. Unlocking this technology could potentially herald a revolution in human progress, revolutionising everything from agriculture to medical science, as well as industrial operations.

The human body is the product of hundreds of thousands of years of evolution, and as such is incredibly sophisticated. Computers have long been able to detect and understand 2D pictures, but dynamic three-dimensional environments are a step far beyond this. Indeed, human vision is not just about simply perceiving the world around us; it is also about understanding it. Our brains are able to constantly provide the vital contextual information to allow us to make sense of our surroundings in real-time. Computers have traditionally been unable to match this level of

Gabriele Fulco

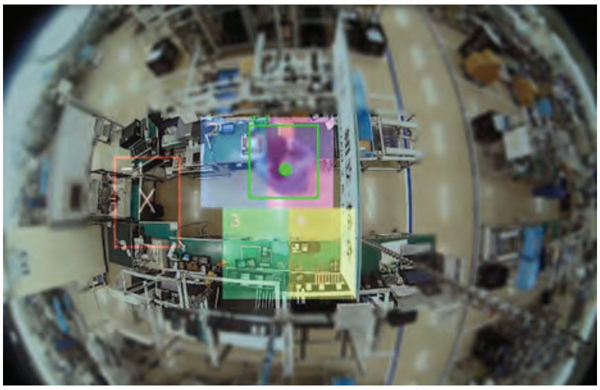
sophistication, that is until recently.

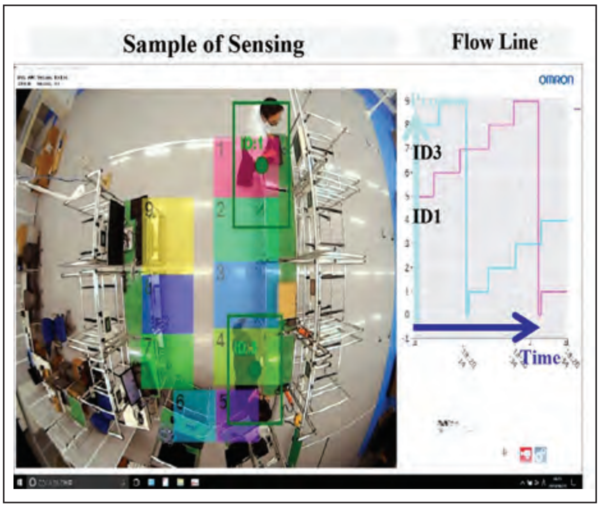
Training a machine to not only perceive but understand the world around it presents complex technological and computational challenges. Detecting humans adds yet another layer of complexity. Indeed, the uniqueness and diversity of humans themselves make them one of the most challenging subjects to reliably detect without training any system extensively on specific individuals.

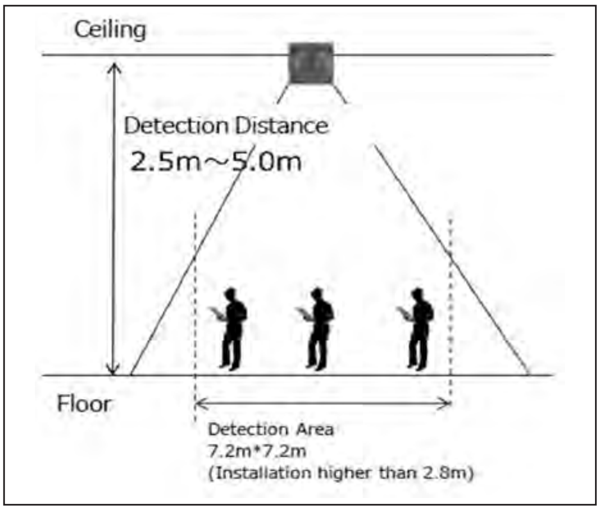
Even a change of clothing or hairstyle can present problems. When you add in additional factors such as the wider environment with which humans are interacting, combined with the unpredictability of human behaviour, the technical challenges quickly mount up. Any viable solution also has to be cost-effective and economical in size in order to be practical in everyday environments.

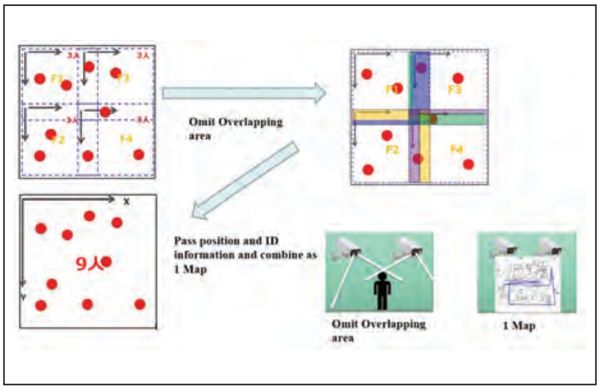
Solving these problems is not easy. In fast-moving industrial settings for instance, several humans may all be working at speed, carrying out various different duties within the same space. Attempting to track their movement from a side-on or even an isometric view has traditionally proven an imperfect solution, as this requires the system to have an understanding of the depth of vision. In a single-camera configuration, one person can also very easily obscure another from view and create blind spots.

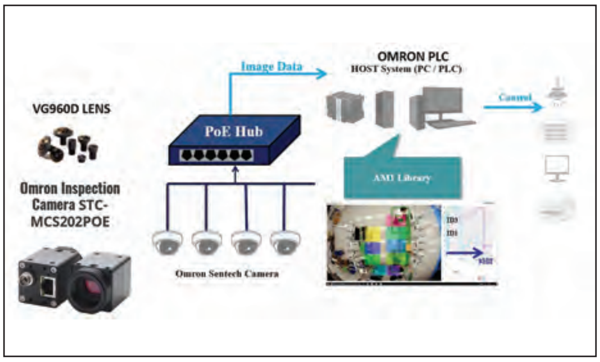
In addition, one of the major challenges in the development of vision sensing technologies is not so much in the capture of images, but in processing them. For a machine to understand human movement in real-time requires a large amount of computational power to ensure high speed and accuracy. Since no two environments are the same, developing a system that can not only understand the nuances of human






movement, but also adapt to different scenes and lighting levels, has traditionally been a barrier to such technologies becoming viable on a wide scale.

Omron's AM1 human detection system tackles these challenges quite literally from a different perspective. Designed for optimising human productivity in industrial settings, it utilises a single top-down camera, combined with sophisticated software optimised specifically to detect and interpret human movement. In doing so, it can provide a more accurate picture of where in a given space human workers are located, while also reducing the likelihood of overlapping and blind spots. The AM1 software has been trained to understand typical patterns of human movement, and can track up to 10 individuals within a 7m x 7m area with an accuracy exceeding 95 percent.

Having this capability allows organisations to track where and how workers are moving, or how long they're staying at a particular station for. This information can in turn be used to detect bottlenecks, and ensure that space utilisation and workflows are as efficient as possible. In practice this could mean removing obstacles, or shortening routes that are most frequently used, or reducing the likelihood of workers having to cross each other's path. By identifying and understanding the problems earlier, solutions can be found more quickly, underpinned by a data-driven approach.

AM1's accuracy is achieved through the system's 10fps frame rate. Image data from the camera (or multiple cameras) is fed into a processing hub via Ethernet, which is powered by an Intel OpenVINO™ accelerator. This is the crucial innovation that allows the system to turn raw data into useful information quickly. Once processed, the information is then conveyed for human operators to a standard PC or PLC. Omron's vast library of data, accumulated through years of developing vision solutions, means that the system does not need to be trained on particular individuals, and can detect any human body type. As such, no specific programming skills are required for users.

Aside from optimising productivity, other potential uses for this technology could involve occupancy detection to determine the appropriate HVAC conditions, or intrusion detection during non-work hours. There are also potential use cases in shared residences for optimising the layout and environment of communal areas.

While the accurate detection of humans across all environments continues to present challenges, systems like Omron's AM1 are proving that human motion detection has finally reached maturity as a viable technological solution. In the future these systems hold immense promise for revolutionising productivity, as well as other aspects of society.

**Gabriele Fulco, Product Marketing Manager, Omron Electronic Components Europe B.V.**
**http://components.omron.com/eu-en**

# Protection and Layout Considerations to Maximize Efficiency in Servo Motor Drive Circuits

Servo motors convert electrical energy into precise mechanical motion making them essential components in today's motion control systems. Their widespread use spans from household appliances to industrial automation, where high-performance and accuracy are required. Known for their superior efficiency and responsiveness, servo motors are typically driven by high-frequency AC voltage, which necessitates specialized power conversion circuitry.

**To deliver the appropriate power to** these motors, a combination of stages is used to convert and condition electrical energy. These stages perform everything from rectifying AC mains, correcting power factor, and generating high-frequency signals, to providing robust protection and accurate feedback. Each stage presents design challenges that can include a reduction in power quality, the need to deal with electromagnetic interference, conditions that require additional thermal management measures, and added requirements for effective surge protection.

This article explores the components required along with the layout considerations in designing servo motor drive circuits. It focuses on the power conversion, circuit protection, and current sensing components that are employed to help designers enhance performance, reliability, and efficiency. Whether powering a compact servo in a precision tool or a large industrial motor, the principles outlined here serve as a foundation for creating robust and energy-efficient drive systems.

## Servo Motor Drive Circuits Layout

The most common application of a servo motor circuit is to convert AC main power into a significantly higher frequency to drive AC or DC servo motors. Figure 1 shows a block diagram of a typical servo motor drive circuit. As shown, the circuit uses a full-bridge rectifier with a filtering capacitor to transform the AC signal into a DC voltage. However, due to the rectified nature of the DC voltage, there are high-value current harmonics present within the power. The presence of these current harmonics can potentially cause outages in the connecting power grid. To prevent outages, Power Factor Correction (PFC) circuits are implemented to increase the power factor.

An H-bridge then converts the DC bus voltage after the rectification and PFC stages to a workable PWM or AC single-phase waveform for the motor. The H-bridge can be replaced for a three-phase, half-bridge design that incorporates similar characteristics but designed for three-phase motors. These connected circuits are typically controlled and monitored by a microcontroller, which handles and operates the high-precision operation of the motor drive circuit. By using a servo motor drive circuit, power is conserved by converting a low-frequency input into a high-frequency signal suitable for servo motor applications.

## Power Protection

Incoming power from the electrical grid is vulnerable to frequent overvoltage and overcurrent events, which pose a risk to drive circuits. Caused by lightning strikes, grid switching transients, or inductive kickback, these surge events are often thousands of volts and amps; much higher than the rated voltages of any connected

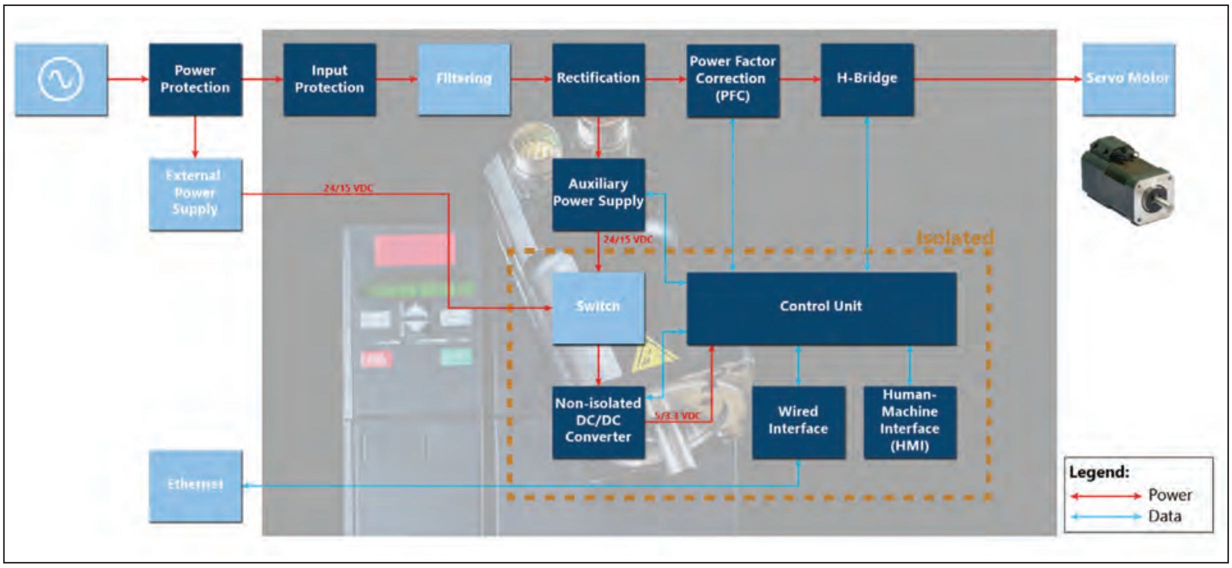
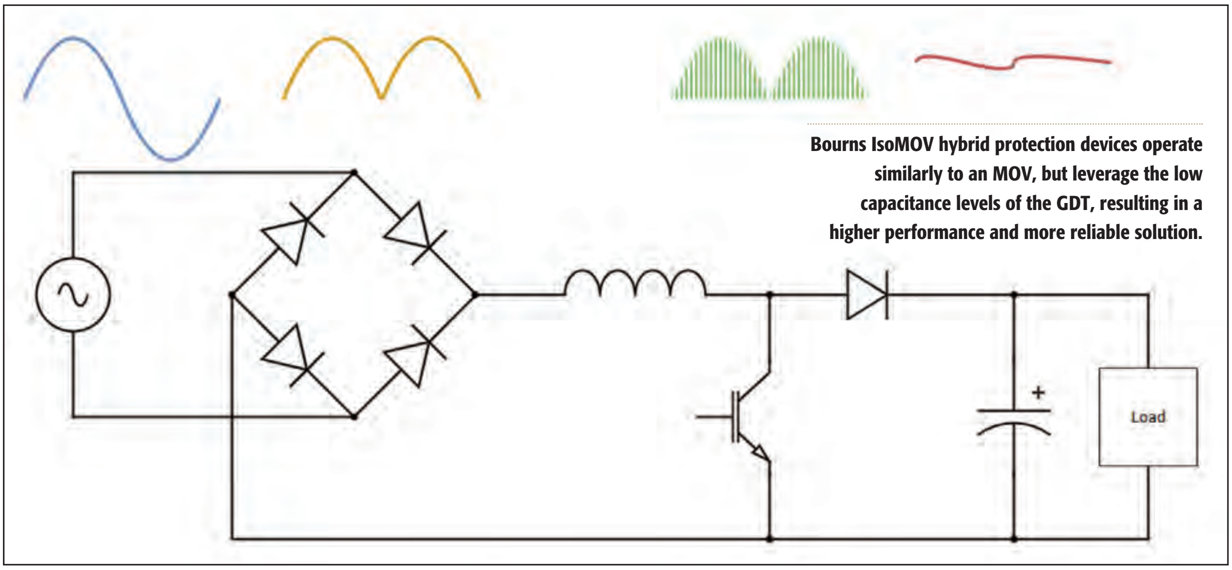



**Figure 1. Block diagram of circuits that make up a servo motor drive circuit.**

device. The industrial standard to prevent these random surges is to implement a surge protective device (SPD) that are specifically designed to absorb incoming energy. SPDs are commonly positioned in the circuit as the first line of defense from potential lightning strikes. These devices are proven to deliver effective protection from their advanced design that uses discrete components like metal-oxide varistors (MOVs) and Gas Discharge Tubes (GDTs). If a surge that exceeds the rated voltage of the SPD occurs, then the device will shunt excess energy away from the motor drive system. This feature helps ensure that even during extremely high voltage surges, the potentially damaging threat would be isolated to the SPD.

To provide a motor drive circuit with complete power protection, the recommended protection design should include a fuse, Negative Temperature Coefficient (NTC) device, a MOV, hybrid protectors, and a GDT. Each device fulfills its niche in protecting the motor circuit.

- The MOV works as a clamping device, absorbing high voltages.
- The GDT is a low-capacitance component that, when connected in parallel to the protected circuit, diverts high currents away from the circuit, 'crowbarring' the power.
- Currently available hybrid protection devices combine MOV and GDT technology in a single space-saving package.
- NTCs are especially important in high-inductive motor circuits, where stored energy kickback and inrush currents are commonly present. NTCs operate normally open, but when current is applied, the device warms up and acts as a short. This behavior protects the circuit from an initial current spike.
- Despite implementing these multiple layers of protection, redundancy is necessary to effectively protect a motor drive circuit. Fuses are considered the most reliable solution for redundant protection as they act to safeguard the circuit if every other device has failed.




Bourns IsoMOV hybrid protection devices operate similarly to an MOV, but leverage the low capacitance levels of the GDT, resulting in a higher performance and more reliable solution.

## The Need for Rectification

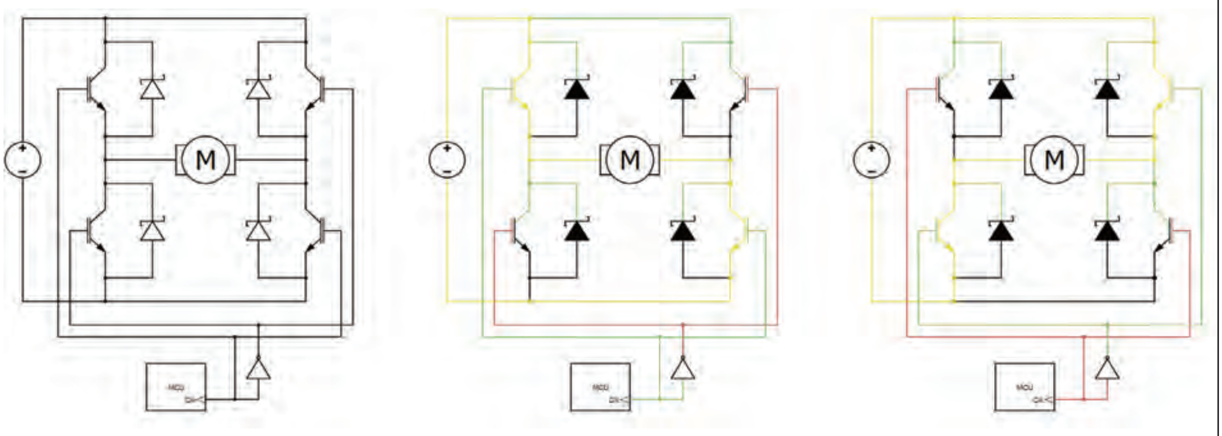
Full-bridge rectification converts an AC signal into a DC voltage. This is accomplished by implementing diodes into a bridge arrangement. The effect of the rectification is like the mathematical function of the absolute value of a sine wave. The resulting signal is completely positive voltage; however, it retains a strong variance and frequency from the original AC input. To achieve a stable DC voltage, designers implement a capacitor low-pass filter, which filters the 50 or 60 Hz frequency harmonics, leaving only the DC voltage. This filtering capacitor smooths out the curve, removing most of the variance in the signal. The efficacy of the filtering—reducing ripple in the voltage waveform—is determined by the capacitance value of the capacitor, which is where the cost and size constraints of the circuit must be considered when designing the filter.

## Power Factor Correction

Some circuit designers settle for a low-pass filter, where there is a small ripple of voltage present in the rectified voltage. However, due to the shape of the waveform, the capacitor experiences large current harmonics. These harmonics are derived from the constant charging and discharging of the capacitor at a constant frequency. The resulting current waveform that flows through the capacitor contains errant harmonics, which, when reentering the electrical grid, cause disturbances and fluctuations. On a large scale, such disturbances can cause damage and power outages within buildings and to associated infrastructure.

Another reason the current waveform is undesirable is the low power factor (PF), which is the ratio of real 'useful' power to total apparent power. The PF is affected by low real power consumption and relatively high reactive power. Real power is determined from the definition of electrical power—the multiplication of current and voltage in the component. As the current from the AC main resembles a non-sinusoidal waveform and the voltage is sinusoidal, the real, 'useful' power provided is low compared to the total apparent power. While real power is consumed by resistive loads, reactive power is consumed by capacitive and inductive loads (which dominate inside a servo motor system). Reactive power results from voltage and current waveforms being out of phase due to the inductive load. This power does not generate mechanical work; however, it still pulls current through the wire. The current sloshes back and forth from the electrical grid to the motor, heating up the wires, lowering the maximum voltage possible, and slowly damaging the connections. This results in the total apparent power—the Pythagorean sum of the real and reactive power—being greater than the real power. This issue shows the inefficiencies of the system that need to be corrected.

A Power Factor Correction (PFC) circuit is implemented to remedy both issues of the current waveform. The most common type of PFC circuit is the high-frequency boost converter. These circuits operate by using a rapidly switching transistor to charge and discharge an inductor. Bourns' recommendation for transistors is its Insulated Gate Bipolar Transistor (IGBT), a high-performance transistor with the characteristics of both the MOSFET and the BJT.




**Bourns® SiC Schottky diodes enable designers to increase power efficiency and decrease noise in PFC designs.**

SiC Schottky barrier diodes can also be used to increase power efficiency for most systems. SiC diodes exhibit negligible reverse recovery charge (Qrr). This drastically reduces switching losses in the PFC switching element where reverse recovery of the diode would otherwise cause high losses and EMI in Si-based solutions. SiC devices can also operate at higher junction temperatures (often up to 175° C), reducing the need for bulky heat sinks or forced-air cooling.

PFC designs can be tricky, but with proper tuning of the frequency, duty cycle, and values of the inductor and filtering capacitor, it is possible to make the current waveform resemble a sinusoidal waveform that is in phase with the AC main voltage. By using a PFC circuit, the unintended effects of a servo motor are minimized, reducing costs in maintenance and electricity fees.

### Implementing an H-Bridge

Once the incoming power has been filtered and passed through the PFC, the power must be reconverted into a high-frequency AC or trapezoidal waveform. An H-bridge configuration is commonly used to convert DC power into a high-frequency signal. The H-bridge uses high frequency PWM signals to control high-performance transistors, similar to the operation of IGBTs. The frequency in an H-bridge is often adjustable, allowing for precision speed and torque control of the motor.

### Accurate Current Sensing

The servo motor drive circuit requires almost constant measurement and adjustment of the switching frequencies of the PFC and the H-bridge, as they are critical motor control operational elements. The most important measurement is the current sensing of the various stages of power conversion. The preferred current sensing solution for servo motor circuits is its high-powered current sensing shunts. These robust devices are known to excel at delivering high precision current measurement. Current shunt resistors operate by providing a low voltage drop through an accurate resistance. By measuring the voltage drop across the resistor, the current can be calculated and monitored. Constant current sensing is required in motor drive circuits as they use a closed-loop feedback system that helps maintain efficient operation.

### Benefits

Servo motor drive circuits are essential in modern motion control systems requiring precise power conversion, protection, and control. The key stages of a typical drive circuit—from rectification and power factor correction to high-frequency AC and trapezoidal generation and current sensing present unique challenges. To remedy the identified harmonic distortion, surge vulnerability, and efficiency loss issues presented, servo motor drive circuits require a high-performance, integrated protection design that can meet manufacturers' efficiency and control goals.

Key components are SPDs that provide robust and rugged solutions that can withstand potentially damaging overvoltage and overcurrent events. Another component in the protection arsenal are today's innovative hybrid protection devices, which combine the fast clamping of MOVs with the low capacitance of GDTs.

In addition, IGBTs and SiC diodes support high-frequency switching in PFC and H-bridge stages, reducing power losses, and enabling higher motor speeds. Plus, advanced current sensing shunts provide a high-precision solution for real-time control feedback necessary in servo motors. These components allow designers to build more compact and accurate servo motor drive circuits that meet ongoing requirements for greater control or adjustment capabilities in increasingly expensive industrial motors as well as in small servo motors.

As servo motor applications continue to expand across automation, robotics, and electric mobility, the importance of reliable drive circuit design will only grow necessitating ever more advanced protection devices to safeguard these essential control systems.

# Not All Grounds Are 0V

Sadia Khan - Systems Engineer, Isolation Products at Texas Instruments

**Industrial and automotive systems are** using mixed-voltage designs for power optimization, improved performance, and cost reduction. Integration of diverse power domains become a challenge due to unintended ground mismatch. This occurs when the ground reference voltage between domains deviates from the expected 0V reference, ranging from a few volts to tens of volts. Ground shifts can disrupt communication between systems. Addressing this concern is key to reliable system performance.

## How is Ground Mismatch Solved Today?

There are multiple methods today used by designers to address ground mismatch in systems. First, proper PCB grounding techniques are used such as dedicated ground planes, star grounding technique, and separating analog and digital grounds. However, this requires careful layout planning and can consume additional board space. If ground shift occurs after the board is already designed, this requires a complete redesign, leading to increased development time. Discrete level shifting is another technique, using resistor dividers or transistor- based circuits to interface across grounds. However, this design is not well-suited for systems with large ground potential differences, suffers from poor signal integrity and timing characteristics, and requires significant board space. Lastly, and perhaps the most commonly used, are galvanic based isolators which are used to decouple subsystems with different ground potentials. Isolators are often associated with higher costs and can introduce additional signal delays. This can also complicate power supply design since isolated sections require separate power sources.

## TI's Latest Voltage and Ground-Level Translator

Texas Instrument's TXG family introduces a new method of mitigating ground mismatch in your system with a translator that can level shift both voltage and ground to enable communication across different power domains. TXG804x, TXG802x, and TXG8010 handles ground mismatch up to ±80V, level shifting of I/O voltages from 1.71V to 5.5V, and has a push-pull output for interfaces such as SPI, UART, I2S, and GPIOs. These devices support very high data rates of >250Mbps and low latency with <5ns propagation delay and 0.35ns channel- channel skew. TXG8122 also handles ground mismatch up to ±80V, level shifting of I/O voltages between 3V to 5.5V (Side 1) to 2.25V to 5.5V (Side 2), and has an open-drain output for interfaces like I2C.

## Examples of Ground Shifting

There are several uses cases where ground mismatch can be an issue and is summarized below under three types of ground shifting: DC shift, AC Ground Noise, and Intentional Ground Shift.

## DC Shift

Ground mismatch can occur due to DC shifts in a system and is shown in Figure 1. DC Shifts can be found when current flowing through a ground path causes a voltage drop because of the wire's parasitics. This creates a ground mismatch between two systems. This phenomenon is particularly common in systems with high current loads or long ground paths.

Figure 2 gives an example of an Electrical Power Steering (EPS) System. In this system, two microcontrollers (MCUs) are used to maintain continued operation during a failure event. Both MCUs communicate with each other, but one serves as a redundant backup in case the primary MCU stops functioning. While both MCUs are typically referenced to a common ground, high current loads in the system can introduce ground shifts between the two domains. Traditionally, digital isolators are used to manage these

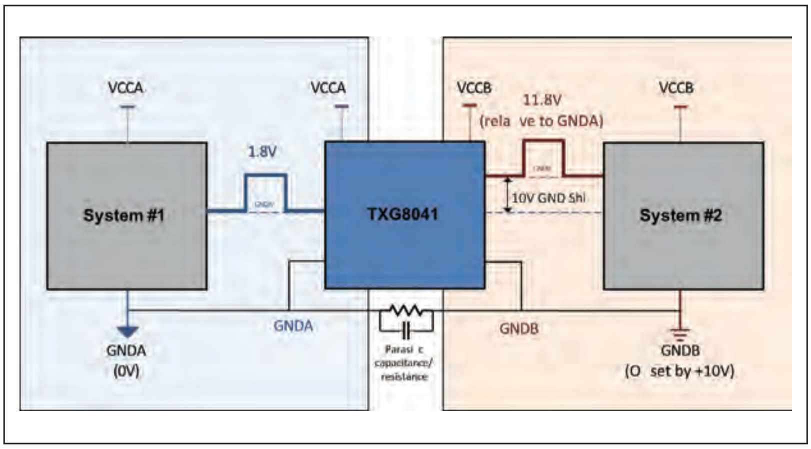



Figure 1. DC Shift

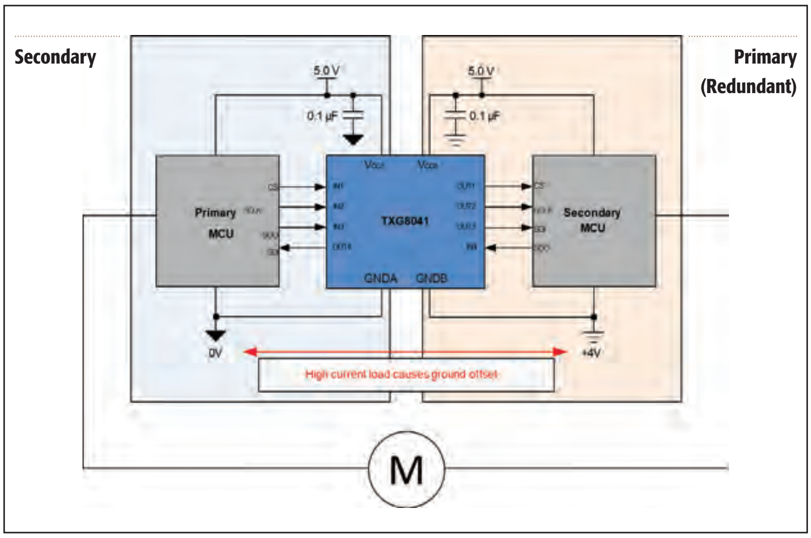



Figure 2. Electric Power Steering with TXG

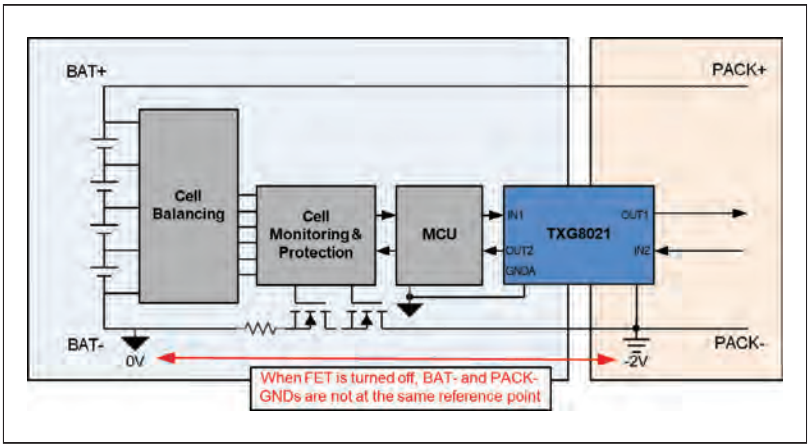



**Figure 3. Cordless Power Tool with TXG**

ground differences. However, galvanic isolation is not required in this case, and the TXG8041 is a more compact and cost-effective alternative.

Another example of DC shift can be seen in battery packs for cordless power tools. In battery pack systems, a battery management system (BMS) is usually used to control power delivery and monitor cell condition. One common design uses a low-side FET to connect the battery negative terminal to the pack ground, which serves as the common reference for the appliance–such as a power drill. When the FET is on, the battery's negative terminal is tied to the pack ground. When the FET is off, the battery's negative terminal effectively floats and can drift to a different reference level than the pack ground, potentially disrupting communication between the BMS and the power drills control circuitry. Traditionally, discrete components are used to level-shift between the battery negative terminal and pack ground. However, this can be completely replaced with an integrated TXG8021 as shown in Figure 3.

### AC Ground Noise

AC noise refers to disturbances on the ground caused by dynamic changes, resulting in a noisy or unstable ground, as shown in Figure 4. This phenomenon is often called ground bounce and can also cause signal integrity issues between systems. In mixed-signal designs, this issue can arise when interfacing high-speed digital circuits with precision analog components.

Figure 5 shows an example in Test and Measurement applications where a Field Programmable Gate Array (FPGA) is referenced to digital ground and has to interface with a Digital-to-Analog Converter (DAC) that is referenced to power ground. Both grounds are ultimately connected together to establish a common reference but can be on separate ground planes on a PCB to help separate digital noise from sensitive analog circuitry. The digital side of the system can see rapid switching which can result in AC noise. Noise that carries to the power ground can introduce fluctuations in the DAC reference voltage, leading to degraded performance or distorted analog outputs. In the example below, TXG8042 is used to eliminate noisy grounds and enable the precise communication needed for accurate digital-to-analog conversion.

### Intentional Ground Shift

Intentional ground shift is when systems deliberately use an offset ground for the benefit of the system. An example of this is topologies with a negative voltage rail. This can be seen in GaN based power stage designs which use a -50V ground in Class D audio amplifiers to increase the total voltage swing available to the amplifier output. The larger voltage swing allows the amplifier to deliver higher root mean square (RMS) power to the speaker, which translate to louder and cleaner >audio output. In the block diagram below, the TXG8010 single-channel device can be used to bridge the offset between the MCU which sits on 0V ground and the GaN Half-Bridge Power Stage which sits on -50V.

Battery stacking is also more common now as a way to support higher voltages, enabling longer runtime and improved energy capacity. This approach is frequently used in systems such as appliances, energy storage systems (ESS), and electric mobility applications. Because traditional battery monitors typically

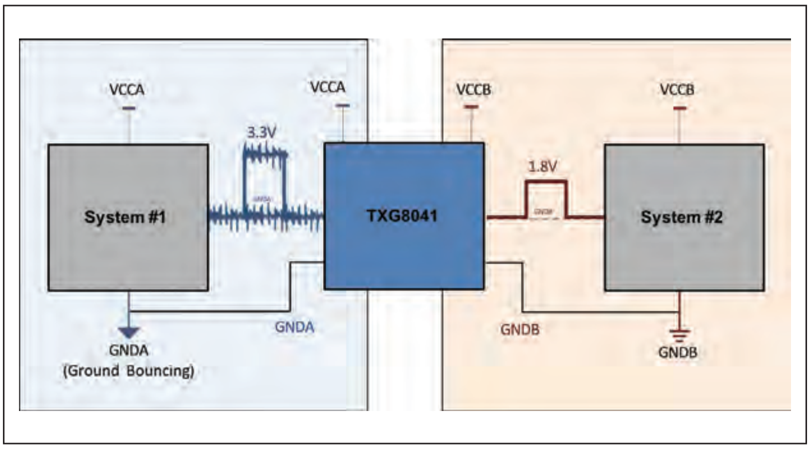



**Figure 4. AC Ground Noise**

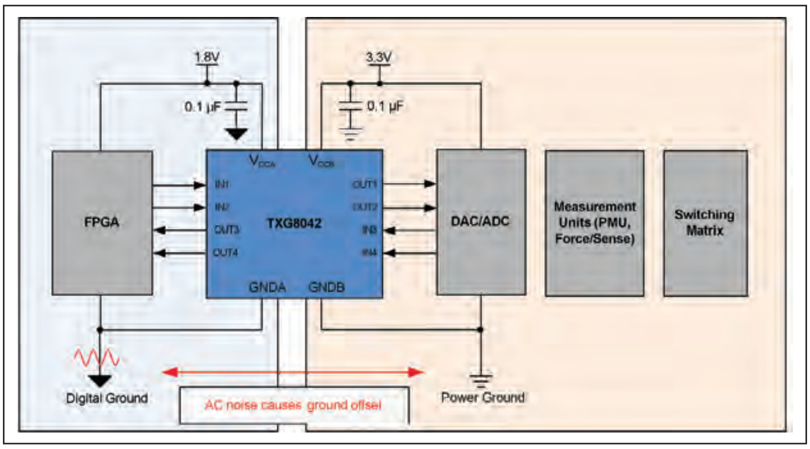



**Figure 5. Semiconductor Test Equipment With TXG**

support only 16 cells in series per device, managing larger stacks often involves using multiple monitors across different voltage domains. In these systems, the TXG8122 facilitates communication over the I2C interface between the MCU at 0V ground and the top battery monitor, which can sit at voltages at 25V or higher.

### When to Use Ground-Level Translators

While galvanic isolators remain essential in high voltage and safety critical applications, understanding when to use a ground-level translator versus a digital isolator can help reduce system cost and size while improving

performance. If safety is not a concern, transient voltages do not exceed 80V, and no isolation certifications are required, the family of ground-level translators is the best option. Following is a comparison between these two designs:

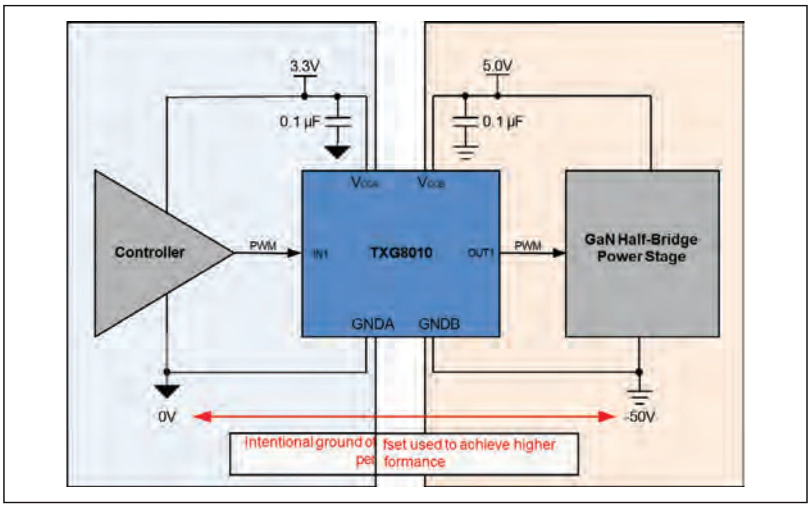



**Figure 6. GaN Half-Bridge Power Stage With TXG**

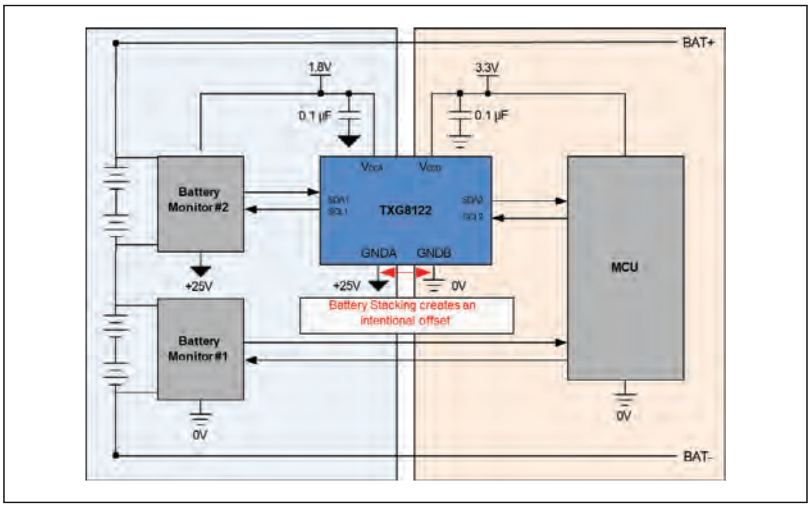



**Figure 7. Battery Stacking With TXG**

| | Ground-Level Translator | Digital Isolator |
|---|---|---|
| GNDA to GNDB Difference | ±80V | >3kV$_{RMS}$ |
| Galvanic Barrier | No | Yes |
| GNDA to GNDB Leakage (VCC to GND shorted) | 70nA | <1nA |
| Size (4ch) | 4mm$^2$ | 29.4mm$^2$ |
| Propagation Delay (3.3V) | 5.8ns | 18.5ns |
| Ch-Ch Skew (3.3V) | 0.35ns | 4.7ns |
| Data Rate | >250Mbps | 100Mbps |
| Level Shifting Capability | 1.71V to 5.5V | 1.71V to 1.89V and 2.25V to 5.5V |
| Operating Temperature | -40 to 125°C | -40 to 125°C |
| CMTI | 1kV/µs | 100kV/µs |
| Certifications (UL, VDE, Surge) | No | Yes |
| EMC (EFT, RI, IEC-ESD) | No | Yes |

### Conclusion

Ground mismatch is an increasingly common challenge in modern systems. Whether caused by DC shifts, AC ground noise, or intentional offsets, ground potential differences can introduce serious communication, reliability, and signal integrity issues. TI's TXG family of ground-level translators offers a compact, cost-effective, and faster alternative to traditional methods, enabling seamless signal transmission across ground differences of up to ±80V. The portfolio offers scalability and design flexibility, empowering engineers to unlock new possibilities in a wide range of automotive and industrial applications.



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NOMINATIONS CLOSE 28TH NOVEMBER

PIA PUMP INDUSTRY AWARDS 2026

The PUMP BPMA industry association

Recognising and Rewarding Excellence

# Will you be crowned a winner in 2026?

**The BPMA's annual Pump Industry Awards programme has been recognising and rewarding the achievements of pump businesses, large and small for over two decades. Throughout that time it has become one of the leading events to serve the industrial and commercial arena. So, if you or your company have a pump related success to shout about, these awards provide the perfect platform.**

The gala presentation dinner caps off the awards programme in style, providing excellent networking opportunities, great food and superb entertainment. It's your chance to celebrate with colleagues, interact with peers, entertain customers and be part of the pump industry's biggest and best celebration. Manufacturing and distribution prowess, product development and application, environmental consideration, skills development and customer support will all be acknowledged through this wide reaching awards programme. So why not consider which of your engineering successes are deserving of industry wide recognition, and be sure to join us at our wonderful venue - *the home of English football* - on Thursday 19th March 2026.

**Venue:** Hilton at St George's Park, Burton upon Trent
**Date:** Thursday 19th March 2026

Lee Tebbatt, BPMA President, says of the Pump Industry Awards,"The pump industry has long been a hotbed of innovation, with manufacturers striving for engineering excellence to deliver greater operational performance and improved efficiencies to its broad customer base. The industry landscape is changing and as a collective, we're moving the dial on important issues such as water scarcity, energy shortage and climate change, we're driving sustainability across our supply chains and we're sharing best practice among our members. This BPMA backed awards programme brings the pump industry together in celebration of this drive for industry excellence.

## Event Calendar

- **Nominations Open**: 1st July 2025
- **Nominations Close**: 28th November 2025
- **Judging Session**: Mid December 2025
- **Voting**: 12th – 16th January 2026
- **Winners Announced**: 19th March 2026

www.pumpindustryawards.com

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Organised by Touchwave Media on behalf of BPMA

# UK can lead new grid tech to reduce likelihood of blackouts and provide smarter energy supply

## New report highlights the potential revolutionary role of solid-state transformers in providing a more flexible and intelligent energy grid

The UK has all the ingredients to take advantage of a promising new semiconductor technology that will make our energy grids smarter, more reliable and less prone to blackouts, according to a new report published recently.

Solid state-transformers (SSTs) are an advanced type of transformer that use power electronics and high-frequency components to convert and control electricity.

They are extremely useful for integrating renewable energy sources and energy storage systems into the grid, as well as managing surges and disturbances, reducing the likelihood of blackouts.

In April this year, a major blackout occurred across Spain and Portugal, disrupting power for more than 10 hours and causing economic losses of an estimated $1.6 billion.

The new report, published by Compound Semiconductor Applications (CSA) Catapult, says the UK is well placed to lead this technology due to its world-leading expertise in power electronics and compound semiconductors.

Compound semiconductors such as silicon carbide (SiC) and gallium nitride (GaN), are the material of choice for this application as they can handle higher voltages, operate at higher frequencies, and perform better at higher temperatures.

Even though SSTs are still a nascent technology, the SST market is projected to grow at a double-digit compound annual growth rate (CAGR) through to 2030. Similarly, the market for SiC power devices is expected to grow at over 20% CAGR over the same period.

The total global investment in power grid technology was projected to peak at nearly $400 billion in 2024, whilst global spending on renewables hit a record $735 billion in 2023.

In the UK alone, there are over 500,000 substations that could benefit from new SST upgrades. Between 2020 and 2023, over 100,000 traditional dielectric transformers were sold in the UK, generating over £90 million in revenue.

Compared to traditional transformers, SSTs are much smaller and lighter, better at regulating voltage and more flexible—they can also convert between AC and DC electricity and help send electricity back into the grid.

Outside of the energy grid, SSTs can also be used to manage power in EV chargers, data centres, and electric rail, marine and aerospace applications.

SSTs will modernise EV charging by providing compact, efficient systems that support high-power, ultrafast charging solutions and a seamless link into renewable energy sources.

Global companies are already developing SiC-based SSTs that can achieve up to 96.5% efficiency and reduce carbon footprint by 40%, weighing up to 70% less.

The report estimates that between 300,000 and 800,000 EV charges could be installed in the UK by 2030, providing a market opportunity of between £570 million and over £4.5 billion.

To overcome the hurdles facing the commercial development of SSTs, the report calls for a more coordinated between academia, industry, and government, improved funding and regulatory frameworks, and the development of large-scale pilot projects to test the technology in the real world.

Nick Singh, Chief Technology Officer at CSA Catapult said: "As the energy landscape evolves and we introduce more renewables into the grid, SSTs have the potential to modernise our infrastructure and transform the way we move electricity around the system.

"Their ability to integrate seamlessly with distributed energy resources, bidirectional power flow, and real-time monitoring will place them at the heart of smart grids and create a whole host of new and advanced applications.

"The UK is in a strong position to take this technology forward with a flourishing power electronics and compound semiconductor ecosystem that is needed to take this technology from concept into real world applications."

# Microchip enters into partnership agreement with Delta Electronics on Silicon Carbide Solutions for the future of power management

This agreement leverages Microchip's mSiC technology and Delta's smart energy-saving solutions to accelerate the development of sustainable applications


The growth of artificial intelligence (AI) and the electrification of everything are driving an ever-increasing demand for higher levels of power efficiency and reliability. Microchip Technology has announced that under a new partnership agreement with Delta Electronics, a global leader in power management and smart green solutions, the companies will collaborate to use Microchip's mSiC products and technology in Delta's designs. The synergies between the companies aim to accelerate the development of innovative SiC solutions, energy-saving products and systems that enable a more sustainable future.

"SiC is increasingly important in sustainable power solutions because of its wide-bandgap properties, which enable smaller and more efficient designs for high-voltage, high-power applications at a lower system cost," said Clayton Pillion, Vice President of Microchip's High-Power Solutions Business Unit.

"We look forward to forging an impactful path with Delta Electronics on innovating SiC solutions to meet the rising demand of the electrification of everything."

As a global leader in power management, Delta advances its core competence in high-efficiency power electronics and continuously evaluates and leverages next-generation technologies to enhance the energy efficiency of its products and solutions. Delta says it intends to leverage Microchip's abundant experience and advanced technology in SiC and digital control to accelerate time to market of its solutions for high-growth market segments such as AI, mobility, automation and infrastructure.

This agreement prioritises the companies' resources to validate Microchip's mSiC solutions to fast-track implementation in Delta's designs and programmes. Other key advantages of the agreement are top-tier design support to include technical training, insight into R&D activities and early access to product samples.

With over 20 years of experience in the development, design, manufacturing and support of SiC devices and power solutions, Microchip says it can help customers adopt SiC with ease, speed and confidence. Microchip's mSiC products include SiC MOSFETS, diodes and gate drivers with standard, modified and custom options.

# The PCIM Expo & Conference 2025 again proves to be a catalyst for innovation and progress in power electronics


From 6 – 8 May 2025, the PCIM Expo & Conference once again delighted international industry visitors with solutions, presentations, and much more from the world of power electronics. As the central industry platform for pioneering product premieres, innovations, and the latest research findings, the leading expo and conference provided plenty of inspiration for the evolution toward greater efficiency and sustainability in the sector.

For the first time extending over six exhibition halls and 41,500 m$^2$ of exhibition space, the event brought together big industry names to drive forward technological developments and unleash the full potential of power electronics. With 685 exhibitors and around 16,500 visitors, this year's exhibition was once more a resounding success. Underscoring the event's global relevance was the strong international presence of exhibiting companies, 62% of which came from outside of Germany – a new record. Besides promoting international dialog, this gave attendees a comprehensive overview of the global market.

433 high-calibre presentations on the latest research topics gave the 818 attendees from 26 countries the chance to delve deeper into the world of power electronics and discover and discuss the latest research findings and technological advances.

### Varied supporting program offering concentrated expertise

All three days of the exhibition were accompanied by a highly focused, specialized program of presentations covering current topics in the industry, such as decarbonization.

Across the three stages of the PCIM Expo, attendees were able to discover more about solutions for electromobility and energy storage, product innovations, and research progress, and speak directly to the experts. The varied presentations also demonstrated the broad applicability of power electronics across numerous industries, including industrial electronics, automation, and drive systems.

The strong response was reflected in the positive atmosphere: "The company has been exhibiting here for 20 years for the simple reason that we think that PCIM is

one of the most important exhibitions for power electronics in the world. We've checked fairs in other countries, but we've not found any equivalent to the PCIM. This Expo has a deep, uncompromising focus on power electronics. And even after 20 years, we continue to meet new contacts within the community whether customers, leads, suppliers or engineers – they're all here over three inspiring days – year after year!" as Karim Zaibat, Business Manager, Cefem Industries, stated.

This sentiment was echoed by Thomas Neyer, Senior Vice President, Infineon Technologies: "The PCIM is much more than a conference - it offers space for dialog, international partnerships and innovative forms of collaboration across company boundaries."

## Focus on industry trends: Current challenges and practical solutions

This year's PCIM Expo & Conference once again addressed key topics that are impacting the entire power electronics industry, such as improving energy efficiency, system integration, and the increased use of new semiconductor materials.

The event offered both industrial and scientific perspectives and demonstrated how research and practice work hand in hand to translate current challenges into innovative solutions.

Pietro Scalia, Sr. Director, Renesas Electronics added: "Our time at the PCIM is full of highlights – expected and unexpected ones! For us at Renesas, it is three days of valuable encounters starting at breakfast, all through the day and going on well into the evening. Networking, chance meetings, the opportunity to solve tangible problems and tackle prevalent issues – this is important for the power electronics community to move the technical and business progress of our industry forward. We have taken the opportunity to showcase our power solutions for the new trends in data center at the conference – the PCIM is an ideal arena to present fresh ideas and challenge yourself against competitors. The result is that the industry, as a whole, learns and grows."

This combined expo and conference gave participants an overview of current developments and fostered an intensive dialog between developers. Specific solutions were discussed and new ideas developed to drive technology forward and address the market requirements of the future. The event once again emphasized the potential of power electronics as a key technology for the future in areas such as the energy transition, e-mobility, and Industry 4.0.

## PCIM Conference 2025: Key platform for technological innovations

The PCIM Conference provided the ideal platform to deepen these discussions and present the latest research findings and technological innovations. Many of the presentations and sessions presented theoretical and practical approaches, positioning power electronics as the driving force behind major topics of the future. With their high-caliber keynotes, Dushan Boroyevich (Virginia Tech), Michael Harrison (Enphase Energy) and Johann W. Kolar (ETH Zurich) provided valuable impetus for the future of the industry. They joined numerous experts from around the world to offer new perspectives on the evolution of power electronics. The conference therefore not only promoted the transfer of knowledge and technology, but also provided valuable impetus for the future design of key technologies.

## Year-round platform for innovation and networking in power electronics

The PCIM – Hub for Power Electronics facilitates networking and knowledge transfer in the field of power electronics beyond the PCIM Expo & Conference 2025. Offering a combination of digital formats and networking events, the hub is a year-round platform that gives experts worldwide ongoing access to the latest trends, technologies, and solutions in such key areas as sustainability, digitalization, and miniaturization. Lisette Hausser, Vice President: "The PCIM – Hub for Power Electronics connects the international power electronics community across national borders. By offering formats such as the PCIM Magazine, PCIM After Work Events, and the PCIM News Platform via the hub, we can play a role in driving innovation and the continuous development of the industry."

For more information about the PCIM – Hub for Power Electronics, visit the website.

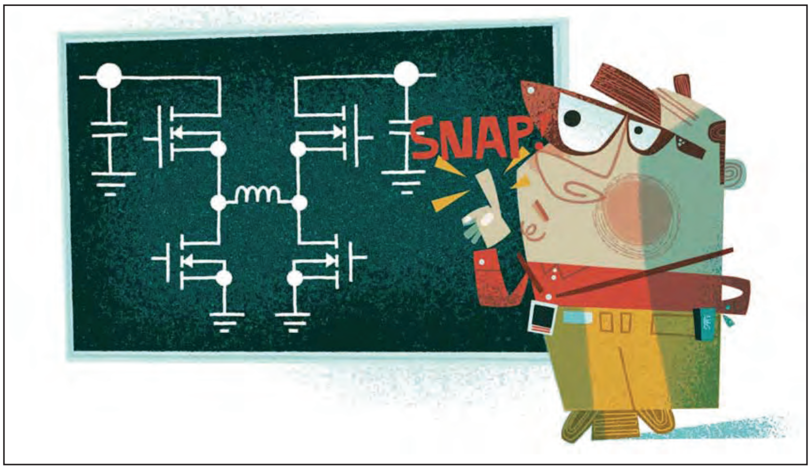
**The PCIM Expo & Conference will be held from 9 – 11 June 2026.**

# Can You Drive GaNFETs with a DC-to-DC Controller Originally Designed for Silicon MOSFETs?

Kevin Thai, Applications Manager, Analog Devices

**Question**

How can I design a 4-switch buck-boost DC-to-DC converter using GaNFETs when there are no controllers specifically made to drive GaNFETs available?




**Answer**

GaNFETs are notoriously more difficult to drive and may require extra protection components if using a driver meant for silicon (Si) MOSFETs. Proper care in choosing the correct drive voltage and some small protection circuitry can provide a safe, all-in-one, high frequency GaN drive for a 4-switch buck-boost controller.

**Introduction**

In the never-ending quest to reduce board size and increase efficiency, gallium nitride field effect transistor (GaNFET) power devices have become an ideal candidate to push these boundaries. GaN is an emerging technology that promises higher power with ultrafast switching and reduced switching losses. These advantages allow for more power dense solutions. The current market is saturated with a myriad of different Si MOSFET drivers, and new GaN drivers and controllers with built-in GaN drivers are some years away from becoming accessible. Along with simple, dedicated GaNFET drivers (such as the LT8418), complex buck and boost controllers targeted for GaN exist on the market (LTC7890, LTC7891). There is still no straightforward 4-switch buck-boost solution. However, driving GaNFETs is not as difficult as it may seem. With some simple background knowledge, Si MOSFET targeted controllers can be adapted to drive GaNFETs. The LT8390A is a great candidate as it is a unique 2MHz buck-boost controller with very low dead time (25ns) (see Figure 1). The buck-boost scheme has the sense resistor in line with the inductor and outside of both hot loops - a novel feature for buck-boosts. This allows the controller to operate in peak

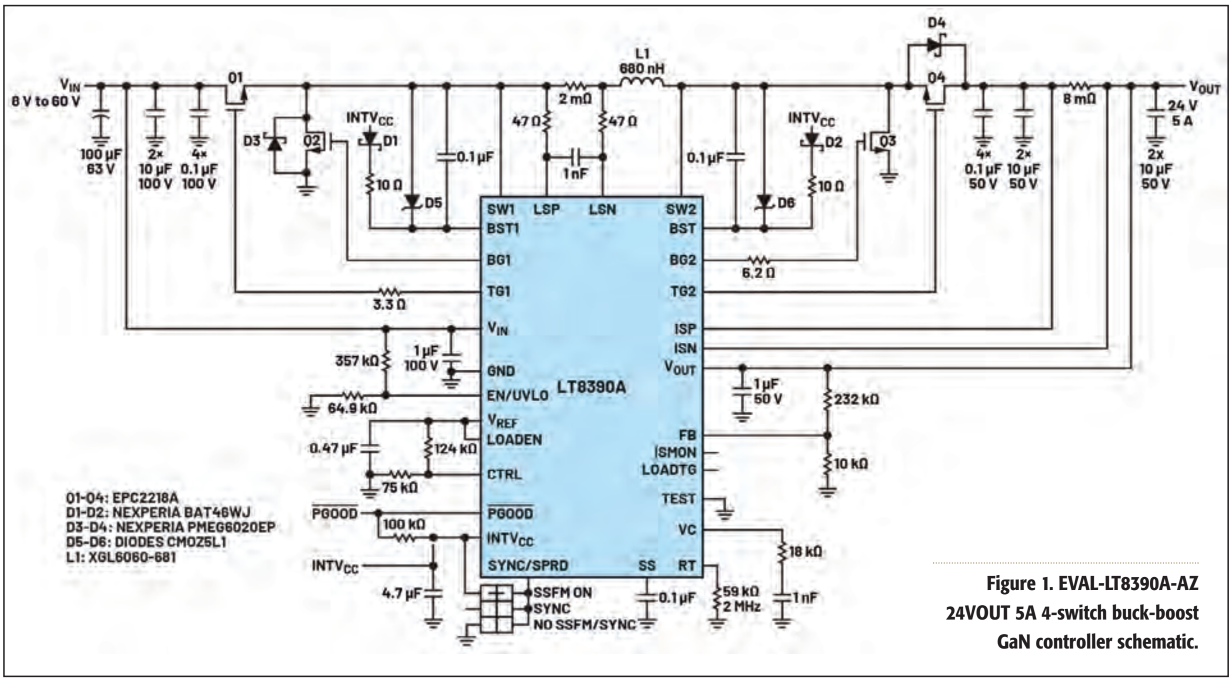



**Figure 1. EVAL-LT8390A-AZ 24VOUT 5A 4-switch buck-boost GaN controller schematic.**

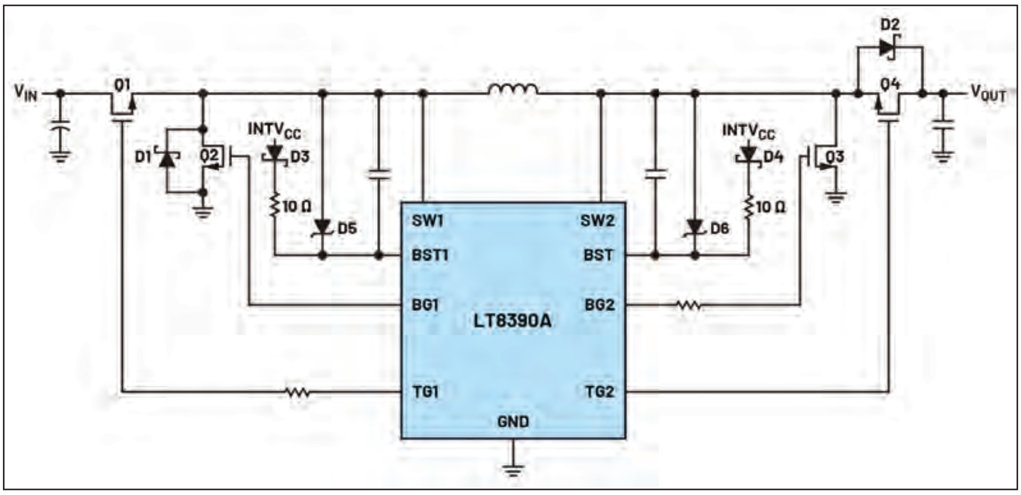



**Figure 2. Simplified 4-switch buck-boost GaN controller schematic with GaN control protection components.**

current mode control in both boost and buck regions of operation (as well as 4-switch buck-boost). While the article delves into 4-switch buck-boost GaNFET control, the information can be extended to simple buck or boost controllers.

## 5V Gate Driver Is a Must

For high power conversion, silicon drivers typically operate above 5V, with typical silicon MOSFET gate drivers ranging from 7V to 10V or even higher. This poses a challenge to GaNFETs, as they commonly have an absolute maximum gate voltage rating of 6V. Even the ringing caused by stray PCB inductances on the gate and source return lines that exceed the maximum gate voltage can lead to catastrophic failures. Careful layout considerations are necessary to safely and effectively drive a GaNFET by minimising inductances in the gate and source return signals. In addition to layout, implementing component-level protection is crucial in preventing catastrophic overvoltage of the gates.

The LT8390A provides a 5V gate driver specifically designed for lower gate drive FETs, making it an ideal choice for GaNFETs. The issue is silicon FET drivers often lack protection against accidental overvoltage. In particular, the bootstrap supply for the top FETs on silicon gate drivers is unregulated, which means that the top gate driver can easily drift up above the absolute maximum voltage of the GaNFET. Figure 2 shows how to address this: a 5.1V Zener diode (D5 and D6) is placed in parallel with the bootstrap capacitor to clamp that voltage at the recommended drive level of the GaNFET. This ensures that the gate voltage remains within the safe operating range.

Additionally, for even more protection, a 10Ω resistor is added in series with the bootstrap diodes (D3 and D4) to reduce any ringing that might be caused by the very fast and high power switch node.

## Dead Time and Body Diode Challenges

In traditional converters, a catch diode is present to conduct during the off-time. Synchronous converters replace the catch diode with another switch to reduce the forward conduction loss of a diode. However, a problem arises if the top and bottom switches turn on simultaneously, resulting in shoot-through. In the event of a shoot-through, both FETS can be essentially short to ground, which can lead to component failures and other disastrous consequences. To prevent this, controllers implement dead time, a period where neither the top nor bottom switch is turned on. Typical synchronous DC-to-DC controllers implement dead times of up to 60ns. This dead time is not a significant concern with silicon MOSFETs since the body diode conducts during this period.

GaNFETs do not have body diodes and switch on/off significantly faster than silicon MOSFETs. Instead of body diodes conducting during the dead time, GaNFETs can conduct with 2V to 4V compared to the typical 0.7V of a diode. This conduction voltage, multiplied by the conduction current, can result in nearly 6? more power loss during the dead time. This increased power loss, combined with a long dead time, can lead to overheating and damage to the FETs. The best solution is to minimise the dead time. However, controllers meant for silicon FETs design the dead time around the fact that silicon

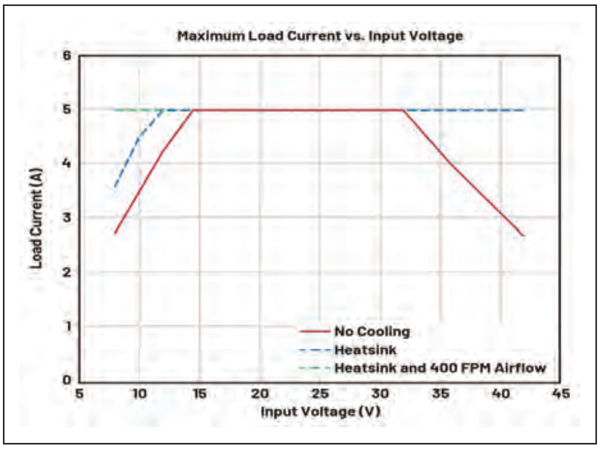



**Figure 3. EVAL-LT8390A-AZ maximum output current vs. input voltage. The board can produce 120W through a wide input range at high frequency.**

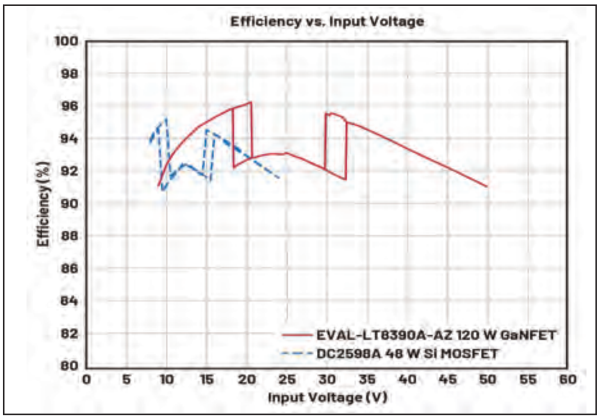



**Figure 4. EVAL-LT8390A-AZ GaN controller efficiency vs. DC2598A Si MOSFET controller efficiency. GaNFETs provide higher efficiency at higher voltage.**

FETs have slow turn-on/off characteristics (in the tens of ns). Therefore, the dead time is set longer to prevent shoot through.

The LT8390A has a set 25ns dead time, which is a shorter dead time compared to many synchronous controllers on the market. While this is suitable for high frequency, high power MOSFET control, it is still too long for GaNFETs. GaNFETs can turn on extremely quickly (in the ones of ns). Therefore, to mitigate additional conduction losses during the dead time, it is recommended to add a catch Schottky diode in antiparallel with the synchronous GaNFET to divert the conduction to a less lossy pathway. D1 and D2 in Figure 2 show which FET to place the Schottky diodes across. D1 is placed across the synchronous buck side FET, and D2 is across the synchronous boost side FET. For a simple buck converter, only D1 is required. For a simple boost, use D2.

### Higher Power with Higher Frequency

The LT8390A has a switching frequency up to 2MHz. GaNFETs have significantly lower switching losses compared to Si MOSFETs, enabling similar power losses at higher switching frequencies and voltages. The EVAL-LT8390A-AZ GaNFET board demonstrates the efficiency and compact size advantages of using GaNFETs by setting the switching frequency to 2MHz.

With an output of 24V, the GaNFETs can produce 120W of power at room temperature. The board size is comparable to the previous LT8390A evaluation board: the DC2598A, which uses silicon MOSFETs and provides a 12VOUT with 48W power.

Figure 3 shows the maximum power capability of a 2MHz GaN buck-boost, while Figure 4 compares the efficiency of both boards. Even at higher voltages, and 2.5? output power, the GaNFET board produces better efficiency than the Si MOSFET board. The utilisation of GaNFETs allows operation at higher voltages and power with a similar board area.

**Table 1. DC-to-DC Controllers Compatible with GaNFETs**

| Recommended GaN Controllers | Topology | Max Input/ Output Voltage | Switching Frequency | GaN Safe features |
|---|---|---|---|---|
| LTC7890 | Dual buck GaN controller | 100V | 100kHz to 3MHz | ▸ Smart bootstrap<br>▸ Split gate drive<br>▸ Smart near-zero dead time<br>▸ Adjustable 7ns to 60ns dead time |
| LTC7891 | Buck GaN controller | 100V | 100kHz to 3MHz | ▸ Smart bootstrap<br>▸ Split gate drive<br>▸ Smart near-zero dead time<br>▸ Adjustable 7ns to 60ns dead time |
| LT8418 | Half-bridge GaN gate driver | 100V | Up to 10MHz | ▸ Low propagation delay<br>▸ Fast and powerful gate drive<br>▸ Split gate drive<br>▸ Smart bootstrap<br>▸ Gate drive over-voltage lockout |
| LT8390/ LT8390A/ LT8392 | 4-switch buck-boost controller | 60V | LT8390/LT8392: 150kHz to 650kHz<br>LT8390A: 600kHz to 2MHz | ▸ Si MOSFET controller with 5V gate driver |
| LT8391/ LT8391A/ LT8391D | 4-switch buck-boost LED driver controller | 60V | LT8391/LT8391D: 150kHz to 650kHz<br>LT8391A: 600kHz to 2MHz | ▸ Si MOSFET controller with 5V gate driver |

### Conclusion

If there are no DC-to-DC controllers that specifically have GaNFET driving capabilities, it is still possible to drive them effectively. Even using a controller originally meant to drive Si MOSFETs, the EVAL-LT8390A-AZ can easily outpower and achieve higher efficiency in a similar board area. Table 1 shows a wide selection of recommended controllers for driving GaNFETs. For even higher power requirements, such as paralleled buck-boost GaNFET control, please contact the factory. By researching a controller that offers a 5V gate driver and incorporating additional external protection circuit components, it is possible to drive GaNFETs safely and explore more options in power conversion design.

**Analog Devices: www.analog.com**

### About the Author

Kevin Thai is an applications manager with Analog Devices in San Jose, California. He works in the IPS Power Products Group and oversees the isolated flyback and protection product lines along with other boost, buck-boost, and GaN controller products. He received his B.S. degree in electrical engineering from Cal Poly, San Luis Obispo, in 2017, and M.S. degree in electrical engineering from University of California, Los Angeles, in 2018.

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