POWER ELECTRONICS EUROPE

ISSUE 3 – November 2024 www.power-mag.com

POWER MODULES Achieving CISPR conducted emission compliance for autos with a single stage filter



THE EUROPEAN JOURNAL FOR POWER ELECTRONICS ----- AND TECHNOLOGY-----

Also inside this issue

Industry News | Market News Semiconductor Materials | Energy Efficiency Connected Electronics | Capacitive digital isolators Switched-mode power supplies | Products | Web Locator





IF IT'S NOT THE HEAT,

 \sim AC ALH SERIES

DC === BLH SERIES

> 1,500 Hours

85°C 85%RH

AEC-Q200

IT'S THE HUMIDITY

Meet the 1,500-hour THB-rated ALH/BLH capacitors

At 85°C and 85% relative humidity, with rated voltage applied, our new inverter-grade film capacitors are tested 50% longer than the industry standard requirements for Temperature-Humidity-Bias. Improve the reliability of your power electronics design with outstanding capacitor performance at high humidity.

cde.com/harsh-environments

0

 $\circ O$

00

News & Features Editor Leslah Garland Tel: +44 (0)1732 370340 Email: leslah@dfamedia.co.uk

Publisher Ian Atkinson Tel: +44 (0)1732 370340 Email: ian@dfamedia.co.uk www.power-mag.com

Production Editor Chris Davis Tel: +44 (0)1732 370340 Email: chris@dfamedia.co.uk

Financial Manager Joanne Morgan Tel: +44 (0)1732 370340 Email: accounts@dfamedia.co.uk

Reader/Circulation Enquiries Perception Tel: +44 (0) 1825 701520 Email: dfamedia@dmags.co.uk

INTERNATIONAL SALES OFFICES

Mainland Europe: Victoria Hufmann Norbert Hufmann Tel: +49 911 9397 643 Fax: +49 911 9397 6459 Email: pee@hufmann.info

Eastern US Ian Atkinson Tel: +44 (0)1732 370340 Email: ian@dfamedia.co.uk

Western US and Canada Ian Atkinson Tel: +44 (0)1732 370340 Email: ian@dfamedia.co.uk

Japan: Yoshinori Ikeda, Pacific Business Inc Tel: 81-(0)3-3661-6138 Fax: 81-(0)3-3661-6139 Email: pbi2010@gol.com

Taiwan Prisco Ind. Service Corp.

Tel: 886 2 2322 5266 Fax: 886 2 2322 2205

Circulation and subscription: **Power Electronics Europe** is available for the following subscription charges. **Power Electronics Europe**: annual charge UK/NI £95, overseas \$160, EUR 150. Contact: DFA Manufacturing Media, 192 High Street, Tonbridge, Kent TN9 1BE Great Britain. Tel: +44 (0) 1732 370340. Refunds on cancelled subscriptions will only be provided at the Publisher's discretion, unless specifically guaranteed within the terms of subscription offer.

Editorial information should be sent to The Editor, **Power Electronics Europe**, 192 High Street, Tonbridge TN9 1BE U.K.

The contents of **Power Electronics Europe** are subject to reproduction in information storage and retrieval systems. All rights reserved. No part of this publication may be reproduced in any form or by any means, electronic or mechanical including photocopying, recording or any information storage or retrieval system without the express prior written consent of the publisher.

Printed by: Warners

ISSN 1748-3530



FEATURE STORY



MHz switching frequency-based devices enable miniaturization of the DC-DC converter and EMI filters

Achieving EMI conducted emission compliance for automobiles with a single stage filter. By Nicola Rosano, Sr. Strategic FA/System Engineer at Vicor

More details on page 8.

PAGE 4

Industry News

PEE looks at the latest Market News and company developments

PAGE 7

Market News

PEE looks at the latest Market News and company developments

PAGE 11

Four mid-voltage applications where GaN will transform electronic designs

Srijan Ashok - Product Marketing Engineer, GaN, at Texas Instruments

PAGE 14

Ecodesign, Reuse, Repair, Prolonging Lifetime and New Technology – Is it the new paradox?

Patrick Le Fèvre, PRBX, Chief Marketing and Communication Officer

PAGE 18

Ensure Interference-free data communication

MEMS-based Precision Timing Delivers Accurate, Reliable, Ultra-Stable Clock Signals for the Era of Intelligent, Connected Electronics. **By Piyush Sevalia**,

Executive VP Marketing, SiTime

PAGE 21

Reimagining the Holdover Oscillator

Galvanic isolation of circuit components is required in many cases, especially in industrial environments. Capacitive digital isolators can be used to safely and reliably transmit user signals across an isolation barrier. The following circuit example shows how capacitive digital isolators can be used to galvanically isolate remote industrial equipment.

PAGE 25

Passive components in modern switched-mode power supplies

Galvanic isolation of circuit components is required in many cases, especially in industrial environments. Capacitive digital isolators can be used to safely and reliably transmit user signals across an isolation barrier. The following circuit example shows how capacitive digital isolators can be used to galvanically isolate remote industrial equipment.

PAGE 28

Products

PAGE 31

Web Locator

The EU's Ecodesign for Sustainable Products Regulation enters into force

The electronics industry will soon be expected to play a big part in the European Union's (EU) measures to create a more circular economy. The Ecodesign for Sustainable Products Regulation (ESPR) entered into force earlier this year to ensure the sustainability and traceability of electronics amongst other priority product groups. Currently, more than 50 million tonnes of e-waste are produced every year, contributing to it being the fastest-growing solid waste stream in the world. This is likely why the EU has named it as one of the priority product groups.

The ESPR will apply to businesses placing electronics within the EU market even if those products weren't produced in the EU. Businesses will be expected to implement Digital Product Passports (DPPs) to comply. In a nutshell, DPPs act as a digital record of a physical product, securely keeping track of information across a product's lifecycle, including event or transactional data, or even data concerning its sustainability credentials. For example, the carbon footprint of its production. Through a data carrier like a QR code, a barcode, or an NFC tag attached to a physical product, information can be accessed by a device such as a smartphone.

Through the implementation of DPPs and the digital record they provide on a product's lifecycle and credentials, the EU hopes to encourage manufacturers and producers to adopt more sustainable practices and inspire circular thinking past the point of manufacture. Crucially for the electronics industry, it will provide insight into the effective disposal of end-of-life (EOL) electronics, which is expected to encourage recycling and circularity.

The delegated acts - specific compliance requirements for each product group impacted are expected to be announced next year. These will include specific timing requirements for compliance for the priority groups. DPP solution provider Protokol is currently working with businesses that are getting ahead of the delegated acts to ensure they are in the best shape to meet compliance standards for what will require a more streamlined approach to collecting and sharing product data.

The advised first steps are to create a team that will track regulatory updates, begin taking stock of data points that may be required and engage with stakeholders to understand their current planning for compliance. For more information, visit: https://www.protokol.com/services/digitalproduct-passport-consulting/

Infineon launches ultra-high current density power modules to enable high-performance AI computing

Data centres are currently responsible for more than 2% of global energy consumption. Fuelled by AI, this number is expected to grow to up to around 7% in 2030, matching the current energy consumption of India.

Enabling efficient power conversion from grid-to-core is vital to enable superior power densities and thereby advance compute performance while reducing total cost of ownership (TCO).

Infineon Technologies has announced it has therefore launched the TDM2354xD and TDM2354xT dual-phase power modules with best-inclass power density for high-performance AI data centres.

The company says these modules enable true vertical power delivery (VPD) and offer industry's best current density of 1.6 A/mm 2. They follow the TDM2254xD dual-phase power modules introduced by Infineon earlier this year.

"We are proud to enable high-performance AI data centres with our TDM2354xT and TDM2354xD VPD modules. These devices will maximise system performance with Infineon's trademark quality and robustness, thereby enabling best TCO for data centres," said Rakesh Renganathan, Vice President Power ICs at Infineon Technologies.

"Our industry-leading power devices and packaging technologies, combined with our extensive systems expertise, will further advance high-performance and green computing as part of our mission to drive digitalisation and decarbonisation."

Infineon says the TDM2354xD and TDM2354xT modules combine its robust OptiMOS 6 trench technology, a chip-embedded package that enables superior power density through enhanced electrical and thermal efficiencies, and a new inductor technology to enable lower profile and therefore, true vertical power delivery. As a result, the modules set new standards in power density and quality to maximise the compute performance and efficiency of AI data centres. The TDM2354xT modules support up to 160 A and are said to be the industry's first Trans-Inductor Voltage Regulator (TLVR) modules in a small 8 x 8 mm? form factor. Combined with Infineon's XDP controllers, they offer extremely fast transient response and minimise on-board output capacitance by up to 50%, further increasing system power density.

The new modules will be showcased at Infineon's global technology forum OktoberTech 2024 in Silicon Valley on 17 October and at electronica 2024 in Munich from November 12 to 14 (hall C3, booth 502).





Infineon at electronica 2024: Solutions for decarbonisation and digitalisation

At the upcoming electronica trade show in Munich, Infineon Technologies has announced it will illustrate how its innovative solutions are driving the global trends of decarbonisation and digitalisation.

The company says it will show how its semiconductors are paving the way to a net-zero economy and to unlocking the full potential of artificial intelligence (AI). From 12 to 15 November at booth 502 in hall C3, Infineon will present highlights from its extensive portfolio and offer the opportunity to talk to its experts.

"Decarbonisation and digitalisation are the key drivers on the way to a climate-neutral future," said Andreas Urschitz, Member of the Board and Chief Marketing Officer at Infineon.

"Semiconductors contribute in many ways to the green and digital transformation and are at the heart of every connected application. At electronica, we'll be showcasing how our leading technologies and innovative solutions are helping master the central challenges of our time."

World's first 300 mm gallium nitride wafers Infineon says it will present its technological breakthrough, reportedly the world's first 300 mm power gallium nitride (GaN) wafer technology, to the general public for the first time. This technological milestone will significantly advance the market for GaN-based power semiconductors. Leveraging 300 mm GaN will strengthen existing solutions and application fields and create new ones, with an increasingly cost-effective value proposition and the ability to address the full range of customer systems.

Shaping the future of mobility

Infineon says it is focused on the development of innovative solutions that drive the transition to clean, safe and intelligent mobility. Products and solutions on display at electronica include the new AURIX TC4x microcontrollers, which support the implementation of future-proof E/E architectures and software-defined vehicles, as well as the main inverter CoolSiC Kit, battery management system solutions, on-board chargers with GaN, steer-bywire system solutions and H 2 sensors for fuel cell applications.

Greener and smarter buildings and homes Semiconductors play a crucial role in the development of smarter and more sustainable living spaces. Infineon's advanced technologies based on silicon carbide (SiC) and GaN can enable maximum energy efficiency and reliability for energy generation and consumption. With advanced sensors, power semiconductors, security solutions such as OPTIGA Trust and microcontrollers such as PSOC Control, Infineon enables the efficient use of green energy while bringing smart automation to modern homes and commercial buildings. The company's booth will showcase comprehensive system solutions including various solar inverter topologies (microinverters and string inverters), as well as demos for optimizing power and boosting heat pump output.

Enabling AI – Efficient, reliable and on the edge Semiconductors also play a crucial role in unlocking the full potential of AI. Infineon says its solutions make it possible for customers to deploy new AI applications quickly, efficiently and at scale. The company's broad range of products, software, tools and services enables energy-efficient data centres, smarter devices and optimised AI edge applications. Demos will include high-performance, low-power AI-enabled microcontrollers from the PSOC family, advanced sensors from the XENSIV portfolio as well as vertical power module architectures, advanced liquid cooling modules and power supply units for AI data centres.

ROHM at electronica 2024: Empowering Growth, Inspiring Innovation



ROHM Semiconductor Europe has announced it will be exhibiting at electronica 2024 – a leading world trade fair and conference for electronic components, systems, applications, and solutions. The event will take place between November 12th to 15th in Munich.

At booth C3-520, ROHM says it will showcase its advanced power and analogue technologies designed to enhance power density, efficiency, and reliability in both automotive and industrial applications. These advancements are crucial for addressing the increasing demands of modern electronic systems, particularly in the context of sustainability and innovation.

Under the theme "Empowering Growth, Inspiring Innovation", ROHM says it will highlight via its various demo application stations in "tree style" how its high-quality semiconductor technologies contribute to solving critical social and ecological challenges. The focus will be on driving sustainability in electronic design and innovation, which aligns with the growing emphasis on creating

environmentally responsible solutions within the industry.

At electronica 2024, the exhibition space has been greatly expanded and the number of items on display has been increased to 30 – more than three times compared to the previous show.

The latest solutions will be exhibited under the three themes of "for E-Mobility", "for Automotive", and "for Industrial".

For E-Mobility

* TRCDRIVE pack with 2-in-1 SiC Molded Module to improve the efficiency of traction inverters

* New EcolGBT products for electric compressors * New EcoSiC Schottky Barrier Diodes for onboard chargers

For Automotive

- * New configurable PMIC with supporting functional safety features for application processors, SoCs and FPGAs
- * LED Driver ICs for Exterior Lighting / Head Lamps
- * Advanced solutions on the ADAS cockpit demo

For Industrial Equipment

* Industrial AC-DC PWM Controller ICs – support a

wide range of power transistors from Si MOSFETs and IGBTs to SiC MOSFETs

* The EcoGaN family of 150V and 650V class GaN HEMTs in several EVKs

* Latest R&D project on Terahertz

In addition to product showcases, ROHM says it is committed to fostering technical exchange and collaboration at electronica 2024. "For us, electronica is more than just a showcase – it's an opportunity to forge new connections, strengthen existing partnerships, and reunite with industry peers," says Wolfram Harnack, President of ROHM Semiconductor Europe.

"We are excited to welcome our guests to Munich as we work together to shape the future of electronics."

Danfoss Power Solutions launches high-performance GH493 four-wire spiral hose in Europe

CIOCUID by Danfoss GH493-6 9.5 mm (0.38 in) Dura-Tuff Exceeds SAE 100R12 / EN 856 R12

-448 BAR (6500 PSI)

Danfoss Power Solutions has announced the launch of its Aeroquip by Danfoss GH493 fourwire spiral hose in Europe, the Middle East, and Africa.

The company says this premium hydraulic hose meets or exceeds four key industry standards in flexibility, lifetime, and working pressure — EN856 Type R12, EN856 Type 4SP, SAE 100R12, and ISO 18752 — offering reliable performance in demanding high-pressure mobile and industrial machinery applications.

With its tighter minimum bend radius, GH493 hose offers greater flexibility for use in cramped spaces. This flexibility provides more design freedom and easier installation. It can also reduce the hose lengths required, which lowers costs and machine weight. The hose's minimum bend radius is, on average, 58% tighter than EN856 Type 4SP and 50% tighter than EN856 Type R12 standards.

GH493 hose offers long in-application lifetime, maximising machine uptime and reducing maintenance and hose replacement costs. Hose sizes -6 to -16 are tested up to 1 million impulse cycles, and hose sizes -20 to -32 are tested up to 500,000 impulse cycles, higher than the requirements of SAE 100R12, EN856 Type 4SP, and EN856 Type R12.

GH493 hose reportedly delivers better average pressure performance than industry standards, enabling use in a broad range of hydraulic systems as well as the creation of more power-dense machines. The hose exceeds the requirements, on average, of SAE 100R12 by 30%, EN856 Type 4SP by 19% (sizes -10 to -32), and EN856 Type R12 by 32%. It meets ISO 18752 constant pressure standards.

"It's rare to find a hose with outstanding flexibility plus higher pressure performance and long lifetime. This combination makes our Aeroquip by Danfoss GH493 hose a versatile solution that maximises uptime and minimises maintenance in a wide range of high-pressure machinery," said Salih Karayagiz, Product Manager, Rubber Hydraulic Hose and Fittings, Danfoss Power Solutions.

"GH493 is our most popular four-wire spiral hose in the Americas, proven over the years in a wide range of applications. Its introduction in EMEA opens new application possibilities while helping our customers drive inventory standardisation."

For increased durability, GH493 hose incorporates the Danfoss Dura-Tuff cover, which is said to be up to eight times more abrasion resistant than standard synthetic hose covers. The material extends hose lifetime while reducing the chances of a hose failure due to abrasion.

GH493 hose is compatible with Danfoss 4S series spiral fittings. Featuring Dura-Seal technology, these high-performance fittings enable better sealing and leak-free operations (Class 0 leakage per SAE J1176). Customised multi-bent fittings are also available.

GH493 hose is available in sizes -6 to -32. It is suitable for operating temperatures of -40°C to 126°C and features working pressures ranging from 275 to 448 bar, depending on size. The hose is ideal for higher pressure hydraulic systems in construction and mining machinery as well as oil and gas and wind power equipment.

To receive your own copy of **Power Electronics Europe** subscribe today at: www.power-mag.com

Infineon announces the next milestone in semiconductor manufacturing technology

Infineon technologies says after announcing the world's first 300-millimeter gallium nitride (GaN) power wafer and opening the world's largest 200-millimeter silicon carbide (SiC) power fab in Kulim, Malaysia, it has unveiled the next milestone in semiconductor manufacturing technology.

The company says it has reached a breakthrough in handling and processing the thinnest silicon power wafers ever manufactured, with a thickness of only 20 micrometres and a diameter of 300 millimetres, in a high-scale semiconductor fab. The ultra-thin silicon wafers are only a quarter as thick as a human hair and half as thick as current state-of-the-art wafers of 40-60 micrometres.

"The world's thinnest silicon wafer is proof



of our dedication to deliver outstanding customer value by pushing the technical boundaries of power semiconductor technology," said Jochen Hanebeck, CEO at Infineon Technologies. "Infineon's breakthrough in ultra-thin wafer technology marks a significant step forward in energy-efficient power solutions and helps us leverage the full potential of the global trends decarbonisation and digitalisation. With this technological masterpiece, we are solidifying our position as the industry's innovation leader by mastering all three relevant semiconductor materials: Si, SiC and GaN."

The company says this innovation will significantly help increase energy efficiency, power density and reliability in power conversion solutions for applications in AI data centres as well as consumer, motor control and computing applications.

For more information visit www.infineon.com



MHz switching frequency-based devices enable miniaturization of the DC-DC converter and EMI filters

Achieving EMI conducted emission compliance for automobiles with a single stage filter. By **Nicola Rosano, Sr. Strategic FA/System Engineer at Vicor**

When it comes to electric vehicles

(EVs), all OEMs want to design lighter, smaller and more affordable solutions. Additionally, utilities, regulatory agencies and OEM's are seeking to leverage a vehicle to grid (V2G) connection to enable energy, period exchange with the distribution network From a power electronics perspective, this pursuit entails power conversion circuitry with greater power densities and the ability to meet the requirements for connecting the vehicle to the grid.

With respect to DC-DC power converters, one notable way to miniaturize the system and increase overall power density is through higher-frequency switching. Yet, despite the potential benefits of systems with switching frequencies over 1.3MHz, technical challenges have kept many designers to working at lower frequencies, such as 100kHz or below.

Imagine having a DC-DC power conversion solutions that harness the benefits of high-frequency switching without incurring conventional shortcomings. That could go a long way toward achieving smaller and lightweight EV power design goals of the OEM while adding V2G capability.

The benefits of high-frequency DC-DC power conversion

In the pursuit of lighter, smaller and more affordable automotive systems, highfrequency power conversion offers a promising solution.

The primary benefit of moving to higherfrequency power conversion systems is a reduction in component size in both the physical device and the supporting input and output EMI filters. Some of the most space-consuming components in the converter itself are the passives, such as inductors and capacitors. Inductors and capacitors store and release energy in each switching cycle to smooth out current and voltage waveforms, respectively. When the converter's switching frequency is higher, these components store less energy per cycle, allowing for smaller-value components allowing a decrease in the overall system size and enabling more power-dense systems for the same power level target.

Beyond the converter, the associated input EMI filters are a major space consumer related to DC-DC conversion. DC-DC converters generate EMI due to the rapid switching of currents and voltages, which can create noise at the switching frequency and its harmonics. To mitigate this noise, EMI filters are employed at the input with cutoff frequencies typically dependent by the power stage requirements. (Figure 1)

These filters also rely on passive components where size is directly correlated to switching frequency. By shifting the converter's switching frequency to the MHz order, the desired EMI filter cutoff frequency can be increased. At higher cutoff frequencies, designers can make the passive components in the EMI filter much smaller, decreasing overall system size and weight while increasing system power density.

Not only does switching to higherfrequency DC-DC conversion reduce component size and weight, but it also enables systems with improved transient responses. In DC-DC converters, the control loop bandwidth is typically a fraction of the switching frequency. Higher switching frequencies enable higher control loop bandwidth, allowing the feedback loop to react more rapidly to disturbances. A higher bandwidth allows the converter to correct output deviations quicker, ensuring that the output voltage remains stable even with sudden load or input voltage changes.



Figure 1: An active EMI filter (labeled QPI) is often employed at the input of a DC-DC converter, with its cutoff frequency determined by the switching frequency of the converter.

Conventional challenges facing highfrequency DC-DC power conversion Although moving to higher-frequency DC-DC conversion can yield many tangible benefits, a number of technical challenges have historically prevented this pursuit.

First, moving to higher frequency operation may present a barrier to achieving EMC compliance. For conducted emissions standards such as CISPR32 (required for V2G applications), the frequency range evaluated by the standard is from 150kHz to 30MHz. Operating at a higher fundamental frequency, such as above 1MHz, creates the largest harmonics within the frequency range of interest, running the risk of compliance failure. For this reason, many power converter designers choose to operate at lower frequencies, such as 100kHz, ensuring that their first harmonic falls below the frequency range of interest. Same issues

can found if the power stage is called to be compliant with the CISPR25 reference standard.

Also, fear of increased losses is another potential drawback when using higherfrequency switching converters. Switching losses occur when a switch, such as a MOSFET, transitions from its on-state to its off-state and vice versa. These losses are significant because both the voltage across the switch and the current through the switch are non-zero during the transition period. (Figure 2)

All else being equal, higher switching frequencies result in more frequent transitions per unit of time, leading to increased switching losses. Since the energy dissipated per switching event is proportional to the crossover time and the product of the voltage and current, increasing the frequency means that these energy losses accumulate more quickly. Therefore, the total power loss due to switching is directly proportional to the switching frequency, making higherfrequency operation associated with higher switching losses.

Finally, issues concerning the selfresonance of passive components occur during high-frequency operations. Selfresonance is a phenomenon in which electrical components exhibit resonant behavior due to their parasitic properties. This leads to unpredictable behavior, impedance peaks, efficiency losses and signal integrity issues. Self-resonance becomes a significant problem at higher switching frequencies as these frequencies approach the self-resonant frequencies of components, amplifying noise and EMI and complicating circuit design. Also working beyond the self resonant frequency an inductor exhibits a capacitor behavior and vice-versa a capacitor



Figure 2: Switching losses occur during "hard switching", where the MOSFET transitions while voltage and current waveforms are both non-zero.



Figure 3: Zero-current switching is achieved through a set of dedicated circuitry, which avoids high-frequency switching losses through specially timed MOSFET transitions.

behaves like an inductor.

Solving high-frequency power conversion

With decades of industry-leading experience in power electronics design, Vicor has developed DC-DC conversion solutions that harness all the benefits of high-frequency conversion without the negative side effects. Specifically, the Vicor NBM™ family of non-isolated bus converter modules successfully switch at frequencies above 1.3MHz.

With respect to efficiency, the NBM[™] line of products can realize minimal power losses at high frequency by using zero voltage switching (ZVS) and zero current switching (ZCS) technology. Zero-voltage switching works by carefully timing the switch's operation so that the switching aligns with the moments when the voltage across the switch is zero. Similarly, zerocurrent switching works by timing the switch's operation so that it coincides with the moments when the current through the switch is zero. (Figure 3)

Vicor ZVS and ZCS are achieved by introducing a separate phase to the pulsewidth modulation (PWM) timing. Utilizing the added phase, the solutions use a clamp switch and circuit resonance to efficiently operate the high side and synchronous MOSFETs with soft switching, avoiding losses incurred during conventional PWM hard switching operation and timing. Thanks to ZVS and ZCS, products like the NBM line of DC-DC converters can operate at 1.5 to 1.7 MHz while still achieving peak efficiencies of up to 99%. The combination of high switching frequencies and efficiency enables solutions with unparalleled power density. up to 550 kW / liter.

In terms of EMC, the NBM[™] products can achieve compliance, even at unusually high frequencies. In a recent set of tests, conducted emission compliance of the NBM9280 power module was evaluated. This Vicor module is capable of converting 37.5kW, with a power density of 550 kW/ liter, for electrified vehicle applications. The testing found that, even at a switching frequency of 1.3MHz, the NBM9280 could satisfy CISPR32 limits with a combination of Pi filtering and introducing a ferrite core around the input power cables. (Figure 4) The resulting filtering components were significantly smaller than what is necessary for a lower-frequency (i.e., 100kHz) solution, yet the same compliance was achieved.

All things considered, automotive designers can simply replace their existing DC-DC conversion systems with the NBM™ line of products and immediately realize the benefits of smaller size and greater power density without risk of compliance failure or efficiency losses. Higher frequency supports today's EV

Higher frequency supports today's EV demand period.

With a shift to EVs the automotive industry is demanding smaller, lighter and more power-dense solutions which can



Issue 3 2024 Power Electronics Europe

Four mid-voltage applications where GaN will transform electronic designs

Srijan Ashok - Product Marketing Engineer, GaN, at Texas Instruments

Introduction

The rapid technological expansion means that the appetite for power is increasing. In order to fuel this expansion sustainably, renewable energy sources such as solar are being deployed to power grids increasingly. Similarly, the need for servers is increasing exponentially to enable faster data processing, big data storage and artificial intelligence (AI). As a result of worldwide trends, designers have a big task at hand: keep increasing efficiency in their designs while delivering more power in the same footprint.

This challenge has already pushed the adoption of gallium nitride (GaN) in highvoltage power designs because GaN has two major advantages:

 Increased power density. GaN's higher switching frequencies enable designers to use smaller-sized passives such as inductors and capacitors, thereby reducing board dimensions.

Increased efficiency. Compared to silicon designs, GaN's superior switching and conduction-loss performance reduce losses by >50%.

Alongside the industry-adopted high voltage GaN (rated >=600V), new mid-voltage GaN solutions (rated 80V-200V)



are becoming increasingly popular to achieve higher power density and efficiency in power systems that high voltage GaN previously could not support.

In this article, I'll describe four major mid-voltage application areas where the adoption of GaN is spreading.

Application No. 1: Solar energy

Solar energy is the fastest-growing source of renewable energy, rising 26% from 2021 to 2022 with a projection to expand capacity at a compound annual growth rate of approximately 11.5% in the next seven to eight years. As solar panel installations increase, so will the need for system efficiency and power density, as it is a space-intensive technology. For solar panel subsystems, the LMG2100R044 and LMG3100R017 devices can help reduce system size by over 40%.

Solar power is enabled primarily by two types of subsystems at the solar panel: a boost stage followed by an inverter stage to convert a DC voltage range to an AC voltage (see Figure 1), and a buck and boost stage in which a power optimizer converts a varying DC voltage to a common DC voltage level (using maximum power-point tracking) for delivery to a string inverter (see Figure 2).

Application No. 2: Servers

Given that we are still in the early stages of the artificial intelligence revolution, the demand for servers to run complicated enable these enhanced processing and storage needs.

As illustrated in Figure 3, three primary systems in server power applications can employ the use of 100V to 200V GaN:

- Power-supply units (PSUs). Changes from the Open Compute Project are increasing the popularity of 48V outputs; however, the required 80V and 100V silicon solutions have significantly higher losses (gate drive and overlap losses) compared to previous solutions. GaN solutions such as the LMG3100 can help minimize these losses in the synchronous rectifier on the secondary of the inductor-inductor-capacitor stage (LLC stage).
- Intermediate bus converters (IBCs). This system converts the intermediate voltage (48V) from the output of the PSU to a lower voltage, which then goes to the server. As the 48V voltage level becomes popular, IBCs help reduce I2R losses during distribution in server subsystems and enable both size and cost reductions of bus bars and power-carrying wires. The drawback of IBCs is that they add another step to power conversion which may dent efficiency. Therefore, it is important to leverage high-efficiency GaN devices such as the LMG2100 and LMG3100, in addition to several new topologies that OEMs are testing for the best combination of high efficiency and power density.

Battery backup units. A buck-boost stage

Uninterruptible power supplies use this stage because it avoids losses caused by DC-to-AC-to- DC conversion by performing just one DC-to-DC conversion directly from the battery.

Application No. 3: Telecommunications power

It is possible to make the power supply in a telecommunication radio a GaN design. Since the radio is typically set up outdoors with only natural cooling, high efficiency is important. Also, progressive generations of mobile networks (5G, 6G) call for higher networking speeds and data processing, thus requiring high-density designs with very low losses. The LMG2100 can help improve power density >40% for these types of designs.

In a typical mid-voltage application, GaN converts power from a negative battery voltage level (typically –48V) to supply power for power amplifiers at +48V using inverting buck-boost or forward converter topologies, or to supply power for field-programmable gate arrays and other DC loads using a buck converter topology.

Application No. 4: Motor drives

Yes, you can use GaN in motor-drive circuitry. The applications are diverse, and include robotics, power tool drives and two-wheeled traction inverter designs, with different load profiles. GaN's zero reverse recovery (because there is no body diode) leads to no settling time for the current in reverse bias of the diode, which causes



machine learning algorithms and enable the storage of larger and more complex data sets will increase exponentially. Highdensity designs with an efficiency requirement of each stage of >98% will typically converts the battery voltage (48V) to a bus voltage (48V). You can also use BBUs for battery power conversion when the mains line goes off and the power flow is bidirectional. lower dead-time losses and better efficiency. As a result of GaN's higher switching frequencies, there is lower current ripple, which as I mentioned earlier enables a reduction in the size of passive components, and can lead to sleeker motor-drive designs.

silicon FETs in mid-voltage applications across the board. Other application areas for 100V to 200V GaN include generalpurpose DC/DC conversion, Class-D audio amplifiers, and battery test and formation equipment. GaN also offers higher switching frequencies and lower power losses, benefits that become more pronounced with integrated power stages that simplify power designs.



GaN has the potential to replace traditional



PRACTICAL ENGINEER'S HANDBOOKS From the publishers of SERVOS AND STEPPED Hydraulics & **IDG** Lante There are now 6 of these handy reference books from the publishers of the Drives & Controls and If you would like to obtain additional copies of the handbooks, please email info@dfamedia.co.uk Hydraulics & Pneumatics magazines. or call us on 01732 370340. Alternatively you can return the completed form below to: Engineers TELES Published in an easily readable style SERVOS AND STEPPERS Handbook, DFA MANUFACTURING MEDIA LTD, HYDRAULICS PNEUMATICS and designed to help answer basic 192 The High Street, Tonbridge, Kent TN9 1BE questions and everyday problems NDUSTRIAL without the need to refer to weighty Cheques should be made payable to DFA Manufacturing Media Ltd and crossed A/C INDUSTRIAL textbooks. Payee. Copies of the handbooks are available at £4.99 per copy. We believe you'll find them invaluable Discounts are available for multiple copies. items to have within arms reach. 2-5 copies £4.30, 6-20 copies £4.10, 20+ copies £3.75 **Postage and Packaging:** COMPRESSED AIR 1-3 copies: £2.99 4-6 copies: £4.99 7 or more copies: £6.99 PLEASE ALLOW UPTO 28 DAYS FOR DELIVERY Name: **Company Name:** Address: **Post Code: Total Number of Copies** Tel: 2 @ Total £ p+p QUANTITY QUANTITY QUANTITY QUANTITY QUANTITY QUANTITY S&S H/B Hyd H/B Pne H/B Ind Mot Drives Comp H/B Air DFA MANUFACTURING MEDIA LTD. 192 The High Street, Tonbridge, Kent TN9 1BE

Ecodesign, Reuse, Repair, Prolonging Lifetime and New Technology – Is it the new paradox?

Patrick Le Fèvre, PRBX, Chief Marketing and Communication Officer

The European Ecodesign is well known for energy related issues such as energy efficiency and standby energy consumption, and many detailed articles have been written on this topic. As one of the key elements of the European Green Deal strategy there is another, less wellknown aspect to Ecodesign that's about reducing waste and granting consumers the 'Right to Repair' thus prolonging the lifetime of equipment. Clearly the time is right for 'Right to Repair' to be addressed, initially for consumer products that are the visible part of the iceberg, forming part of the much bigger problem of changing our way of working and dealing with the issue of prolonging the lifetime of equipment whilst developing a circular economy. Many business segments will be highly influenced by the new European Directives and will need to figure out new ways to

deal with obsolescence.

So how will the power supply industry embrace this change and how could it contribute to prolonging the lifetime of equipments and to reduce waste?

New EU rules to make sustainable products the norm.

As announced in the EU Circular Economy Action Plan, the Commission has proposed new rules to make almost all physical goods on the EU market more environmentally friendly, circular, and energy efficient throughout their whole lifecycle from the design phase through their daily use, repurposing, and end-of-life. As part of the Action Plan dated June 2023 the Environment Committee put forward a proposal to make products in the EU ready for those conditions by developing a strategy to prolong the



lifetime of equipments and to protect consumers. An important part of this proposal is to set common rules promoting the repair of goods, advancing towards the objective of sustainable consumption under the European Green Deal (Figure 01).

Developing a repair approach will reduce e-waste and reduce the environmental impact, resulting in significant savings for consumers and all of society. As part of that and similar to how it is for Ecodesign energy consumption labeling, France has proposed the use of a similar label bearing a reparability index to inform consumers about the possibility of repairing a product whilst consumers should have access to repair guidelines.

As proposed in the scope of the project, on December 4 2023 the European Parliament and Council provisionally agreed an update to the 'ecodesign' rules, aiming to improve various aspects of products throughout their lifecycle to make them more durable, reliable, easier to reuse, upgrade, repair and recycle, use less resources and energy and water.

The proposal covers consumer goods and concerns defects that may occur in them, whether or not still under legal guarantee. The producer will have an obligation to repair goods for five to ten years after they were purchased. Goods for which reparability requirements currently exist include household products such as washing machines, washer-dryers, dishwashers, refrigeration appliances, electronic displays, welding equipment, vacuum cleaners, and servers and data storage. Mobile phones, cordless phones and tablets are also listed in the recent draft, and EV chargers have been considered in the latest discussions. All of these products use power supplies and manufacturers need to keep future legislation and regulations in mind and monitor their evolution.

Figure 01 Left - Green Deal policy framework around ESPR (green) and the ESPR's relationship to the Ecodesign directive (blue). (Source:PRBX/Ecochain)

Why the new Ecodesign rules will matter for the power industry.

This introduction may appear to give the impression that it's mostly the consumer segment that will be the subject of future legislation but in fact, inspired by the Ecodesign workgroup a lot of activities are taking place within industry to prolong lifetime and this is where it becomes an interesting area for the power supplies industry.

Regarding consumer applications for power supplies, they are either built-in the equipment and part of the overall system, or external such as USB chargers, and the legislator is working on a classification of the level of reparability in making it environmentally and economically a good idea to repair instead of replace. This is part of the 2024 workgroup that is working in parallel with the industry to define reasonable classifications for the benefit of end users and the environment.

Considering the high levels of integration and current building practices, e.g., the use of sealed plastic products such as external adapters, these may not be classified as repairable but the manufacturers might still have the obligation to guarantee support and service for ten years. Also, for embedded power supplies to listed equipments power supplies, manufacturers will be obliged to guarantee the availability of spare parts during the service period.

At higher power levels, as for the energy consumption Ecodesign regulation, servers and data storage are already included in the proposition, and power supplies manufacturers are working in close cooperation with the European representatives to develop power solutions meeting the reparability needs, but also to guarantee longer life time in operation.

When considering the circular economy, up to 80% of a product's environmental impact can be determined at the design phase. When designing a power supply for a datacenter we always take into consideration energy efficiency, and power designers use the latest technologies such as Wide Bandgap Semiconductors in order to deliver the highest levels of performance. Regarding prolonging lifetime there is a lot of work going on to select components able to keep their original performance for more than ten years in operational conditions, but designers must also include reparability in the mechanical design, which could imply a modular concept easing maintenance, and when end of life arrives, recycling.

For many designers it will be a new way of working but for those used to developing power solutions for refurbishing and system modernization it's nothing really new and a lot of the best practices deployed in this industry are already meeting future Ecodesign regulations.

Before Ecodesign regulation, Reuse, Repair and Prolong Lifetime was already the norm in the railway industry!

Outside of what the Ecodesign is aiming for in consumer segments, many industrial applications require power supplies manufacturers to provide power solutions for refurbishing and systems modernization. Among many, the transport industry and especially the railway are the best examples to illustrate what might be applicable to other segments when it comes to Reuse, Repair and Prolonging Lifetime.

One good example is the French railway state-owned operator, 'Société National des Chemins de Fer (SNCF)', which in September 2023 announced that as part of its commitment to sustainability, SNCF Voyageurs and its Rolling Stock Division are committed to optimizing the use and lifespan of their trains at every stage of their life cycle: mid-life and end-of-life refurbishment to extend their service life and combat obsolescence, and recycling and reuse of spare parts, etc. To achieve that goal, the SNCF has announced the commencement of a major refurbishing project to restore and upgrade 104 high speed trains, 'Trains à Grande Vitesse (TGV)' to "combat obsolescence" (Figure 02).



Figure 02 -SNCF is renovating 104 TGVs with the aim of expanding the current fleet's lifespan. (Source: PRBX/SNCF)

www.prbx.com



Figure 03 Left – Power supplies required by railway companies when refurbishing trains is very large and going from low power modules to high power converters up to hundreds of kilowatts. (Source : PRBX/Shutterstock/E CO LENS)

These 104 eligible trainsets have been assessed during the 4th quarter of 2023 and 1st quarter of 2024. A number of criteria will be taken into account when deciding the fate of each train set, including the condition of the structure of the train set, its metal components, the boiler, the bogies and the electrical installations including power supplies. Based on these criteria, the trainsets will be classified into three categories:

- Those in perfect condition that will continue to be in service, but will undergo renovation to improve their comfort.
- Those that require more extensive reliability and renovation work due to their advanced age.
- 3. Those that will be withdrawn from service due to obsolescence of parts (electronic components or state of the chassis). These written-off trainsets will be used as parts banks as they contain up to 3,000 potentially recoverable

components that can be reused to repair other trainsets.

illustrates within an industrial environment what Ecodesign Reuse, Repair and Prolong Lifetime is aiming for. Reusing parts to reduce waste and optimize resources has been part of the SNCF life cycle process for a long time as rather than buying new, checking and repairing 500,000 TGV spare parts every year represents a saving of half a billion euros a year.

Designing power supplies for refurbishing – New technology paradox.

The variety of power supplies required by railway companies when refurbishing trains is very wide and covers from low power modules to high power converters up to hundreds of kilowatts (Figure 03). In a train, many power supplies are embedded within sub-assemblies e.g., LED lighting with built-in power supplies and drivers, but a number of systems require standalone power solutions meeting the



Issue 3 2024 Power Electronics Europe

latest legislative requirements. In general, refurbishing contractors are

using referenced part numbers approved by the train manufacturers, and about 80% of the need is available as Commercial off-the-shelf (COTS) from certified power supplies manufacturers, complying with railways standards. However, when refurbishing and modernizing trains that might have been manufactured decades ago, 20% of the power supplies will require extra features, higher power density, lower energy consumption and many more things, often with the need to fit into an existing box that's specific to the application (Figure 04).

When refurbishing or modernizing, the railway industry is following the same pattern as the others, and with the increased demand for higher power density and lower power consumption, power designers are now investigating the implementation of Wide Bandgap (WBG) switching semiconductors, Gallium Nitride (GaN) and Silicon Carbide (SiC).

SiC diodes have been used in railway power supplies for decades, but power switching transistors are relatively new in railway applications. Considering that the lifetime of railway equipment could be greater than 20 years, reliability and supply chain sustainability are a must, and implementing a new technology requires a thorough technical evaluation and the need to ensure that the supply chain is able to guarantee product support for more than 20 years.

In the process of validating a new technology for highly demanding railway

Figure 04 Left – PRBX 110VDC, 10kW Nickel-Cadmium battery charger for refurbishing when replacing Lead-Acid batteries in railway applications. (Source: PRBX) applications, the parallel, ongoing process to electrify other transportation and machinery applications is contributing to accelerate market adoption and confidence in WBG and especially SiC. A lot of research has been conducted by the automotive industry to validate WBG technology and the adoption of SiC and GaN in powertrains and battery chargers thus setting a ground base for other segments to adopt the technology.

In high power switching conversion many projects utilize SiC MOSFETs instead of IGBTs and it's worth mentioning the Fraunhofer Institute for Energy Economics and Energy System Technology's MUSiCel research project which by using innovative SiC wide-band-gap semiconductors managed to deliver 250 kW at a switching frequency of 50 kHz with an efficiency across the entire power range exceeding 98 % (at 100 kW, an efficiency of even 98.8% was measured!) (Figure 05). Originally the MUSiCel research project was aimed at the electrification of agricultural and construction machinery, although it can equally apply to railway high power conversion systems and there's no doubt that such research will contribute to the adoption of SiC in future designs.

The research of feasibility, reliability and benefits compared to previous technologies is very important, but for railway manufacturers it is crucial that long term supply chain sustainability is guaranteed for the lifetime of the final equipment. As it was for MOSFET technology, WBG semiconductors manufacturers have invested in volume manufacturing facilities or partnerships, but we also see a number of acquisitions e.g., Infineon acquiring GaN Systems, and Renesas acquiring Transphorm. The WBG supply chain for SiC and GaN is now entering a mature phase, thus securing a much-needed long term components availability situation.

In conclusion:

To the question: Ecodesign, Reuse, Repair, Prolonging Lifetime and New Technology – Is it the new paradox? The answer is not "Yes" or "No" but as for the railway industry we have given as an example, industry as a whole will have to consider all those aspects when designing new products. The EU Ecodesign is setting a new way of working, and from higher energy efficiency to prolonging the lifetime of final equipments, power electronics will play an important role. One thing is for certain, it is a wonderful opportunity for power designers to explore new frontiers.



Fraunhofer Institute for Energy Economics and Energy System Technology IEE / Project MUSiCel

Figure 05 - SiC 250 kW DC-DC converter developed as part of the Fraunhofer IEE project MUSiCel. (Source: PRBX/Fraunhofer IEE)

To receive your own copy of

Power Electronics Europe

subscribe today at:

www.power-mag.com

Reimagining the Holdover Oscillator

MEMS-based Precision Timing Delivers Accurate, Reliable, Ultra-Stable Clock Signals for the Era of Intelligent, Connected Electronics. By **Piyush Sevalia, Executive VP Marketing, SiTime**

Precision timing provides the heartbeat of all electronics, playing a crucial role in the seamless operation and synchronization of countless devices, systems, and networks. In today's era of intelligent and connected electronics, the demand for precise and reliable timing technology has exponentially increased with the rise of AI computing, 5G networks, cloud data centers and the Internet of Things (IoT). These advancements underscore the importance of precision timing in critical network infrastructure. All nodes in a network must be precisely synchronized with increasing accuracy to maximize performance and reliability. For example, 5G network nodes must be synchronized within hundreds of nanoseconds, which is ten times more stringent than required by 4G LTE networks.

MEMS-based Precision Timing: Disrupting the Century-Old Quartz Legacy

Precision timing technology has evolved rapidly in recent years to meet the demands of high-speed, time-sensitive



networks. Microelectromechanical systems (MEMS) technology has emerged as a game-changer in the realm of precision timing. MEMS-based precision timing technology is rapidly gaining traction, disrupting the century-old legacy dominated by quartz-based timing solutions. While quartz crystals have served the electronics industry well for decades, MEMS technology elevates precision timing to new levels of performance and reliability.

MEMS resonators are miniature mechanical systems fabricated on a microscale, typically in the range of micrometers. They integrate electronic, mechanical and electromechanical elements to create highly stable and reliable timing components that offer several advantages over traditional quartzbased systems:

- Miniaturization: MEMS timing components are significantly smaller than their quartz counterparts, facilitating the development of compact, lightweight electronic devices without sacrificing performance.
- Improved resilience: MEMS devices can withstand extreme environmental conditions, including temperature variations, airflow, shock, and vibration, making them ideal for applications that demand robust performance and reliability in challenging environments.
- Lower power consumption: MEMS devices are more energy-efficient than quartz alternatives, contributing to longer







battery life in portable and IoT devices. In our increasingly wireless and mobile world, the low power consumption of MEMS-based timing solutions is a significant advantage.

- Enhanced frequency control: MEMSbased oscillators offer better control over output frequency, enabling more precise, stable timing. This precision plays a pivotal role in enhancing the overall performance and synchronization of electronic systems.
- Customization: MEMS technology enables the development of programmable timing solutions to meet specific application requirements. MEMS timing devices can be programmed for 15 different parameters, such as frequency, operating temperature range and supply voltage, while a crystal is manufactured to have a single, fixed frequency. This adaptability enables

MEMS-based precision timing to be deployed across a wide array of industries and use cases.

Maintaining Time Accuracy with Frequency Stability and Holdover

A key metric in precision timing is frequency stability, which directly influences the performance and reliability of electronic systems. Frequency stability is critically important in applications such as GNSS/GPS, radar, aerospace and defense, 5G networks, automotive safety systems, and financial technology (fintech). Realtime networks based on the IEEE 1588 precision time protocol (PTP) also require precision timing devices that excel in frequency stability.

Defined by low phase noise and negligible drift over time, frequency stability is crucial for an important timing

capability known as holdover. A synchronized network relies on multiple, redundant timing sources to ensure continuous operation. One of these timing sources is an ultra-stable local oscillator. typically an oven-controlled oscillator (OCXO), which will "holdover" the network and ensure continued, seamless network operation when upstream timing sources are disrupted and temporarily unavailable. The length of the holdover period is directly proportional to the stability of the local oscillator., highlighting the importance of using a highly stable precision timing solution. The more stable the oscillator, the longer the holdover period, and the longer the system can operate until the upstream timing reference (such as a GPS signal) is restored.

System developers can enhance frequency stability and minimize drift by choosing specialized timing devices, such as OCXOs and temperature-compensated oscillators (TCXOs), which are designed to minimize the negative impact of temperature change on frequency stability. High-precision OCXOs and TXCOs are designed to generate more stable frequencies than conventional oscillators when exposed to rapid temperature changes.

New Ultra-Stable Holdover OCXOs Outperform Quartz

Recognizing the critical need for greater stability and longer holdover in today's demanding electronics applications, SiTime reimagined the holdover oscillator by developing the Epoch Platform. The Epoch Platform distinguishes itself by offering twice the holdover period of conventional quartz-based solutions under common environmental stressors, enabling telecom and cloud service providers to ensure service continuity in real-world conditions.

In contrast to the Epoch Platform, legacy quartz OCXOs are inherently unreliable and prone to performance degradation in the presence of environmental stressors such as temperature changes and vibration. To date, OCXO vendors have compromised on real-world performance, reliability, size, power, and warm-up time to achieve the one attribute most OCXOs are designed to deliver – a stable clock reference.

The Epoch Platform overcomes the limitations of quartz OCXOs by integrating two MEMS resonators through SiTime's DualMEMS temperature sensing technology, resulting in 100 percent thermal coupling. This ensures 40x faster temperature tracking, a crucial timing attribute, especially under conditions of fluctuating airflow and rapid temperature changes. In addition, SiTime's TempFlat



MEMS has 10x the resilience to temperature variations compared to traditional quartz resonators, while also eliminating activity dips. The ultra-small MEMS resonator, with its extremely low mass, mitigates the effects of g-force, resulting in 30x better vibration immunity than quartz. Pairing innovative MEMS technology with SiTime's advanced analog circuitry results in exceptional dynamic stability, ultra-low phase noise, and a broad frequency range.

Epoch Platform OCXOs enable 12 hours of holdover, support any frequency between 10 and 220 MHz, are programmable up to six decimal places of accuracy, and offer digital control with I2C and SPI interfaces for unparalleled flexibility. Designed for low power consumption, these MEMS-based OCXOs consume just 420 mW, 3x less than quartz devices. The Epoch Platform's small footprint (9 mm x 7 mm x 3.73 mm) occupies 9x less area and is 3x times thinner than comparable quartz-based timing solutions, enabling a greater degree of freedom for hardware designers.

SilTime

SiTime's Epoch Platform is setting new standards in MEMS-based precision timing

technology, ensuring nanosecond accuracy in critical network infrastructure. With its exceptional stability, longer holdover, high reliability, and low power consumption, the Epoch Platform is poised to revolutionize the world of precision timing, making it an indispensable technology for today's intelligent, connected electronics.

Direct Grow your business with DFA Directfrom over 95,000

qualified contacts

• E-Campaign

- List Rental
- Lease

Contact:

Damien Oxlee on +44 (0)1732 370342 damien.oxlee@dfamedia.co.uk lan Atkinson on +44(0)1732 370340 ian.atkinson@dfamedia.co.uk



Ensure Interference-free data communication

Galvanic isolation of circuit components is required in many cases, especially in industrial environments. Capacitive digital isolators can be used to safely and reliably transmit user signals across an isolation barrier. The following circuit example shows how capacitive digital isolators can be used to galvanically isolate remote industrial equipment.

> For electronics in typical industrial environments interference-free data communication and personal safety are the two major challenges. Strong electromagnetic fields, overvoltages, transient voltages and high EMC interference are the order of the day. If, for example, the communication cable is laid unfavorably close to a control cable of a frequency inverter, the pulses are capacitively coupled in and the signals in the communication cable oscillate with the pulse pattern of the frequency inverter. This interference can guickly reach a level where significant malfunctions can occur and even endanger the safety of people.

For example, when a thermocouple is used to measure the temperature of a motor, voltages in the millivolt range are generated. If these voltages are transmitted over a cable length of several meters to a central control unit that is referenced to a different ground potential, the measurement signal will be distorted by the potential differences.

Summarizing the phenomena described, the following four challenges arise

- Interference free data transmission
- Separation of ground loops between spatial circuits
- Minimize common-mode interference
- A safety barrier between hazardous

voltages and a user **Figure 1** shows the situation of the data transmission system. In order to meet the requirements of shielding dangerous voltages from the user and still guarantee interference-free data transmission, galvanic isolation must be implemented to separate the zones electrically, i.e. in terms



of potential, so that they can work separately and thus without interference. The data flow passes through the isolator. However, interference and potential equalization currents are prevented by the galvanic isolation.

Isolated battery voltage measurement

Distributed sensing of physical parameters is the state of the art, and powerful microcontrollers facilitate data processing. However, recording the data on the object is often a challenge, and wireless transmission of the data is often not possible. The data must be recorded on the object in such a way that the probe does not influence the variable to be measured, otherwise measurement errors will occur. This requires electrical decoupling, which must be implemented in the circuitry. Furthermore, the wired transmission of the data must be potentialfree and symmetrical so that the transmission is not disturbed by electromagnetic coupling and ground loops. In this application, the use of microcontrollers was deliberately avoided in order to demonstrate that a powerful, interference-free design can be implemented with little effort using analog circuit technology. The design is divided into two circuits, a transmitter and a receiver. The transducer can record a DC

Figure 1: Basic concept of an isolated system for separating different potentials.







Figure 3: Block diagram of the receiver for potentialfree voltage measurement.

voltage of ± 30 V max. with a variation period of one second. The current consumption has been minimized to < 85mA for the transmitter and < 25 mA for the receiver with a voltage supply of 15 V. Both the transmitter and the receiver are electrically isolated, the transmitter between the measurement data acquisition and the signal transmission path and the receiver between the signal transmission path and the data output. Special DC/DC power modules and digital isolators with galvanic isolation and particularly low parasitic coupling capacitance were used to achieve this isolation in the circuitry. The signal is transmitted between the transmitter and receiver via a two-wire cable. Depending on the electromagnetic environmental influences, the distance can be several hundred meters.

Transmit circuit

Figure 2 shows the block diagram of the transmitter. The circuit is divided into six blocks:

1. probe: transducer with voltage divider and amplifier for measuring positive and negative polarity.

2. level shifter: level shifter for the voltage-frequency converter.

3. voltage-frequency converter: digital output signal, frequency dependent on the input voltage.

4. digital isolator: galvanic isolation between measuring potential and interface

5. interface buffer: Low-impedance line driver with balanced output.

6. power supply: DC/DC converter, galvanically isolated converters for the probe head section.

To ensure functional reliability, measures for transient protection and filters are

provided both on the probe side and at the driver output; low-pass filters are also provided before and after the DC/DC power modules to effectively attenuate RF coupling.

Receiver circuit

side buffer.

Figure 3 shows the block circuit of the receiver. The circuit is divided into five blocks:

input buffer: signal pick-up, signal conditioning with balanced input. The link indicator shows whether there is a detectable connection to the transmitter.
digital isolator: galvanic isolation between input signal and secondary signal processing / output interface. Additional galvanically isolated voltage for the input-

3. frequency-to-voltage converter:

Generates an output voltage from a digital signal. The voltage level depends on the frequency of the input signal.

4. interface buffer with polarity

indicator: Level converter for the output signal. The output signal has a positive polarity, the polarity indicator shows the polarity of the input signal.

5. power supply: DC/DC converter for the secondary-side supply.

Numerous EMC measures are also provided in the receiver section. The signal input from the twisted pair cable is equipped with transient protection and a common mode filter to effectively attenuate interference from the cable. The power supplies around the DC/DC converters are equipped with low-pass filters on both the input and output sides to significantly reduce electromagnetic interference from outside and inside the circuit caused by the switching operations of the DC/DC converters. This ensures a high signal-to-noise ratio and high reliability.

Capacitive digital isolators

The digital isolator from Würth Elektronik [1,2] consists of an oscillator and a modulator on the primary side. A demodulator and a signal buffer are located on the seco ndary side. The components on the primary side are electrically isolated from the components on the secondary side by a capacitive structure with an isolation barrier made of



Figure 4: Basic structure of a digital isolator from Würth Elektronik.



Figure 5: Block diagram of the digital isolator

SiO2.

The signal is transmitted across the isolation barrier using a modulation process known as on/off keying. The onchip oscillator is used to modulate the input signal, which is driven by a Schmitt trigger. The modulator generates a differential signal that is transmitted across the capacitive isolation lines.

Figure 4 shows the basic structure of a capacitive digital isolator. The demodulator, on the secondary side of the isolator, performs the functions of amplification, filtering and reconstruction of the input signal. The signal delay and signal distortion are minimal. Finally, a buffer routes the signal from the demodulator output to the overall output, whereby the buffer amplifies the signal to the required level. Figure 5 illustrates the internal structure.

Digital isolators are manufactured using standard CMOS technology, which means they use familiar and proven materials and processes. The transmitter and receiver capacitors are mounted on a lead frame. The capacitors themselves, shown in gray in Figure 4, are located between the two horizontal contacts shown in red. The dielectric material between the electrodes or capacitor plates serves as a galvanic isolation barrier.

The isolation thickness achieved by the

process is in the range of a few tens of micrometers. In digital isolators, SiO2 is used as the isolating material in the capacitor because its much higher dielectric strength of 500 V/µm means that it requires considerably less space for the isolating gap. Other common insulation materials, such as polyimide, have a dielectric strength of only 300 V/µm. The two capacitors are electrically connected with a bonding wire so that two capacitors are connected in series, as shown in the block circuit in Figure 4. To protect the entire structure, the die and leadframe are molded using a standard IC assembly process.

Reliability and safety

Digital isolators are designed to protect people from dangerous voltages. They must therefore meet the highest safety and durability requirements. The digital isolators of the CDIP and CDIS series from Würth Elektronik have been certified by the VDE in Germany according to the latest and most demanding standard DIN EN IEC 60747-17 (VDE 0884-17):2021-10 "Magnetic and capacitive couplers for basic insulation and reinforced insulation".

But what do the terms "basic" and "reinforced" actually mean for the safety of a person? The standard itself only gives a rather abstract definition here, see IEC 60747-17:202X: So, when do you use basic or reinforced isolation? Simply put, it comes down to "single fault condition" and "normal operating conditions". Reinforced insulation provides protection against electric shock even under single-fault conditions in normal operation. Basic insulation is only effective in normal operation, i.e. without considering a single fault.

Literature:

[1] Uludag, T.: Reliable Galvanic Isolation, Simplified. Power Electronics News, December 2023, S. 6ff.

[2] Digital Isolators WPME-CDIS from Würth Elektronik: https://www.weonline.com/en/components/products /DIGITAL-ISOLATORS-WPME-CDIS

Authors:

Timur Uludag graduated with a degree in mechatronics engineering from Regensburg University of Applied Sciences. He then worked for several years as a hardware engineer in the fields of switching power supplies and analog circuit design. Since 2015, Uludag has been working as Senior Technical Marketing Manager at Würth Elektronik eiSos in the Mag!?C Power Modules business unit. There he specializes in the roadmap planning and market launch of new power modules.

Dr. Heinz Zenkner studied electrical engineering with a focus on communications and radio frequency technology and holds a doctorate. He has been a publicly appointed and sworn expert for EMC for many years. In addition to numerous scientific publications, he is a frequent author of many works on EMC. Heinz has also worked as a lecturer at various universities, at the Chamber of Industry and Commerce and at numerous seminars. He has been involved in industrial electronics for many years, from the initial idea of a product through to series production. He is particularly interested in wireless energy transmission, for which he has developed his own theoretical and practical concepts.

	Basic Isolation	Reinforced Isolation	
Package	SOIC-8NB	SOIC-16WB	
VIOSM - max. Surge Isolation voltage	5000 Vpk	7070 Vpk	
Test	VTEST = 1.3 x VIOSM VTEST = 6.5kV	VTEST = 1.6 x VIOSM VTEST = 11.3kV	
Error rate over the lifetime	≤ 1000 ppm	≤ 1 ppm	

Tap into the world of automation

Every day, *Drives & Controls*' Web site attracts hundreds of visitors from around the globe, eager to find out what's happening in the world of automation and motion engineering. The site's viewing figures often exceed 1,000 pages per day.

Free from the space restrictions of the printed magazine, the easy-to-navigate Web site carries more news stories, as well as longer versions of articles in the magazine.

So, visit the *Drives & Controls* Web site regularly to keep up to date with what's happening around the world.

The Drives & Controls Web site delivers:

- Frequently updated business and technology news stories from around the world – many exclusive to the Web site.
- Access to our unrivalled archive of more than 4,000 articles on industry news and technological developments, stretching back for more than a decade.
- Exclusive in-depth reports on key industry events such as the Hannover Fair and the SPS IPC Drives exhibition.
- Access to our unique online database of hundreds of UK suppliers of automation and engineering equipment.

Plus you can:

- Use the site search function to find relevant articles from our vast, exclusive archive
- Find out what's trending in our "top ten" most viewed articles
- Sign up for our monthly newsletter
- ➤ Follow our latest Tweets and reTweets
- Watch videos explaining technological developments

<complex-block><complex-block><complex-block><complex-block><complex-block><complex-block><complex-block><complex-block><complex-block><complex-block><complex-block>

OUR HEART BEATS - FOR INDUSTRY 4

Nrives&Controls

BALLUFF

ETEL

de la

moore

Drives&Controls

www.drivesncontrols.com

Passive components in modern switched-mode power supplies

Hidden specialists

Switched-mode power supplies are often dismissed as low-budget applications, but they hide specialized components inside without which they are unable to operate efficiently. This technical article shows what these passive components are and how they can ensure operational reliability.

Although the design of modern switched-mode power supplies is often characterized by newer semiconductor technologies, in particular wide band-gap power semiconductors, a wide range of passive components is required for them to work. It is important to match the characteristics of the components to the respective application. Rutronik presents the most important passives for switchedmode power supplies.

Inductors

The high-frequency (HF) transformer and other inductors form the core of a switched-mode power supply (SMPS). Located in the input section, the interference suppression components ensure suppression of interference voltages and currents on the power supply lines.

Current-compensated chokes (common-mode chokes) suppress asymmetrical interference present on both lines in common mode. They are typically constructed with high-permeability ferrite cores or nanocrystalline core materials.

Linear filter chokes or differential mode chokes attenuate symmetrical interference. Most models have an iron-powder toroidal core or a ferrite EE core with an air gap, but open core designs such as bar or thread chokes are also possible.

In some cases, common-mode and differential mode chokes are combined into one component. This means fewer components and therefore less space requirement and lower cost. In this case, the leakage inductance of the commonmode choke assumes the function of the differential mode choke; a magnetic bypass can act as an amplifier. Sumida offers this combination, for example through its RK17S and RK23S series.

Optionally, power factor correction (PFC) chokes can be added to the suppressor chokes to provide sinusoidal current consumption for power factor correction. Like the chokes, the active PFC stages contain either iron powder or ferrite cores with an air gap to smooth the output current.

Gate driver transformers (trigger transformers) are used to drive the power transistor (MOSFET and IGBT). Typically based on smaller ferrite core geometries than the chokes, they are characterized by low winding and coupling capacitance and low leakage inductance. Normally, they are rated for isolation voltages ranging from 1.5 kV to 5 kV and are available in THT or SMD versions.

Power transformers made of ferrite cores are the heart of a switched mode power supply. On the one hand, they ensure power transfer from the primary to the secondary side of the power supply, and on the other hand, they are responsible for the safe galvanic isolation of the primary and secondary sides. Since the output side of the power supply is often open, i.e. accessible, this isolation is required by safety standards and must be taken into account in the design of the transformer.

Proven soft magnetic and low-loss materials with high saturation flux density are used for the power transformers. Their size is reduced as the switching frequency of the power supply increases. For switching frequencies between 500 kHz and 1 MHz, the pulse transformers therefore require fewer raw materials, which has a positive effect on the environmental balance and sustainability of the power supply – an aspect that is increasingly coming into focus.

Customized inductors

In addition to standard inductors. application-specific ones are also available. For power transformers, for example, these are models with several different output voltages. Sumida specializes in this area. These can be variants of existing components that are tailored to a customer's specific application based on standard pre-materials and existing technologies. Standardized core shapes and magnetic materials (e.g. standard EE, UU, ETD, EVD, EFD, EP, RM, ER, PQ, toroid core shapes) and standard plastic components (coil formers, packages, and base plates) are also used. For this purpose, Sumida can partly rely on its own MnZn and NiZn ferrites as well as iron

powder cores, which the supplier produces in Obernzell, Germany. The nanocrystalline and amorphous core materials are purchased from specialized raw material producers.

Increasingly, however, there are requirements that can only be met with completely customer-specific components based on new magnetic core geometries and, in some cases, even new magnetic material compositions, proprietary plastic parts, and new manufacturing technologies. These completely application-specific geometries are only suitable for a very specific application - but they are perfect for that application in terms of both geometry and size as well as their electrical function. This applies, for example, to high-power transformers for half-bridge, full-bridge, or LLC topologies in a power range of up to 30 kW. They are used, for example, in photovoltaic inverters or DC/DC converters in e-vehicles or in high-power DC charging (HPC) applications.

Capacitors

Capacitors perform many functions in switched-mode power supplies. AC capacitors on the mains side (primary side) are mainly used to suppress or filter interference pulses. Ceramic or film capacitors can be used for this purpose. When they are connected between phase and neutral, it is important that they are X2 or X1 certified. For the connection between phase and protective conductor, a Y classification is mandatory. Since this provides greater electrical and mechanical safety than X capacitors, short circuits cannot occur due to a capacitor malfunction, for example.

Since X capacitors are connected between phases or neutral conductors, they do not have the same high safety requirements as Y capacitors.

X and Y capacitors are further subdivided into different test/pulse voltages according to the requirements of IEC 60384-14 and are referred to as X2 and X1 or Y2 and Y1 types. The most common combinations are X1Y2 and X1Y1. Standard subdivisions are shown in Table 1.

In addition, test marks such as ENEC, VDE, UL, or CQC can be found on most X and Y capacitors, since the components



Table 1: Classification into (sub-)classes for capacitors in switched-mode power supplies

must be tested with regard to these standards.

Robustness of film capacitors

Those who choose film capacitors should check if the application requires an increased temperature-humidity-biased (THB) class. This ensures that the capacitors are sufficiently robust against moisture – and therefore corrosion – to ensure the desired service life of the application.

The temperature-humidity bias test is a recognized standard for accelerated life testing. It involves accelerating the aging process of capacitors and measuring in two different tests whether they maintain their capacitance, dissipation factor, and isolation resistance at a given temperature, relative humidity, and nominal voltage over a defined period of time. Three levels (grades) are distinguishe).

Figure 2: X-Y capacitors usually carry one or more test marks as shown in the photos. Because of the relatively small capacitance values usually required, ceramic capacitors are mainly used as Y capacitors in a value range of between 10 pF and 4.7 nF. However, they are available with a maximum value of 22 nF.

In addition to the classifications mentioned so far, capacitors are also differentiated according to their target application (commercial, industrial, or automotive) and according to their design.

In terms of design, radial types as single layers are the most common and best known. These are ceramic single disks with spacing of 5 and 7.5 mm for X#Y2 and 10 and 12.5 mm for X#Y1 versions (Fig. 3).

In addition, many SMD types are now available as X2, Y2, or X1Y2 versions as multilayer ceramic capacitors (MLCC) and Y1 or X1Y1 versions as single-layer plasticmolded leadframes for surface mounting. Compared with the leaded, radial versions, these offer advantages above all in terms of smaller volume and lower overall height as well as higher suppression levels with the same capacitance values (Fig. 4).

In switched-mode power supplies, a high-voltage electrolytic capacitor is typically used as a buffer downstream of the AC filter on the input side and the first rectifier. Models with a low ESR and a long service life are recommended for this purpose.

On the secondary side, too, low capacitor ESR is also a priority. This allows high output currents and minimizes the residual ripple of the output voltage as much as possible. Low ESR electrolytic capacitors are usually used for this purpose. Additional parallel ceramic



Figure 3: Structure of a radial single-layer capacitor



capacitors filter possible output-side RF interference.

Resistors

Resistors perform a variety of tasks in switched-mode power supplies: Among other things, they are used as bleeder or leakage resistors and as pre-charge resistors, for protection against overvoltages and overcurrents, and for current measurement.

The bleeder resistor is used to discharge the capacitor, as this could otherwise cause an electric shock even when the power supply is switched off. It is not absolutely necessary in regulated low-voltage power supplies, and it is not needed in linear voltage regulators or switched-mode power supplies with fast duty cycle control to maintain a constant DC voltage. Highohmic/high-voltage series are used for this application.

Axial, leaded safety resistors are typically used as pre-charge resistors for the buffer capacitors. This is because they bring low resistance value and high pulse strength.

In addition, resistors are used to detect the phase position of the AC voltage to achieve a more accurate divider ratio. Thin film MELF resistors with outstanding pulse load capability and flat chip precision resistors in thin film technology are suitable for this purpose.

Varistors "clamp" overvoltages to protect

the non-inverting input of the comparator. Overvoltage metal oxide varistors perform this task. Thanks to their halogen-free, high-temperature-resistant silicone coating, they operate at an operating temperature of up to 125 °C and have a maximum current-carrying capacity of 13 kA.

Resistors for overcurrent protection and current measurement

When powerful loads are switched on, very high currents occur for a short time, which can cause damage to the system. PTC and NTC thermistors are used as switch-on current limiters or overcurrent protection. They can also be used for temperature measurement since their electrical conductivity changes as a function of temperature.

The easiest way to limit high switch-on currents is to use low impedance power resistors. In normal operation, however, a relatively high power loss occurs at these resistors. For this reason, the use of NTC or PTC thermistors is recommended. When combined they offer the greatest advantages.

The most important selection criteria for the NTC thermistor are the maximum current and the nominal resistance (R25). The latter must be at least large enough, by circuitry in series with the load, to limit the current to a value that will not blow the fuse and cause damage to other components. The maximum current is

Figure 6: Resistor elements made of solid metal are suitable for current measurements.

determined by the power of the load. The derating of the NTC thermistor must also be taken into account.

PTC thermistors are suitable for safe current limiting with high-capacitance capacitors in DC intermediate circuits. Due to the high current flow, they heat up and become highly resistive and thus intrinsically safe. As a result, they limit the current to safe values in the event of a short circuit in the DC intermediate circuit. They are designed for DC voltages of 260 to 560 V, offer resistances of 22 to 1100 Ω at 25 °C, and, depending on the type, have UL, IECQ, and VDE approvals as well as AEC-Q200 qualification.

Another application of resistors in switched-mode power supplies is current measurement. Low impedance shunt resistors are used for this purpose. The current flow can be detected and evaluated via the voltage drop at the resistor. Full metal resistor elements made of manganese-copper and nickel-chromium-aluminum alloys are ideal in this respect. Their material properties mean that they have very low temperature coefficients and are also low in inductance. If the resistive element is a metal strip, resistance values of as low as 15 $\mu\Omega$ can be achieved.

Summary

The importance of passive components in switched-mode power supplies should not be underestimated, as they perform a wide range of tasks. As their importance continues to grow, suppliers are working to improve their performance. As such, it remains exciting to see where the journey of technical developments will take us. All the components mentioned are available from Rutronik with a wide variety of choices in all designs and performance classes. Customer-specific solutions, especially for inductors, are of course also possible, depending on the required quantities.

www.power-mag.com

EIRE300 Open Frame AC-DC Power Series



Vox Power has announced the EIRE300 series, an advanced range of AC/DC power supplies that combines compact design with exceptional reliability and efficiency, designed for medical and ITE applications, the EIRE300 delivers 300 Watts with a peak output of 375 Watts within a compact 4" x 2" footprint and a slim 1" profile.

The company says the EIRE300 series stands out with its best-in-class power density exceeding 37.5W/in? and efficiency reaching up to 95%, significantly minimising power losses and enabling it to outperform all other products available on the market. It offers versatility with unrivalled convection-cooled ratings of 200 Watts (115VAC), making it suitable for a wide range of applications.

Engineered for seamless integration into medical and industrial applications, the EIRE300 features 2 x MOPP isolation, low leakage currents, standard mounting holes and a dedicated auxiliary fan supply. Additional standard features include internal dual line fusing, remote sensing, and an AC_OK signal. The EIRE300's low standby power consumption of typically 0.25W makes it optimal for energy-critical applications.

The series is not only certified to the latest international Medical and ITE Safety Standards but also offers a "BF" rating, making it suitable for equipment that requires direct contact with patients. This rating is crucial for applications like surgical instruments and critical care medical devices, ensuring that they can be safely used close to the patient without risk of electrical hazards.

The EIRE300 series offers a range of output voltages from 12V to 60V, including standard options of 12V, 15V, 18V, 24V, 28V, 36V, 48V, and 54V. Each output has a wide adjustment range, ensuring compatibility with most non-standard voltage requirements within this range. Comprehensive protection features such as over-voltage, over-current, and over-temperature safeguards are standard.

Designed for both Class I and Class II equipment, the EIRE300 meets EMC Class B standards for conducted and radiated emissions. It is capable of operating at altitudes up to 5000 meters and is approved to 60601-1 and 62368-1 for medical and ITE applications, as well as compliant with 60601-1-2 (EMC), 60335-1 (Household appliances), 61010-1 (Measurement, Control & Laboratory Equipment) and 61558-1 (Safety of Power Transformers) standards.

To maximise reliability and performance, the product design utilises ultra long-life electrolytic capacitors and comes conformal coated as standard to protect against environmental contaminants. Its highefficiency design reduces heat output, supporting a wide operating temperature range of -40°C to 70°C, with a calculated MTBF exceeding 500k hours.

Microchip's RTG4 FPGAs with lead-free flip-chip bumps achieve highest space qualification



Satisfying mission assurance requirements for the most critical space programs, Microchip Technology says its Radiation-Tolerant (RT) RTG4 Field-Programmable Gate Arrays (FPGAs) with lead-free flip-chip bumps have earned the Qualified Manufacturers List (QML) Class V status.

The company says as designated by the Defense Logistics Agency (DLA), QML Class V is the highest level of qualification for space components and a necessary step to satisfy mission assurance requirements on the most critical space missions such as human-rated, deep space and national security programs. Because QML qualifications are standardised based on specific performance and quality requirements governed by the DLA, customers can streamline their design and certification processes by using QML-qualified products.

In 2018, RTG4 FPGAs became the first RT FPGAs offering more than 150,000 logic elements to achieve a QML Class V qualification, and this nextgeneration solution with lead-free flip-chip bumps is the first of its kind to achieve QML Class V status. In advanced flip-chip package construction, such as that used in the RTG4 FPGA, flip-chip bumps are utilized to connect the silicon die and the package substrate. Lead-free bump material will help extend the longevity of the product, which is critical to space missions.

"This is another milestone for our RTG4 FPGAs that will provide customers with added confidence in designing these devices in space flight systems, while allowing them to take advantage of our high-reliability, zeroconfiguration-upset and low-power consumption FPGAs," said Bruce Weyer, Corporate Vice President for Microchip's FPGA Business Unit.

"For more than 60 years, Microchip solutions have powered space flight missions, and we are dedicated to product longevity and providing the highest quality solutions."

RTG4 FPGAs are designed to bring high levels of density and performance to space applications, saving cost and engineering efforts through low power consumption and immunity to configuration upsets. Unlike SRAM-based FPGA alternatives, the programming technology used in RTG4 FPGAs provides low static power, which assists in managing thermal issues common in spacecraft.

RTG4 FPGAs consume only a fraction of the total power compared to equivalent SRAM FPGAs, while exhibiting zero configuration upsets in radiation and thus requiring no mitigation, reducing engineering expenses and total system costs. To achieve QML Class V qualification, the RTG4 FPGA with lead-free bump has undergone extensive reliability testing, enduring up to 2,000 thermal cycles from ?65°C to 150°C junction temperature. The lead-free flip-chip bump interface connections passed MIL-PRF-38535 inspection criteria and exhibited no signs of tin whiskers. The flip-chip bump is inside the FPGA package, so there is no impact on the user's design, reflow profile, thermal management or board assembly flow when converting to lead-free bump RTG4 FPGAs.

Microchip boasts one of the industry's most comprehensive space product portfolios of radiation-hardened and RT solutions that include QML Class Q RT PolarFire FPGAs and sub-QML FPGAs that bridge the gap between traditional Qualified Manufacturers List (QML) components and Commercial Off-The-Shelf (COTS) components.

Vicor releases highest density automotive-grade power modules, enabling 48V power systems for electric vehicles



Vicor has announced it has released three automotive-grade power modules for 48V EV systems, which deliver industry-leading power density, and support automotive OEMs and tier one production in 2025. The BCM6135, DCM3735 and PRM3735 use AEC-Q100 certified Vicor-designed ICs and have completed the PPAP process with automotive customers.

"Vicor has set a new standard for power density in the automotive industry with these scalable and flexible miniature power modules," said Patrick Wadden, VP of the Vicor Automotive Business Unit.

"Our high-performance converters enable new possibilities for automotive manufacturers to reduce the size and weight of power systems throughout the vehicle."

The company says the BCM6135 is a 98% efficient 2.5kW BCM bus converter which converts 800V from the traction battery to 48V to provide a safety extra-low voltage (SELV) power supply for the vehicle. The BCM6135 internally provides the isolation between high voltage and low voltage which creates a large reduction the space required for the DC-DC conversion. The BCM6135's power density of 158kW/L allows EV system designers to reduce size of the primary DC-DC converter and reduce vehicle weight. The bidirectional rapid current transient response rate of 8 mega amps per second allows the BCM6135 to replace a 25lb 48V battery — by serving as a virtual 48V battery in the xEV vehicle and delivering additional cost and weight savings.

The DCM3735 2.0kW DCM DC-DC converter transforms an unregulated 48V input into a regulated 12V output. The DCM3735 has a wide input range that is compatible with a variety of automotive applications because the output can be trimmed within a range of 8 - 16V. The DCM3735 has a power

density of 300kW/L making it an attractive choice for architectures bridging a 48V distribution to 12V subsystems in zonal ECU applications.

The PRM3735 is a 2.5kW PRM regulator for 48V power that is 99.2% efficient. Its small footprint and 260kW/L power density frees up packaging space and reduces the overall DC-DC power supply. It is best suited to support regulated 48V loads that are implemented in new vehicle architectures.

The newly released Vicor modules can be arranged in over 300 configurations, offering extreme flexibility and scalability to support innovation for a variety of vehicle subsystems. Further, as the market shifts from 12V to 48V Zonal Architecture, these products are highly efficient in converting to and from 48V. All three modules can be arrayed easily to increase power supply levels, and they have automatic power sharing for optimum performance in an array. These modules solve complex challenges with 800V, 400V 48V and 12V systems.

"Our power modules make it easy to convert from the primary battery (800V or 400V) to 48V and down to load," said Wadden. "They are very versatile, and our customers are using the modules in innovative ways that are helping them remove size and weight from their power systems."

Vicor says its power modules are reducing power delivery networks throughout the vehicle in innovative ways:

Active suspension comes of age in EVs

Power needs of active suspension system are too high to be met with 12V power. Switching to a 48V bus and converting down with the bidirectional BCM6135 is an efficient way to deliver high performance. This application also capitalizes on the BCM6135's high slew rate as the active suspension is a regenerative power load, which requires immediate current flow reversal to pass regenerated power back to the battery.

Deleting or reducing the low-voltage battery

The industry-leading slew rate of the BCM6135 presents an opportunity to replace a 48V battery — with the BCM serving as a virtual 48V battery in the xEV vehicle, delivering cost and weight savings. Since the BCM6135 can switch from zero current to full current at 8.0MA/s, it can step down the traction battery's 800 to 48V and power a load as fast as drawing the power from an auxiliary 48V battery. No other DC-DC converter can match this speed and enables customers to reduce vehicle weight by up to 25kg while reducing vehicle costs by up to \$100.00.

48V zonal architecture adoption is on every roadmap

The new power modules can be easily configured to make this transition easier. The DCM3735 is used in conjunction with BCM3735 to create a regulated 12V power supply off the BCM6135 48V output. When used as a part of the 48V zonal architecture, the DCM3735 can be mounted remotely to create a local 12V supply in a vehicle zone, for example on the right-hand side. This application method allows the PDN designer to effectively support 12V loads while achieving up to 90% of the cost and weight savings that come from transitioning to a 48V bus.

Pre-charging prevents current surges and saves weight

Pre-charging is a necessary step of the start-up process. It prevents current surges at battery engagement that will damage the loads (such as pumps and compressors). Currently this is done using high voltage contactors and resistors, which add 1kg and over \$50 in cost. The alternative is to use BCM6135 as the main DC-DC converter and one of the low-voltage batteries installed in the vehicle. The BCM6135 can boost the low-voltage battery power up to high voltage and achieve the needed pre-charge, eliminating the legacy pre-charge contactor and power resistor.

The company says the flexibility of the power modules enable a host of automotive applications to be powered. More importantly, they deliver on the promise of 48V adoption. Whether converting the high voltage traction battery to 48V, delivering point-of-load power from a 48V bus, or enabling legacy 12V sub-systems to live in new 48V zonal architectures, Vicor's high performance, automotive grade power modules deliver the highest power density while reducing power loss and simplifying designs.

Molex Unveils Versatile VaporConnect Optical Feedthrough Modules Enabling Thermal Management Innovations to Address AI-Driven Data Centre Growth

Molex, a global electronics leader and connectivity innovator, has announced it has introduced a thermal management solution that reduces the time and cost of deploying and upgrading high-performance data centres to meet unrelenting demand for generative AI and machine learning workflows.

The company says Molex VaporConnect Optical Feedthrough Modules for two-phase immersion cooling address constant increases in data centre speed and capacity by leveraging a unique, cassette-based design that bolts directly onto immersion tanks and enables optical transceivers and network cabling infrastructure to be swapped out without changing mechanical interfaces or impacting immersion tank architecture. Reference designs for the new modules will be available commercially in Q1 of 2025.

"Molex continually embraces innovative optical solutions to ease data center deployments and upgrades while alleviating critical thermal management challenges," said Trevor Smith, General Manager, Optical Connectivity, Molex. "VaporConnect gives customers the flexibility to upgrade connectivity and scale cooling system designs to keep pace with data center growth by simply deploying a different module, which will accelerate upgrades while reducing overall energy, cooling and technology costs."

Streamlining Two-Phase Immersion Cooling

Molex VaporConnect Optical Feedthrough Modules simplify the connections between optical transceivers contained within immersion tanks and cabling infrastructure that exists outside the tank using fully upgradeable sealed modules. With VaporConnect, sealing and cabling is accomplished inside the module, giving customers the opportunity to upgrade connectors without impacting immersion tank design or architecture. Additionally, customers have the flexibility to re-use standard cabling infrastructure for multiple product generations, which further reduces deployment time, cost and complexity.

A full range of industry-standard and Molex optical connector form factors are available for single- and multi-mode fibre solutions. They also feature mixand-match functionality to facilitate system upgrades to newer or denser connectors. Customizable module footprints are available to fit specific space and application requirements.

Also, Molex VaporConnect Optical Feedthrough Modules are designed to minimise external patching and shuffle requirements by leveraging Molex FlexPlane optical circuitry technology. As a result, complex optical shuffles and high-density fibre routing are integrated seamlessly within the module for simpler installation and plug-and-play operation.

Reliable, Versatile, Upgradeable Optical Interconnects

A sealing gasket comes with every VaporConnect module, which is thoroughly tested using industry-standard, helium-leak testing to ensure a reliable seal with the tank wall. This also assures a seamless transition from the server line cards inside the tank to outside cabling infrastructure. Testing is underway for compliance with industry-standard GR-1435-CORE.

VaporConnect modules are designed to accommodate customer specifications, with the number of fibre channels dependent on the number and type of connectors used. As many as 576 fibres can be integrated into a single module. A range of form factor options are available, including MPO, LC and very small form factor (VSFF) options, such as MMC, MDC, SN and SN-MT. This ensures conformance to existing infrastructure and streamlines system upgrades. As part of Molex's continued investment in this area, an EBO connector option is currently in development, with availability slated for the first half of 2025.

Commitment to Optical Network Innovations on Display at ECOC 2024

As one of the largest manufacturer of Optical Feedthrough Modules for twophase immersion cooling, Molex says it has shipped more than 350,000



optical channels to date. At this year's ECOC'24, Molex says it will reinforce its commitment to optical network infrastructure innovations with on-site product displays, including the new VaporConnect Optical Feedthrough Modules. The company's extensive line of optical connectivity products, optoelectronics solutions and wavelength management systems also are being featured at Stand C75. As a participating member in OIF, Molex is part of an interoperability demonstration, which takes place at Booth B83, to spotlight optical networking innovations and solutions for data centres, AI/ML technologies and disaggregated systems.

Bourns Introduces Low Profile, High Creepage Isolation Transformer for Gate Drive and High Voltage Battery Management Systems

Bourns, a leading manufacturer and supplier of electronic components for power, protection, and sensing solutions has announced it has introduced a new AEC-Q200 compliant, automotive grade, low profile, high creepage isolation transformer. The Bourns Model HVMA03F4A-LP8S Series flyback transformer is designed to support high power density for greater efficiency in a compact form factor. These capabilities are required in a wide range of applications, including gate drive and high voltage battery management systems (BMS).

The company says this new flyback transformer series expands its portfolio of low power, high creepage isolation transformers. This series operates from a typical 12 V supply with an extended input voltage range of 10 to 24 V, and features a new coil mechanical design that helps to increase system performance and safety. These features are said to make the Model HVMA03F4A-LP8S Series ideal for use with Silicon Carbide (SiC), IGBT and Gallium Nitride (GaN) switching elements in automotive, industrial, and energy storage applications.

The Model HVMA03F4A-LP8S Series is constructed with a centre-tapped output to generate a \pm 5 V supply to aid in biasing gate drive turn on and off circuitry. This new series is AEC-Q200 compliant and uses a basic insulation layer that complies with the IEC 60664-1 standard with a working voltage up to 800 VDC. It also features an 8 mm creepage and 2 mm clearance with a Hi-Pot isolation voltage up to 2750 VAC with an extended operating temperature range of -40 to 125 °C.



Accelerated Life Test Instruments

www.accelrf.com

Accel-RF Instruments Corporation Tel: 001 858 278 2074

Arbitrary 4-Quadrant Power Sources

www.rohrer-muenchen.de Rohrer GmbH Tel.: +49 (0)89 8970120

Busbars



www.auxel.com Auxel FTG Tel: + 33 3 20 62 95 20

Capacitors



www.cde.com Cornell Dubilier Tel: 001 508 996 8561

DC/DC Converters



www.protocol-power.com Protocol Power Products Tel: +44 (0)1582 477737



www.neutronItd.co.uk Neutron Ltd Tel: +44 (0)1460 242200

Diodes

www.proton-electrotex.com/ Proton-Electrotex JSC/ Tel: +7 4862 440642;

IGBT modules	2004 		Tred product / service	
Products	1000	Information	Conterna	
Tanks	in the second	-Calendari of parents	German Same	
Trans Typesed Law Webse	PCW Europe 2018 Prater Schelter of anisot i version ways of anisot personalistic datase with the basic dataset of 2017 and personalistic from	Artista Later sprinks		
There are a subserver and the subserver as a subser	20 Auril 2014	Com of original array		
Mature course spences	April 5.7 Perilso Charmine Appl. pat in Joint & Rep. mod. Injuritual Adds. of Report	Mirrison .		
tight i contains	Second State	Application (PUN)		
armortisters.	19 March 2018			
un	Peter-Department Departure Landropartment Departure COPUT virtualiti DTB			

Discrete Semiconductors

www.digikey.com/europe Digi-Key Tel: +31 (0)53 484 9584

Hall Current Sensors



www.dgseals.com dgseals.com Tel: 001 972 931 8463

High Voltage and High Power Electronics

Dean Technology, Inc. www.deantechnology.com +1 (972) 248-7691



IGBTs

www.microsemi.com Microsemi Tel: 001 541 382 8028

Magnetic Materials/Products

www.dextermag.com Dexter Magnetic Technologies, Inc. Tel: 001 847 956 1140



Mosfets

www.aosmd.com Alpha and Omega Semiconductor Tel: 001 408 789 3233

www.neutronltd.co.uk

Neutron Ltd Tel: +44 (0)1460 242200

Optoelectronic Devices

www.digikey.com/europe Digi-Key Tel: +31 (0)53 484 9584

Packaging & Packaging Materials

www.curamik.co.uk curamik[®] electronics GmbH Tel: +49 9645 9222 0

Power Amplifiers

www.rohrer-muenchen.de Rohrer GmbH Tel: +49 (0)89 8970120

Power ICs www.digikey.com/europe

Digi-Key Tel: +31 (0)53 484 9584

Power Modules

www.picoelectronics.com Pico Electronics Tel: +44 1634 298900

www.fujielectric-europe.com Fuji Electric Europe GmbH Tel: +49 (0)69-66902920

www.proton-electrotex.com/ Proton-Electrotex JSC/ Tel: +7 4862 440642;

Power Semiconductors

www.proton-electrotex.com/ Proton-Electrotex JSC/ Tel: +7 4862 440642;

Power Substrates

www.universal-science.com Universal Science Ltd Tel: +44 (0)1908 222211

Resistors & Potentiometers

www.isabellenhuette.de Isabellenhütte Heusler GmbH KG Tel: +49/(27 71) 9 34 2 82

RF & Microwave Test Equipment. www.ar-europe.ie AR Europe Tel: 353-61-504300

9.

Simulation Software

www.power.ti.com Texas Instruments Tel: +44 (0)1604 663399

www.universal-science.com Universal Science Ltd Tel: +44 (0)1908 222211

Solder

www.indium.com Indium Corporation Tel: +44 (0) 1908-580400

Switched Mode Power Supplies

www.citapower.com Bias Power, LLC Tel: 001 847.419.9118

Thermal Management & Heatsinks

www.abl-heatsinks.co.uk ABL Components Ltd Tel: +44 (0) 121 789 8686

www.dau-at.com Dau GmbH & Co KG Tel: +43 3143 23510

Thyristors

www.proton-electrotex.com/ Proton-Electrotex JSC/ Tel: +7 4862 440642;

Industrial sensors The eyes and ears of automation

DigiKey has a wide range of high-quality industrial sensors from leading suppliers that guarantee the perfect match for any application. Find the inventory, content, and expertise you need. We are your industrial sensor experts.

You'll find the sensors to fit your needs at digikey.co.uk/industrial-sensors



we get technical

DigiKey is a franchised distributor for all supplier partners. New products added daily. DigiKey and DigiKey Electronics are registered trademarks of DigiKey Electronics in the U.S. and other countries. © 2024 DigiKey Electronics, 701 Brooks Ave. South, Thief River Falls, MN 56701, USA

SECIA MEMBER