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Next-Level Prototyping with Arduino UNO™ Q

GOODSKY's GQ: Raw Materials Drive Design

DINKLE: Lever Clamps for Smart Wiring

CONTENTS

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14 | Next-Level Prototyping with Arduino UNO™ Q

Qualcomm® is acquiring Arduino to strategically establish Dragonwing™ Edge-AI SoCs in the IoT space and to create a powerful platform for rapid prototyping. Following the development phase, CODICO leverages the Qualcomm partner network and offers SOMs, SBCs, as well as edge computers for production projects.

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Focus on sustainability. Our vSME report

»What gets measured gets managed.«
Peter F. Drucker

At CODICO, we are committed to this principle. For years, we have been actively addressing sustainability and want to transparently show what we have achieved so far. The sustainability report according to vSME (Voluntary Small and Medium Enterprise European Sustainability Reporting Standards) provides us with a European framework to present our sustainable actions in a clear, structured, and verifiable way.

Although the report is voluntary, it is aligned with the European Sustainability Reporting Standards (ESRS), developed by the European Financial Reporting Advisory Group (EFRAG). This allows us to report on sustainability transparently without the complexity of a full report under the Corporate Sustainability Reporting Directive (CSRD).

With vSME, our corporate responsibility becomes measurable, controllable, and decision-relevant.

By addressing double materiality – asking »What affects us?« and »What do we affect?« – and considering impacts, risks, and opportunities (IROs), we achieve greater transparency. The report provides insights into environmental and social impacts as well as financial sustainability risks. This makes it an important foundation for informed decisions, responsible actions, and long-term value creation.

The insights gained are not just analysis, they are a call to action. We have already implemented numerous concrete measures in the identified areas.

Would you like to learn more about our sustainability initiatives?
We would be happy to provide you with our voluntary sustainability report. Contact our Quality Management team or visit our website at *www.codico.com.*

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Karin Krumpel
CEO CODICO

vSME Makes Responsibility a Basis for Decision-Making.

Editorial

Dear Readers,

The world of electronics has always been defined by rapid change, but rarely has its complexity felt as tangible as it does today. We're talking about AI-driven design, fragile global supply chains, and technological leaps that would have seemed like science fiction just yesterday. The word »complexity« is used almost to the point of overuse and in electronics distribution, we experience firsthand what it truly means every single day. Yet amid all this constant motion, one thing stands out to me as more valuable than ever: the stability of long-standing human relationships in a professional context.

Every day, I see just how important the collaboration between customers, suppliers, and us as a design-in distributor really is. Success isn't built on products alone – it comes from the coordinated efforts of many stakeholders. It's not just about delivering a component on time. It's about a deep mutual understanding between suppliers, us as the distributor, and our customers. And it's about the tireless work happening behind the scenes.

Each party plays a unique role: suppliers bring innovation and quality, customers contribute their requirements and expertise, and we as a design-in distributor connect both sides – creating transparency and ensuring that processes run reliably. This kind of collaboration demands attention, commitment, and a shared drive toward sustainable solutions.

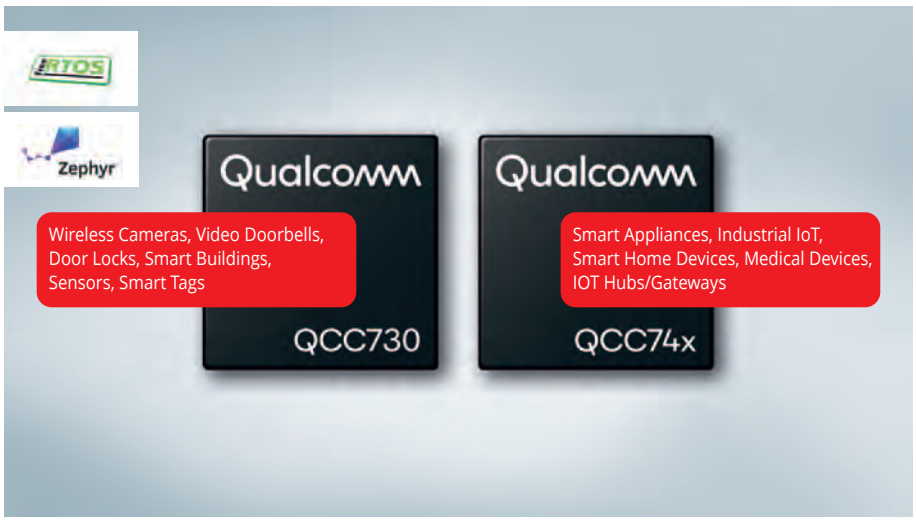
For me, being part of this network – built on trust, expertise, and shared goals is a true source of motivation. I value the spirit of partnership and the stability it creates. It provides direction, builds confidence, and turns complex processes into dependable collaboration. With this in mind, we see ourselves not just as a distributor, but as a partner you can rely on. And complexity becomes something we work together to transform into something positive, every single day.

Karin Krumpel, CEO

MORE POWER AND MEMORY

Qualcomm Technologies Expands Wi-Fi IoT SoCs

Qualcomm Technologies is continuously expanding its portfolio in the field of Wi-Fi IoT. In this article, we focus on the underlying SoC components, with particular emphasis on the new Qualcomm® QCC743-4 and Qualcomm® QCC748-3 SoCs, which feature increased memory to meet the growing demands of memory-intensive IoT applications.



First, we will take a general look at the two component families, Qualcomm® QCC730 and Qualcomm® QCC74x, which could hardly be more different in terms of their architecture and features.

The QCC730 SoC supports Wi-Fi4 on the 2.4GHz and 5GHz bands and is based on a Cortex-M4 architecture. Thanks to TSMC's advanced 22nm Ultra-Low-Leakage (ULL) process and Qualcomm's new power management, power consumption is reduced by up to 88% compared to previous solutions. This results in significantly extended battery life, which is particularly beneficial for applications such as wireless cameras, video doorbells, door locks, sensors, smart buildings, and smart tags.

The QCC74x SoC family, on the other hand, is based on a RISC-V architecture and supports Wi-Fi6 as well as Bluetooth 5.4 and IEEE 802.15.4 (Thread & Zigbee ready). However, there is a big

TABLE 1: QCC-74X COMPARISON SHEET

	FEATURE	QCC-743-1/-4	QCC-748-2/-3
Processor	32-bit RISC-V @ 325MHz	Y	Y
Onboard Memory	128KB ROM, 484KB SRAM	Y	Y
SiP Memory (Optional)	4/8/16MB pSRAM (optional)	N	4MB / 8MB
	4/8MB NOR Flash (optional)	0 / 4MB	N
Wi-Fi Standard	1× 1 2.4GHz 802.11b/g/n/ac/ax (Wi-Fi6)	Y	Y
Bluetooth Standard	Bluetooth Low Energy v5.4	Y	Y
IEEE 802.15.4 Standard	Thread and Zigbee-ready	Y	Y
Operating Temperature	-40 to +85°C	Y	Y
Ethernet	RMII (via GPIO)	N	Y
Audio Codec	1× DAC (Speaker) / 1× ADC (Mic) via GPIO	N	Y
Video Codec	MJPEG Encoding	N	Y
Camera Interface	DVP (via GPIO)	N	Y
Display Interface	DBI (via GPIO)	N	Y
GPIO	19 (5×5 QFN) or 35 (7×7 QFN)	Up to 19	Up to 35
SDIO	SDIO 2.0 Slave, SD Card Interface	Y	Y
USB	1×	N	Y
UART	2×	Y	Y
CAN (ISO 11898)	1×	Y	Y
SPI	Master / Slave	Y	Y
I²C	2×	Y	Y
I²S	Master / Slave	Y	Y
PWM	1× PWM (4x channels)	Y	Y
QSPI	XiP QSPI (Flash)	Y	Y
Timers	RTC, 2× 32-bit, 1× 16-bit	Y	Y
IR Controller	Receiver	Y	Y
ADC	General Purpose 12/14/16-bits	Y	Y
DAC	General Purpose 12-bit	Y	Y
JTAG	via GPIO	Y	Y

difference between the two versions within this family, the QCC743 and QCC748. Although both SoCs offer numerous interfaces such as QSPI, SPI, SDIO, UART, I2C, I2S, CAN, ADC, and DAC, the QCC748 additionally supports multimedia functions and interfaces for video and audio applications as well as USB and RMII, making it particularly suitable for smart appliances, industrial IoT, smart home devices, and medical devices.

The suffix -1/2/3/4 indicates the SiP (System in Package) memory configuration in which the QCC74x SoCs are delivered. For example, the QCC743-4 has 4MB of flash memory integrated into its housing, compared to its little brother, the QCC743-1. In the QCC748-3, the PSRAM* (Pseudo-Static RAM) memory has been upgraded from 4 to 8MB compared to the QCC748-2. However, the package shapes for the two families remain unchanged: 5×5mm QFN-40 for QCC743 and 7×7mm QFN-56 for QCC748.

A direct comparison of the features of the QCC74x device family can be found in the adjacent Table 1.

The following table 2 provides an interesting direct comparison of the QCC74x and QCC730 device families. It shows that the QCC730 clearly plays to its strengths with extremely low power dissipation, while the QCC74x family scores

TABLE 2: SoC COMPARISON SHEET

	QCC730	QCC743	QCC748
Processor	Cortex M4F @ 60MHz with FPU	RISC-V @ 325MHz with DSP and FPU	RISC-V @ 325MHz with DSP and FPU
Memory	640KB SRAM	128KB ROM, 484KB SRAM	128KB ROM, 484KB SRAM
NVM (Non-Volatile Memory)	1.5MB RRAM	Flash/PSRAM SIP optional, External Flash	Flash/PSRAM SIP optional, External Flash
GPIO	Up to 15	Up to 19	Up to 35
Wi-Fi Standard	1×1, 802.11a/b/g/n (Wi-Fi4)	1×1, 802.11b/g/n/ax (Wi-Fi6)	1×1, 802.11b/g/n/ax (Wi-Fi6)
Frequency Bands	2.4GHz, 5GHz	2.4GHz	2.4GHz
Channel Bandwidth	20MHz	20MHz, 40MHz	20MHz, 40MHz
Voltage	Input: 2.6 to 3.6V, I/O: 1.8 / 3.3V	Input: 2.9 to 3.6V, I/O: 1.8 / 3.3V	Input: 2.9 to 3.6V, I/O: 1.8 / 3.3V
Temperature	-20 to +85°C	-40 to +105°C	-40 to +85°C
Active TX Power	64mA @ 1Mbps (802.11b) 44mA @ MCS3 (802.11n)	372mA @ 1Mbps (802.11b) 262mA @ MCS9 (802.11ax)	372mA @ 1Mbps (802.11b) 262mA @ MCS9 (802.11ax)
Active RX Power	4.2mA @ 1Mbps (802.11b) 4.2mA @ MCS3 (802.11n)	55mA @ 1Mbps (802.11b) 77mA @ MCS9 (802.11ax)	55mA @ 1Mbps (802.11b) 77mA @ MCS9 (802.11ax)
Sleep Power	6.0µA Deep Sleep	64µA Deep Sleep 2.1µA Hibernate	64µA Deep Sleep 2.1µA Hibernate
DTIM	DTIM10: 26µA	DTIM10: 185µA (RC 32K)	DTIM10: 185µA (RC 32K)
Bluetooth Core Specification	NA	5,4	5,4
802.15.4	NA	Yes	Yes
Interfaces	QSPI, SPI, UART, I2C	QSPI, SPI, SDIO, UART, I2C,I2S, CAN	QSPI, SPI, SDIO, UART, I2S,CAN, RMII, USB
Multimedia	NA	NA	Display, Camera, Spkr/Mic, Video
Packaging	WLCSP, 3.3.×3.5mm	QFN-40, 5×5mm	QFN-56, 7×7mm

points with its tri-radio architecture and numerous interfaces and multimedia functions.

In addition to FreeRTOS, all devices now also support the increasingly popular open-source real-time operating system Zephyr.

Development kits can be found as usual on our support page:
https://downloads.codico.com/misc/wifi-modules

To do this, open the »IoT« product matrix and then select the »DevKit« sheet. Here you can order all kits free of charge. Under the »Wi-Fi4« and »Wi-Fi6« sheets, you will also find all module solutions for the SoCs mentioned.

A01

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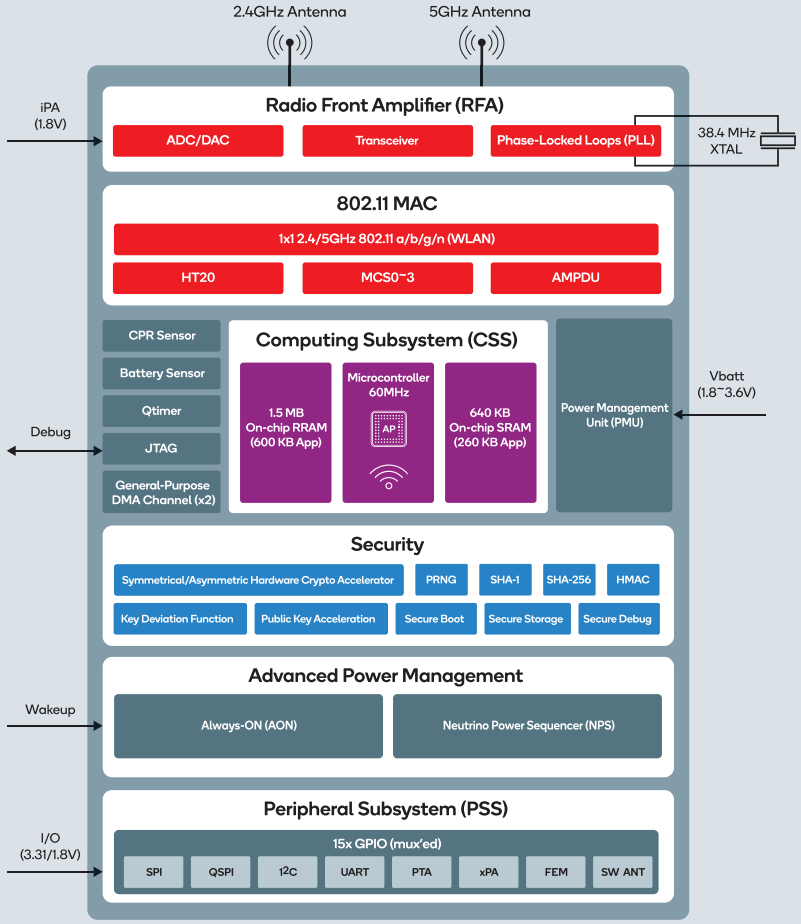
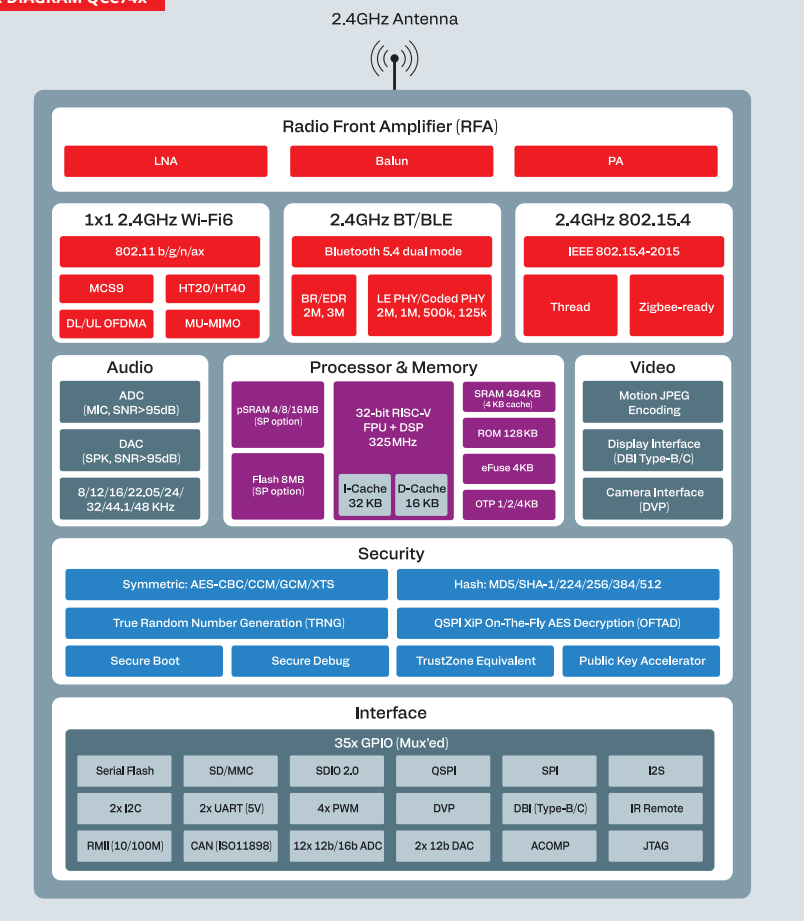
**PSRAM (Pseudo-Static Random Access Memory) is a type of memory that combines the advantages of DRAM (high density, low cost) and SRAM (easy control) by using DRAM cells with integrated refresh circuitry to appear like SRAM and avoid external refresh logic.*

BLOCK DIAGRAM QCC730



BLOCK DIAGRAM QCC74x



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POWER MANAGEMENT

Ultra Low Power Load Switching for Next Generation Electronics

As modern electronic systems continue to demand higher integration, longer battery life and tighter power budgets, the need for advanced load switch ICs has become more critical than ever. Whether in wearables, IoT sensor nodes or industrial modules requiring precise power sequencing, designers increasingly look for solutions that deliver ultra low power consumption, reliability, and intelligent behaviour.

The new TOREX XC8115 and XC8116 series meet these requirements head on. These 6V, 1A ultra low power load switch ICs incorporate integrated protection, externally adjustable soft start, and near zero quiescent/standby current. With typical supply currents of 0.0µA in both active and standby modes, the XC8115/XC8116 establishes a new benchmark for power path control.

Architecture Optimized

At the heart of the XC8115/XC8116 series is an integrated P channel MOSFET, optimized for low ON resistance across the entire 1.5V to 6.0V input range. In the tiny DFN1515 6A package, ON resistance is as low as 130mΩ at VIN = 5.0V, minimizing conduction losses even at higher load currents.

Unlike conventional load switches that draw microamps of bias current in standby, the XC8115/XC8116 architecture eliminates unnecessary internal current paths. Both operating and standby current levels remain effectively zero, making these devices exceptionally well suited to battery powered and energy harvesting systems where every nanoamp matters.

Figure 1 illustrates the typical application configuration, highlighting the VIN and VOUT connections and the external CSS capacitor used to define the soft start time. By choosing an appropriate CSS value, designers can control the output voltage ramp up and reduce inrush current when charging downstream capacitors.

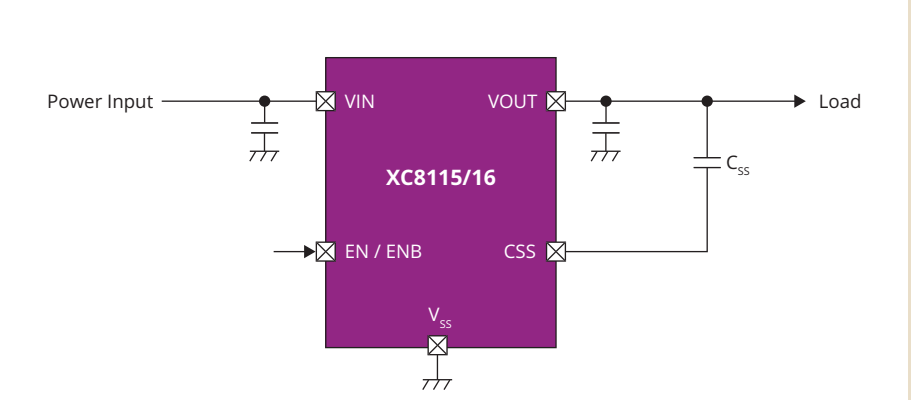

Figure 1: XC8115/XC8116 Functional Block Diagram

PRACTICAL APPLICATION EXAMPLES

Figure 2 – RF & Sensor Load Switching
This example illustrates independent control of RF and sensor power domains using XC8115A devices. Each IC enables complete power disconnection with 0µA standby current, significantly reducing leakage during sleep mode. The adjustable soft start ensures smooth output ramping and helps maintain stable operation of the MCU and upstream supplies.

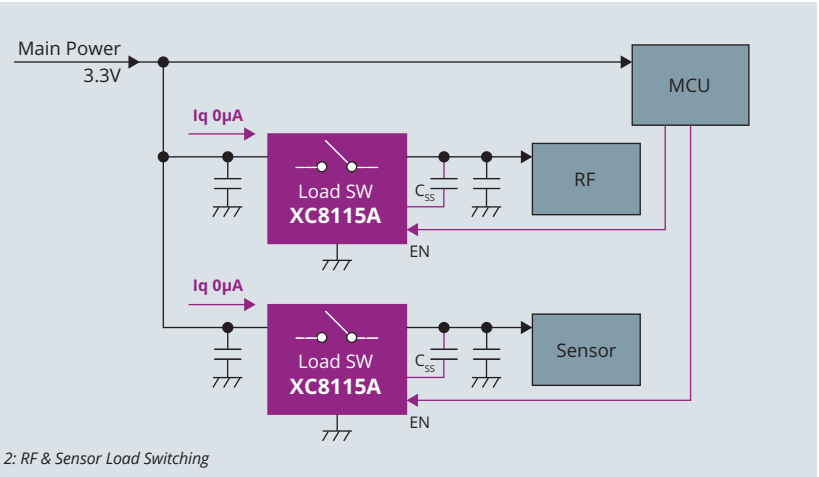

Figure 2: RF & Sensor Load Switching

Figure 3 – Power Multiplexer (Battery/Source Selection)
This example uses XC8116A (active high) and XC8116B (active low) devices to construct a compact power multiplexer. Benefits include:

- Reverse-current prevention during standby
- Safe switching between rails or batteries
- A simple single signal control interface

This approach provides a small, efficient alternative to discrete MOSFET or ideal diode circuits.

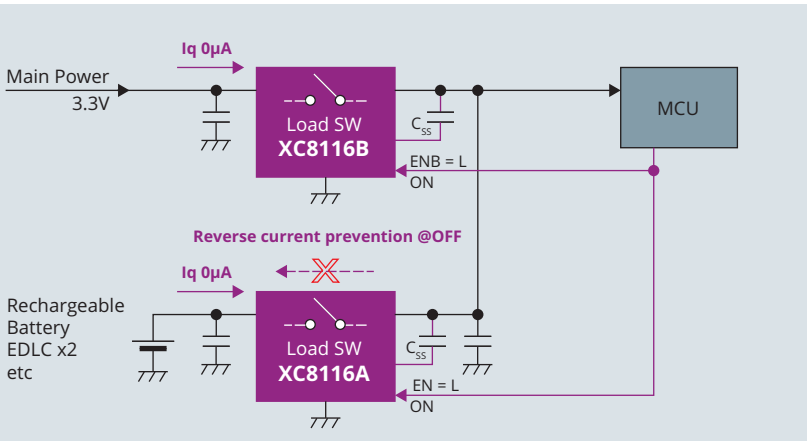

Figure 3: Power Multiplexer (Battery/Source Selection)

Soft-Start

The XC8115/XC8116 series includes an externally adjustable soft start function that enables precise management of the output ramp up. Adding a capacitor to the CSS pin allows designers to tailor:

- Startup ramp rate
- Input rail stability
- Inrush current behaviour
- Power rail sequencing

Soft start times can be set from microseconds up to several seconds, enabling everything from fast system wake up to controlled power up of sensitive loads. This improves system stability, reduces stress on upstream supplies, and helps ensure long term robustness of both the power source and the load.

Two Variants for Two Distinct Application Needs

XC8115 – Fast and Clean Power Down

The XC8115 integrates a CL discharge function, which automatically discharges the output capacitor during standby. This provides:

- Guaranteed power down behaviour
- Predictable restart conditions
- Elimination of residual charge on VOUT

It is ideal for subsystems requiring deterministic shutdown, such as sensors.

XC8116 – Reverse Current Prevention in Standby

The XC8116 is designed to prevent reverse current flow when VOUT exceeds VIN during standby mode. This makes it an excellent choice for:

- Power multiplexing
- Multi source systems

Unlike ideal diode type solutions that consume continuous bias current, the XC8116 activates reverse-current prevention only in standby, enabling near-zero quiescent operation.

Flexible Enable Logic

Both series offer selectable enable logic:

- A type: active high
- B type: active low

This ensures compatibility with a broad range of MCU architectures without requiring additional logic components.

Compact Packaging

To support space-constrained, high-density applications, the XC8115/XC8116 series is offered in:

- DFN1515 6A (1.5×1.5×0.38mm)
- SOT 25

Both packages are EU RoHS compliant and rated for industrial operation from –40°C to +105°C.

Enabling Smarter, More Efficient Power Systems

The XC8115/XC8116 series is ideal for:

- Wearables
- IoT devices
- Industrial sensing
- Multi rail power architectures
- Battery or solar powered systems

By combining near-zero standby current, flexible soft start, robust protection features, and application specific variants, the series enables a new class of ultra efficient power rail designs.

Comparison with Other TOREX Load Switch ICs

TOREX offers a wide range of load switch and reverse current prevention ICs that cover:

- Standard load switches
- Ideal diode type solutions
- Standby only reverse-current prevention (XC8116)

This breadth enables designers to select the perfect balance of functionality, efficiency, and cost for any application.

The XC8115 and XC8116 represent a major advancement in ultra low power load switching. With adjustable soft start, short circuit protection, robust enable options and targeted functional differences, the series is well equipped for next generation low power designs.

The XC8115 provides clean power down, while the XC8116 offers standby controlled reverse-current prevention, giving system designers precise control over how each rail behaves in both active and standby states.

Together, these devices help extend battery life, improve system reliability, and simplify power path design across a wide range of modern electronics.

Samples and evaluation boards are available via CODICO.

A02

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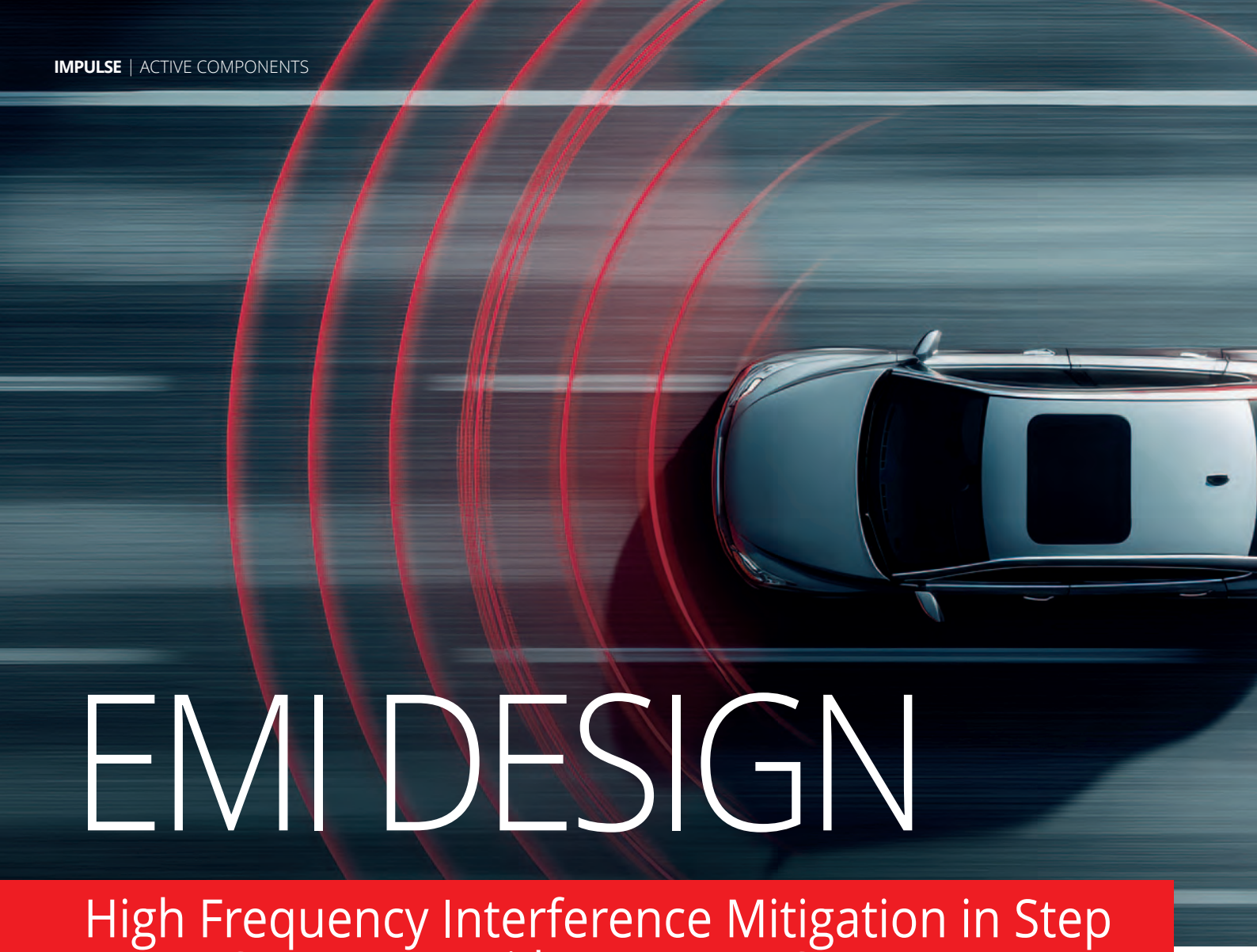


EMI DESIGN

High Frequency Interference Mitigation in Step Down Converters with Hot Loop Components

Modern step-down converters are becoming increasingly efficient. At frequencies in the several hundred MHz range, however, they can generate significant Electromagnetic Interference (EMI). New IC designs and clever layouts are already able to compensate for such disturbances. By implementing high-frequency ferrite beads, interference can be further effectively eliminated.

In this article, the effectiveness of ferrite beads is demonstrated using an oscilloscope. Properly placed ferrite beads filter out most of the high-frequency interference, thereby preventing its radiation via the cable harness. This is necessary to improve the design of EMC filters and the layout of printed circuit boards so that they comply with Class 5 automotive standards according to CISPR 25.

Automotive Step-Down Converters with Symmetric V_{IN} Pin-out

Symmetric V_{IN} pin-out achieves the higher requirements of CISPR 25 Class 5 by employing a mirrored arrangement of the hot loop multilayer ceramic capacitors (MLCCs C1, C2, C3, and C4). Current drawn from the V_{EMI} filter is symmetrically divided in the same direction into the IC, cancelling the magnetic field between the two V_{IN} traces. This reduces the overall magnetic field radiated to the environment and allows for effective placement of hot loop components, as shown in figure 1.

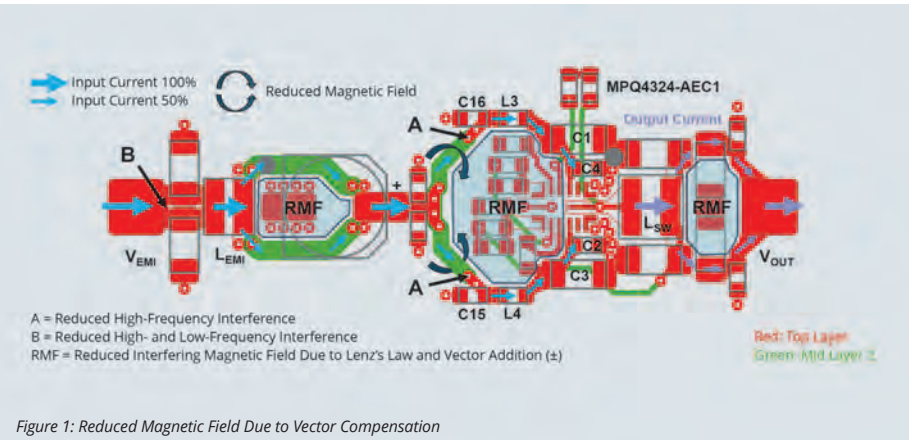
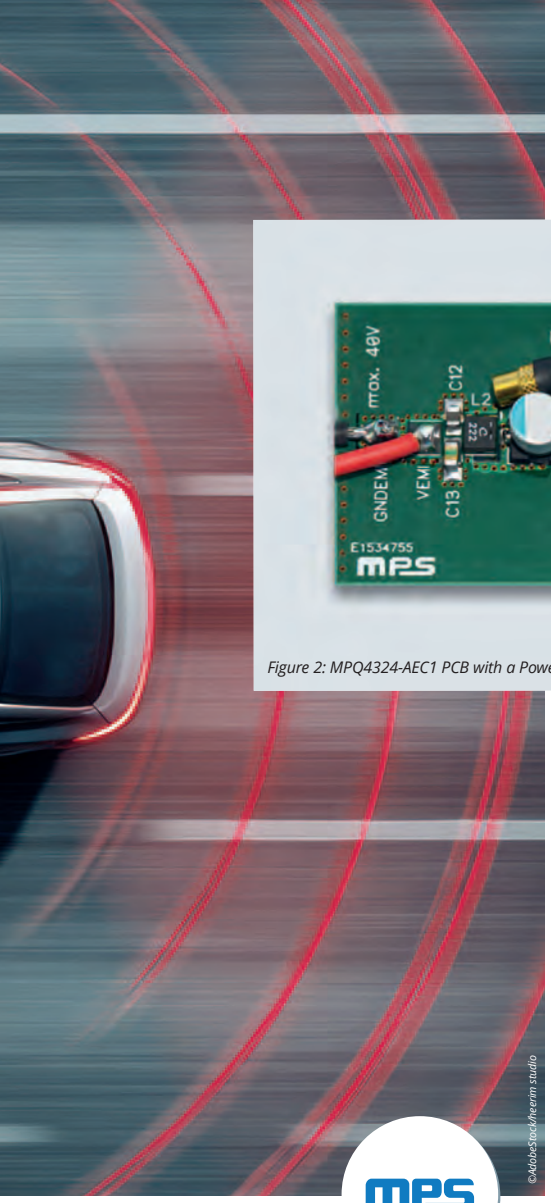


Figure 1: Reduced Magnetic Field Due to Vector Compensation



The MPQ4324-AEC1 is a family of configurable-frequency (350kHz to 2.5MHz), synchronous, step-down switching converters with symmetric V_{IN} pin-out, as well as integrated, internal high-side and low-side power MOSFETs (HS-FETs and LS-FETs, respectively).

The family provides 0.5A to 3A of continuous output current (V_{OUT}) and 4A of highly efficient peak I_{OUT} with peak current mode control. The MPQ4324-AEC1's three package variants feature two hot loop pins for V_{IN} and two hot loop pins for PGND, which achieve reduced EMI.

Other automotive step-down converters with symmetric V_{IN} pinout include the MPQ4334-AEC1, MPQ4326B-AEC1, MPQ4371-AEC1, and MPQ4385-AEC1, which offer a wide 0.5A to 25A range and optimized MOSFET control for a switch-node signal with low ringing.

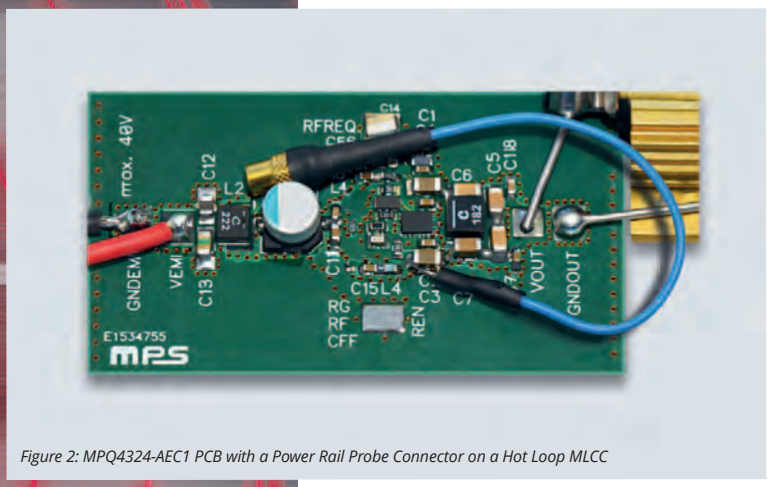


Figure 2: MPQ4324-AEC1 PCB with a Power Rail Probe Connector on a Hot Loop MLCC

Switch-Node and Hot Loop Measurements of the MPQ4324-AEC1

Figure 2 presents a 4-layer PCB with a coaxial cable connection, enabling transient voltage waveform capture using a 1GHz bandwidth power rail probe. The high-frequency voltage waveform at both the switch node and the hot loop directly influences the converter's EMC performance. Therefore, it is recommended to employ a power rail probe for measuring small, high frequency voltages directly at the component. The shielded coaxial connection minimizes coupled interference.

Component Placement of the Switching Inductor, Hot Loops, and Ferrite Bead

Figure 3 illustrates the optimal placement of the switching inductor (L1), the four hot loops (C1 – C4), and the low-pass ferrite beads (L3, L4) together with the low-pass multi-layer ceramic capacitors (C15 and C16). This symmetrical layout is deliberately engineered to satisfy stringent automotive EMC specifications such as CISPR 25 Class 5. The hot loops have a high di/dt, and the parasitic inductance in these hot loops must be kept as low as possible to minimize the ringing amplitude (Figure 4 – 6).

Table 1 shows the component selection for the SW node and the hot loop in a 2.2MHz switching frequency (f_{SW}) design.

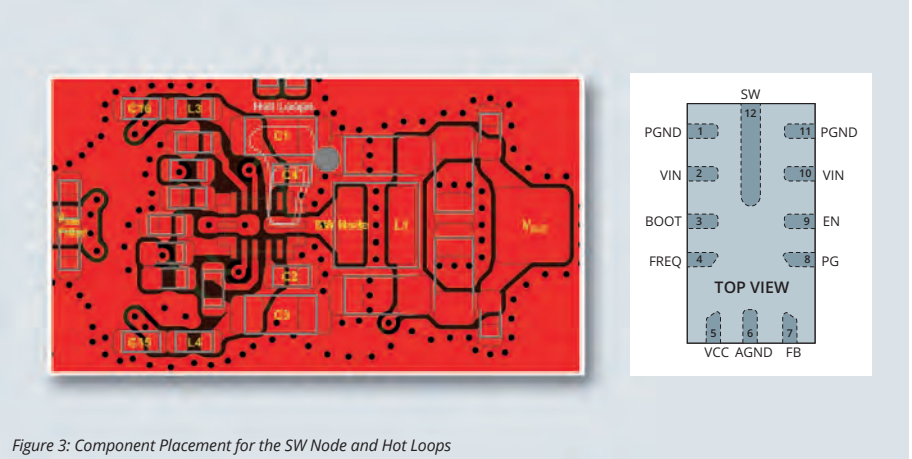


Figure 3: Component Placement for the SW Node and Hot Loops

TABLE 1: COMPONENT SELECTION FOR 2.2MHz f_{SW} DESIGN

REFERENCE DESIGNATOR	VALUE	RECOMMENDATION
L1	1.8µH R_{DC} = 12.6mΩ, I_{RMS} = 7.2A, 4×4×2.5mm	• Select an inductance that is as flat as possible to create a vertical radiating antenna with the lowest possible height. • Use an inductor with a marker on top of the package for the inner shielded winding. The marker must point towards the switch node. • Enclose the SW inductance with the output voltage (V_{OUT}) MLCCs to provide additional shielding.
C2, C4, C15, C16	100nF 50V 0402	• Place C2 and C4 as close to the IC package as manufacturing allows. • Connect the V_{EMI} filter output directly to the positive pin of C15 and C16. • Maximize the capacitances for the selected SMT package size.
C1, C3	4,7µF 50V 1206	• Place C1 and C3 close to C2 and C4. • Maximize the capacitances for the selected SMT package size.
L3, L4	0402 0.5×I_{OUT}	• Select a ferrite bead with the highest impedance at the measured ringing frequency in figure 5.

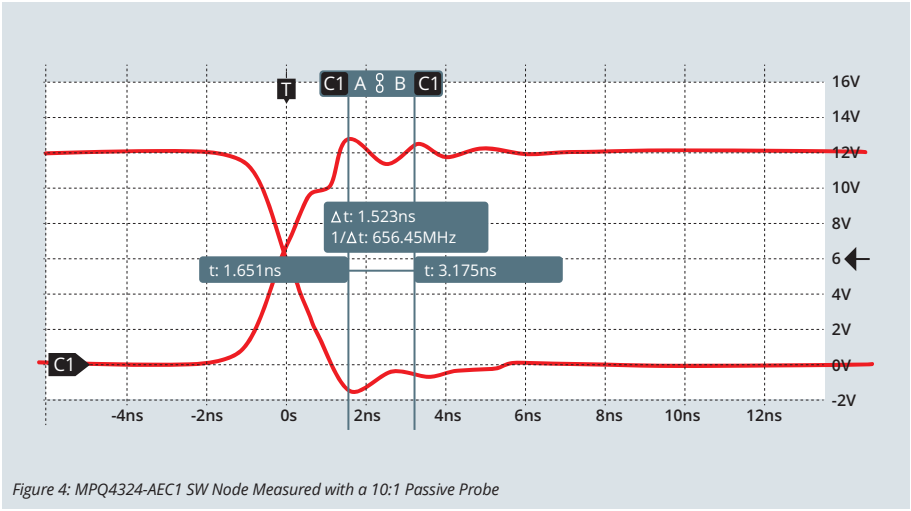


Figure 4: MPQ4324-AEC1 SW Node Measured with a 10:1 Passive Probe

Measurement on the Switching Inductor (L1)

Figure 4 shows the SW node measured with a 10:1 passive probe, with a 1GHz bandwidth on the probe tip. The switch-node voltage on the SW pin has rising and falling times of about 1ns. With these rising and falling times, the MPQ4324-AEC1 can achieve efficiencies approaching 97%.

The observed 656MHz ringing frequency results from a combination of the parasitic series inductances in the hot loop, the hot loop MLCCs, and the MOSFET transistors' size and package. Typically, step-down converters with higher nominal currents have a lower ringing frequency (and vice versa). In comparison, the MPQ4371-AEC1 family is available in adjustable versions from 6A to 11A of nominal current, with a ringing frequency of about 270MHz. For V_{EMI} filter design, ferrite beads are well-suited for filtering higher frequencies, while power inductors better cover lower frequency ranges.

Measurements on the Hot Loop Multi-Layer Ceramic Capacitors (MLCCs)

100nF Hot Loop MLCC (C2)

Figure 5 shows the 656MHz ringing frequency throughout the PCB with a 300mV peak-to-peak amplitude measured on both pins of the 100nF hot loop multi-layer ceramic capacitor (C2). The layout must be routed to ensure that the ringing frequency cannot be radiated via unshielded PCB antennas, such as traces, vias, polygons, and components. The EMI voltage (V_{EMI}) filter prevents the frequency spectrum of the rectangular SW node waveform and ringing frequency from being radiated into the wiring harness.

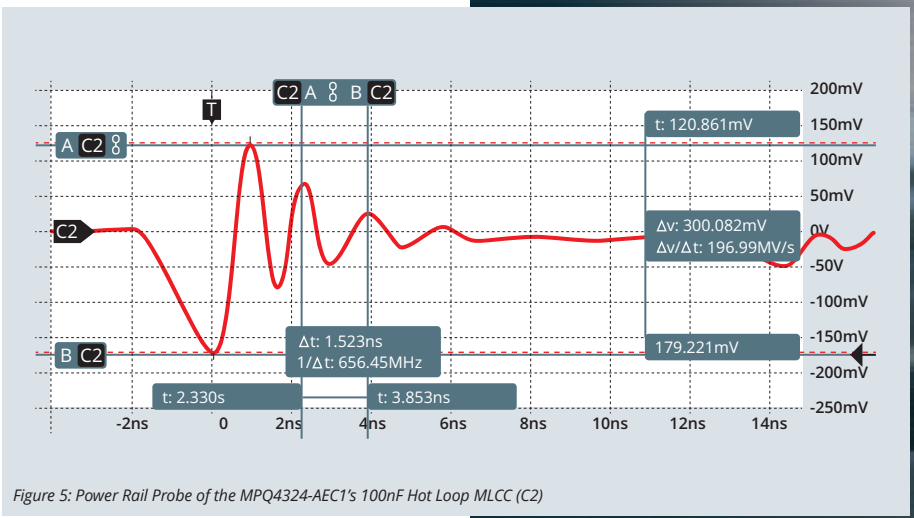


Figure 5: Power Rail Probe of the MPQ4324-AEC1's 100nF Hot Loop MLCC (C2)

4.7µF Hot Loop MLCC (C3)

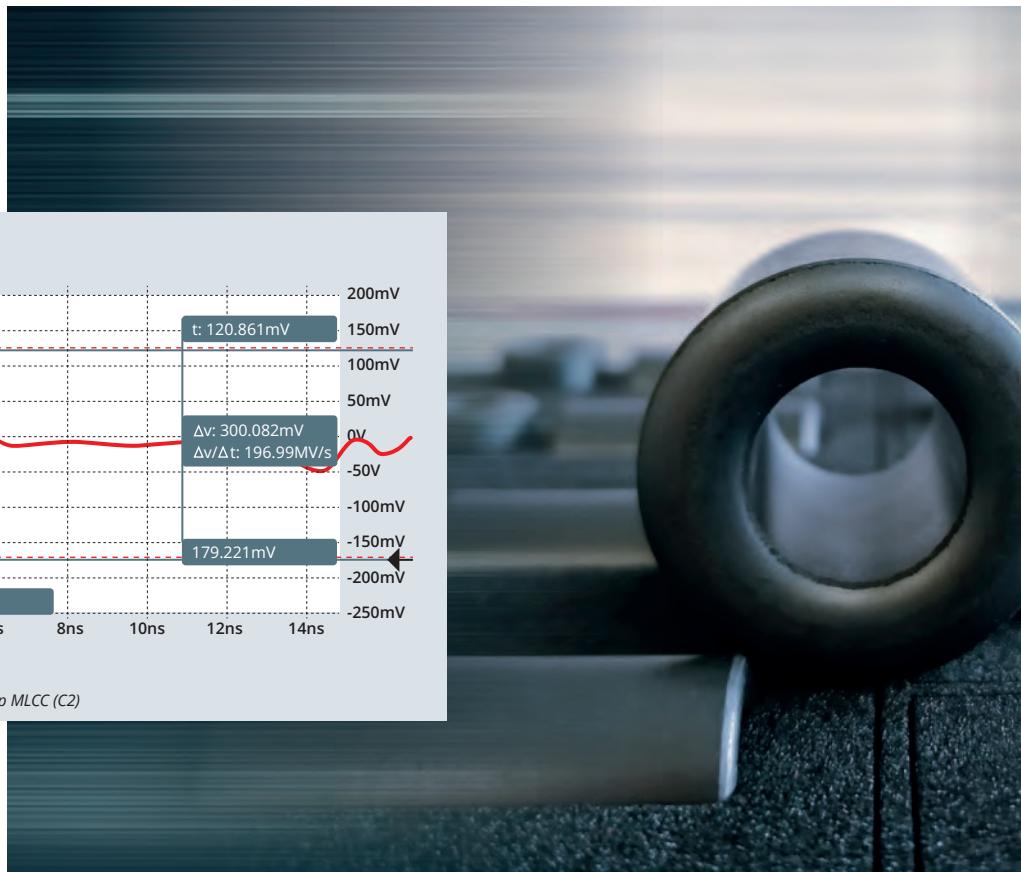
Figure 6 shows the 656MHz ringing frequency with a 72mV peak-to-peak amplitude measured on the 4.7µF hot loop multi-layer ceramic capacitor (C3). Although C2 and C3 are connected on the same V_{IN} net, the amplitude at C3 is significantly lower. At 656MHz, the trace between C2 and C3 functions as an inductive series impedance for the low-pass filter with C3, where there is a voltage drop that reduces the amplitude. This demonstrates how correctly placed traces can effectively work as the desired low-pass filter, and reduces the 300mV peak-to-peak amplitude to 72mV for overall lower radiated emissions.

100nF Hot Loop MLCC (C15)

Figure 7 shows the low-pass filter output of a ferrite bead (L4) measured at the 100nF hot loop multi-layer ceramic capacitor (C15). The filter attenuates the 656MHz ringing amplitude to a negligible level for EMC, and removes the high-frequency in C15. Radiated emissions at 656MHz and comparable frequencies no longer exist in the V_{EMI} filter on traces, vias, components, and in the wiring harness.

Significance of the EMI Voltage Filter

The V_{EMI} filter is a two-stage low-pass filter, where MLCCs with ferrite beads attenuate the higher frequencies in the range of several hundred MHz. The power inductor (L2) (Figure 2) with



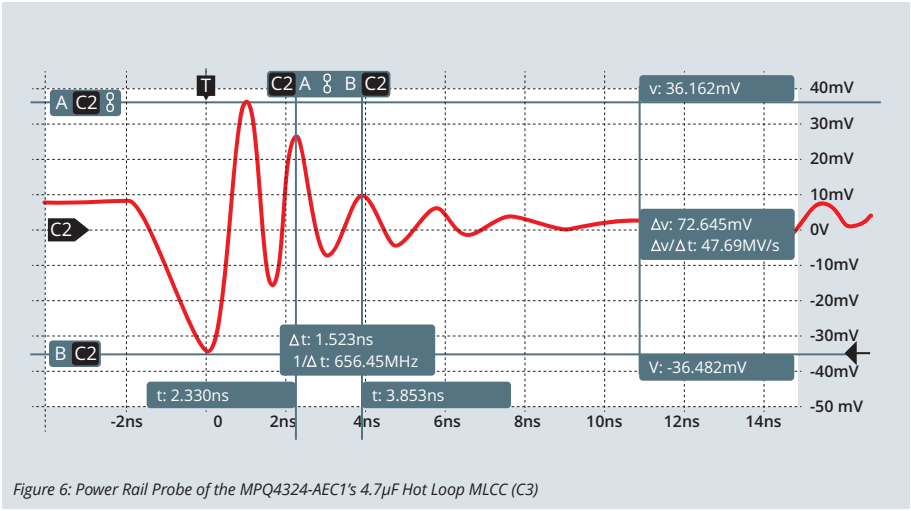


Figure 6: Power Rail Probe of the MPQ4324-AEC1's 4.7µF Hot Loop MLCC (C3)

the MLCCs attenuates the lower frequency ranges. For step-down converters, the filter with the power inductance is more important since CISPR 25 Class 5 requirements cannot be met without the power inductance.

In certain applications, especially at low ringing frequencies (about <300MHz), the ferrite bead can be omitted. A V_{EMI} filter without series impedance (for example, a power inductor and/or ferrite bead) is not able to sufficiently meet CISPR 25 Class 5. The V_{EMI} filter recommendation can usually be found in most data-sheets, depending on the application specifications.

Ferrite Bead Placement

There are three possible ferrite bead placements on the PCB:

- **Two ferrite beads** (L3 and L4) are placed directly next to the current loops and split the V_{IN} current. This reduces the current by half, allowing for a smaller form factor. The advantage of this placement is that high frequencies are filtered directly at the current loop, preventing them from propagating across the PCB.
- **A single ferrite bead** can be placed on the right side of the V_{EMI} filter inductor to prevent the V_{EMI} filter inductor, in combination with parasitic inductances and capacitances, from becoming a radiator or oscillator.
- **The ferrite bead filter can be positioned on the left side of the power inductor**, thereby reducing the V_{IN} inrush currents and minimizing transients in the large 2.2µF x2 MLCCs. These MLCCs, in combination with the V_{EMI} filter inductance, form a low-pass filter that completely filters out high-frequency leakage currents.

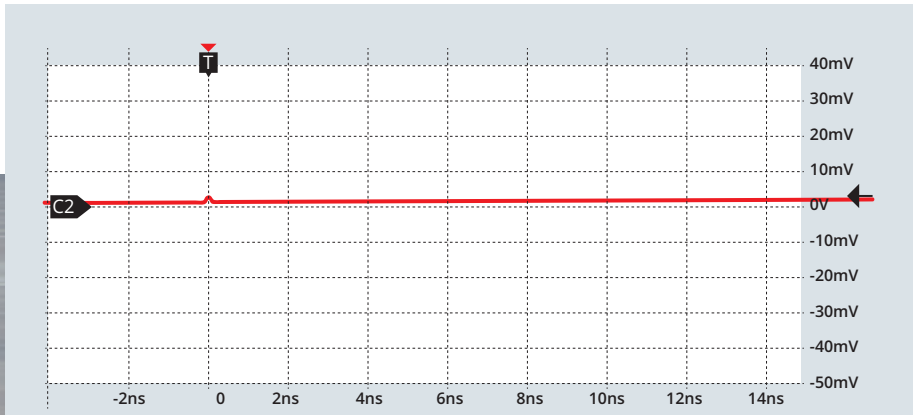


Figure 7: Power Rail Probe of the MPQ4324-AEC1's 100nF Hot Loop MLCC (C15)

Overview

This article has demonstrated how high-frequency ferrite beads can be leveraged to suppress the majority of high-frequency interference in automotive step-down converters. By adopting a symmetrical placement of multilayer ceramic capacitors, traces, and vias within the hot loop architecture, designers can meet stringent EMC requirements such as CISPR 25 Class 5. Key design guidelines include:

- **Ferrite bead selection:** Choose a bead that delivers the highest impedance at the ringing frequency identified in the layout.
- **Capacitance optimization:** Maximize the capacitance within the constraints of the SMT package to enhance low-frequency filtering.
- **V_{EMI} filtering**: Always incorporate a V_{EMI} filter with series impedance to further dampen conducted emissions.
- **Early EMC validation:** Initiate EMC testing at the earliest project stage to avoid costly redesign iterations.

CODICO provides all the required active and passive components for the step-down converter and the filters, and supports development projects with technical expertise.

A03

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NEW ERA

Next-Generation Prototyping

Arduino UNO™ Q Dual-Brain Board

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Qualcomm Technologies, Inc. acquires Arduino to promote their Dragonwing™ Edge AI SoCs to a vast IoT ecosystem and to secure a rapid prototyping platform for Edge AI applications.

In October 2025 Qualcomm Technologies, Inc. announced that they had acquired Arduino, the world renowned Italian tech company. It was another significant step for Qualcomm in becoming a leading provider to the internet of things market, and a huge leap for Arduino in terms of resources it can now leverage to offer its users more powerful tools.

Over more than 20 years, Arduino has built a strong reputation as a technology enabler for a massive community of over 33 million users. Its value proposition is to make complex electronics accessible to hobbyists, makers, educators and companies via open-source hardware and software designs. Arduino MCU and sensor boards are also broadly adopted by engineers for prototyping concepts before committing their ideas to mass production.

By onboarding Arduino into the Qualcomm organization, the footprint of potential users for Qualcomm Dragonwing™ SoCs and enabling technologies increases. Additionally, as the demand for Edge AI increases, Qualcomm now has the possibility to launch innovative Edge AI solutions based on the accessible Arduino development environment to complement Arduino's portfolio.

Arduino will continue to enable the IoT community with their MCU and sensor solutions leveraging the semiconductor vendors they used in the past. Additionally, their commitment to the open-source community remains.

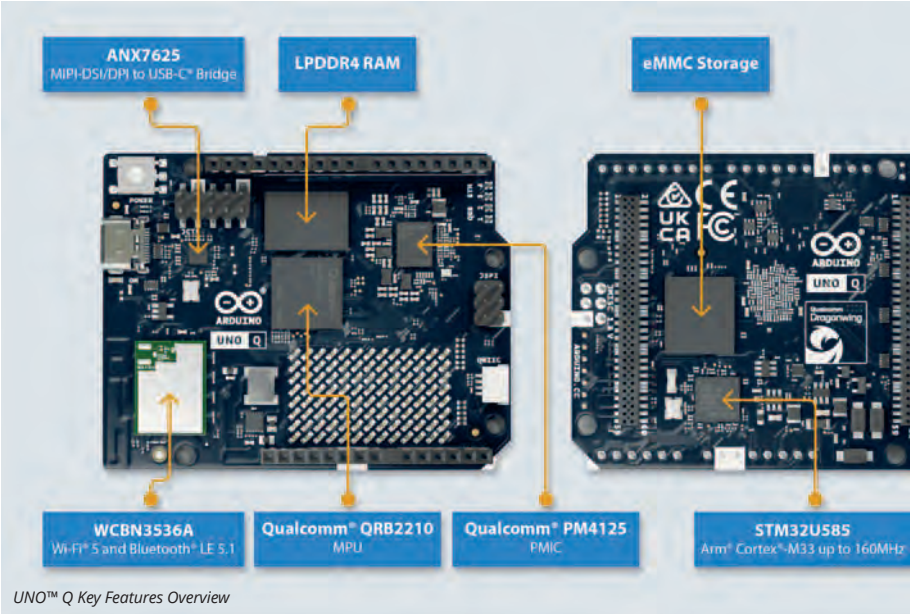
Qualcomm Technologies, Inc. will, however, complement the traditional Arduino IoT solutions with a new category of products that deliver advanced use cases such as multi-camera computer vision, edge AI and high-performance compute together with real-time sensing and actuation. Qualcomm recognizes the trend for AI inference at the edge in the industrial market and will use this new portfolio of Arduino platforms based on their technologies to get early traction.

When the acquisition was announced, a first example of this new strategy for the Edge AI category was unveiled: the Arduino UNO™ Q .

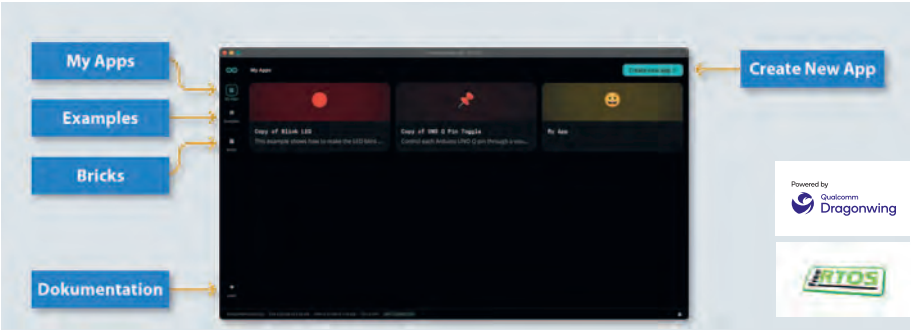
Arduino UNO™ Q Dual-Brain Board

UNO™ Q is the first project that brings the best of Arduino together with the strengths of Qualcomm Dragonwing™ processors in a unique dual-brain architecture.

The board is based on the combination of the Qualcomm Dragonwing™ QRB2210 microprocessor, a highly integrated system-on-chip that com-



UNO™ Q Key Features Overview



Arduino App Lab Overview

bines 64-bit quad-core compute running Debian Linux together with an integrated dual-camera ISP and a small AI DSP for Edge AI applications, and separately a 32-bit real-time system based on the STM32U585 running Arduino sketches over Zephyr OS.

The QRB2210 delivers high performance compute, camera and Edge AI use cases, while the STM32 responds in real time to inputs from sensors. Both communicate via a dedicated remote procedure call mechanism (RPC). UNO™ Q comes pre-certified (CE/FCC/UKCA) and is built to meet the requirements of the new EU Cyber Resilience Act (CSA) rules, making it an ideal solution to use as it is for prototypes or small quantity production runs.

The innovative UNO™ Q hardware approach is accessible using Arduino's traditionally intuitive and easy-to-use software interface and development tools. That being said, Arduino had to build new tools specifically for the UNO™ Q.

UNO™ Q Key Features Overview

With UNO™ Q in your hands, it is a process to set it up and start development. The UNO™ Q landing page is rich with setup instructions and troubleshooting guides for the hardware and software environment. UNO™ Q can be controlled by the innovative Arduino App Lab. While the traditional Arduino IDE is designed for writing code for a single microcontroller, App Lab is designed to orchestrate apps that run across the dual-brain architecture of UNO™ Q, managing both the high-level Linux/Python side for the QRB2210 SoC and the low-level real-time C++ side for the STM32 simultaneously, as well as the communications between both subsystems.

Arduino App Lab Features

- **Dual-Editor Interface:** side-by-side editors for C++ (Sketches) and Python. This allows to write the code that controls a motor with C++ to run on the STM32 next to the code that runs an AI vision model or a web dashboard with Python on the QRB2210.
- **The »Bridge« Service:** It uses a built-in Remote Procedure Call (RPC) system that lets the Linux »brain« and the microcontroller »brain« talk to each other. You can trigger a Python function from a C++ command and vice-versa with little setup.
- **Arduino »Bricks«:** To speed up prototyping of design concepts, App Lab uses modular code blocks called Bricks. These are pre-packaged AI and functional modules (e.g., an »Object Detection« brick) that can be dragged into a project to give the board high-level capabilities.
- **On-Device Development:** Unlike the classic IDE where you compile on your PC and »upload,« App Lab can run directly on the board itself. Since UNO™ Q is a full Linux computer, you can plug in a monitor and keyboard and code directly on the hardware in standalone mode (the 4GB RAM variant is for this setup).

UNO™ Q and future Arduino Edge AI solutions – such as the newly launched Arduino VENTUNO™ Q – create new opportunities to develop low-cost IoT solutions that take the Arduino pre-certified, open platforms and incorporate them into a wider system that leverages real-time sensing and control with Edge AI.

Together with our partner JMO, we have developed our first UNO™ Q offering: an industrial panel in seven- and ten-inch configurations that presents a Linux interface controlled via touchscreen to the user. In addition, it also offers the real-time performance of Zephyr OS running on the STM32 to manage the external industrial interfaces such as CAN, RS485, RS232 and GPIO which customers can use to control machinery connected to the panel.

The industrial panel incorporates an UNO™ Q, which is fixed to a carrier board that exposes the MIPI Display, touchscreen interface, and connects the UNO™ Q with industrial interfaces required for a typical industrial application. The industrial panel is shipped with its own SDK running on the Arduino assets, and it is CE-certified and ready to install and use.

With the launch of Arduino UNO™ Q and their plan to launch Qualcomm Dragonwing™ processor-based solutions, we now have access to an open-sourced development platform that will help us to prototype design concepts and ideas focused on computer vision and Edge AI. Once the prototype has been realized our team at CODICO can leverage our Qualcomm partner ecosystem to offer SOMs, SBCs and edge computers based on Qualcomm Dragonwing™, which are suitable for mass-production projects.

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Industrial Display – 10-inch configuration

Industrial Display – Carrier board with UNO™ Q mounted

Industrial Display – CAN / RS232 / RS485 with Ethernet, USB and power

ASTRA™ SL2610

SoC Family for Embedded AI in Industrial Environment

SYNAPTICS has introduced a new SoC family, the SL2610 series. This pin-compatible series is equipped with single or dual Arm® Cortex®-A55, Cortex-M52, and offers an optional 1 TOPS NPU for machine learning or for the efficient execution of AI models in industrial applications. The NPU is based on the open-source Coral core and is supported by open-source compilers.

The SYNAPTICS Torq™ Edge AI platform, including the transformer, together with the CNN-capable Torq T1 NPU and the industry's first production implementation of Google's Coral NPU, forms an integrated architecture. This enables dynamic support for new operators, future-proofing Edge AI IoT system design. Torq advances true AI developer freedom by means of a disruptive, end-to-end compiler and runtime based on the open-source IREE/MLIR projects, supporting both standard and emerging model formats such as LiteRT, PyTorch, ONNX and JAX.

Developers in the IoT segment are facing a growing dilemma between microcontrollers that require more external accelerators just to keep up with modern User Interface (UI), camera, and voice function requirements, and powerful application processors that come with higher power consumption, costs, and complexity. The SL2610 series targets this growing market for IoT gateways with diverse connectivity.

The goal is to offer developers a practical processor series in the right size, specially developed for Human-Machine Interfaces (HMI), image processing, and voice applications at the edge.

Today's »simple« products are anything but simple. A modern device needs a fluid display, a touch user interface that responds immediately, a camera for perception or security, and perhaps a small transformer model to make voice commands feel natural and conversational. And all of this must be delivered with secure connectivity and years of reliable operation.

The biggest challenge today is not hardware but software. The pin-compatible SL2610 family covers a wide range from low-end with single arm to high-end with dual arm, 1 TOPS NPU, and powerful GPU, all with the same software SDK base.

SYNAPTICS developed a balanced platform where computing, graphics, and AI functions work together harmoniously to create a product that meets the demands of today's market. The SL2610 architecture is based on four pillars:

1. An NPU that's just the right size for on-device AI

In this price range, the Neural Processing Unit (NPU) outperforms the specifications listed on paper. It may not stand out particularly in terms of pure metrics such as operations per second.

However, with the software tools, it achieves far more than developers would expect. It is optimized for efficiency – you can think of it as getting more work done per clock cycle. It has all the leeway it needs for important AI tasks such as object detection, object classification, and small language models without overloading.

2. High-frequency Arm® application cores

To ensure that the entire system is fast and responsive, SYNAPTICS has integrated High-frequency Arm® cores that effortlessly handle a Linux stack and fast control loops.

3. A modern 3D GPU

The user experience comes first. A modern 3D GPU ensures that HMIs feel clear and fluid, rather than like a piece of outdated hardware.

4. Industrial I/O and timing control

This chip was developed to function reliably not only in the laboratory, but also in practical applications. With industrial-grade I/O and timing control, it is ready for use in factories, vehicles, buildings, and devices.

The SL2610 Lineup

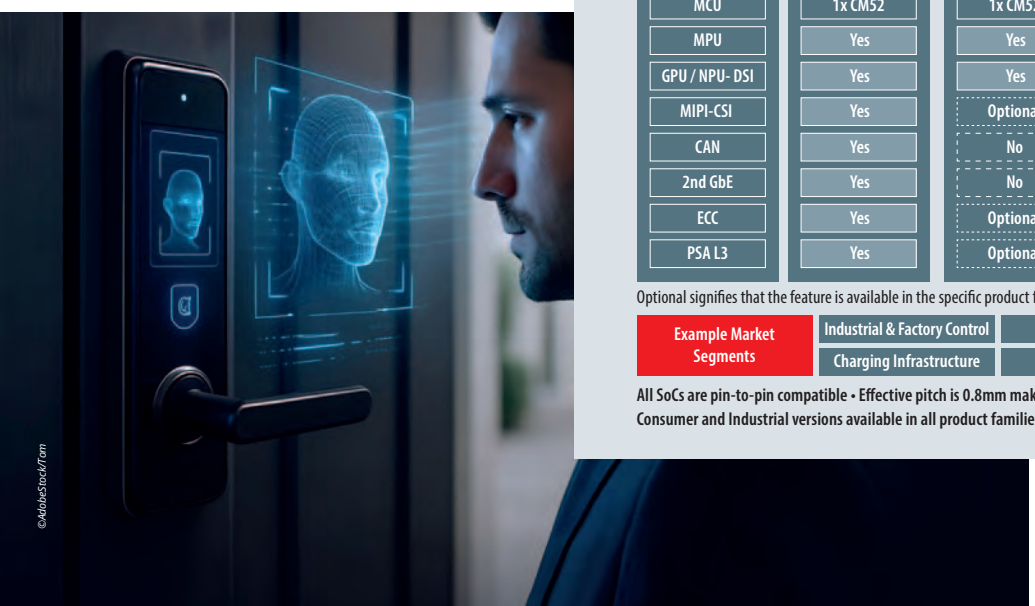
The Astra SL2610 is a single platform organized into five families, offering a clear entry point for any need. The entire lineup shares a single software stack and consistent developer experience, so investments in one family follow across the others.

- **SL2611:** This is the entry-level family, perfect for getting started with a first embedded Linux product. It's HMI-first, designed for responsive touch and display with a lean BOM for cost-sensitive applications.
- **SL2613:** This family adds lite vision capabilities, making it ideal for camera-centric features like presence detection, occupancy sensing, and simple object classification.
- **SL2615:** This is the balanced workhorse of the lineup and the sweet spot in the middle. It's the ideal choice when you need reliable HMI, camera, and voice capabilities together.
- **SL2617:** For more demanding vision applications, this family is vision-forward, offering more headroom and interfaces for richer camera pipelines and analytics at the edge.
- **SL2619:** At the high end, this family provides expanded connectivity and industrial options for gateways, transportation, and other demanding environments.

Security by Design

AI adds a new dimension to security. It is no longer just a matter of protecting the device from hacker attacks, but also of protecting the AI model itself. SYNAPTICS refers to this as secure inference.

Security begins the moment the chip boots up with a hardware trust base and extends to a secure enclave (Arm PSA Level 3 in some variants) that is tamper-proof and protects the execution of the AI model.



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SYNAPTICS SL2610 PRODUCT LINE

Secure and scalable GenAI Linux Processors for the IoT

Optional | AI-Native | ULP | Pin-to-Pin compatible

Peripherals
- 5x SPI
- 2x SDIO 3.0
- 8x UART
- 2x USB 2.0
- 4x I²C, 1x I3C
- 99x GPIO
- 12x sPWM
- 1x ADC (8 channels)
- Sensor HW mute
- 1x GbE with TSN/1588
- 1x GbE with TSN/1588
- 1x CAN 2.0-FD
- 1x CAN 2.0-FD

Memory Interface
- eMMC 5.1
- DDR: 16bit LPDDR4x/LPDDR4/DDR4/DDR3L up to 3,200 MT/s
- xSPI (8-bit)

CPU
- Arm Cortex A55, 2GHz 32KB-I/D L1, 64KB L2 Arm NEON
- Arm Cortex A55, 2GHz 32KB-I/D L1, 64KB L2 Arm NEON
- 256KB Shared L3

AI Engines
- Synaptics Torq NPU Subsystem (1 TOPS)
- T1 Transformers, CNNs Int8/Int16/BFloat16
- Coral NPU RISC-V ML Core

System Manager
- Arm Cortex-M52 w/ Arm Helium 200 MHz / 256KB
- Secure JTAG

Secure Island
- psacertified™ L2 L3
- Anti-tamper | Crypto (DPA) TRNG, TrustZone
- AES | RSA | SHA | OTP

Video / GFX
- MIPI-DSI 1080p60
- 3D GPU Arm Mali G31
- MIPI-CSI 2 lane

Audio
- 3x I2S (16 channels)
- 4x PDM
- 1x SPDIF

Development Kits and SOMs

The SYNAPTICS Astra Machina SL2600 series development kit enables quick and easy prototyping of multimodal, AI-native IoT applications. A flexible design approach supports a core compute module, an I/O base board, daughter cards for integrated Wi-Fi/Bluetooth connectivity, debugging, and programmable I/O.

The evaluation system supports the SYNAPTICS SL2619 SoC family, which offers unparalleled price-performance for the IoT and features an open, unified software experience based on Yocto Linux. The Machina SL2600 series is based on the SYNAPTICS Torq™ Edge AI open-source platform and utilizes the Coral Open NPU subsystem.

SOM solutions are currently being developed by our partners GRINN and AMPAK and will soon be available from our Sample Shop.

Astra SDK Download from Github:
https://github.com/synaptics-astra

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SYNAPTICS SL2610 PRODUCT LINE

Secure High-Performance Embedded Linux® Processors

Pin-to-Pin compatible

Product Family	SL2619	SL2617	SL2615	SL2613	SL2611
Core	2x CA55	2x CA55	2x CA55	1x CA55	1x CA55
MCU	1x CM52	1x CM52	Optional	1x CM52	Optional
MPU	Yes	Yes	Optional	Optional	No
GPU / NPU- DSI	Yes	Yes	Optional	Optional	No
MIPI-CSI	Yes	Optional	No	Optional	No
CAN	Yes	No	Optional	Optional	No
2nd GbE	Yes	No	No	No	No
ECC	Yes	Optional	No	Optional	No
PSA L3	Yes	Optional	No	Optional	No

Optional signifies that the feature is available in the specific product family for designated SKUs. All product families include 1xGbE and RGMII.

Example Market Segments				
	Industrial & Factory Control	Healthcare	POS & Scanners	Audio
	Charging Infrastructure	AI Hub	Home Consumer Goods	Home Control & Automation

All SoCs are pin-to-pin compatible • Effective pitch is 0.8mm making it easy to design products with 4L PCB
Consumer and Industrial versions available in all product families

CONVERGENCE

Ag401: USB-C Power Delivery from a PoE Source

In order to complement their extensive range of PoE modules, SILVERTEL is introducing a brand-new concept design: a PoE PD (Powered Device) to USB-C PD (Power Delivery) module. The Ag401 is an entry-level product which allows designers to combine the reach that Power-over-Ethernet has to offer with the flexibility and popularity of USB-C.

The growing popularity, not at last driven by legislative acts (Directive (EU) 2022/2380), of USB-C as the interface of choice is a well overdue and welcome addition to the world of physical interfaces. Its flexibility, along with its convenient, bi-directional topology and small form factor has contributed to the proliferation of products being launched with USB-C interface ports. Countless consumer products, known as »PEDs« (Portable Electronic Devices), now rely on USB-C. Not only for the reasons already outlined, but also because of the increased data rates and power levels that can be delivered through this interface.

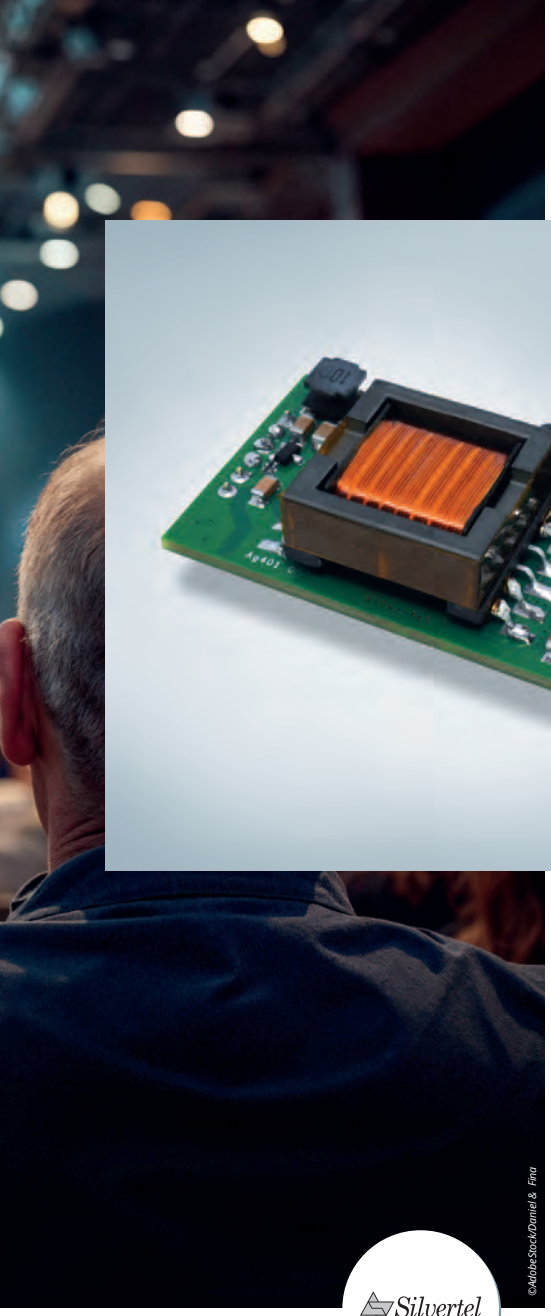
USB-C has become an essential feature of any new products coming to market, offering universal connectivity across most, if not all, modern eco-systems. However, although many of its features align well with current requirements for data throughput and power delivery, it is limited in reach (< 3m) and what can be achieved over longer distances. Ethernet and Power-over-Ethernet are well-established and extremely reliable technologies for providing high-speed data transport and powering connected devices over 100m of Cat 5e/Cat 6a Ethernet cable.

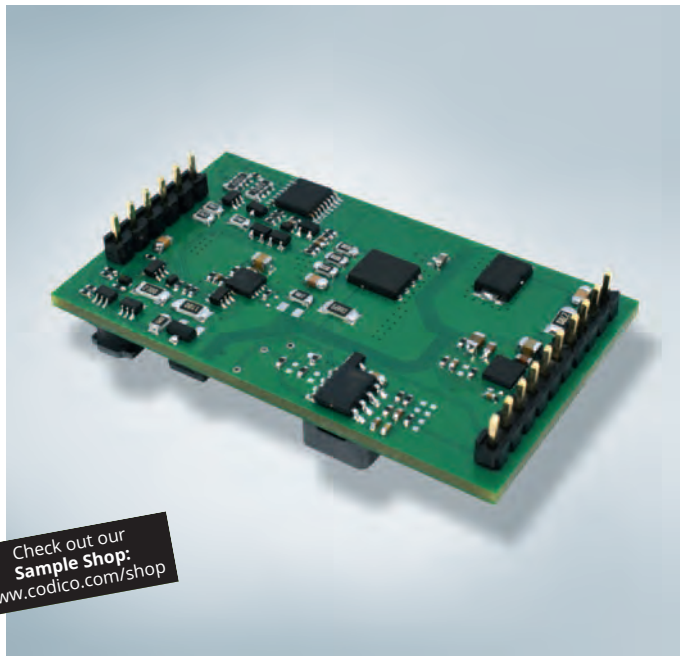
What better way to combine these two interface technologies using a low-cost module which takes up very little board space and requires few external components to construct an Ethernet-powered USB-C Power Delivery port?

When integrated with an Ethernet physical interface, SILVERTEL's Ag401 enables high-speed data pass-through as well as providing power in the form of a USB-C Power Delivery port.

The Ag401 is fully IEEE802.3bt-compliant and presents the PoE ID and signature as a Class 8 Powered Device (PD), requesting up to 70W of power from a connected PSE (Power Sourcing Equipment) switch or injector.

The Ag401 uses the CC (Channel Configuration) lines to detect, negotiate and control the avail-





Check out our **Sample Shop:** www.codico.com/shop

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Silvertel

able voltage and power to the end application via the output port. The power lines as well as the USB-C data & control lines can be recombined through a USB-C physical interface to produce a fully configured USB-C Power Delivery port.

The Ag401 output is fully isolated, provides 1.5kV impulse protection, and is compatible with USB-C PD Rev 3.1 V1.2. The module provides standard preconfigured voltage levels, known as PDOs (Power Data Objects): 5V@3A, 9V@3A, 15V@3A and 20V@3A.

The Ag401 module also provides access to a PPS (Programmable Power Supply) mode over a range of 3.3V to 21V. This mode allows charging to take place in an efficient and safe way thereby prolonging battery life.

The Ag401 is additionally equipped with an auxiliary +5V, 5W output derived from a high-efficiency DC-DC converter, which can be used to power a media controller or similar processor device. Thereby enabling this module to be used wherever a relatively high-power USB-C output is required, making it equally well-suited for applications with increased power demands, such as A/V conferencing products and security devices incorporating the latest AI functionality.

Designed for operation over the industrial temperature range (-40°C to +85°C) and equipped with overload, over temperature and short-circuit protection, the Ag401 is a highly robust device, ideally suited for meeting some of the most challenging operating environments.

The Ag401 is available in a 16-pin Dual-In-Line (DIL), PTH (through-hole) format and requires only a few low-cost external components to construct a PoE-to-USB-C compliant data and power delivery solution.

Samples are available at CODICO.

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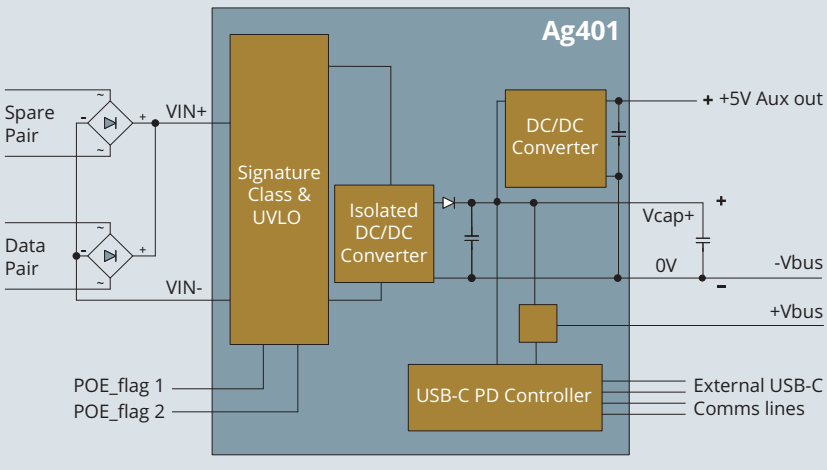

AG401 Block Diagram

ACCELERATED TRANSITION TO 5G

From LTE to High-Performance 5G NR and RedCap Modules

CAVLI WIRELESS develops industrial-grade 5G NR and 5G RedCap modules designed for scalable, future-ready IoT deployments. Built on Qualcomm platforms and integrated with eSIM technology and global connectivity, the portfolio combines ultra-low latency, high throughput, and power-efficient design. Paired with the CAVLI Hubble™ Connectivity and IoT Module Management Platform, we simplify connectivity while accelerating the transition to 5G across industrial and enterprise applications.

Connectivity has long served as the backbone of the Internet of Things (IoT). Over the past decade, LTE technologies have enabled large-scale digitization across industrial systems, infrastructure, and machine networks. Today, however, IoT is transitioning into a new phase, defined by data-intensive workloads, real-time interaction, and distributed intelligence at the edge.

Applications such as industrial automation, smart surveillance, robotics, private cellular networks, and edge computing can no longer rely on best-effort connectivity alone. These systems require deterministic performance, sustained uplink and downlink capacity, bounded latency, and long-term architectural stability. These evolving requirements are fundamentally reshaping how networks are designed and how connectivity modules are integrated into next-generation devices.

Standalone vs Non-Standalone: The Architectural Foundation

Initial 5G deployments have largely followed a Non-Standalone (NSA) architecture, where 5G New Radio operates in conjunction with an LTE core network. NSA enables faster market introduction while leveraging existing EPC infrastructure. However, because control-plane functions remain LTE-based, certain 5G capabilities, such as full network slicing and ultra-low latency optimization, are constrained.

Standalone (SA) architecture introduces a native 5G core (5GC), built on cloud-native principles and service-based interfaces. This architecture supports network slicing, Control and User Plane Separation (CUPS), Multi-access Edge Computing (MEC), and fine-grained quality-of-service management. For industrial IoT and private networks, SA is particularly relevant: it enables deterministic performance, logical service isolation, and tighter integration with edge processing platforms.

5G RedCap: Optimizing the Mid-Throughput Segment

5G Reduced Capability (RedCap) has been introduced to serve the mid-performance tier of IoT deployments. Positioned between LTE and full 5G NR, RedCap enables devices to access native 5G core networks, benefit from improved latency performance, and align with long-term network evolution, while maintaining a simplified radio architecture optimized for efficiency and scalable throughput.

CQM220: Bridging Performance & Efficiency

CQM220 is CAVLI's 5G RedCap module designed to address this emerging class of IoT devices. It targets applications such as home and wireless

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routers, as well as critical monitoring systems, that require dependable cellular connectivity, precise location awareness, and extended operational life.

By integrating processing, connectivity, and positioning within a compact, power-efficient architecture, CQM220 enables OEMs to design space-optimized systems without compromising throughput performance. As one of the most compact 5G RedCap modules available today, it provides a practical migration path for developers transitioning from LTE-based platforms toward 5G, offering enhanced performance while preserving deployment scalability.

Furthermore, optional support for the CAVLI Hubble™ Connectivity and IoT Module Management Platform enables CQM220 to support centralized connectivity management, remote provisioning, and device diagnostics, simplifying fleet-scale deployment and long-term lifecycle control.

5G NR for High-Performance IoT Systems

Advanced IoT deployments increasingly require sustained uplink throughput, multi-carrier aggregation, and stronger embedded processing capabilities. Smart surveillance gateways, industrial controllers, AI-enabled edge systems, and high-speed data concentrators must handle significant data volumes while maintaining low latency and operational stability

CAVLI WIRELESS addresses this segment with its 5G NR Advanced portfolio:

CQM211: A Scalable Entry Point into 5G NR
CQM211 addresses the growing need for edge devices that combine high-speed 5G connectivity with onboard application capability. By integrating processing, connectivity, and positioning within a single module, CQM211 allows developers to reduce the number of external components while maintaining sufficient performance headroom required for modern industrial systems. The module is well-suited for CPE, industrial routers, and gateways that demand fast, reliable broadband connectivity. Built for high-throughput applications, it enables smooth fixed wireless access, secure backhaul, and always-on connectivity for enterprise and industrial deployments.

CQM212: Delivering High-Throughput 5G NR for Industrial Applications
CQM212 targets applications that push beyond basic edge connectivity and require sustained throughput alongside enhanced compute resources. It is designed for industrial systems that aggregate large data streams, perform cloud analytics, or interface with high-bandwidth peripherals.

By pairing higher 5G NR throughput with multi-core processing and high-speed interfaces, CQM212 enables next-generation industrial controllers, AI-enabled cameras, and advanced connectivity gateways to operate as self-contained platforms. This reduces architectural complexity while supporting scalable performance across product families.

CQM215: Designed for Ultra-Low Latency Edge Platforms
CQM215 sits at the top of CAVLI's 5G NR portfolio, addressing the most demanding IoT and Edge-to-cloud use cases. CQM215 is intended for devices that must sustain very high data rates, aggregate multiple data sources, and perform local processing simultaneously.

Across all three modules, CAVLI combines high-performance 5G NR connectivity with optional integrated eSIM and support for the CAVLI Hubble™ Connectivity and IoT Module Management

PRODUCT OVERVIEW OF 5G NR AND 5G REDCAP MODULES

FEATURE	CQM220 (5G RedCap)	CQM211 (5G NR)	CQM212 (5G NR)	CQM215 (5G NR)
RAT / Technology	5G RedCap	5G NR Sub-6GHz	5G NR Sub-6GHz	5G NR Sub-6GHz
3GPP Release	Release 17	Release 16	Release 18	Release 18
Architecture Support	SA	SA / NSA	SA / NSA	SA / NSA
Peak Downlink Speed	~220Mbps	Up to 3.4Gbps	Up to 5.36Gbps	Up to 7.01Gbps
Peak Uplink Speed	~120Mbps	Up to 550Mbps	Up to 1.25Gbps	Up to 1.25Gbps
Carrier Aggregation	–	Supported	3× CA	4× CA
Processor	Arm Cortex-A7	Arm Cortex-A7	Quad-core Arm Cortex-A55	Quad-core Arm Cortex-A55
Operating System	OpenWrt	Linux / OpenWrt	Linux / OpenWrt	Linux / OpenWrt
Memory (Max)	Up to 1GB RAM + 1GB ROM	8GB RAM + 4/8GB ROM	1/2GB RAM + 8GB ROM	1/2GB RAM + 8GB ROM
GNSS	L1 + L5	L1 + L5	L1 + L5	L1 + L5
LTE Fallback	LTE Cat-4	LTE Cat 16	LTE Cat-20	LTE Cat-20
PCIe Interface	Gen2	Gen3	Gen4	Gen4
USB Interface	USB 2.0	USB 3.1 / 2.0	USB 3.1 / 2.0	USB 3.1 / 2.0
Form Factor	LGA, M.2	LGA, M.2	LGA	LGA
eSIM Support	Optional	Optional	Optional	Optional
Target Segment	Mid-throughput, power-optimized IoT	High-performance IoT	Advanced high-throughput IoT	Ultra-high-throughput IoT

Platform, enabling OEMs to manage connectivity, monitor device health, and control lifecycle operations from a centralized cloud environment.

A Structured Migration Path to 5G

With CQM220 addressing optimized RedCap use cases and CQM211, CQM212, and CQM215 covering high-throughput 5G NR applications, CAVLI delivers a structured and scalable migration path aligned with the evolution of 5G network architectures.

As 5G Standalone networks mature and private cellular adoption accelerates, connectivity modules are evolving from simple data interfaces into intelligent system enablers. The transition to 5G is no longer incremental – it represents a foundational shift in how industrial connectivity platforms are designed, deployed, and managed.

Why Choose CAVLI 5G Portfolio?

- Qualcomm-based industrial-grade platforms
- Optional integrated eSIM for simplified global deployments
- Linux and OpenWrt support for edge application development
- Support for CAVLI Hubble™ Connectivity and IoT Module Management Platform
- Long-term product roadmap and global certification readiness

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5G-Powered Use Cases

5G RedCap

- Home Gateways
- Wireless Routers
- Critical Monitoring Applications

5G NR

- Industrial Routers & Gateways
- Hi-Res Surveillance Solutions
- Customer Premise Equipments

HAPTIC TOUCH

»All devices need to interact. If a thing does not interact, it will be considered broken.«

The Inevitable by Kevin Kelly

In his book »The Inevitable«, Kevin Kelly explores technological trends that will inevitably shape and transform our lives over the next 30 years. Although published in 2016, the 12 technological forces he describes are becoming increasingly influential in everyday life.

The quote above opens the chapter on interactivity. By now, we humans are accustomed to devices and machines communicating with us that is, interacting. This traditionally happens in a variety of ways, such as visually different blinking signals might require a user action or audibly, where sounds or voice messages indicate operating states.

Relatively new, however, is interaction via haptic methods.

What does »haptic« mean?

The term haptics comes from the ancient Greek word ἁπτικός (haptikos), meaning »able to be touched or grasped,« and relates to our sense of touch. Haptic uses the sense of touch to convey forces, vibrations, or movements, enhancing immersion in the digital world.

Touchscreens and Haptics

Early haptic technologies include switches and buttons, which provide clear tactile feedback through flipping a switch or pressing a button.

With touchscreens that respond to touch it's different. They are now standard in electronic devices, but their drawback is the lack of tactile feedback. Without looking at the screen, it is impossible to know whether the device has detected the touch and triggered the desired action. Smartphones use acoustic signals, typically clicks or buzzing sounds, to provide feedback. However, in noisy environments, this is not always the best solution.

Generating haptic effects requires suitable hardware. Currently, three different solutions are most commonly used:

Eccentric Rotating Mass (ERM)

An ERM consists of an electric motor with an off-center weight attached to its shaft. As the motor rotates, the mass is deflected, generating omnidirectional vibration (figure 1).

This simple, cost-effective method has become popular, especially in gaming controllers and mobile phones where space is limited. Strong vibrations also make ERMs an attractive option for automotive applications.

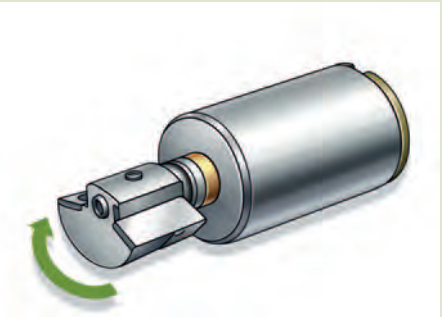

Figure 1: ERM

The downside is precision: starting and stopping are slow due to the mass's inertia, limiting the range of sensations. The resulting waveform is simple, and operation can be noisy. Analysts have predicted a gradual shift towards LRAs since 2022.

Linear Resonant Actuator (LRA)

An LRA consists of a magnet attached to a spring, surrounded by a coil and a housing. An electromagnetic coil moves the magnetic mass back and forth until resonance frequency is reached, producing perceivable vibrations (figure 2). Some variants move the mass vertically instead of horizontally (figure 3).

LRAs respond quickly and are more energy-efficient than ERMs. They are used in devices requiring fast haptic feedback, such as laptops, gamepads, VR controllers, and increasingly smartphones. By modulating the signal, different amplitudes and waveforms can create a variety of haptic effects.

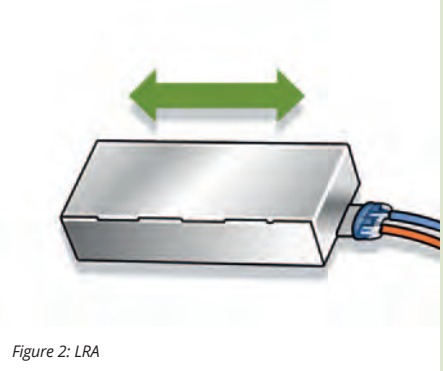

Figure 2: LRA

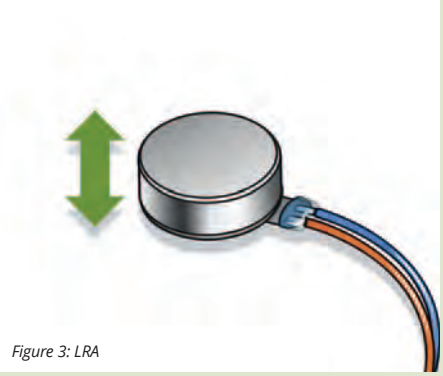

Figure 3: LRA

LRAs are slightly more expensive than ERMs. The spring is the only moving part, subject to wear, but improved designs ensure it operates within a fatigue-free range.

Piezoelectric Actuator

Certain materials, such as crystals or ceramics, generate voltage when mechanically stressed. Piezo actuators work in reverse: applying an electric charge causes the material to expand or contract, producing movement and force, resulting in vibrations.

Piezo actuators are more precise than ERMs or LRAs, work across a wide frequency range, and allow variable amplitudes without losing performance. They respond in milliseconds and generate minimal noise. Their compact size makes them suitable for space-constrained applications. However, they require specialized drivers capable of up to 400V peak voltage, and overall power consumption is higher than with LRAs.

A comparison of these technologies is shown in the table below.

Type	ERM (ECCENTRIC ROTATING MASS)		LRA (LINEAR RESONANT ACTUATOR)		PIEZOELECTRIC
	Bar	Coin	Z-axis	X-axis	Ceramic Plate
Voltage	1.5-3.0V DC	2.5-3.0V DC	1.2-2.0Vrms AC	0.9-2.0Vrms AC	6-400V AC
Current	65mA	65mA	65mArms	100mArms	<50mA
Vibration Acceleration [1]	0.15-0.6G, Y-Z axis	0.5-0.7G, X-Y axis	0.5-0.8G, Z axis	0.8-2.0G, X axis	0.1-35G, Z axis
Response Time [2]	35-130ms	50-200ms	10-50ms	5-50ms	<10ms
(Motor) Height	>2.5mm	>2.0mm	>2.5mm	>2.5mm	>0.3mm
RF Interference	✔	✖	✔✔	✔✔	✔✔
Cost	✔	✔✔✔	✖	✖	✖✖✖
Life Cycle [3]	>200kcycles	>100kcycles	>1kkcycles	>1kkcycles	>1kkcycles
Notes	most common vibration motor	most cost-effective vibration motor	excellent performance	top-notch performance	thin profile, low power

[1] measured with 100g cube, [2] 90% rise time, [3] 2s on / 1s off

Looking Ahead

As gaming controllers, smartphones, and new hardware continue to evolve, haptic functionality will become increasingly integrated, transforming human–machine interaction. Starting with commercial mass-market applications, industrial devices will also adopt these features.

For industrial and automotive applications, LRAs appear optimal, combining fast response, strong vibration, low power consumption, minimal interference, and durability at a reasonable cost.

Benefits of Haptics

- **User Experience**
  Haptics enhances usability by adding a »tactile« element to the digital environment.
- **Accessibility**
  For people with impairments, haptics provides an alternative to purely visual or auditory systems.
- **Safety**
  Tactile feedback improves safety and reduces errors. In medical applications, it enables more precise work.
- **Competitive Advantage**
  Implementing this emerging technology can give companies an edge over competitors.

The primary goal is to improve user experience without complicating devices. Haptics adds tangible value to technology.

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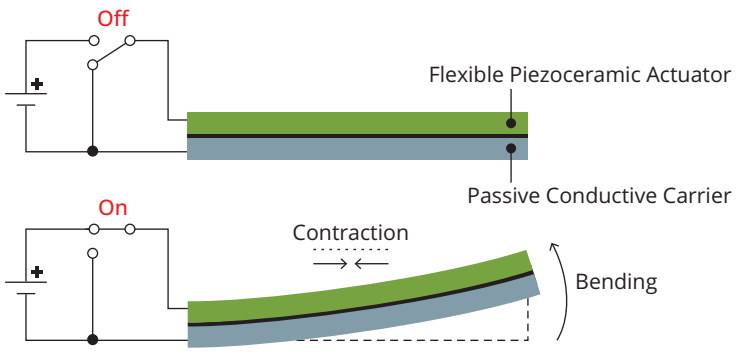
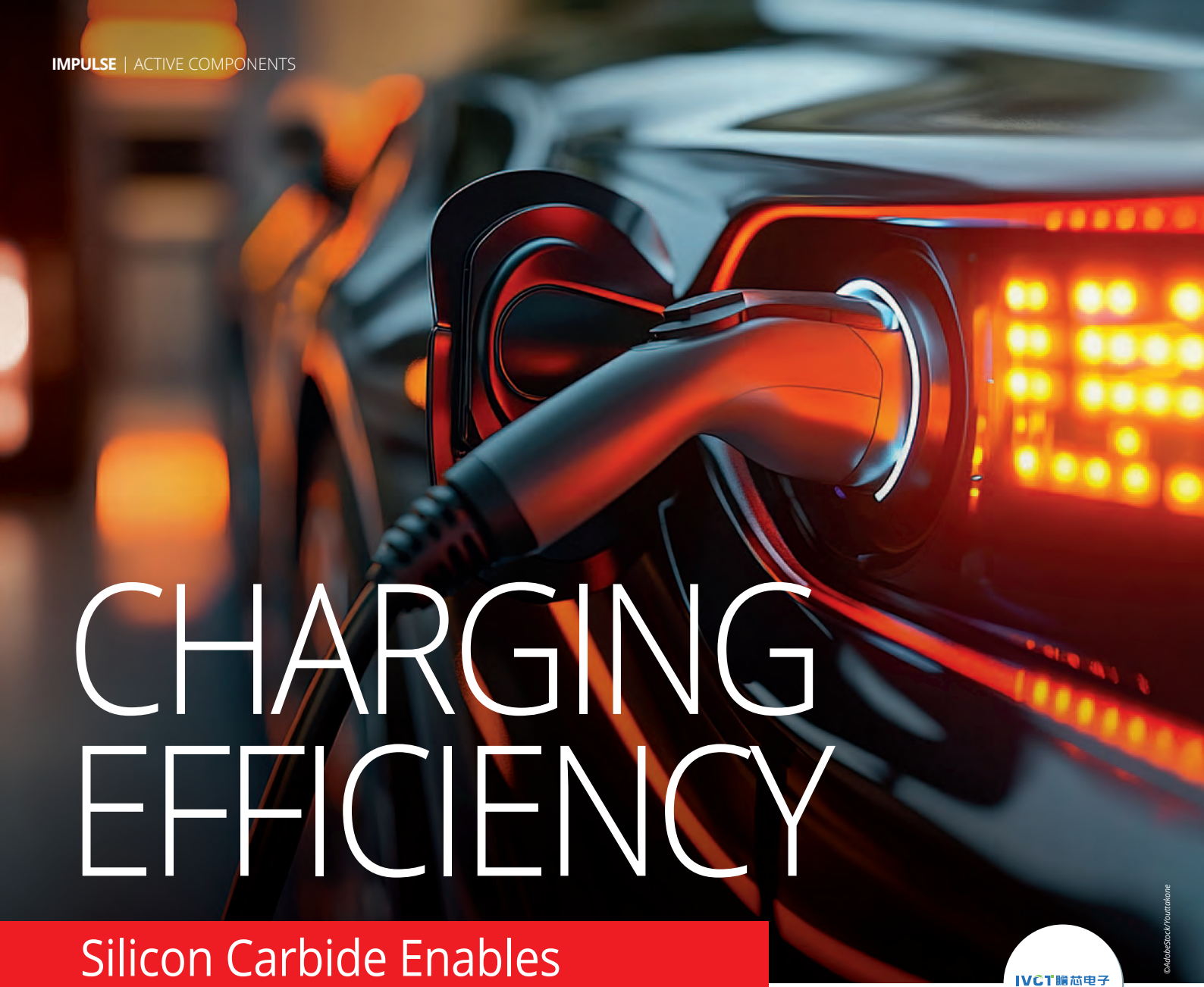


Figure 4: Piezoelectric Actor



CHARGING EFFICIENCY

Silicon Carbide Enables Fast Charging Solutions

Today's need for fast charging solutions for electric vehicles from passenger cars up to EV trucks require highly efficient, cost-efficient topologies with a high power-density: This remains a significant challenge.

According to IEC 62196 an overall efficiency η of the charging station's power electronics of 95 to 99% is expected while the total harmonic distortion of the line current i_{THD} shall be lower than 8%. Additionally, the charger system including all stages of energy conversion has to be EMI compliant with the standards gathered in the series IEC 61000-4. Furthermore, a modern charger system should be able to serve different voltage levels for the battery to be charged e.g. up to $1000V_{DC}$.

All these requirements ask for efficient components which enable high switching frequencies at high switching voltages.

Silicon Carbide: Cost Efficient and High Power Density

The efforts to achieve cost efficiency with high power-density create an ideal area of application for silicon carbide (SiC) based semiconductors like MOSFETs and diodes. In general, at a constant power level a higher operation voltage reduces the current and thus the needed thickness of busbars and cables.

But realizing this based on silicon (Si) semiconductors like IGBTs with a higher voltage class would lead to higher conduction and switching losses. At least the switching losses could be partly compensated by reducing the switching frequency, which would significantly increase the size, weight, and cost of the magnetic components for transformers and inductors.

Here MOSFETs and diodes based on silicon carbide can really make a difference. SiC MOSFETs can bring the speed of unipolar switching into voltage classes which were dominated by Si-IGBTs, while SiC diodes offer an excellent reverse-recovery behavior. Both elements based on silicon carbide additionally show a more temperature stable behavior which makes them a perfect match for topologies with a high power-density.

Table 1 shows a selection of physical properties of Silicon and Silicon Carbide* with their significance on the electrical behavior of a semiconductor. Here the factor $F_{SiC/Si}$ shall indicate the multiples that these parameters distinguish. Focus-

** The most common polytype crystal structure of Silicon Carbide is 4H-SiC.*

TABLE 1: MATERIAL PROPERTIES OF SILICON AND SILICON CARBIDE

Property	Band Gap	Intrinsic Carrier Density	Dielectric Constant	Electron Mobility	Breakdown Field Strength	Electron Saturation Rate	Heat Conduction Rate
	E_g (eV)	n_i (cm^{-3})	ε_r	μ_n ($cm^2/V{\cdot}s$)	E_b (MV/cm)	V_{sat} (10^7cm/s)	λ (W/cm·K)
Implication	High Temperature Stability and Leakage	High Temperature Capability	Parasitic Capacitance	Conduction Resistance	Breakdown Voltage	Switching Speed	Heat Conduction Capability
Si	1.12	$1.5{\cdot}10^{10}$	11.8	1350	0.3	1	1.5
4H-SiC	3.23	$8.2{\cdot}10^{-9}$	9.7	900	3	2	4.9
$F_{SiC/Si}$	2.9	$5.5{\cdot}10^{-19}$	0.8	0.7	10	2	3.3

ing on the different values for Breakdown Field Strength and the Electron Saturation Rate explains why 4H-SiC makes fast switching devices for high blocking voltages possible.

INVENTCHIP: China's Leading SiC MOSFET Provider for EV Charging and Power Systems

INVENTCHIP Technology Co., Ltd. (abbr: IVCT) has been dedicated to developing SiC power devices, gate-drivers and controller ICs. INVENTCHIP provides customers with one-stop chip solutions focusing on SiC power semiconductor applications. They pioneered SiC MOSFET technology on 6-in wafers in China. With an automotive-grade SiC wafer fab, INVENTCHIP commits on-time and high-quality delivery of SiC products to customers and pursues continuous technology innovations.

INVENTCHIP is the top SiC MOSFET provider for onboard charger applications in China. The company has sold about 51 million silicon carbide MOSFETs onto the market. In 2025 alone, more than two million EV-cars used IVCT's silicon carbide MOSFETs, and 70% of e-compressors in China use IVCT's gate drivers. Additionally, INVENTCHIP's SiC semiconductors and drivers are widely used in EV chargers, photovoltaics, and energy storage applications. The reason for that is that INVENTCHIP has its own fab and can provide high quality products at a competitive price. Furthermore, INVENTCHIP supports customer designs both at the component level and at the system level.

Standard Industry Charger Architecture: A Proven Blend of Performance and Economics

In the following, a topology is presented that is widely used across the industry. Although it is not a new design, it still shows a good balance between efficiency, power density and cost-efficiency.

Figure 1 depicts the overall structure of the charger topology. Besides the required auxiliary blocks such as overvoltage- and overcurrent protection, EMI-filtering, inrush control and current measurement, the core of this topology is a Vienna Rectifier followed by two paralleled LLC bridges that feed a diode rectifier.

The outputs of these two rectifiers can be switched either in series or parallel by the voltage range selector. The last component is an ORing diode which protects the output against reverse currents and voltages. The main idea is to use one block to rectify the grid voltage. This rectified voltage feeds the LLC-inverters which provide two galvanically isolated DC-voltage sources that can be combined in series or parallel according to the needs of the battery system.

The Vienna Rectifier

One of the core components of the charger system is the Vienna rectifier. For a high-power system, the 3-phase variant of the rectifier is used. It consists of a classical diode B6 bridge and bidirectional switches between the AC-inputs and the midpoint between the two DC-link capacitors C1 and C2.

The Vienna rectifier is known to operate in Continuous Conduction Mode (CCM). It provides an inherent three-level switching and reduces the voltage stress on the switching MOSFETs. Figure 2 shows the circuit diagram of the Vienna rectifier, which combines a normal diode B6 bridge

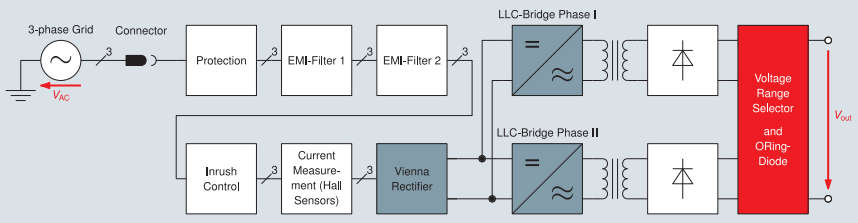


Figure 1: Block Diagram Of The Charger Topology

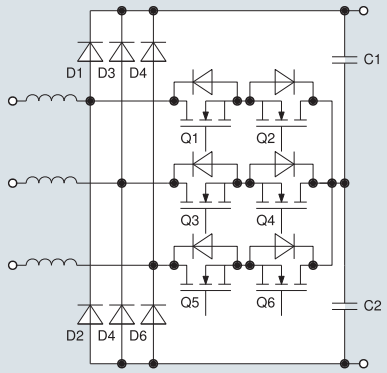


Figure 2: 3-Phase Vienna Rectifier

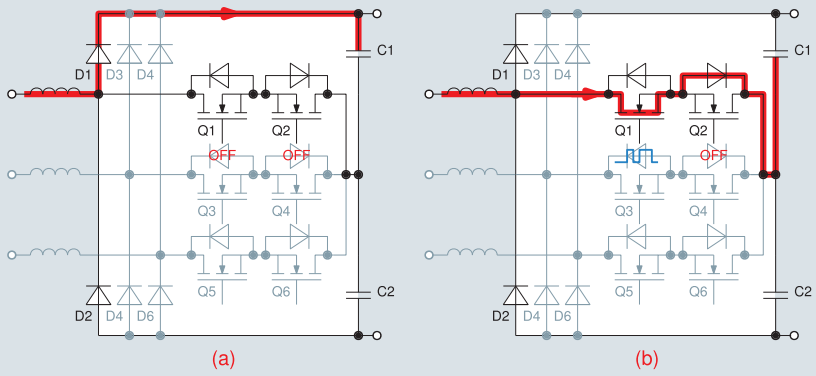


Figure 3: Principal Function of one Phase of the Vienna Rectifier for a Positive Input Current

with two boost converters that share one boost inductor. For controlling the topology, hysteresis-based or carrier-based schemes are used. Equipped with 1200V-diodes and 750V-MOSFETs, it allows operation at an AC-voltage of $400V_{LL}$ and provides a rectified DC-link voltage of $V_{Vienna,Out}$ = $700\text{-}800V_{DC}$.

In Figure 3, only one phase is shown with its principal commutation scheme for a positive input current. In general, there are two time periods within one half-wave of the input current.

- **Phase (a):** The AC-current charges directly the upper DC-link capacitor C1 and magnetizes the boost inductor on the AC-side.
- **Phase (b):** The middle point either connects the middle point to the input node or uses the stored energy in the inductor to boost the output voltage. Here Q1 is modulated while Q2 remains switched off. For the negative half-wave, both MOSFETs alternate their functions.

For the switching semiconductors, Q1-Q6 are connected to the middle point of the capacitive divider and thus only have to block half of the output DC voltage. Highly conductive SiC-MOSFETs with a low $R_{DS(ON)}$, like INVENTCHIP's IV3Q07011T4Z (750V, 11mΩ) in a TO-247-4 housing, are recommended.

The rectifier diodes D1-D6 must block the full DC-link voltage up to $800V_{DC}$. Therefore, the 1200V-class of SiC-diodes is recommended. INVENTCHIP offers a wide variety of diodes in the 1200V class in most common packages. Here, the 40A types in the TO-247-2 package IV1D12040U2 or IV2D12040T2L are recommended. If improved thermal performance is required and a parallel connection of the diodes is planned, two 20A types (IV1D12020T2) can be used. INVENTCHIP's SiC diodes have a positive temperature coefficient on the forward voltage V_F, which brings an inherent thermal balancing behavior in a parallel connection.

In the Vienna rectifier, the electrical potentials of the gate-source-pins of the MOSFETs Q1-Q6 are floating and can't be referenced to the control ground potential. Therefore, isolated gate drivers must be used. INVENTCHIP provides gate driver chips adapted to the special needs for the control of SiC MOSFETs. Depending on the isolation scheme of the whole converter, a high isolation voltage from primary to secondary side of the driver might be requested. IVCT's isolated single-channel driver IVCO1412DDWQ provides an isolation voltage of up to $5.7kV_{RMS}$. For gate control, it has a maximum gate current capability of ±4A. A negative gate turn-off voltage, generated by the chip itself, avoids the risk of a parasitic turn-on while operating at high drain-source-voltage slopes dv_{DS}/dt.

The LLC Bridge

The proposed LLC converter design consists of a standard 2L-voltage-source full bridge, which feeds a so-called LLC tank. This tank consists of a capacitor, the stray inductance as well as the main inductance of the transformer. The design of this transformer is crucial because it also provides the galvanic isolation needed for the free combination of the output voltages of the charger topology. On the secondary side of the transformer, a simple B4-diode bridge is doing the rectification of the mostly sinusoidal-shaped currents and charges the output capacitor. Figure 4 shows one LLC bridge.

The voltage gain of the whole LLC topology K_{LLC} is determined by the gain of the full bridge (= 1), the gain of the LLC tank K_{res} and the turn-ratio N_{sec}/N_{prim} of the transformer with $K_{LLC} = K_{res} \cdot N_{sec}/N_{prim}$.

When designing the transformer, the main inductance L_M should be at least five times the stray

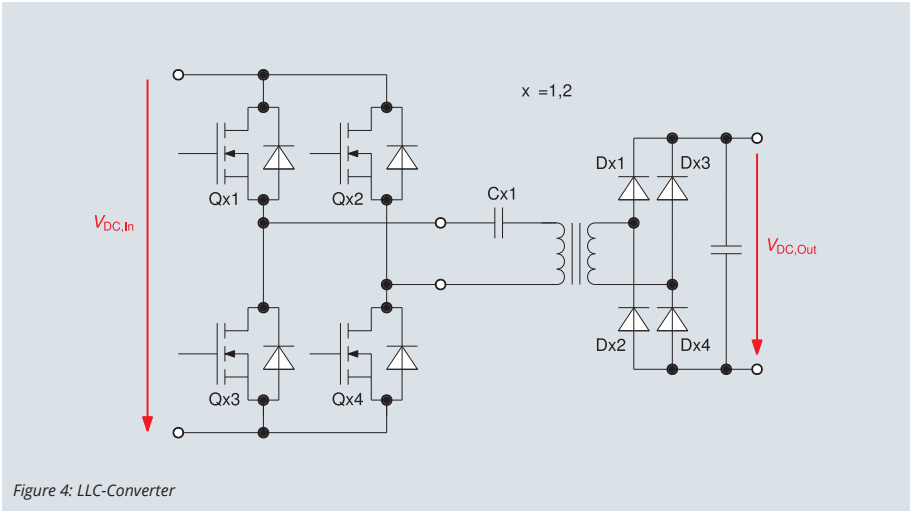


Figure 4: LLC-Converter

inductance L_σ, so that the inductance ratio m = $(L_M + L_\sigma)/L_\sigma$ reaches at least 6. The main idea of this topology is to set the switching frequency of the full bridge equal to the resonant frequency $f_{res} = 1/(2\pi \cdot L_\sigma \cdot C_{x1})$ of the LLC tank. In this case, the efficiency of the circuit is maximized. Switching frequencies higher than the resonant frequency will lead to an inductive behavior of the LLC load with zero-voltage switching for the MOSFETs. Switching at lower frequencies, however, leads to capacitive behavior of the load and causes additional unwanted losses in the MOSFET bridge.

Assuming that the output voltage of the whole charging topology ranges from 300V to a maximum 1000V, and two LLC bridges are combined, a maximum DC-output voltage of $V_{DC,out}$ = 500V is required for one LLC bridge. Thus, with a minimum output voltage of the Vienna rectifier of 700V, the voltage gain of the LLC tank and the transformer can be defined as $V_{DC,out} / V_{Vienna,out} = K_{LLC}$ = 500V / 700V = 0,71.

The semiconductors used in a MOSFET LLC full bridge must be optimized for switching rather than conduction. Therefore, IVCT's 1200V-MOSFETs in a TO-247-4-package with a slightly higher on-state resistance IV2Q12030T4Z (with $R_{DS(on)}$ = 30mΩ) and IV3Q12035T4Z (with $R_{DS(on)}$ = 35mΩ) are recommended for the switch positions Qx1-Qx4 (x = 1, 2). The secondary diode full bridge is dimensioned for conduction. Therefore, the same diode types used in the Vienna rectifier, namely IV1D12040U2, IV2D12040T2L or two IV1D12020T2, can be used.

For the high-side switches of the MOSFET full bridge, the isolated gate driver IVCO1412DDWQ by INVENTCHIP shall be used. The low-side channels could be referenced to control ground. Therefore, non-isolated drivers like the dual (means two individual gate driver channels), non-inverting IVCR2404MPQ and the dual inverting or non-inverting IVCR2504 can be used. Both provide a maximum gate current of $I_{G,max}$ = ±4A.)

Overview

This article presents a popular charging topology which combines efficiency of energy and cost. Figure 5 depicts the complete topology with all components. The output power is around 40kW but by using stronger components for the Vienna rectifier or a higher number of LLC stages, this outpower could be increased. It is a good solution for whether high-current or high-voltage charging.

CODICO can not only supply SiC semiconductors for these charging solutions, but also support customers in selecting all necessary active and passive components for their designs, drawing on many years of expertise.

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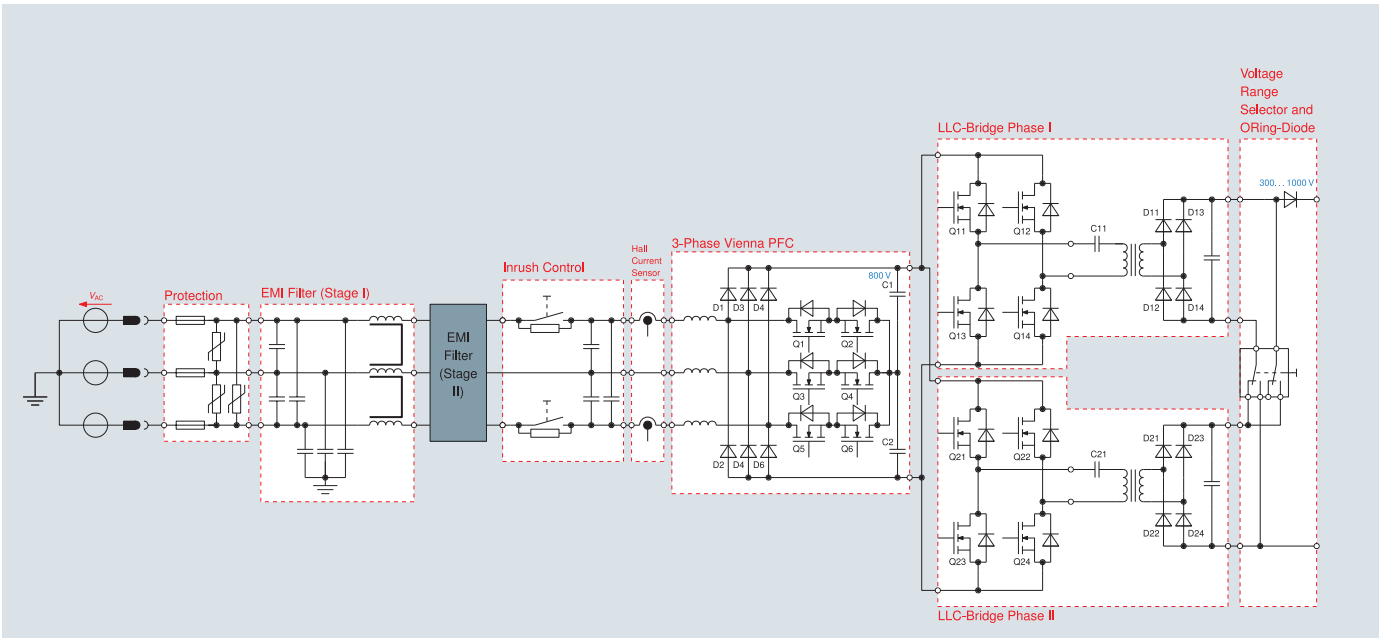
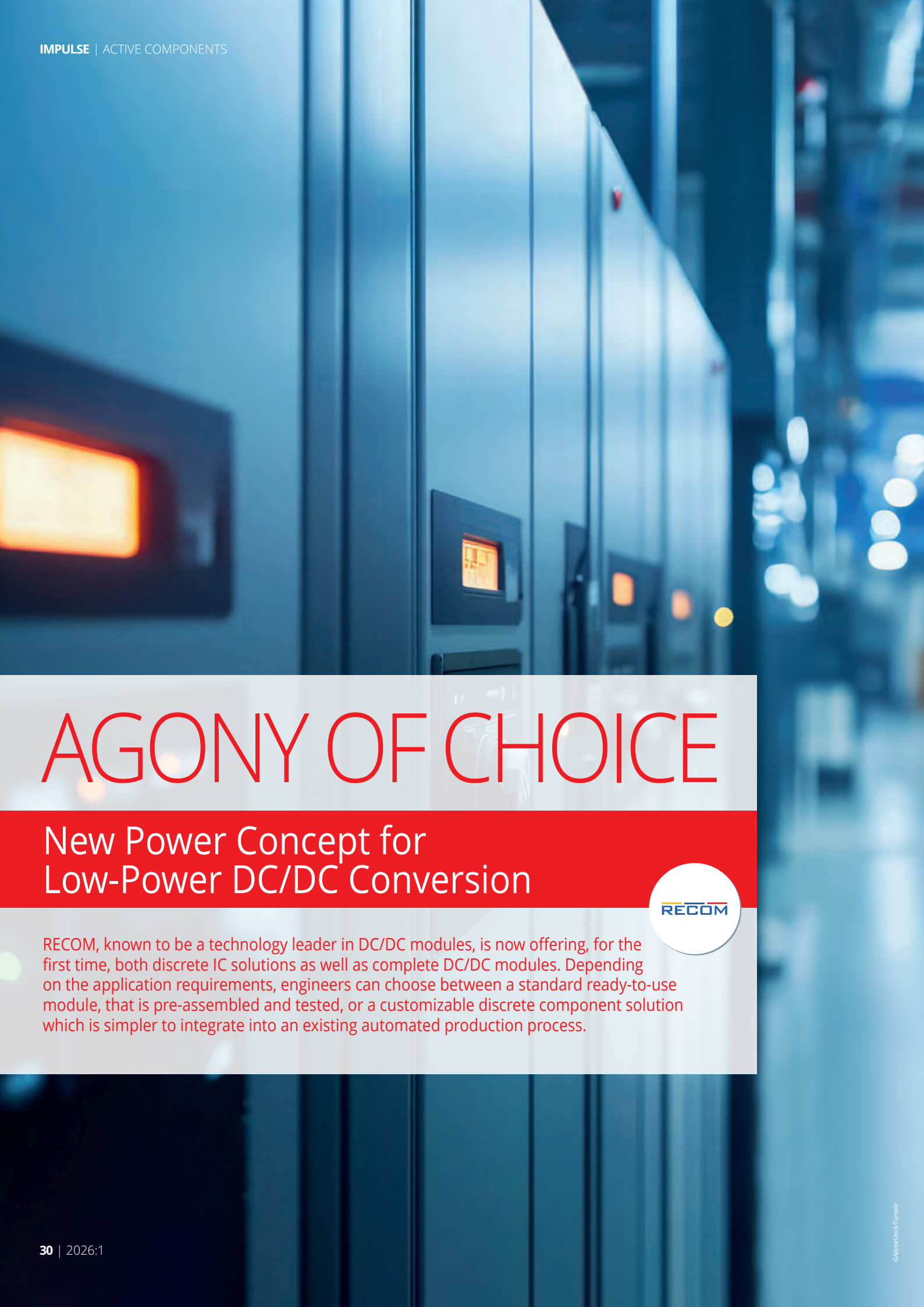


Figure 5: Complete Charger Topology



AGONY OF CHOICE

New Power Concept for Low-Power DC/DC Conversion

RECOM, known to be a technology leader in DC/DC modules, is now offering, for the first time, both discrete IC solutions as well as complete DC/DC modules. Depending on the application requirements, engineers can choose between a standard ready-to-use module, that is pre-assembled and tested, or a customizable discrete component solution which is simpler to integrate into an existing automated production process.

The customer determines both the layout and the component positioning, with the benefit of lower pricing as the volume increases – just like any other SMD component. Currently, RECOM is the only power supplier manufacturer that offers both solutions.

Putting the IC approach into perspective, there are three main Transformer Driver Topologies used for low power isolated DC/DC conversion:

Flyback Topology

Flyback topology is used for isolated power ratings from 5 to 10W, offering a wide input voltage range (4:1) and a regulated output that remains stable, irrespective of changes in input voltage or load conditions. The power transistor can be either internal for maximum integration or external for higher current/higher voltage designs.

RECOM's RVPWxxx range of flyback driver ICs are unique because they offer three feedback modes:

1. Primary Side Regulation:
The output is regulated by monitoring the waveform on the auxiliary winding used to power the IC after start up. This avoids the need for an optocoupler and is ideal for high-reliability, very high-isolation voltage and minimum BoM count designs.

2. Secondary Side Regulation:
The output is regulated by a shunt regulator controlling an optocoupler to maintain the isolation. This method offers a more accurate control of the output voltage.

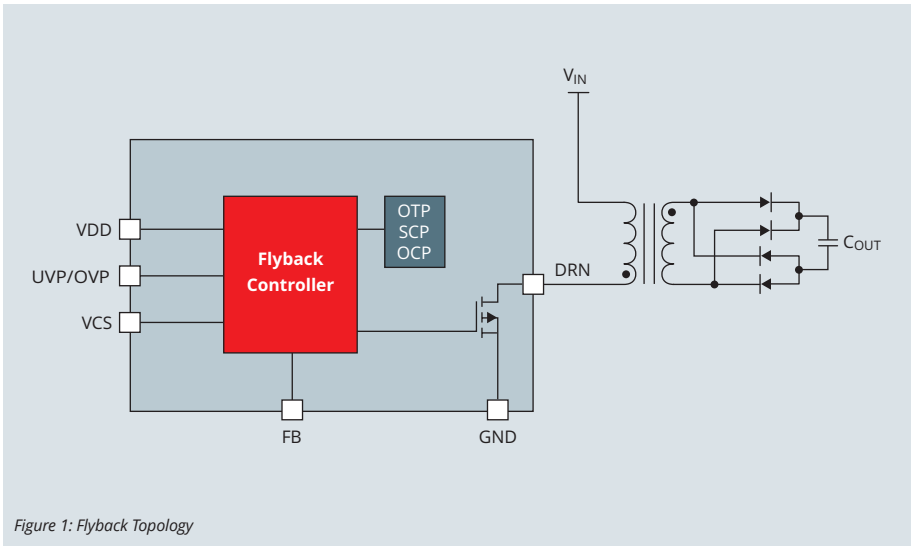


Figure 1: Flyback Topology

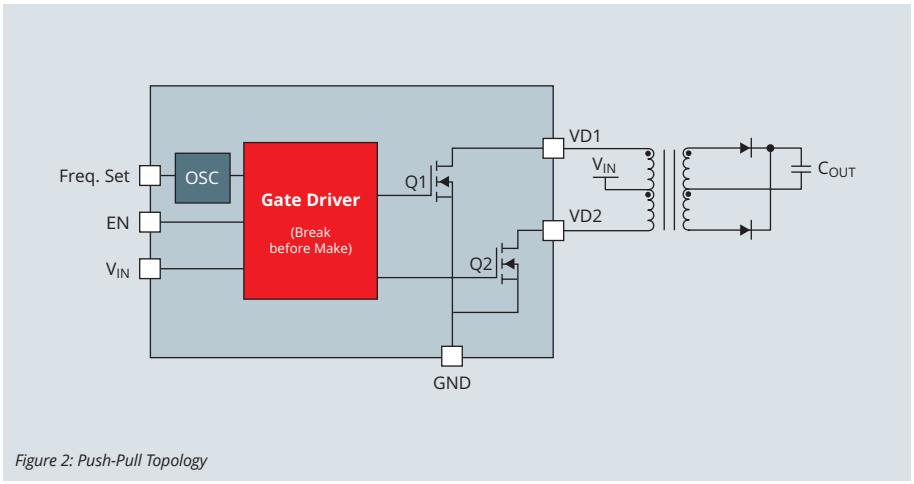
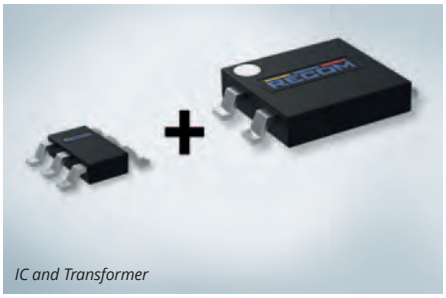


Figure 2: Push-Pull Topology

3. Direct DC Monitoring:
For non-isolated applications, the output voltage can be monitored directly by the feedback pin. This method offers the most accurate control of the output voltage and the fastest reaction time to transients.

RECOM offers five different discrete flyback power ICs: RVPW011, RVPW012, RVPW014, RVPW015 with integrated switches and the RPVW016 for use with external FETs, plus the RVSW013, which is suitable for low voltage bidirectional solutions.

Power IC



IC and Transformer

Push-Pull Topology

Push-Pull transformer drivers use two power transistors that alternately pull down the outer legs of a centre-tapped primary winding. As each transistor switches half the average current, this topology is suitable for higher currents and lower voltage inputs (3-6V). The IC packaging can also be made very compact (e.g. DFN2x2), yet still deliver up to 2W (figure 2).

RECOM offers two different push-pull driver ICs: the RVP010 and the RVP6501, which is pin compatible with the SN6501.

Full Bridge Topology

Full-bridge transformer drivers use four transistors to drive a single primary winding. This makes the driver IC more complex but simplifies the construction and lowers transformer cost. As each transistor switches the full input current, but only half the input voltage, making full bridge drivers suitable for higher input voltage, lower current designs. Under special circumstances, it is also possible to use a full-bridge driver in resonant LLC mode.

RECOM offers four different full bridge driver ICs: the RVP001, RVP003, RVP003S and the RVP005 (figure 3).

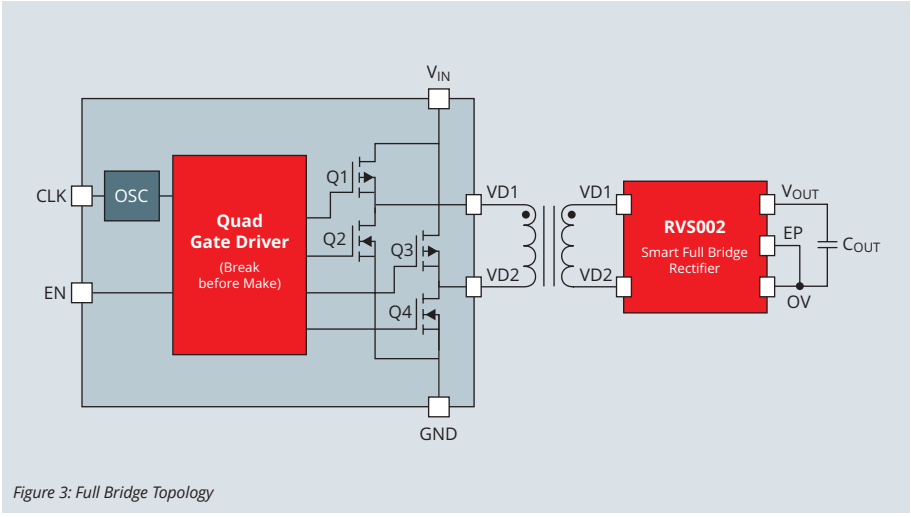


Figure 3: Full Bridge Topology

In addition to the primary side transformer driver Power ICs, RECOM also offers secondary-side synchronous rectifier ICs, which significantly reduce losses. The RVS002 is a full bridge rectifier in a DFN2x2 package which takes up less board space than four rectifier power diodes. The RVSY018 is a synchronous rectifier MOSFET driver IC, that is self-powered and can be used for either high-side or low-side rectification. The RVSW013 is a bidirectional rectifier IC.

Why chose a discrete over a modular solution?

A module solution offers many advantages: it is a complete, well-known, drop-in DC/DC power supply that is pre-assembled, pre-tested and pre-certified, and comes with comprehensive specifications and performance graphs. This guarantees predictable and reliable performance under all operating conditions. It also comes with a manufacturer's warranty for peace of mind. The downside is that the pinout, the input/output voltage combinations, and package size is decided by the manufacturer. Furthermore, as the assembly and encapsulation costs are fixed, as the project volume increases, the cost eventually bottoms out and remains fixed, even with very high project volumes (figure 4).

For existing discrete designs, RECOM offers a range of standard SMD transformers. In addition, there are ICs plus optimized transformer pack-

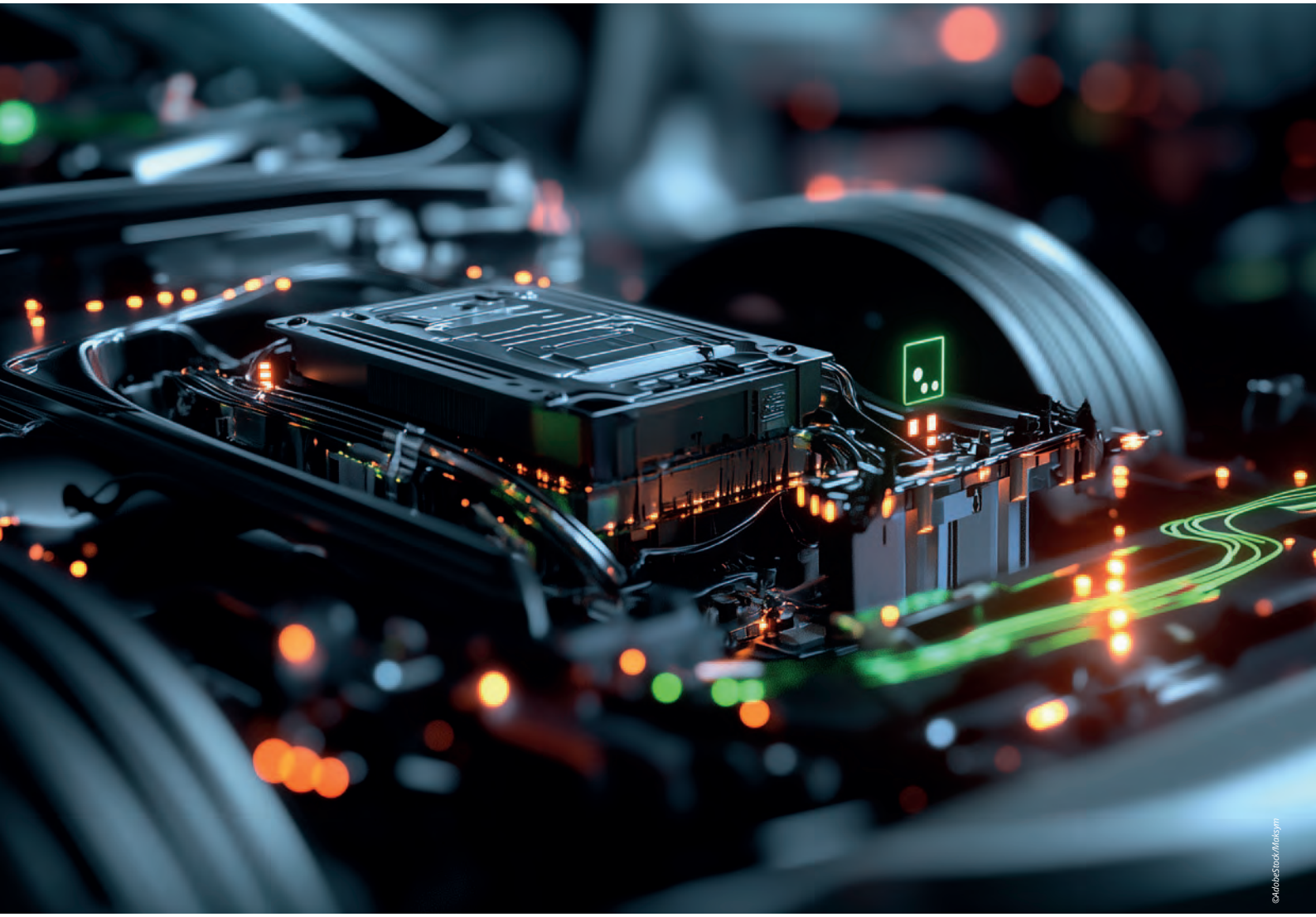


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Figure 4: Quantities may deviate depending on various factors

ages, which have been pre-tested to ensure they work well together. The combination of both equals a complete discrete solution board (DS series) for test and evaluation, covering common input/ output and isolation voltages with pre-mounted driver IC, transformer and rectifier.

Discrete solutions offer more flexibility, allowing unusual or non-standard component placement to fit into tight spaces. There can also be advantages in logistics and production supply chain management as all components can be pick-and-place assembled. For high volume projects, the unit cost continues to decrease with higher quantities, thus lowering the overall cost.

Discrete Solution evaluation boards with any standard IC and matching transformer combination can be supplied within 20 days. For a 50kpcs MOQ, fully customizable transformers with a free choice of input, output and isolation voltages are offered.

Samples are available at CODICO.

A10

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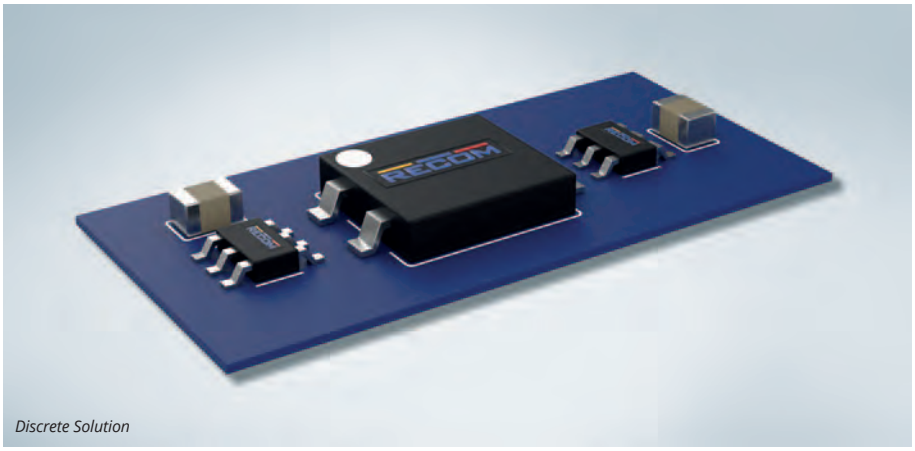
Transformer



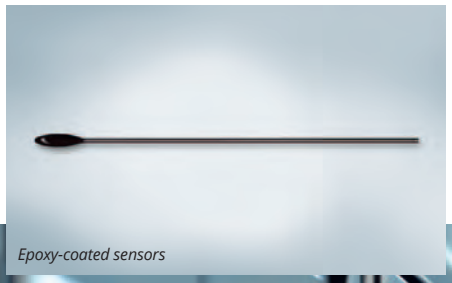
Discrete Solution

KEEPING TEMPERATURE UNDER CONTROL

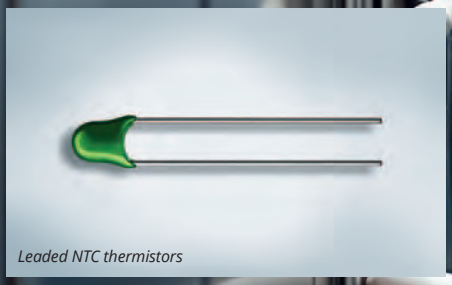
Reliable Sensor Solutions for Industrial Applications

Overheating is one of the most common causes of unplanned downtime in industrial equipment. Whether in motors, drives, control systems, or battery-powered applications, temperature is a critical operating parameter that directly affects lifetime, efficiency, and system reliability. As industrial automation continues to advance and power density increases, the requirements for precise, robust, and early temperature monitoring become more demanding.


Screw-mounted sensors


Epoxy-coated sensors


SMD thermistors


Leaded NTC thermistors

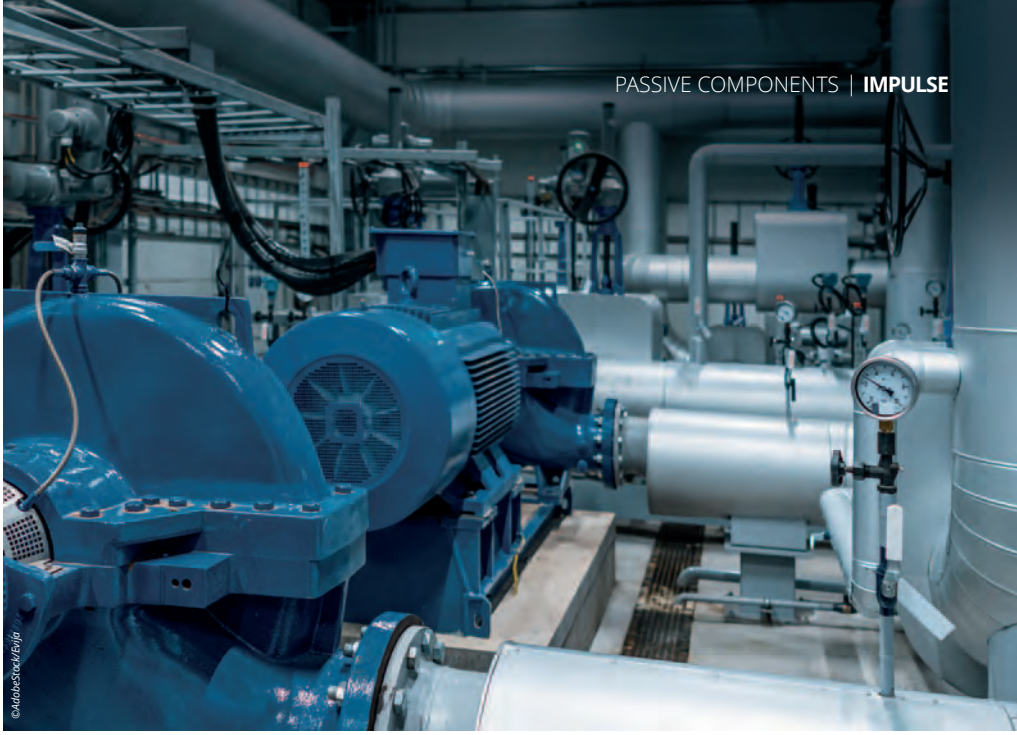
NTC temperature sensors are widely established in industrial environments due to their accuracy, reliability, and compact design. However, the decisive factor is often not the sensor technology itself, but how the sensor is integrated into the application.

Standard Solutions – When Boundary Conditions are Clearly Defined

In many industrial designs, thermal hotspots and installation points are well defined. In such cases, standard NTC temperature sensors offer an efficient and proven solution, for example:

- **Screw-mounted sensors** for direct temperature measurement on heat sinks, power devices, or transformers
- **Epoxy-coated sensors** for motors, battery packs, and control boards
- **SMD thermistors** for compact layouts and automated assembly processes
- **Leaded NTC thermistors** for flexible positioning close to the heat source

Standard solutions provide a good balance between performance and cost, provided that mechanical installation, thermal coupling, and manufacturing processes are compatible with the application requirements.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When standard is not sufficient: Temperature Sensing as Part of System Design

In practice, standard sensors often reach their limits. Typical challenges include:

- Restricted installation space
- Defined distances between sensor and heat source
- Tight mechanical tolerances
- Fully automated assembly (taping & reel, pick-and-place)
- Increased requirements for vibration resistance and long-term stability

In such scenarios, temperature sensing becomes an engineering task that requires close coordination between electrical design, mechanical integration, and manufacturing considerations.

Application Example: Custom Temperature Sensor for a Motor Control Unit

A representative industrial example is the development of a customized NTC temperature sensor for a pump motor control. The requirement was to position the sensing element at a defined distance from the PCB, as close as possible to the monitored component, while ensuring mechanical robustness during automated assembly.


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The solution did not focus solely on the thermistor element, but on a mechanically integrated sensor assembly. A snap-fit holder combined with ultrasonic welding enabled precise positioning and reliable fixation of the sensor. At the same time, the design allowed delivery in taping-and-reel format, ensuring compatibility with high-volume production.

This example illustrates that the real value of temperature sensing solutions often lies not in the sensor itself, but in its application-specific integration into the overall system.

Design-In as a Key Factor for Reliable Temperature Monitoring

Temperature sensors should ideally be considered already during the concept and design phase of a product. Early integration allows optimization of thermal measurement points, mechanical mounting, and manufacturing processes, reducing the need for later compromises.

Together with technology partners such as THINKING, CODICO supports customers throughout the design-in process by providing expertise in:

- selecting suitable standard or custom sensor solutions
- electrical and mechanical integration
- alignment with manufacturing and packaging requirements
- coordination between development, purchasing, and production

The result is a temperature sensing solution that is technically robust, manufacturable at scale, and precisely aligned with the requirements of the industrial application.

P01

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CONCLUSION

The selection of a temperature sensor in industrial applications is inseparably linked to the overall system architecture. Measurement accuracy, response time, sensor positioning, mechanical fixation, and assembly processes influence the quality of temperature data just as much as the choice of the NTC element itself. While standard sensor solutions cover a wide range of applications, they reach their limits in complex installation environments or highly automated production processes. In such cases, application-specific sensor design becomes essential to ensure reproducible measurement results and stable series production.

INNOVATIONS

CJV/CHV Launch & High-Voltage PMLCAP Production Starts

The new hybrid capacitors CJV (125°C, 4,000h) and CHV (135°C, 4,000h) combine top-tier specifications with attractive pricing. At the same time, RUBYCON is beginning mass production of high-voltage PMLCAPs – here's an overview of what makes these capacitors stand out and why they are important for the industry.

CHV Series

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The Conductive Polymer Aluminum Solid Electrolytic Capacitor (hereafter referred to as hybrid capacitor) is currently one of the most competitive segments in the capacitor market, particularly in terms of new product development. Manufacturers introduce nearly new series every year. The material »Conductive Polymer« still offers significant development potential, meaning that intense competition among capacitor manufacturers in this segment is expected to continue in the future.

Hybrid Capacitors with Affordable Prices and Top-Tier Specifications

RUBYCON will soon introduce the new CJV (125°C, 4,000h) and CHV (135°C, 4,000h) series. Both belong to the so-called C series within the PZ Cap© hybrid capacitor portfolio. The C Series is positioned as a cost-effective alternative, placed below the flagship P Series. The P Series serves as a platform for introducing the most technologically advanced specifications in the industry. It focuses on mass production of standardized products while still offering some room for customization, a key strength of RUBYCON.

In contrast, the C series targets affordable standard solutions, with specifications approximately one generation behind the latest developments. Despite this, it currently represents the largest volume segment in the market. The new CJV and CHV series guarantee at least the same specifications as the existing PJV and PHV series.

At first glance, a price-oriented product series might not seem ideally suited to the profile of Impulse magazine, which focuses on cutting-edge technologies and market trends. Nevertheless, the CJV and CHV series are being presented, although the final decision on how they will be positioned in the portfolio has not yet been made. RUBYCON has recently identified that these series have the potential to exceed the specifications of the existing PJV and PHV series, particularly in terms of capacitance values and ripple current capability. For this reason, the originally planned start date for sample orders has been postponed from January 2026 to April 2026, allowing time to further review and validate the enhanced specifications.

RUBYCON is considering whether to integrate the upgraded specifications into the existing CJV and CHV series or to create a completely new series. Regardless of the decision, the new specs deliver cost efficiency while meeting the industry's highest performance standards.

Expansion to Larger Sizes

The CJV and CHV series stand out not only for their evident development potential regarding future specification upgrades but also for the planned expansion to larger case sizes – ø10×12.5mm and ø10×16.5mm – by 2026. In hy-

CHV SERIES SPECIFICATIONS – TODAY AND POTENTIAL

SIZE		8×10.5mm		10×10.5mm		10×12.5mm		10×16.5mm	
VOLTAGE		CAPACITANCE	RIPPLE CURRENT*	CAPACITANCE	RIPPLE CURRENT*	CAPACITANCE	RIPPLE CURRENT*	CAPACITANCE	RIPPLE CURRENT*
25V	Today	220µF	1,600mA	330µF	2,000mA	470µF	2,300mA	560µF	2,900mA
	Potential	270µF	2,800mA	470µF	3,300mA	560µF	3,600mA	820µF	4,300mA
35V	Today	150µF	1,600mA	270µF	2,000mA	330µF	2,300mA	470µF	2,900mA
	Potential	180µF	2,800mA	330µF	3,300mA	390µF	3,500mA	560µF	4,100mA
50V	Today	68µF	1,300mA	100µF	1,600mA	150µF	2,100mA	180µF	2,600mA
	Potential	82µF	2,500mA	150µF	2,800mA	180µF	3,300mA	220µF	3,800mA
63V	Today	33µF	1,200mA	56µF	1,500mA	68µF	2,000mA	100µF	2,400mA
	Potential	47µF	2,300mA	82µF	2,600mA	100µF	3,300mA	150µF	3,800mA

**Ripple current at 100kHz, 135°C*

brid capacitors, these dimensions are generally considered »large.«

The reason hybrid capacitors rarely reach larger dimensions (ø >12.5mm or height >20mm) lies in the technical challenge of reliably impregnating aluminum foil elements with conductive polymer. As the element size increases, it becomes increasingly difficult to ensure complete impregnation to the center of the element.

Here lies RUBYCON's technological advantage: the company is currently the only manufacturer on the market offering ø10×20mm elements in through-hole design. Furthermore, RUBYCON plans to expand the CJV and CHV series to ø10×20mm as well. If successful, this will open a new dimension for hybrid capacitors: a »dream capacitor« – a compact unit at a reasonable price that delivers 2,000µF capacitance while simultaneously handling 8A ripple current over its entire lifetime – could become a reality for the first time.

Key Features of CJV Series

- Temperature Range: -55 to +125°C
- Rated Voltage Range: +25 to +80Vdc
- Lifetime: 125°C / 4,000hours
- Size: ø6.3×6.1mm to ø10×16.5mm

Key Features of CHV Series

- Temperature Range: -55 to +135°C
- Rated Voltage Range: +25 to +80Vdc
- Lifetime: 125°C / 4,000hours
- Size: ø6.3x6.1mm to ø10x16.5mm

Production Schedules

- From April 2026: Sample Production schedule below ø10×10.5mm
- From May 2026: Mass Production schedule below ø10×10.5mm
- From August 2026: Sample Production schedule above ø10×12.5mm
- From 2027: Mass Production schedule above ø10×12.5mm

High-Voltage PMLCAP Enters Mass Production

RUBYCON announces the start of mass production of the HPB series of Polymer Multi-Layer Capacitors (PMLCAPs) from April 2026.

What is PMLCAP Technology?

The PMLCAP technology (Polymer Multi-Layer Capacitor) is based on a stacked polymer dielectric structure. Compared to conventional film capacitors in DC-Link applications, PMLCAPs offer the following advantages:

- Higher power density (30–50% smaller size at the same performance)
- Improved ripple current handling across the entire temperature range
- No voltage derating even at high temperatures up to 125°C
- Stable capacitance from −40°C to 125°C
- Lower losses at high switching frequencies (>10kHz), ideal for SiC- and GaN-based inverter topologies

Thanks to these features, the HPB series is particularly suitable for DC-Link filtering, On-Board Chargers (OBC), industrial drives, and high-frequency inverter stages.

Key Specification Updates

AEC-Q200 Compliance: The reference to AEC-Q200 compliance has been temporarily removed from the datasheet until full qualification and verification are completed. Once the extended testing program is finished, the AEC-Q200 status will be reinstated.

Discontinuation of the 20% Tolerance Option: The HPB series will now be manufactured with a standard 10% capacitance tolerance, reflecting typical process capabilities.

Final Specifications: As part of the transition to mass production, the ripple current values have been adjusted to the final material and process configuration. This ensures that the updated datasheet accurately reflects the actual performance of the capacitors in production. All revised ripple specifications are included in the new datasheet tables.

For samples, pricing, or technical design-in support, we are happy to assist you.

P02

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HPB Series

HPB SERIES SPECIFICATIONS

RATED VOLTAGE (Vdc)	CAPACITANCE (MF)	SIZE					TERMINAL NUMBER	RIPPLE CURRENT Arms/10kHz	PART NO.
		T	H	L	S	S1			
500	5	11	25	23	18	–	2	7.0	500HPB505K
	10	16	25	23	18	–	2	10.0	500HPB106K
	15	27	25	23	18	10.2	4	15.5	500HPB156K
	20	27	25	23	18	10.2	4	17.5	500HPB206K
900	5	13	25	31	26	–	2	7.0	900HPB505K
	10	21	25	31	26	10.2	4	11.5	900HPB106K
	15	21	35	31	26	10.2	4	16.0	900HPB156K
	20	26	35	31	26	10.2	4	19.0	900HPB206K
	25	31	35	31	26	20.3	4	22.0	900HPB256K

Derating is required for category temperatures above 85°C. Ripple current is a calculated value assuming Δ T=40°C and is not a guaranteed value.

MINIATURIZATION

A Response to the Rising Raw Material Prices

New Design Concepts – Less Silver, Less Copper, More Efficiency.

The current economic situation poses major challenges for the electronics industry. In particular, the sharply rising prices of silver and copper are increasing cost pressure across the sector. Traditional relay designs, which rely on generous use of materials and form factors that have evolved over decades, are increasingly reaching their limits. The answer lies in:

- Miniaturization
- Intelligent design
- Technological leadership

Raw Material Prices as an Opportunity for New Designs

Silver is required for contacts, while copper is used for coils, connection pins, and other current-carrying components. Rising raw material prices therefore have a strong and immediate impact on the manufacturing costs of relays. At the same time, market requirements remain consistently high:

- Higher power densities
- More compact designs
- Long service life
- International approvals

Existing designs based on current relay generations are reaching their economic limits. New architectural approaches are required that maintain or even increase performance while using less material.

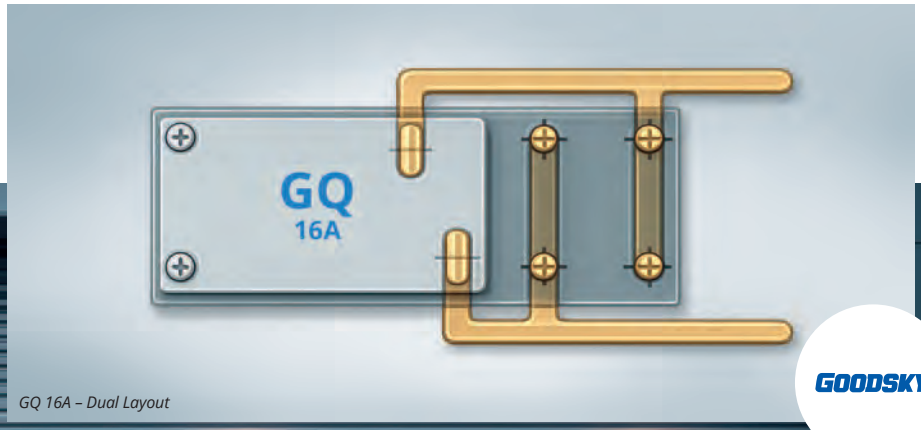
Miniaturization & Dual Layout: Replacing Legacy Designs

A key solution is the consistent miniaturization of modern power relays. By reducing the footprint, optimizing contact systems, and using more efficient coil concepts, both material costs and installation space can be significantly reduced.

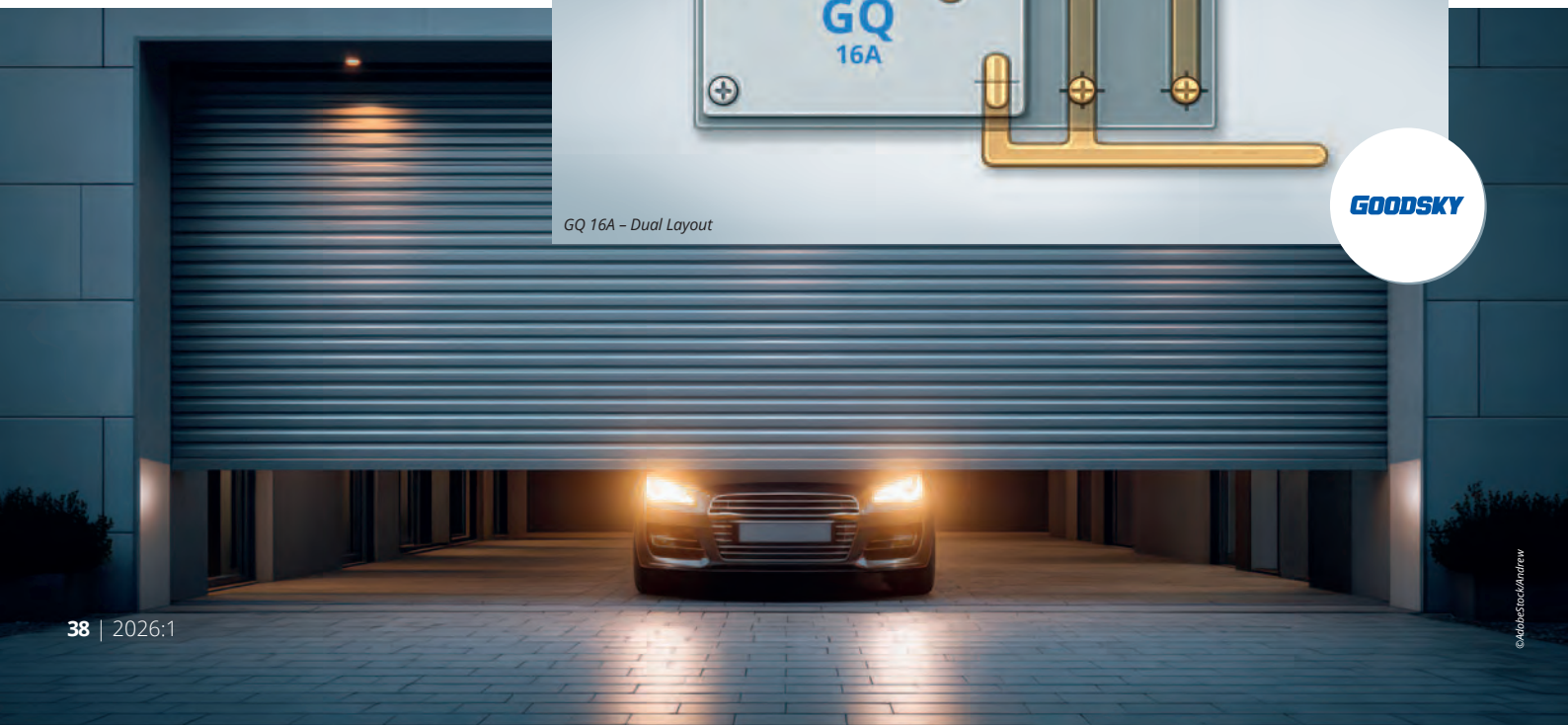
The new miniature relays are designed to allow a simple dual layout with existing, larger standard relays (e.g., classic 16A form factors). Developers benefit in several ways:

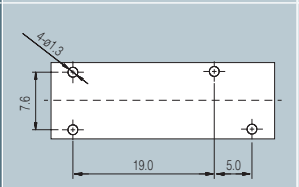
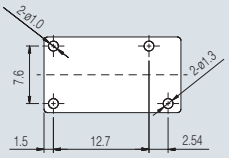
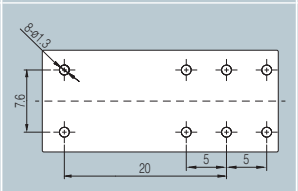
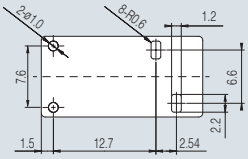
- Reduced use of silver and copper
- Potential space savings on the PCB, allowing additional functions or more compact device housings

In the first step, the solution can be implemented directly in a dual layout, which keeps the required design changes to a minimum. This means that



GQ 16A – Dual Layout



	8A / 10A CLASS		16A / 20A CLASS	
	OLD	**NEW**	**OLD**	**NEW**
Series	Traditional 8/10A PCB Relays	Goodsky GQ, Sanyou SJ	Traditional 16A PCB Relays	Goodsky GQ-16/20A, Sanyou SJ-16A
Volume [cm³]	3.54	2.73	5.78	2.73
PCB space [mm²]	287	182	368	182
Weight [g]	8.0	5.5	12.5	6.0
Footprint				
Contact Configuration	NO / CO	NO	NO / CO	NO

legacy designs are not only replaced from a technical perspective, but also from an economic standpoint.

Technologically Leading Relay Solutions as a Response to Market Requirements

One example of this approach is the modern relay portfolio from GOODSKY, particularly the GQ series. This relay generation was designed specifically to meet today's market requirements:

- High-end miniaturization up to the 20A performance class
- Optimized contact materials for high inrush currents with reduced use of precious metals
- Variants rated for ambient temperatures up to 105°C
- SMD/reflow versions available, supplied in both tube and tape & reel packaging for automated PCB assembly
- Variants for explosion-protection applications, e.g., in systems using modern refrigerants
- Low coil power consumption for improved energy efficiency

Despite their significantly reduced size, these relays meet all relevant UL, IEC, and TÜV requirements and are suitable for demanding applications – from smart home systems and heating controls to household appliances and industrial electronics.

Reducing Costs, Saving Space – Without Compromising Quality

Miniaturized relays are no longer a compromise product. On the contrary: Through innovative product design, highly automated production lines, and comprehensive quality monitoring, modern relays achieve the highest levels of reliability – while simultaneously reducing the use of raw materials. For device manufacturers, this means:

- Cost optimization despite volatile raw material markets
- Optimized PCB space utilization
- Future-proof designs through next-generation relay platforms

Partnering for the Optimal Relay Solution

As a European relay specialist, we support our customers far beyond simple distribution. With in-depth manufacturer-level expertise, application support, and strategic roadmapping, CODICO actively assists customers in migrating from legacy relay designs to modern, miniaturized platforms.

Conclusion

The dramatic rise in raw material prices for silver and copper is not a temporary phenomenon but a structural shift. Miniaturization, new design approaches, and technologically advanced relay models are the key to reducing costs, saving space, and maintaining the highest quality standards at the same time. Modern relay portfolios – such as the GQ series from GOODSKY – clearly demonstrate how economic pressure can be transformed into technological progress. High-end miniaturized relays are not just an option – they are the logical response to current market demands.

P03

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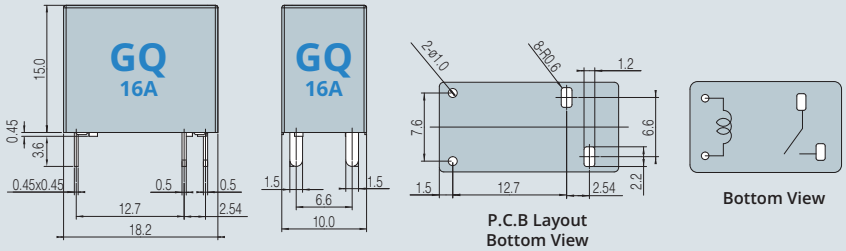

GQ 16A – Dimensions

APPLICATIONS

- **White Goods:** Washing machines, refrigerators, dryers, dishwashers, coffee machines
- **Smart Home:** Alarm systems, lighting control, irrigation systems, garage door controllers, switching actuators
- **Heating, Ventilation, and Air Conditioning:** Heat pumps, air conditioning systems, boilers, burners, thermostats, mixing valves, inverters
- **Industrial Applications:** Programmable logic controllers (PLCs), I/O modules

FREQUENCY STABILITY

More Precise Timing for High-Speed Communication

Data communication is experiencing rapid growth, further accelerated by the use of AI. Optical network standards are evolving from 400G to 800G, while 1.6T is becoming increasingly realistic. At the same time, internal server interfaces are also advancing to PCIe Gen 6.0.

For high-speed communication systems, differential crystal oscillators (DCXOs) are indispensable. They provide high frequencies, ultra-high precision, extremely low jitter, and strong noise immunity. KDS offers suitable products that meet these demanding requirements.

According to forecasts, global data traffic is expected to increase by about 30 times by 2030 and by as much as 4,000 times by 2050. This trend is significantly driving the further development of optical transceivers and PCIe interfaces in servers.

These communication standards use the PAM4 modulation scheme. While PAM4 is already well established in optical transceivers, starting with PCIe version 6.0 this modulation will also become common in high-speed server communication. As data rates continue to rise, the requirements for precise timing devices are increasing as well.

Due to this modulation scheme, crystal oscillators with differential output are required, with the following characteristics being particularly important:

- **High noise immunity:** To maintain signal quality in PAM4 modulation
- **Extremely low jitter:** For stable and reliable data transmission
- **High frequency:** To suppress interference caused by frequency multiplication and to optimize transmission efficiency
- **Low frequency deviation:** To enable lossless transmission of large data volumes and ensure perfect synchronization between transceivers

Differential-output oscillators are primarily used to increase noise immunity. They simultaneously provide two signals with a 180-degree phase difference (non-inverted and inverted outputs).

Conventional single-ended oscillators generate only one output signal. When external interference occurs, it is directly superimposed on the signal, which can lead to noise, synchronization errors, and degraded communication quality – an especially critical disadvantage in high-speed data transmission. Differential-output oscillators operate differently (see figure 1): they use the difference between the two opposite-phase signals, which effectively cancels out external noise that appears equally on both lines (common-mode noise). As a result, the IC can receive the signal from the oscillator stably and without distortion,

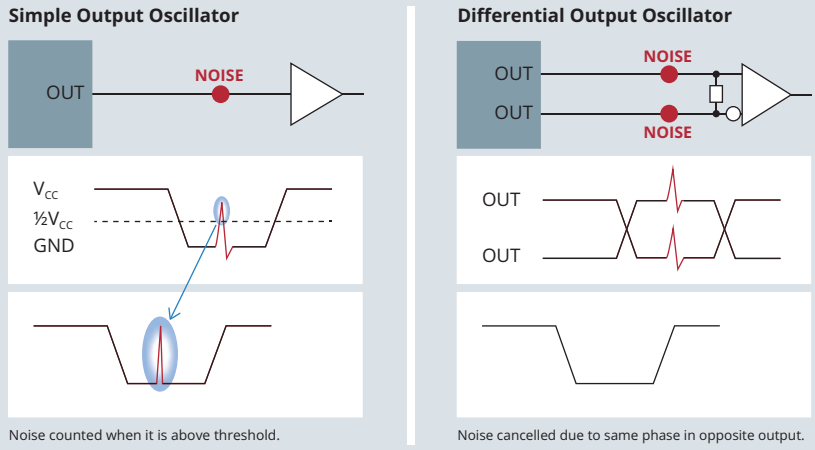

Figure 1: Difference of Single Output and Differential Output

even in environments with significant electrical interference.

Noise does not originate only from external sources. The clock signal generated by a crystal oscillator is always multiplied in the receiving IC. However, the more frequently this multiplication occurs within the PLL, the more the timing noise of the signal – its jitter characteristics – deteriorates. Reducing the multiplication factor, on the other hand, significantly improves jitter performance.

For a long time, the maximum achievable frequency of crystal oscillators was a limiting factor. In recent years, however, the development of frequencies above 100MHz has advanced through the use of reverse-MESA crystal blanks (see figure 2). To minimize the noise amplification caused by multiplication within the IC, the industry is now increasingly shifting from the conventional 100MHz to 156MHz band toward higher frequencies.

Among the key characteristics required for timing devices in high-speed communication, the jitter performance of the signal generated by the timing device is probably the most important. Jitter directly leads to communication errors. In this respect, crystal oscillators outperform MEMS oscillators. Although MEMS technology has made remarkable progress in recent years, MEMS oscillators internally multiply frequencies using oscillation ICs, which results in higher jitter levels.

In contrast, the naturally high Q factor of quartz enables significantly more stable and precise signals.

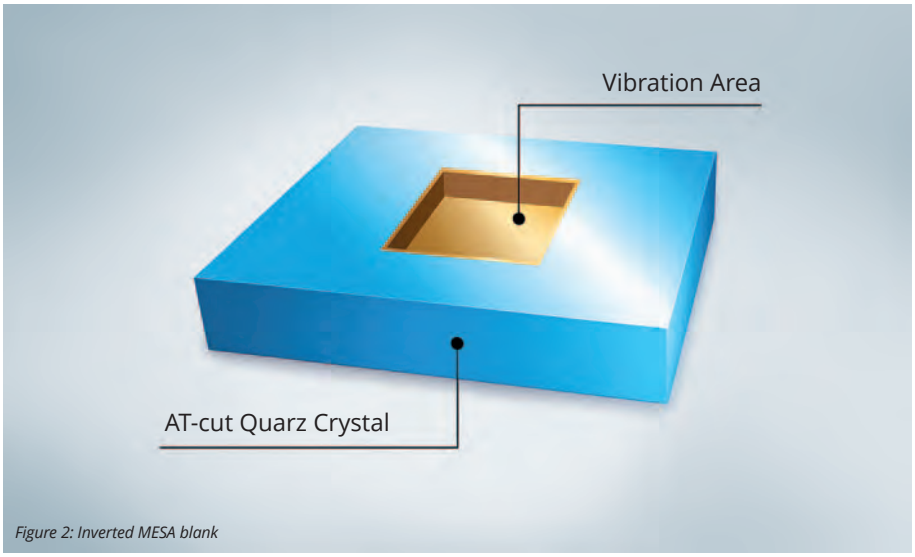

Figure 2: Inverted MESA blank

New KDS Differential Output Oscillators: DS Series and DE Series

To meet these requirements, KDS has announced the DS and DE differential-output oscillator series, both of which feature improved jitter performance. In the future, the DS series will cover standard applications, while the DE series will target the high-performance segment.

The DS series is specifically designed for the widely used 156.25MHz frequency. Its frequency stability of ±50 ppm within a temperature range of –40 to +105°C meets the industry standard. However, the jitter performance has been significantly improved: while the established DSO223SK with LV-PECL output in a 2520 package achieves a typical jitter value of 90fs, the DS2520AK achieves a typical value of only 32fs, setting a new benchmark in its class.

The DE series goes a step further and extends the capabilities of the DS series in two key areas. First, it offers an even lower frequency deviation of ±20 ppm over the temperature range of –40 to +105°C. Second, it maintains this high stability even at double the frequency of 312.5MHz. In direct comparison with the DS series, the jitter performance of the DE series is slightly lower when adjusted for the respective frequency ratio, but it still remains at a similarly high level of performance. For example, compared with the previously mentioned DS2520AK at 156.25MHz, which has a typical jitter value of 32fs, the DE2520AK at 156.25MHz achieves a typical value of 35fs.

The development of the DE series to support 312.5MHz signals illustrates a broader trend toward even higher frequencies in crystal oscillators. In fact, KDS aims to develop oscillators capable of reaching 625MHz – twice 312.5MHz – and even 1.3GHz – four times that frequency – by around 2027 or 2028. Crystal oscillators that struggled to reach 125MHz just a generation ago now appear ready to enter this higher frequency range, thanks to the introduction of inverted MESA crystal blanks.

Key Features of the DS Series

- Available frequencies: 100MHz, 125MHz, and 156.25MHz
- Frequency deviation: ±50ppm (–40 to +105°C)
- LV-PECL output oscillators: DS2016AK (2.0×1.6mm) and DS2520AK (2.5×2.0mm)
- LVDS output oscillators: DS2016AJ (2.0×1.6mm) and DS2520AJ (2.5×2.0mm)

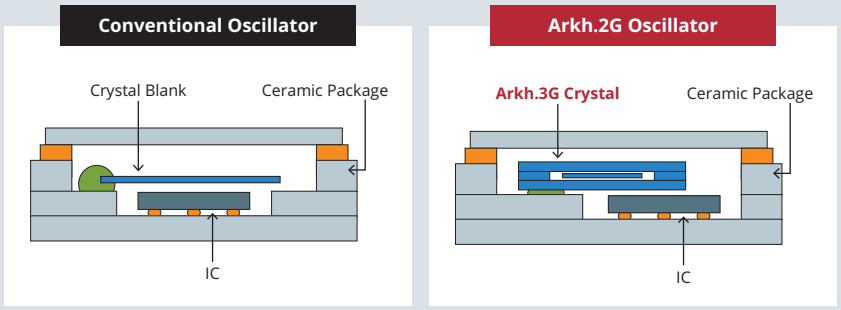

Figure 3: Difference of Conventional Oscillator and Arkh.2G Oscillator

- HCSL output oscillators: DS2016AD (2.0×1.6mm) and DS2520AD (2.5×2.0mm)
- Supply voltage: LVDS +1.8V, +2.5V, +3.3V
- Samples are already available. Mass production will start in June 2026.

Key Features of the DE Series

- Available frequencies: 100MHz, 125MHz, 156.25MHz, and 312.5MHz
- Frequency daviation: ±20ppm (–40 to +105°C)
- LV-PECL output oscillators: DE2016AK (2.0×1.6mm) and DE2520AK (2.5×2.0mm)
- LVDS output oscillators: DE2016AJ (2.0×1.6mm) and DE2520AJ (2.5×2.0mm)
- HCSL output oscillators: Coming soon
- Samples are already available. Mass production will start in August 2026.

Future Frequencies: 625MHz/1.3GHz

Unique Features of the DE and DS Series: Arkh.3G and Arkh.2G

The DS and DE series are based on KDS's oscillator architecture »Arkh.2G«. While it has the same structure as a conventional crystal oscillator, it uses a pre-assembled crystal resonator made from three crystal wafers, referred to as »Arkh.3G«, instead of a single qcrystal blank. This approach offers three key advantages (figure 3):

- Increased shock resistance due to the robust multi-disk construction
- Significantly lower field failure rates
- Easier scaling of production capacity thanks to the reduced space requirements for oscillator manufacturing processes and equipment

Using a pre-assembled crystal oscillator as the oscillation source can significantly increase shock resistance and drastically reduce failure rates in the field. The crystal blank is doubly encapsulated, making it more resilient to external shocks than conventional crystal oscillators. Even with the introduction of reverse-MESA blanks, which enable higher frequencies, the vibrating element remains a thin crystal blank – a structure that is particularly advantageous at higher frequencies.

Moreover, using a pre-tested, fully assembled oscillator ensures a much lower failure rate after device installation compared to solutions that use only raw crystal blanks. A large portion of crystal failures is caused by foreign particles adhering to the crystal blank. Even if contaminants accidentally enter the oscillator during assembly, a pre-tested oscillator as the source remains completely unaffected.

Today, space efficiency in the oscillator manufacturing process is a critical factor. In a typical crystal oscillator production flow, the crystal blank processing stage occupies the largest portion of floor space. This is because each crystal blank must be cleaned, washed, equipped with electrodes, and frequency-trimmed, with each step requiring large specialized equipment. Additional space is also needed for oscillator IC assembly, final product assembly, testing, and packaging. To significantly increase current mass production volumes, building an entirely new factory might be required – an option with enormous costs. With wafer-based crystal oscillators like Arkh.3G, however, the entire oscillator source manufacturing process can be completed in a single production facility. This frees up space for additional assembly and packaging processes, allowing for more efficient scaling of production (see figure 4).

Major crystal manufacturers are currently operating at full capacity, while demand for crystal oscillators continues to rise. Over the past ten years, crystal oscillators have always been the first to be affected whenever adjustments to crystal component production capacity were needed. This makes the Arkh.2G structure the optimal strategy to meet the expected significant increase in demand for differential-output oscillators.

By using the Arkh.3G structure for the DS and DE series, ultra-miniaturization to sizes such as 1.0×0.8mm will also be possible in the future.

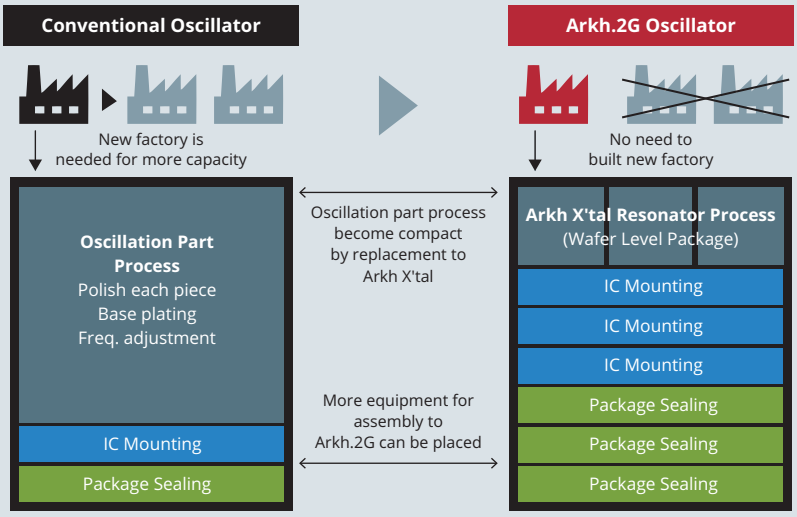

Figure 4: Scalability difference of Conventional Oscillator and Arkh.2G Oscillator Production Lines

KDS LOW JITTER DIFFERENTIAL OUTPUT XO SELECTION GUIDE

						SIZE		
SERIES	**FREQ. (MHz)**	**STABILITY**	**MODEL**	**OUTPUT**	**PHASE JITTER**	**2016**	**2520**	**3225**
New DE Series (High Stability)	**312.5**	**±20ppm** (-40 to +105°C)	DExxxxAJ	LVDS	**32**fs typ.	DE2016AJ	DE2520AJ	DE3225AJ
			DExxxxAK	LV-PECL	**27**fs typ.	DE2016AK	DE2520AK	DE3225AK
New DS Series (Standard)	100	±50ppm (-40 to +105°C)	DSxxxxAJ	LVDS	**38**fs typ.	DS2016AJ	DS2520AJ	DS3225AJ
	125		DSxxxxAK	LV-PECL	**32**fs typ.	DS2016AK	DS2520AK	DS3225AK
	156.25		DSxxxxAD	HCSL	**34**fs typ.	DS2016AD	DS2520AD	DS3225AD
Conventional Oscillator	156.25	±50ppm (-40 to +105°C)	DSOxxxSJ	LVDS	**70**fs typ.		DSO223SJ	DSO323SJ
			DSOxxxSK	LV-PECL	**90**fs typ.			DSO323SK
			DSOxxxSD	HCSL	**150**fs typ.		DSO223SD	DSO323SD
Arkh.3G (1.0×0.8mm)	156.25	±50ppm (-40 to +105°C)	DS1008JJ	LVDS	80fs typ.			
			DS1008JK	LV-PECL	73fs typ.			

Wafer-type crystal resonators with the Arkh.3G structure become full crystal oscillators once an IC is mounted.

The Potential of Differential-Output Oscillators

The adoption of AI is remarkable. Currently, many AI systems, such as Large Language Models (LLMs), are often operated by a few high-performance AI server hubs. However, with the rise of Edge AI, these functions are increasingly distributed across numerous smaller, local hubs. This shift offers benefits such as higher processing capacity, better scalability, lower energy consumption through decentralization, and improved data privacy.

In the future, a variety of electronic devices supporting Edge AI are likely to enter the market. To achieve fast communication for the massive amounts of data generated by these devices, precise timing devices are required. Consequently, the demand for differential-output oscillators is expected to increase in Europe as well. KDS is ready to actively support this development, both technically and strategically.

If you require ultra-compact oscillators, contact us.

P04

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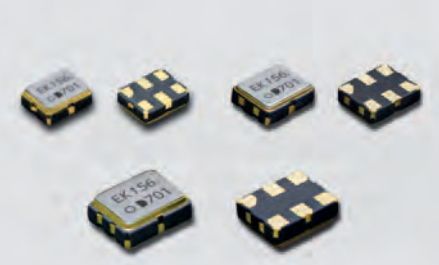
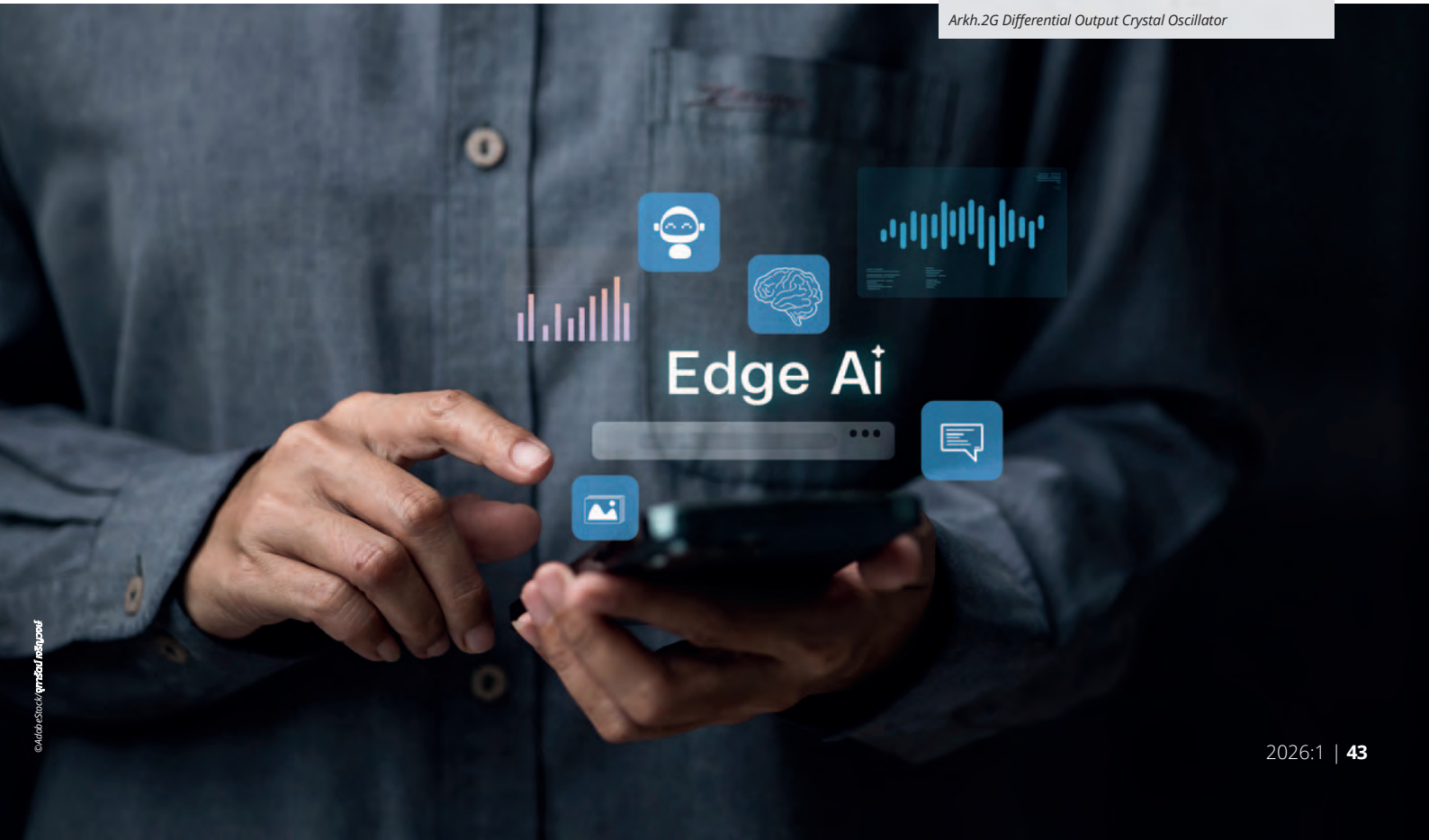


Arkh.2G Differential Output Crystal Oscillator



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POWER

MTA Inductors Family Powers Advanced EV Charging Technology

Electric vehicle (EV) adoption continues to accelerate globally, creating an urgent need for efficient charging infrastructures that can support both vehicle-integrated and stationary high-power applications. EV charging ecosystems run the gamut from onboard AC charging systems operating at 11kW and above to ultra-fast DC charging networks delivering 350kW or more to increase the charging speed. Engineers developing these systems face ever-mounting pressures to achieve maximum power density and reliable operation in harsh environmental conditions while meeting strict electromagnetic compatibility (EMC) standards.

Typically, EV charging systems require power conversion circuits that operate under demanding conditions, such as high currents, compact designs, and thermal stress, which push traditional inductors beyond their performance limits. A DC fast charging infrastructure, for instance, requires multi-stage power processing, incorporating power factor correction and galvanically isolated conversion topologies that are subjected to currents easily exceeding 400A. Vehicle onboard chargers have equally demanding requirements for power conversion systems that can operate reliably in automotive temperature extremes while fitting into constrained under-the-hood packaging. Both scenarios require inductors capable of high-frequency switching up to 1MHz to minimize passive component sizes, coupled with electromagnetic shielding to reduce interference issues with vehicle electronics and communication systems.

Many inductor solutions cannot sustain the high current levels required in these next generation charging systems without impacting thermal performance. Standard wire wound constructions often exhibit poor high-frequency characteristics and temperature stability, resulting in efficiency losses and potential reliability issues during extended operation. Moreover, insufficient magnetic shielding in some designs generates interference that violates automotive emission standards and disrupts sensitive electronic systems in both the vehicles and the charging infrastructure.

To meet these critical design challenges, EATON's MTA family inductors employ innovative molded construction and advanced magnetic materials. Available in ABC configurations, these compo-

MTA Series

nents deliver current handling from 37A to 440A across inductance values of 0.82µH to 6.8µH. The proprietary molded architecture enables exceptional thermal management and soft saturation characteristics while maintaining stable electrical parameters from –55°C to +155°C. The integrated magnetic shielding within the molded structure effectively contains electromagnetic fields, reducing EMI and simplifying system-level compliance with automotive and commercial EMC requirements.

Manufacturing these inductors using advanced molded techniques yields several performance advantages particularly beneficial for EV charging applications. The flatwire terminal construction and variety of compact footprint designs, ranging from 27x19mm to 52.9x23.9mm packages, help to increase power density and enable efficient thermal dissipation compared with typical inductor constructions. The MTA family's high frequency operation capability (up to 1MHz) supports wide-bandgap semiconductor switching devices, allowing designers to achieve higher switching frequencies that reduce passive component sizes and system weight. The through hole terminal design provides mechanical robustness for automotive environments, which are subject to vibration, thermal cycling, and mechanical stress during vehicle operation.

The MTA inductors meet AEC-Q200 grade 1 certification for automotive applications with low DC resistance performance, which minimizes power loss and heat buildup in high-power EV charging systems. With their high current handling capabilities, wide operating temperatures, and automotive grade reliability, the MTA family offers an effective solution for next-generation EV charging infrastructures.

Features and benefits

- Multiple compact THT package sizes optimize PCB space in high current applications
  MTA2V: 26.8×22.8mm, 27×23mm, 27×19mm, 30×22mm
  MTA3V: 38.8×23.8mm, 40×23.9mm, 52.9×23.9mm
- Wide inductance range (0.82µH to 6.8µH) and current ratings (37A to 440A) support advanced buck/boost converters and power filtering applications
- High power flat-wire THT terminals provide superior mechanical strength, electrical performance, and enhanced thermal management
- Unique molded construction with soft roll-off maintains stable inductance at high currents while minimizing saturation losses
- Advanced EMI shielding materials enhance EMI immunity for reliable operation
- Robust construction ensures reliable performance in harsh automotive environments
- An extended operating temperature range (–55°C to +155°C) supports automotive, industrial, energy, and AI computing applications.

P05

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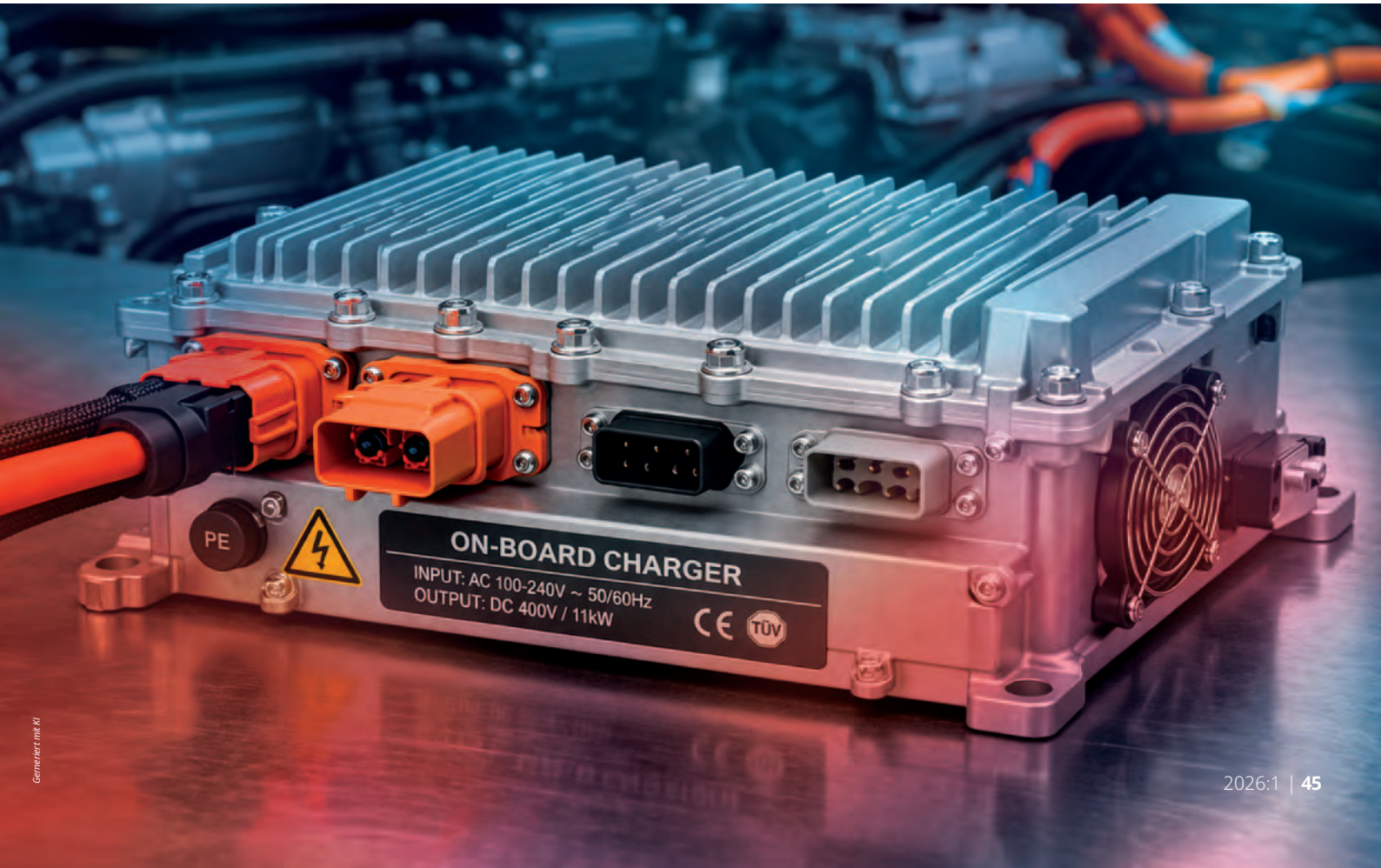


Generiert mit KI

RELIABLE SOLUTIONS

Energy-Efficient and Secure Building Automation

The implementation of automation systems in buildings – such as heating, ventilation and air conditioning (HVAC), lighting control, automatic doors and elevators – requires consideration of energy efficiency, security and environmental impact. Meeting these requirements can be challenging, but they can be addressed with the help of CELDUC® relais solid state relays and magnetic sensors.

Solutions for Energy Control and Efficiency in Commercial and Industrial HVAC Systems

Heating, ventilation and air conditioning (HVAC) systems are found almost anywhere, providing thermal comfort for people indoors. Many of these systems still use electromechanical relays and contactors (EMRs). EMRs have a short lifespan due to the wear and tear of their moving parts with frequent use. These moving parts also generate clicking sounds that may be inappropriate in quiet environments.

Moreover, their switching operation is slower and less precise than solid state relays (SSRs). However, CELDUC® solid state relays offer several advantages in HVAC applications. They offer a long life expectancy, an absence of mechanical noise, low input current, and a fast response time.

Solid state relays can handle almost any types of load used in HVAC systems, such as fans, blowers, motors and compressors. They are also ideal for heating control applications where electric heating elements need to be switched on and off frequently to maintain a specific temperature. An even more precise temperature control is possible using proportional power control methods, such as phase angle or burst fire control. These types of control are solely used with a solid state technology.

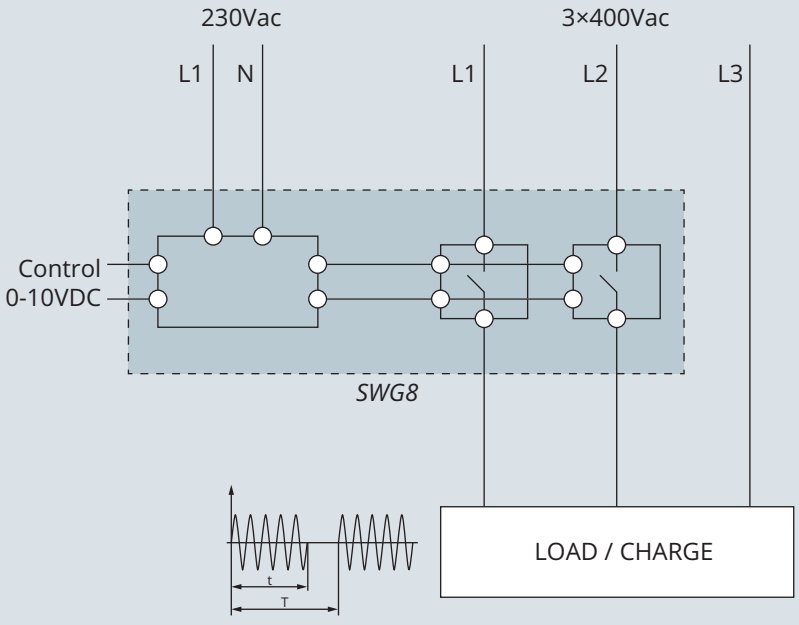
Solid state relays, controlled by a monitoring software, regulate the heating and cooling cycles to ensure that these systems only operate when necessary and at optimal levels.

Precise temperature control not only reduces energy consumption, but also improves indoor comfort. Both of these factors are particularly important in environments that require constant air conditioning.

SWG8 Series

ECOM0010 Module

SO465620 Single-Phase Angle Controller



HVAC Application

CELDUC® relais provides a range of solutions that are perfectly adequate for HVAC applications and proposes the following products.

- The **SWG8 series** of three-phase controllers features a 0–10 VDC control module and a power module. The control module is isolated from the mains and has an analogue input to proportionally vary the operating duty cycle of a heating element (or a set of heating elements) connected to the power module.
- The **ECOM0010 module**, in combination with our SU/SUL/SUM range, provides a compact solution that offers a communication interface, current monitoring and a PID temperature controller.
- Reference **SO465620** is a single-phase angle controller with pulse width modulation (PWM) control, which adjusts the power supplied to resistive loads according to a linear power law.

SK Series

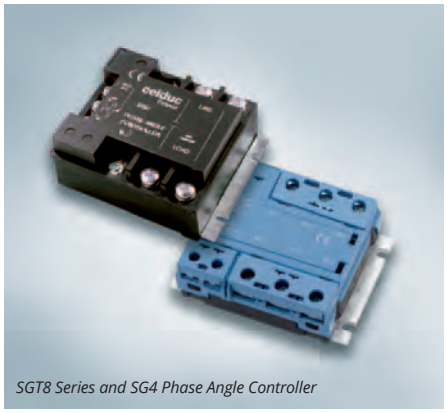
SO8 Series

Solutions for Accurate Control of Lighting Systems

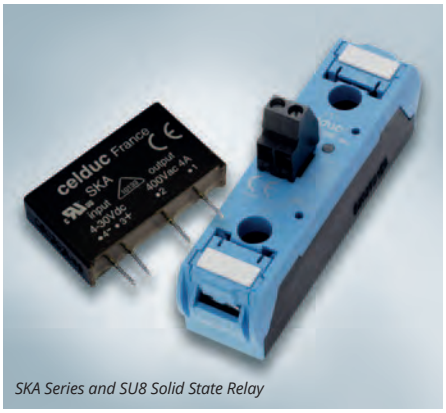
While inefficient room temperature control is considered a major cause of energy losses, the potential savings from optimized lighting usage are often underestimated. Intelligent lighting control therefore plays a key role in reducing energy consumption. CELDUC® solid state relays are designed for reliable operation under high loads with minimal wear. In lighting control systems, they enable the automatic switching of lights on and off depending on room usage or the presence of occupants. This helps save energy, extend the lifespan of lighting fixtures, and reduce overall energy costs.

CELDUC® relais offers solutions for the most used lamp technologies:

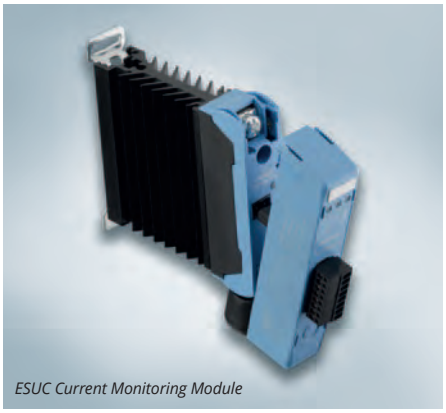
- The **SK series** of PCB mount single-phase SSRs provides AC outputs from 1A to 30A and 600-1600Vpeak. They are perfectly adequate for discharge and metal halide lamps (AC-5a loads).
- The **SO8 series** of zero-cross SSRs can be a perfect match for either discharge & metal halide lamps (AC-5a loads), standard incandescent lamps, halogen incandescent lamps, & fluorescent lamps (AC-5b loads), or LED lights.
- The **SGT8 series** of three-phase SSRs, the **SO7 random single phase SSRs** and the **SG4 phase angle controllers** are perfectly adequate for standard incandescent lamps, halogen incandescent lamps, and fluorescent lamps (AC-5b loads).
- The **SKA PCB mount SSR**s and the **SU8 low profile SSRs** can be used for LED lights.
- The **ESUC current monitoring module**, in combination with the **SU/SUL/SUM** product range, can be used to independently detect wire breaks, miswiring, or open-circuit failures, and report these faults to a microcontroller.



SGT8 Series and SG4 Phase Angle Controller



SKA Series and SU8 Solid State Relay



ESUC Current Monitoring Module

Magnetic Proximity Sensors and Position Sensors

Solutions for Smoke Extraction Systems in Case of Fire

Smoke vents allow natural smoke ventilation. Such ventilation is crucial for managing fire safety in buildings. It enables smoke to be evacuated efficiently, thereby reducing the risk to occupants and facilitating an effective emergency response. Adequate compartmentalization and installation that complies with standards are essential to ensure that natural smoke ventilation is effective. Building managers are concerned about whether the smoke vents are open or closed. Even when they are supposed to be closed, these smoke vents are sometimes left open, either intentionally or unintentionally.

Being able to quickly identify whether a smoke vent has been opened enables you to act swiftly, limiting the damage that could be caused by bad weather and preventing intrusion into communal areas. It also ensures that essential maintenance work has been carried out.

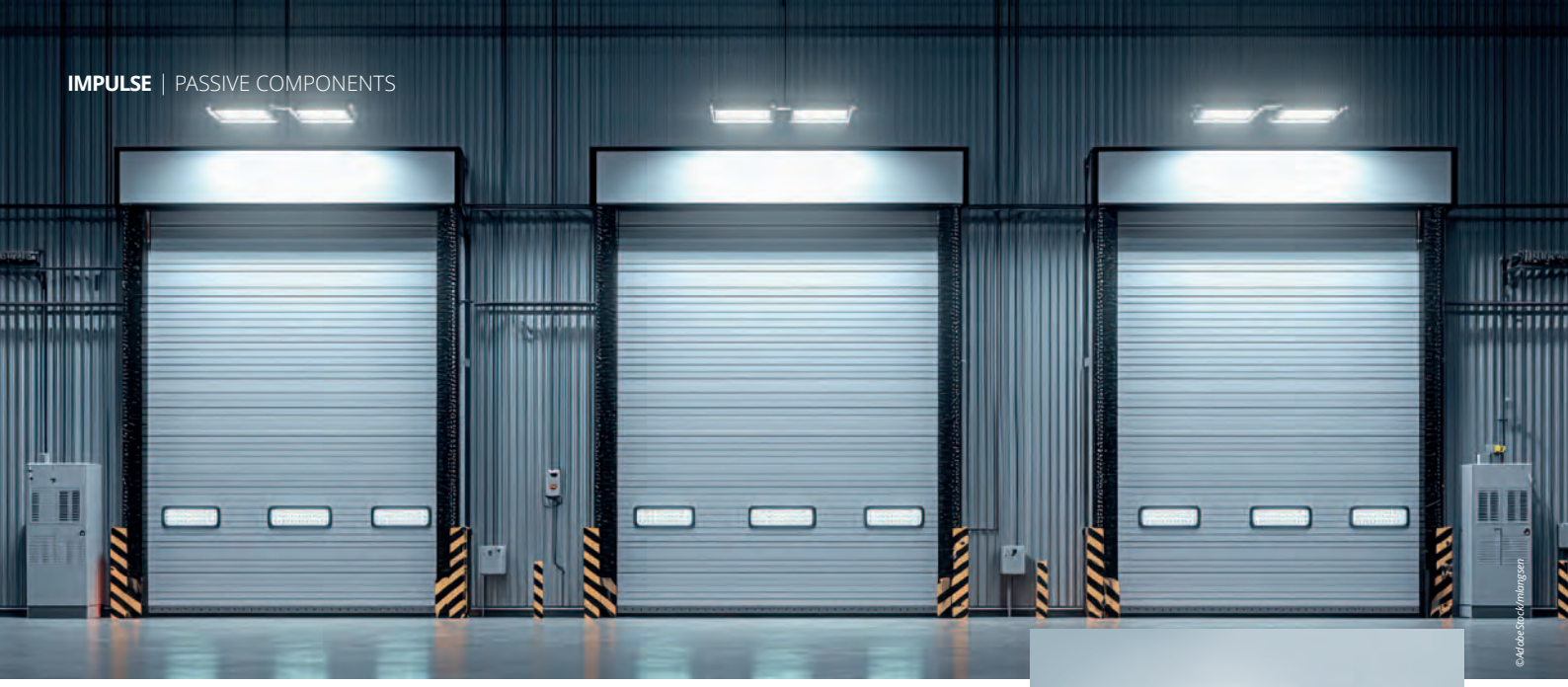
Magnetic proximity sensors are used in smoke ventilation systems and are mounted on smoke vents to provide an alert when a smoke extraction or vent hatch is opened. This firefighting equipment is essential for preventing fires from spreading too quickly and for enabling effective smoke extraction to protect occupants. The reliability of smoke extraction hatches and mechanical smoke extraction devices is crucial to ensure the safety of building occupants. Only two sensors are required to check if a smoke vent is opened or not. It is an effective, easy to install solution.

CELDUC® relais offers a wide range of screw-in position sensors that are perfect for this kind of application.

Solutions for Window and Door Monitoring

Position sensors also provide an easy way to monitor the opening and closing of windows and doors. The function of magnetic sensors is to detect whether a door or window is shut (i.e. the magnetic fields are touching) or open (i.e. they are not touching) by using magnetic fields.

These sensors, when connected to an IoT communication system, can alert you when doors or windows in a building have been left open, thus improving security. The data they provide can also help to make a building more energy efficient. To enable the sensors to monitor whether a window or door is open or closed, magnets are mounted on the interior door and window frames, and the sensors are mounted on the fixed frames. The contact is not activated as long as the doors or windows remain closed.



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Solutions for Industrial Automatic Gates

CELDUC® relais presents the PLMA0100, a particularly robust proximity sensor designed for demanding environments. This rectangular magnetic proximity sensor features a full-metal housing and is specifically engineered for operation under harsh industrial conditions.

The sensor is highly resistant to deformation and corrosion, making it ideal for detecting the opening status of industrial gates, as well as for a wide range of other applications. In addition, the PLMA0100 is resistant to regular and intensive cleaning processes, making it especially suitable for demanding industrial environments.

Proximity Sensor PLMA0100

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change state when the magnet on the lift moves past each sensor as it moves up or down. To meet this need, CELDUC® relais features the PMG series of magnetic reed sensors.

Automation systems in the building sector must balance performance with energy efficiency, security, and environmental responsibility. As buildings become smarter and more connected, the choice of reliable and efficient control components becomes increasingly critical.

CELDUC® relais solid state relays and magnetic sensors delivers robust solutions to these challenges by ensuring precise control, long service life, reduced maintenance, and improved energy management. Their integration into HVAC systems, lighting control, access management, and vertical transportation contributes to safer, more efficient, and more sustainable buildings. Ultimately, adopting these technologies supports the development of intelligent building infrastructures that meet modern operational and environmental expectations.

P06

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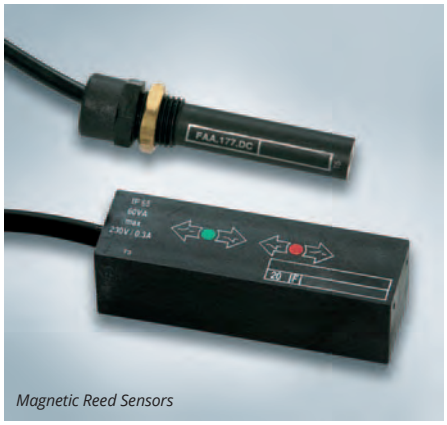

Magnetic Reed Sensors

Solutions for Lifts

The electric motors in lifts should start and stop at the required floors.

Therefore, feedback on the exact position of the lift cabin should be provided. Latching reed sensors provide this feedback very accurately: they stay in an actuated state as the lift passes floors on the way up, and in a non-actuated state as it passes floors on the way down. These latching reed sensors are mounted on every floor and

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NEXT LEVEL

Aluminum Electrolytic Capacitors for 48V Automotive and Industrial Systems

As 48V architecture continues to dominate the automotive electrification and industrial automation landscape, engineers require capacitors that can safely handle higher voltage demands without sacrificing size, ripple current capability, or thermal stability.

YAGEO Group expands PEx227 and PEx228 Al-electrolytic capacitor series with new 80V options, which reflects their commitment to advancing power electronics with higher voltage capability, improved reliability, and enhanced design flexibility for today's demanding 48V automotive and industrial systems.

The new 80V addition bridges the voltage gap between existing 63V and 100V ranges, delivering a balanced solution that combines high capacitance, low ESR, and proven AEC-Q200 reliability up to +150°C. This enhancement ensures stable operation under severe thermal and vibration conditions, supporting applications such as DC-Link, smoothing, decoupling, and power conversion in environments where performance and endurance are paramount.

These capacitors are specifically designed to meet the growing voltage requirements in modern automotive and industrial power platforms with extended thermal performance. PEx227 and PEx228 deliver higher voltage capability in a compact form factor, allowing designers to achieve greater power density and reliability without increasing board space or compromising thermal performance. They ensure performance and stability in high-demand power circuits and deliver efficient energy storage with minimal losses. Additionally, they offer design flexibility across a wide range of applications.

FEATURES

- 80V rated voltage for 48V systems (total voltage range 25V to 100V)
- High capacitances of up to 10,500µF
- Low ESR and high ripple current capability
- Long life time and an operation of up to +150°C
- Multiple form factors like axial, radial and SMD
- AEC-Q200 certified

Target applications are DC-link, smoothing, and decoupling circuits for:

- Power conversion and SMPS
- Automotive 48V systems such as cooling fans, power steering, water cooling pumps, braking, and injection
- Industrial motor control and automation equipment
- Power distribution, inverter, and energy storage systems
- Server, computing, and data center power management
- Telecommunications and networking infrastructure
- Base station power systems

P07

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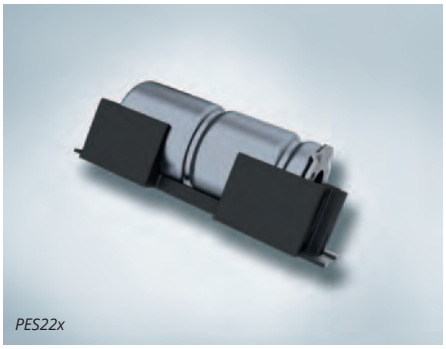
PEH227



PES22x

PEV227

ROBOTICS

Technologies Driving Reliable Connections in Humanoid Robots

Amphenol
COMMUNICATIONS SOLUTIONS

Explore how advanced connector technologies power the intelligence, motion, and perception of humanoid robots, enabling lifelike movement, durability, and seamless power and data flow across every subsystem.

Humanoid robots represent a highly integrated convergence of mechanical design, electronics, and artificial intelligence. These systems are designed to process information, move with precision, and interact with their surroundings, learn and adapt in dynamic environments. From industrial automation to healthcare and service applications, they depend on reliable power and data connectivity to achieve coordinated and responsive movement.

Behind each motion lies a network of connectors and interconnect systems that distribute power, control signals, and sensor data – forming the foundation of a robot's operational integrity.

Connector Technologies Enabling Humanoid Design

Achieving lifelike movement requires compact, high-performance connectivity solutions that can maintain stable electrical and mechanical performance under dynamic stress. This is reflected in the high-performing connectors of today that feature superior miniaturization, multi-function integration, and ruggedness. Advances in high-flex cables and vibration-resistant designs also enable better durability and long-term reliability in constantly moving joints and articulated limbs, where repeated bending, twisting, and tension can otherwise compromise connectivity.

Miniaturization

Miniaturization enables dense system layouts. Solutions such as BergStak® 0.40mm Self-Alignment Board-to-Board Connector and Densi-Mate™ 1.25mm Double Row connectors provide high-density board-to-board stacking within slim robotic limbs and compact control modules. These interfaces ensure consistent signal transmission under vibration and repetitive motion, reducing overall mass without sacrificing performance.

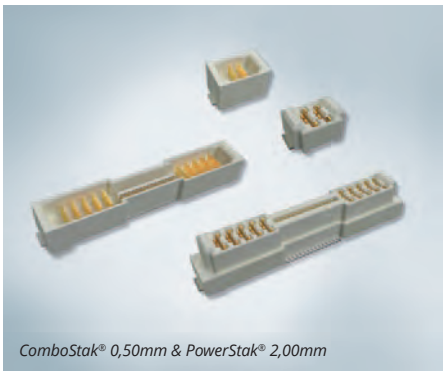
BergStak® 0.40mm

Hybridization

Hybrid connector systems combine multiple transmission paths into one interface. The Cool Edge 0.80mm Hybrid Power & Signal Ethernet Connectors is a one-piece card-edge solution that integrates high-power and high-speed data transmission within EMI shielded housing. This connector supports both Ethernet and PCIe® specifications with data rates up to 32G. It provides a unified power and signal interface, simplifying internal layouts and enhancing space utilization. This architecture supports real-time motion control and sensor feedback, integral for coordinated balance in humanoid operation.

Slim Cool Edge

The ComboStak® 0.50mm and PowerStak® 2.00mm Board-to-Board Connectors deliver a compact hybrid solution that combines high-speed signals and high-current power within a single interface. Featuring up to 25A per power blade and data speeds up to 14Gb/s to 20Gb/s, these connectors ensure reliable performance across diverse stack heights.



ComboStak® 0,50mm & PowerStak® 2,00mm

Ruggedization

Humanoids operating in variable or high-impact conditions require sealed, vibration-resistant, and thermally stable connectors. Rugged connectors ensure mechanical endurance and EMI protection during extended motion cycles. Connectors like the Single Pair Ethernet (SPE) IP67 Circular Push-Pull Connectors and Cables bring direct Ethernet connectivity to peripheral devices like sensors, actuators, and vision system cameras that operate at speeds up to 1Gb/s.

SPE IP67 Circular Push-Pull Connectors and Cables

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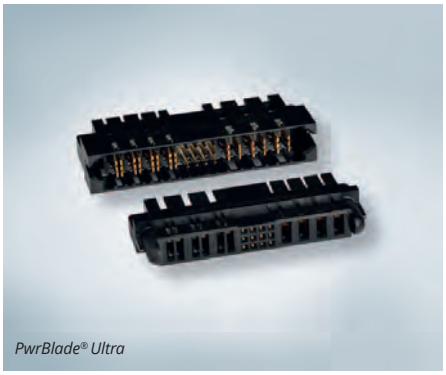
At the system level, high-speed data interfaces like USB 4 Gen 3 Type C provide the necessary bandwidth for sensor fusion, motion coordination, and real-time processing.

Connectivity Across Application Environments

Humanoid robots vary in design and connector requirements depending on operational context; industrial versus personal-assistance environments demand different engineering approaches. In manufacturing, humanoids perform repetitive or heavy-load tasks in demanding environments.

Rugged power and signal connectors with high current capacity, ingress protection, and vibration tolerance are used in industrial humanoid robots. Connectors such as PwrBlade® ULTRA HD Connector and Minitek® Pwr 4.2 High Current Connector ensure consistent power delivery to motor drives, while high-speed Ethernet interfaces enable real-time communication between control units and sensors.



PwrBlade® Ultra

Modular rectangular connectors and quick-disconnect systems simplify serviceability and reduce downtime. Products like the Modular Jack enable IoT connectivity for Ethernet and other Industrial protocols used in humanoids.

Slip-ring assemblies and sealed interfaces support 360° rotational motion while maintaining signal continuity, ensuring reliability under temperature changes, dust, and mechanical stress. In humanoid robots, these devices are integrated into joints such as the neck, waist, or shoulders to simulate human-like motion and agility.

For further questions, please contact:

S01

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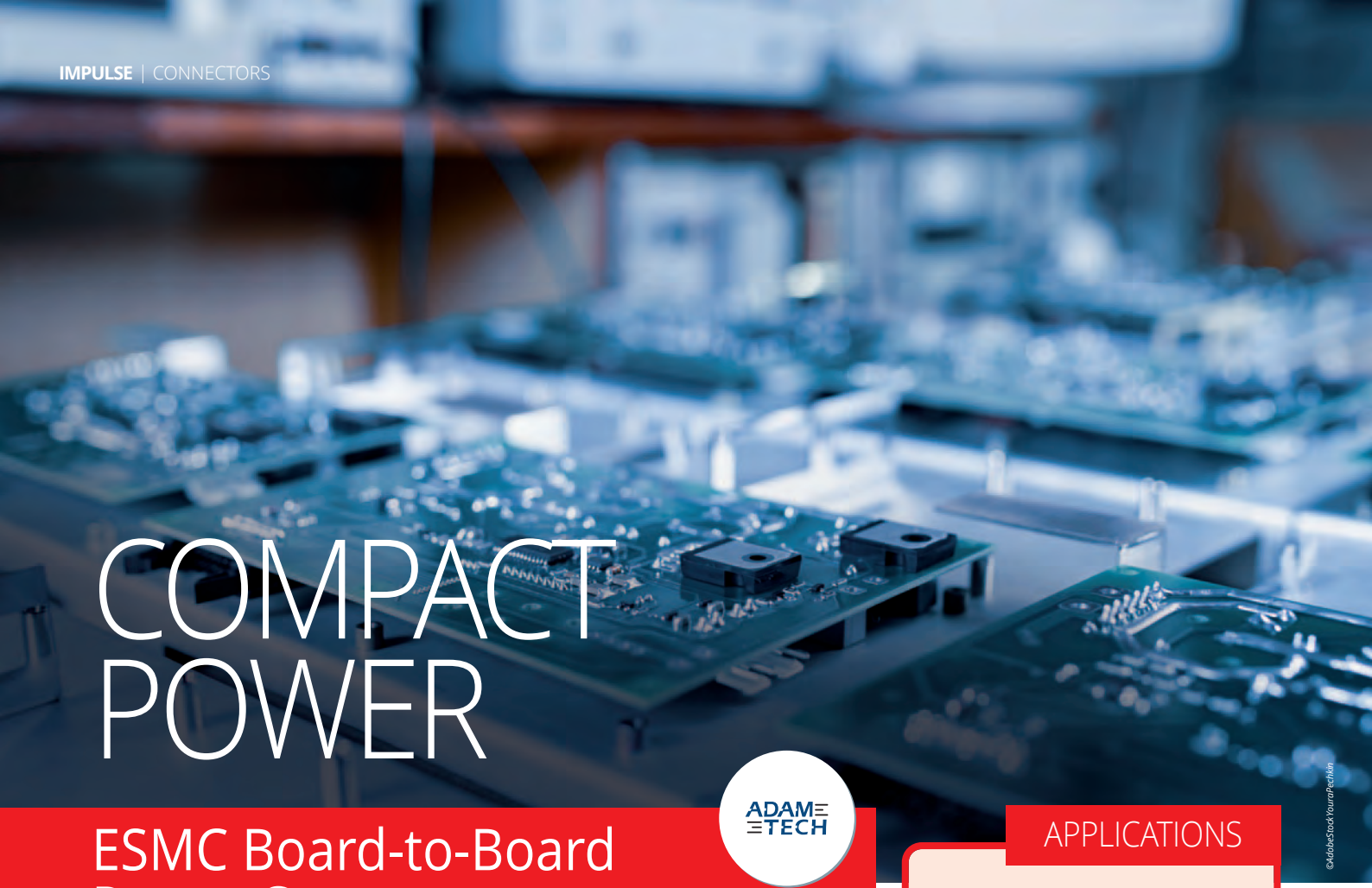

COMPACT POWER

ESMC Board-to-Board Power Connectors

ADAM TECH's ESMC Power Series delivers dependable, high-power board-to-board connectivity in a compact 2.54mm pitch design, engineered for demanding power applications.

This stacking and coplanar connector family is available in 2 to 12 positions, with each precision-formed contact supporting up to 24A for stable, high-current transmission. Featuring selective gold plating and a robust terminal structure, the ESMC series ensures excellent conductivity, mechanical strength, and long-term reliability. Flexible parallel, perpendicular, and side-by-side PCB configurations, along with vertical or right angle orientations and SMT or DIP mounting options, simplify layout and integration while supporting efficient automated assembly through plug and socket options, pick-and-place caps, and tape-and-reel packaging.

APPLICATIONS

- Industrial control systems
- Medical devices
- Automotive
- Power supplies
- Embedded systems
- Telecommunications

Features

- Supports high current transmission up to 24A per pin
- Robust terminal structure ensures mechanical strength and stable conductivity
- Board-to-board connections
- 2.54mm pitch
- 2-12 positions
- Parallel, perpendicular, and side-by-side PCB connection arrangements
- High-reliability, precision-formed contact design
- High temperature thermoplastic insulator (UL 94V-0)
- Operating temperature: -55°C to +125°C
- UL certified
- RoHS compliant

We look forward to receiving your inquiry.

S02

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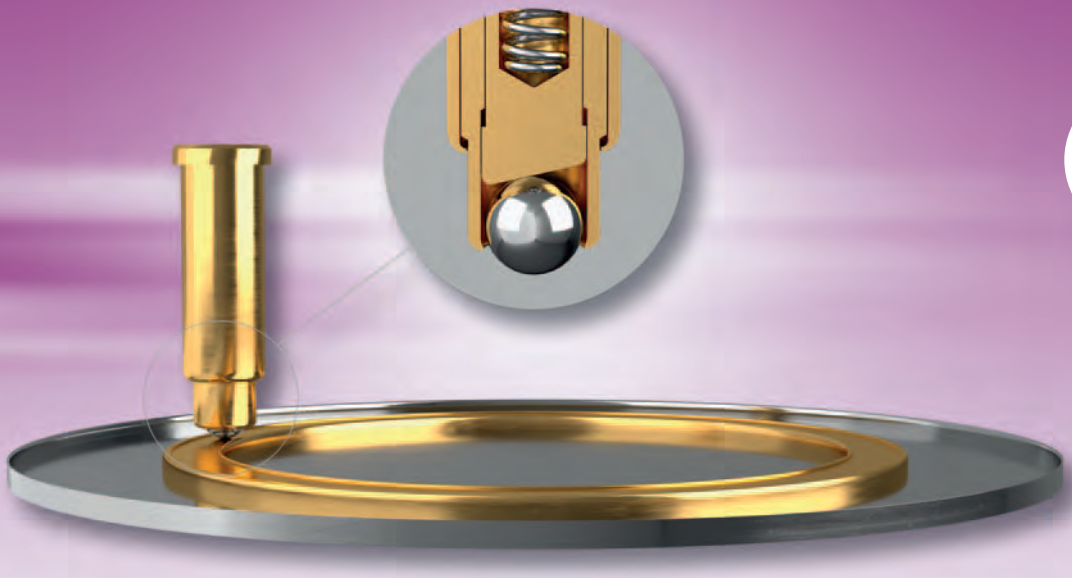

ROLLING POGO PINS

Maintaining a stable and reliable connection to a moving target presents a significant technical challenge, especially in dynamic systems subjected to continuous mechanical stress.

Inappropriate contact systems can suffer material fatigue and surface wear under progressive stress, impairing functionality in the long term. Under certain circumstances, this can lead to complete system failure.

To ensure long-term operational stability under such conditions, a well-thought-out design is required, as well as a comprehensive understanding of load distribution, material behavior and lifespan performance.

CCP's Rolling Pogo Pins have been designed and developed to create secure and long-lasting connections to moving targets. Their innovative design makes traditional cable-based connections redundant. This results in a more organized system layout, reduced assembly complexity, and increased robustness and reliability.

Depending on the application requirements in terms of current carrying capacity, spring travel, life cycle, and cost factors, various concepts are available in terms of design and internal structure.

In addition to the option of using Ball-Point Pogo Pins as individual contact elements (figure 3), there is also the possibility to integrate them into housings and overmold them (figure 1 and 2).

In addition to existing solutions, the development of customized dimensions and concepts, tailored and optimized for the specific application, is always possible.

Due to the optimal combination of mechanical load-bearing capacity, design flexibility, and optimized integration, CCP's Rolling Pogo Pins set a new standard for dynamic connection technologies in demanding industrial applications!

Are you interested? Get in touch with us.

S03

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Figure 1

Figure 2

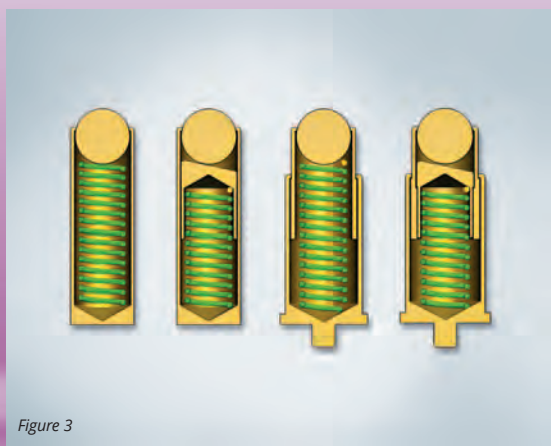
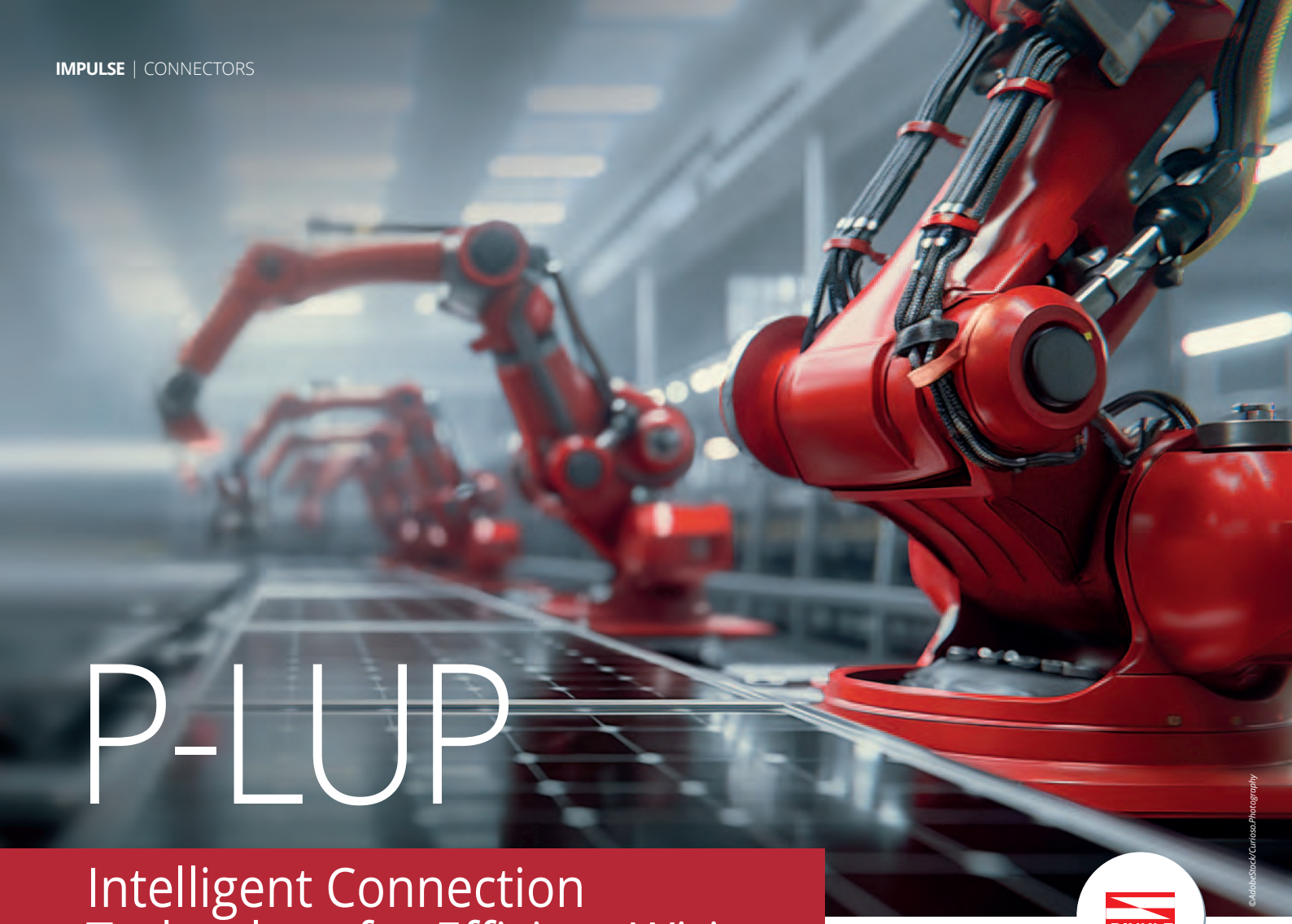


Figure 3



P-LUP

Intelligent Connection Technology for Efficient Wiring

In modern device and system design, speed, safety, and flexibility are key success factors. Innovative PCB terminal blocks with lever actuation address precisely these requirements, offering a forward-looking solution for demanding applications.

Push-In Lever Up: Whether in vehicle electrification, power supply units, or frequency inverters, lever-operated terminal blocks demonstrate outstanding performance wherever compact designs and efficient assembly processes are required. They combine maximum user convenience with high process reliability.

Tool-Free Wiring – Fast, Safe, and Convenient

Control cabinets and electronic devices are becoming increasingly compact. In many cases, there is no longer sufficient space for conventional screwdrivers. The innovative lever design of P-LUP provides an effective solution:

- Direct hand actuation
- Tool-free connection of all conductor types – including fine-stranded wires
- Fast disconnection and reconnection
- High process reliability even in confined spaces

The integrated lever enables intuitive handling and significantly reduces assembly time. Adjustments, maintenance work, or subsequent optimizations can be carried out quickly and easily at any time. The result: substantially more efficient installation combined with high contact reliability.

Direct PCB Terminal Blocks

The one-piece PCB terminal blocks of series 0275 and 0290 are available in pitches ranging from 3.50mm to 15mm, allowing flexible adaptation to different PCB layouts.

Conductor entry can be configured vertically, horizontally, or at a 45° angle, depending on application requirements. Various PCB layout options are available, including double- and triple-pin versions to enhance mechanical stability. Versions with staggered solder pins are also offered to increase clearance and creepage distances.

The maximum current rating is 101A according to UL and 125A according to IEC standards. The rated voltage is 600V (UL) and 1000V (IEC).

P-LUP Series 0290

Pluggable Lever Terminal Blocks for Industrial Applications

Pluggable connection solutions are indispensable in industrial environments. To extend the benefits of lever technology to this area, the P-LUP portfolio has been expanded to include series 0256, 0257, and 0258 from DINKLE.

These series combine the flexibility of pluggable systems with the convenience of tool-free lever operation – ideal for applications where rapid assembly, serviceability, and easy replacement are essential.

Seamless Integration into Existing Systems

A particular advantage: P-LUP cable sockets are compatible with existing DINKLE headers in pitch sizes of 3.50/3.81mm, 5/5.08mm and 7.62mm. This enables straightforward modernization of existing systems – without complex PCB layout modifications. Alternatively, in-line versions for cable-to-cable connections are also available.

Additional locking options such as screw flanges or side latches increase mechanical stability and ensure secure connections, even under demanding operating conditions.

Moreover, compatibility with common market standards ensures maximum flexibility in development and procurement. Existing designs can be retained while assembly and servicing are significantly simplified.

Easy Customization

Individual requirements can be implemented quickly and cost-effectively without fundamental design changes. Variable color combinations and marking options are available for clear visual differentiation. This enables unambiguous assignment of individual connections or functional areas and supports well-structured system design. As a result, both installation and maintenance are simplified, and the risk of errors is reduced. In addition to various housing colors, versions with black actuating levers are also available.

Your Advantages with P-LUP

With P-LUP lever technology, you invest in:

- Time savings during installation and maintenance
- Reduced assembly errors
- Enhanced user-friendliness
- Future-proof connection technology
- Simple system upgrades without PCB layout modifications

The »Push-In Lever Up« connection solution from DINKLE is not only a convenience feature for installers, but also a powerful design tool for hardware engineers. It is particularly suited for developers aiming to implement robust, assembly-friendly, and future-proof device architectures.

P-LUP represents a new generation of PCB connection technology: high-performance, application-oriented, and consistently designed for efficiency.

S04

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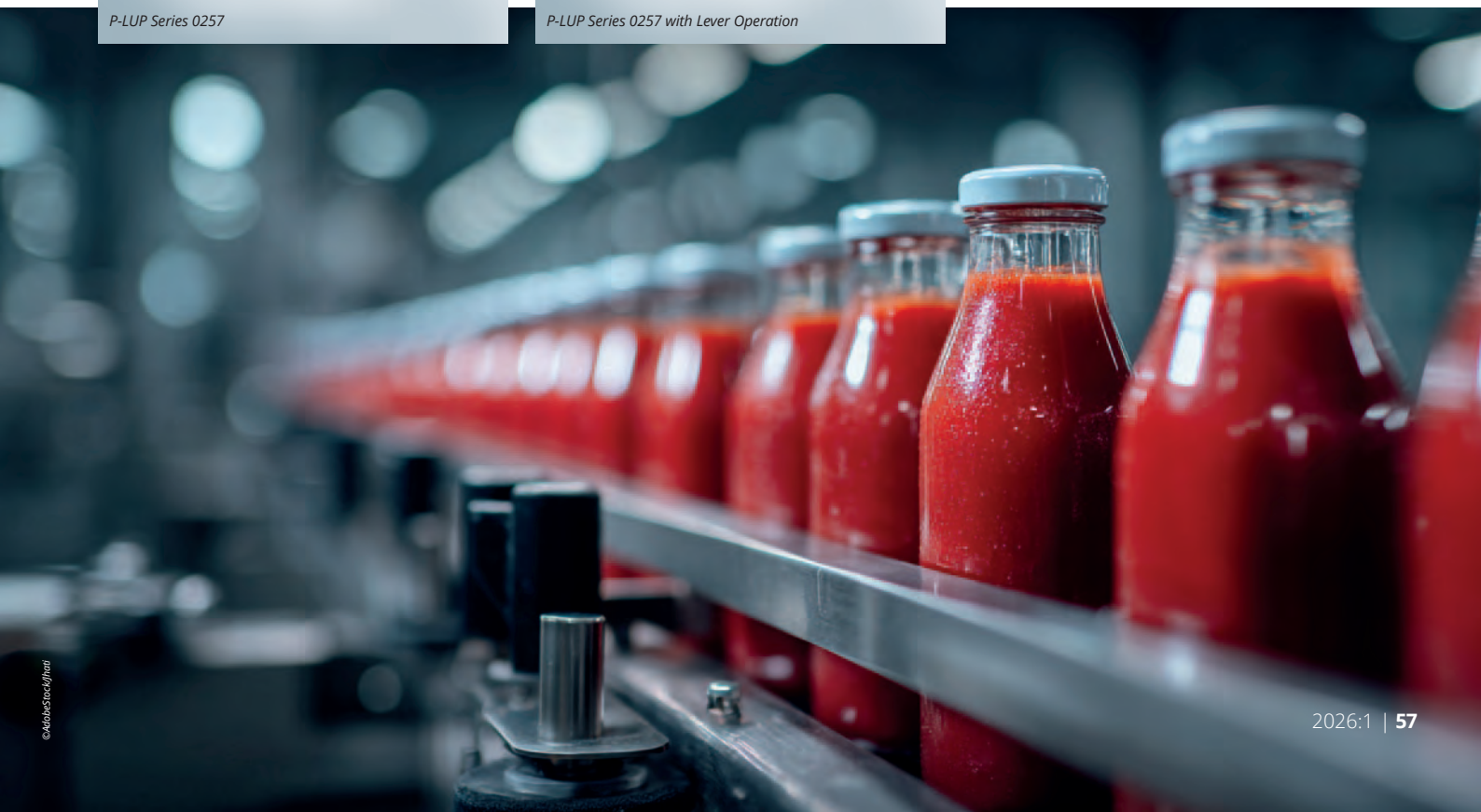
P-LUP Series 0257

P-LUP Series 0257 with Lever Operation



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ix Industrial™

HIROSE Expands the Series

HIROSE has added a new field-assembly connection type and a water- and dustproof (IP67-compliant) version to the ix Industrial™ series.

The ix Industrial™ is the next-generation connector for Ethernet and other industrial equipment transmissions. Its small, robust design makes it ideal for use in industrial environments.

Waterproof Version

The ix Industrial™, which has gained attention as a high-speed communication interface for industrial equipment, is now available in a waterproof and dustproof version (IP67). It enables stable communication even in harsh environments such as manufacturing sites with high humidity and dust levels. The ix Industrial™ is around 45% smaller than standard RJ45 connectors, offering considerable space savings and significantly increasing design flexibility and cabling efficiency.

This waterproof solution consists of a plug with a waterproof structure and a flange-type receptacle that can be mounted on the equipment panel. The plug features a push-pull locking for straightforward insertion and removal. It also features a double-lock mechanism to prevent accidental disconnections. The receptacle is compatible with existing upright, right-angle or vertical models.

With the addition of water- and dustproof variants, the ix Industrial™ series now supports even more robust industrial wiring environments, making it an ideal solution for challenging industrial settings. Typical applications include FA controllers, servo amplifiers, industrial robots, PLCs and security systems.

Field-Assembly Option

In industrial environments where cable lengths often can't be determined in advance, field-assembly connectors offer flexibility. The field-assembly version of the ix Industrial™ series supports reliable on-site termination, even when cable lengths cannot be predetermined. Its patented ratchet-style clamp enables secure connections to be made using general-purpose tools, eliminating the need for specialized equipment.

This field-assembly option helps save space and enhances usability and reliability in industrial environments. They are supplied in blister packs for easy transportation to factories, outdoor work sites and other installation environments.

Please feel free to contact us.

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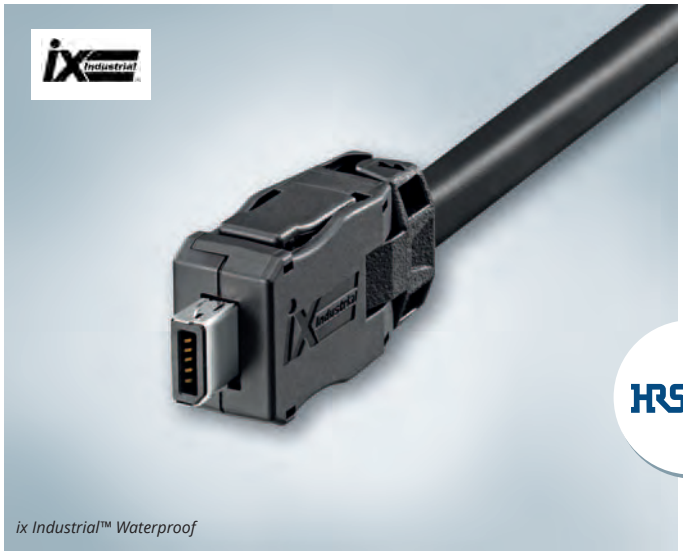
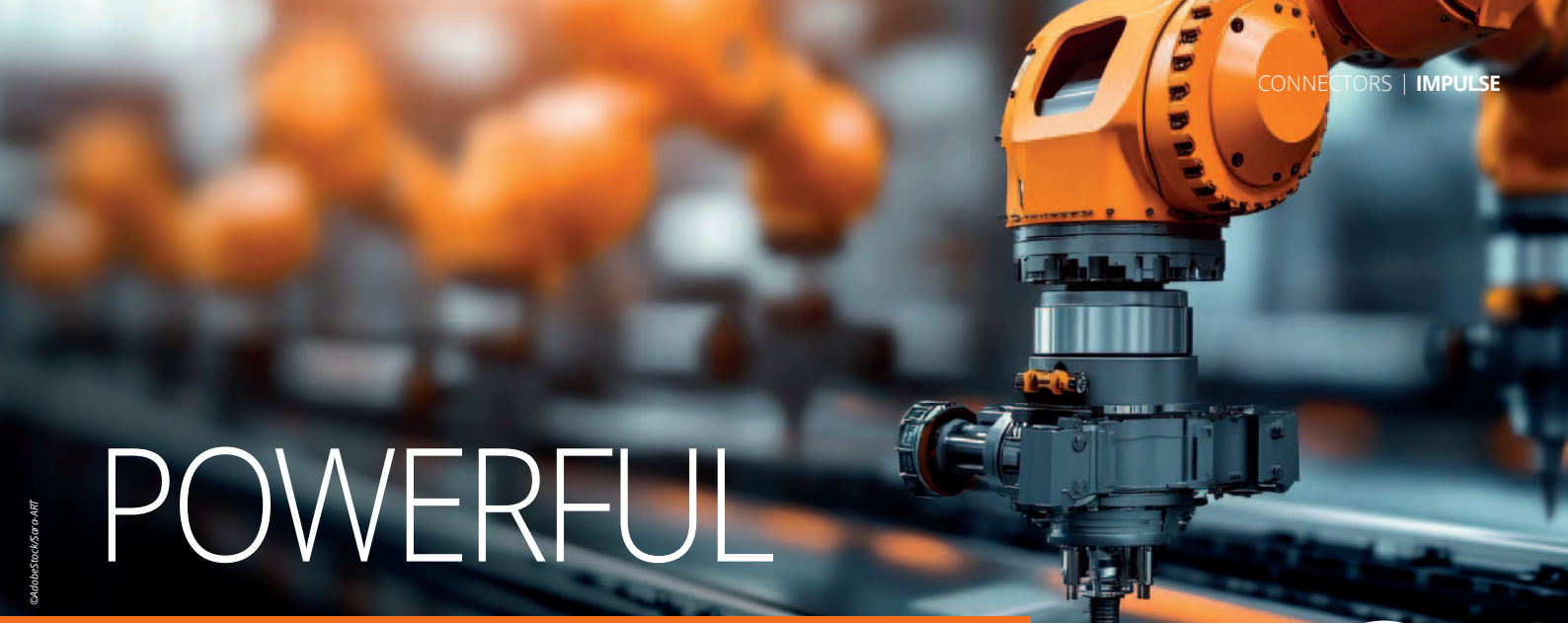


ix Industrial™ Waterproof

ix Industrial™ Field-Assembly Version



POWERFUL

ZE05 Series for On-Board Chargers & Industrial Equipment

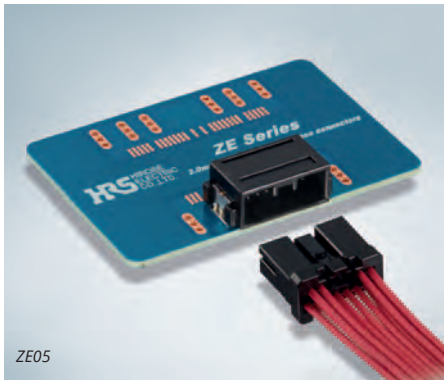
HIROSE ELECTRIC EUROPE B.V.

The ZE05 is a miniature low profile and robust wire-to-board connector with a 2mm pitch. Its compact design maximizes board space efficiency and minimizes the required mounting area.

The ZE05 series is polarized to prevent mismating and ensure correct insertion. It features tin plating and is rated for operating temperatures up to 125°C, meeting the demands of harsh automotive and industrial environments.

For added design flexibility, ZE05 is available with straight or right-angle receptacles. Both versions use surface-mount contacts and reinforced metal fittings, with options for DIP soldering or SMT, delivering strong board retention and high reliability. The plug side uses crimp contacts for AWG 20 to AWG 26 wires.

To support demanding vibration conditions, the ZE05 housing integrates a rib design that reduces the clearance between mated parts, improving vibration isolation and maintaining a stable, continuous connection. Optional retainers further increase the retention force.



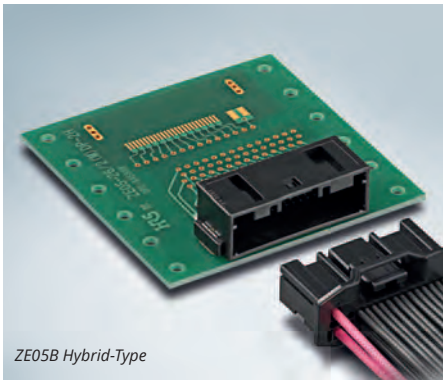
ZE05

Typical applications include battery management systems, monitoring sensors, engine-compartment devices, heavy-duty vehicles, ECUs, on-board chargers, inverters, robotic automation equipment, and automotive communication interfaces.

Hybrid-Type

A hybrid-type connector combines signal contacts with a 0.5 tab size on a 2mm pitch and power contacts with a 1.5 tab size on a 3mm pitch. This design helps reduce the overall size of the end product.

High vibration resistance is achieved through a specially engineered female contact with a three-point contact design. It ensures consistent contact, while a dual-spring structure provides additional stability. As a result, the connector maintains reliable contact even under intense vibration, significantly improving overall reliability.



ZE05B Hybrid-Type

For further information please contact:

S06

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KEY FEATURES

	ZE05	ZE05 HYBRID
Contact Pitch	2.00mm	2.00mm
Number of Contacts	2, 4, 5, 8, 12, 16, 20, 24	Signal: 26, Power: 2
Rated Current	5A (Single pin power supply), 2A (All pins power supply)	Signal: 2A Power: 10A
Rated Voltage	60V AC/DC	60V AC/DC
Compatible Cable	20-26 AWG (0.13-0.5mm²)	Signal: 20-22 AWG (0.3-0.5mm²), 24-26 AWG (0.13-0.22mm²) Power: 16-18 AWG (0.75-1.25mm²)
Operating Temperature	-40°C to +125°C	-40°C to +125°C
Mating Cycles	30	30

EMC SOLUTIONS

Interference-Free Data Centers

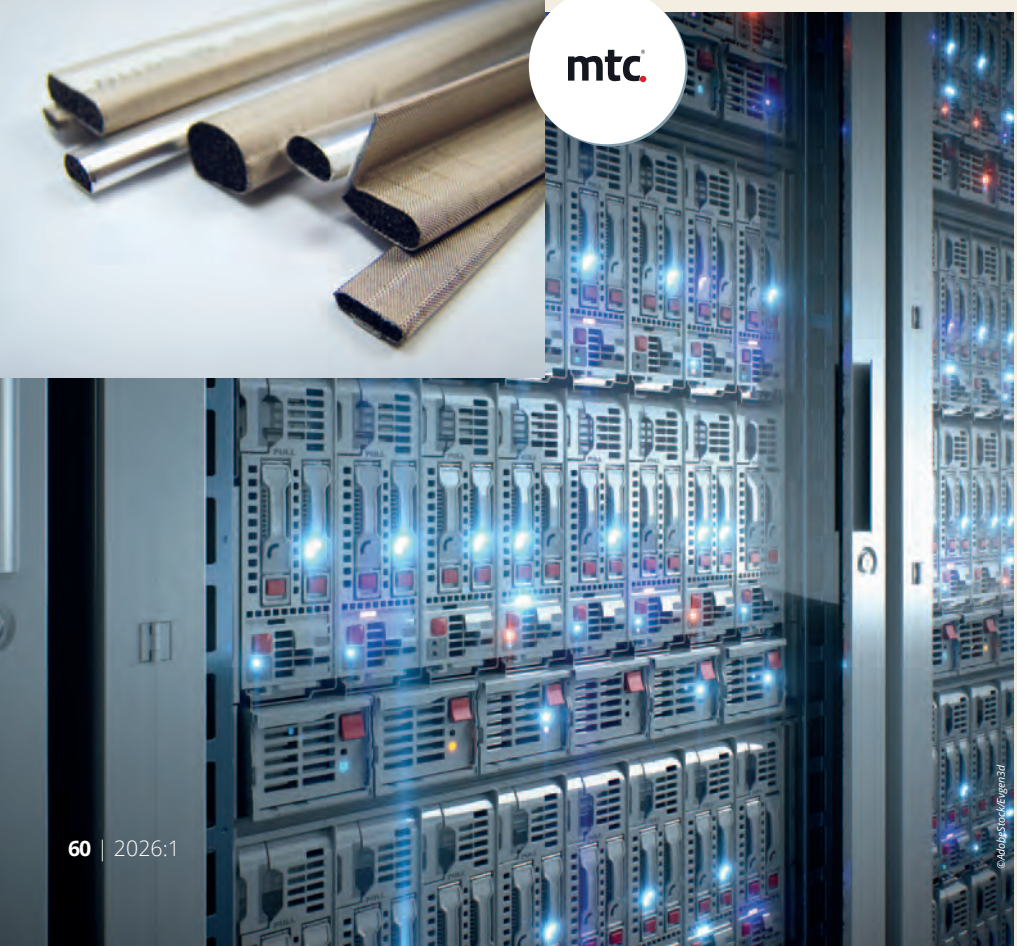
Data centres form the backbone of the digital infrastructure. Cloud services, industrial networking and critical applications require maximum availability, security and stability. Electromagnetic compatibility (EMC) plays a central role and is often underestimated.

EMC ensures that electronic components work together without interference, without influencing each other or being affected by external fields. Especially in data centers, where high packing densities and powerful systems come together, a consistent EMC concept is essential.

Key foundations are established as early as the planning phase: a carefully engineered grounding and equipotential bonding system, shielded cabling, appropriately specified connectors, and EMC-optimized power supply solutions provide a sustainable reduction of electromagnetic interference. Equally critical is the clear spatial segregation of high-power cable routes from sensitive data pathways. Even computing modules, control cabinets and complete rack systems must be designed in compliance with EMC requirements – without compromising accessibility or thermal management.

EMC Fabric Gaskets from MTC Provide Flexible and Efficient Solutions for Control Cabinets

EMC fabric seals have a high level of importance in the field of control cabinets. They offer an efficient and economical opportunity of reducing interference radiation and ensure the performance of computer systems.



MTC fabric gaskets consist of a polyurethane foam core covered with an electrically conductive fabric with copper nickel metallization.

The core is available in four different hardnesses (32 / 45 / 70 / 150kg/m³) und has a high compressive capacity. Because of this property the fabric seals adapt perfectly to their applications. In addition to a wide range of different profiles, customized solutions are possible, too.

EMC fabric seals from MTC offer the following key advantages:

- **Easy compression:** Low compression forces enable thinner sheets and cost savings.
- **Individual dimensions:** In addition to an extensive standard portfolio, the seals can be manufactured exactly to customer specifications and requirements.
- **Cost-effective EMC protection:** Despite high efficiency, the solutions remain economical and are attractive for series and special applications.
- **High shielding values over a wide frequency range:** The fabric seals provide effective attenuation of electromagnetic interference in the low and high frequency range: 80dB@100MHz–18GHz.
- **Certification:** MTC's fabric gaskets are UL94-V0 certified.

EMC fabric seals are a simple, flexible and economical solutions to protect control cabinets reliable against electromagnetc interference. They are essential components for permanently interference-free data centers and industrial applications.

Take advantage of the expertise and partnership of CODICO and MTC to optimize existing systems and to align new projects for reliable EMC protection.

Interested? We look forward to receiving your inquiry.

S07

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Y-VES

Vehicle Ethernet System

YAMAICHI ELECTRONICS

FEATURES

- Data rate 1000BaseT1
- IP69K in mated conditions, IP67 unmated
- 5000 mating cycles between male and female module
- Qualified based on MIL-STD-810H, SAE J560, SAE J1455, TC9

Y-VES is a system specially developed for Ethernet applications in commercial vehicles, construction machinery, and other heavy-duty vehicles. It combines high data transfer rates with robust construction and meets the requirements of the automotive industry.

The Y-VES system can be implemented in existing power and signal connections. The system consist of male, female, and cable module.

Advantages

- Male and female modules are exchangeable, while the cable module is assembled via crimp contacts to the cable tree
- Two SPE connections per connector, easy differentiation through color coding
- Easy assembly system between male and female module just by plugging, and between cable modules and other modules by screwing

Based on the wide product range, YAMAICHI Electronics offers many solutions which are dedicated to automotive applications. These products feature a reliable design and functionality, especially for the rough environmental and mechanical conditions in automotive use.

Application Example

Easily Replaceable Female/Male Module

Male Module, Female Module, Cable Module

This includes board-to-cable connectors, e.g. for battery applications, board-to-board connectors, high-speed data Ethernet connectors, and standard I/O connectors like Fakra, Minifakra, and HSDs.

For more information about the system please contact:

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The CODICO TEAM says hello!

Florian Sostek

Dear readers, my name is Florian Sostek, I am 33 years old and have been part of the CODICO team since November 1, 2021. I began my professional career in 2012, directly after completing my civil service, working as a Passenger Handling Agent at Vienna Airport. In 2017, I was given the opportunity to further develop my career and started working as a dispatcher for a food corporation.

Through a fortunate coincidence – more precisely, through a former colleague who had joined CODICO shortly before me – I became aware of the company. I decided to apply for a position in the Supplier Order Management team, and I have now been part of this team for almost five years. What I enjoy most about my role is facing new challenges every day and working closely with colleagues and suppliers to ensure that our customers are supplied on time.

In my free time, I play football in a club three to four times a week. Beyond that, sports in general play a major role in my daily life – I particularly enjoy strength training, running, and playing padel tennis with friends.

Another hobby of mine is cooking. I am very passionate about it and enjoy experimenting with a wide variety of dishes, ingredients, and cooking techniques, or browsing through my small private cookbook collection, which currently includes more than 50 books (and growing).

In addition to sports and cooking, traveling is one of my favorite hobbies. Together with my partner, I regularly go on both short and longer trips, discovering new cultures, places, and local cuisines along the way. Of course, spending time with our dog Caya, as well as with family and friends, is equally important to me.

I am very grateful to work for such a well-managed company as CODICO. At CODICO, you are not just an employee – you are part of a large family, and this is truly lived every day. I am genuinely happy to have found an employer where I feel completely comfortable and where I can continue to grow both professionally and personally.

D02

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Nico Mathias Nagy

Dear readers, my name is Nico Mathias Nagy, I am 19 years old, and I have been with CODICO since September 2021. Even during my time at the Polytechnic School in Mödling, I knew that I wanted to do an apprenticeship.

From the very beginning, it was clear to me that I didn't want to continue with further schooling or attend university. Instead, I wanted to start working relatively early. Through the acquaintance of a colleague, I learned about CODICO and was able to begin an apprenticeship as an Industrial Logistics Clerk here.

My start at CODICO was a bit challenging, as I wasn't used to working life as a teenager, and everything felt very fast-paced. By the time I had settled in, a year had already passed, and I started attending vocational school. I was lucky that my first two school blocks were back-to-back, which helped me really absorb the material. Back at CODICO, it was then time to gain experience in other departments – learning front office tasks, managing goods inbound and outbound, or learning more about accounting. All of these were valuable experiences for my personal development.

Our work in the warehouse includes managing incoming goods, picking orders in the AKL (Automated Small Parts Warehouse), packaging goods for customers, transporting palletized goods via shuttle, and finally shipping through courier services and freight companies. Time went by quickly, and before I knew it, I had successfully completed three classes and was ready for the apprenticeship final exam, which I passed with good results.

In my free time, I enjoy going for walks with my dog, listening to music, and spending quality time with my family. As a child of the modern era, I also enjoy video games and watching TV series of all kinds.

I am happy to be part of the CODICO team and look forward to future challenges as well as my continued personal and professional development.

D03

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Tomas Scholz

Hello everyone, today I'd like to take the opportunity to introduce myself: My name is Tomas Scholz, and since July 1, 2021, I have been supporting the logistics team here at CODICO in Perchtoldsdorf. I was born in May 1976 in Prostějov, Czech Republic – under the sign of Taurus, which probably says a thing or two about my personality :-). True to my zodiac, I'm more of a »less talk, more action« type, I prefer to let my deeds speak for themselves.

After finishing high school with the Matura and completing my basic military service, I started my professional career in the Czech Republic as a dispatcher in international truck transport. Over the years, I gained 20 years of experience in logistics and freight forwarding across the Czech Republic, Germany, Luxembourg, and finally Austria before joining CODICO.

At CODICO, I am responsible for ensuring smooth incoming goods operations. I act as a link to our warehouse colleagues, resolve issues with imports, and handle all customs documentation for import and export. What I particularly enjoy about my work is the variety of tasks and the solution-oriented collaboration within the team.

At home, there's never a dull moment: my family includes three adult children and now three dogs, who keep us on our toes. During the season, my wife, two of our dogs, and I travel across Europe to participate in flyball tournaments, representing Austria. In the flyball team, I also handle logistics, making sure everything runs smoothly on our trips. Community engagement is very important to me as well: during the pandemic, I joined the Austrian Red Cross to contribute to society. I also bring this experience to CODICO, so if anything ever happens, I am always ready as a first responder!

When I'm not active with the dogs, I enjoy the freedom on two wheels. Whenever the weather allows, I ride my 125cc motorcycle from my home in Bad Vöslau to work in Perchtoldsdorf. It's my perfect way to start the day fresh and clear my mind after work.

A big thank you for the warm welcome at CODICO! Even in my private life, I feel very comfortable in Austria – it has become my second home. I am very happy to be part of the CODICO family and to help keep things moving in our logistics together!

D04

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Matteo Nervo

My name is Matteo Nervo, I am 27 years old, and work in Product Marketing for passive components at CODICO. Although I was born in Vienna, I grew up in Italy and lived there until I was 18 – interestingly, only about one kilometer away from CODICO's Italian office.

During school, I mainly focused on languages. In addition to Italian, German, and English, I also learned French and Spanish, which has proven very useful today.

After finishing school, I moved to Austria to pursue my studies. I initially enrolled at TU Wien to study Industrial Engineering. However, I soon realized that the program was very theoretical and technically focused, which did not fully match my interests. I therefore decided to switch to FH Technikum Wien and study Industrial Engineering & Business instead.

I originally applied to CODICO for a position in Inside Sales for passive components. Unfortunately – or fortunately, depending on how you look at it – the position had already been filled just a few days before my interview. Instead, I was offered a role in Order Management, which I gladly accepted. After two and a half years, I had the opportunity to move into Product Management, where I work today.

From the very beginning, CODICO has been very supportive in helping me balance work and my studies, which I truly appreciate. This support continues today: while completing my master's degree, I am able to write my thesis in collaboration with CODICO on a strategic expansion topic.

After 27 years of fairly close self-observation, I would describe myself as a curious and ambitious person. I am always looking for ways to expand my knowledge – whether through self-learning, courses, or spontaneous deep dives into topics that suddenly catch my interest. Admittedly, some of these discoveries turn out to be completely useless, but at least I now know them – which somehow still feels like a win.

People often say that I am a good listener and remain diplomatic even in difficult discussions. So if you ever find yourself in a heated debate with me, feel free to put that to the test – I'm curious to see where my diplomatic skills (and patience) reach their limits.

And finally, my hobbies: I enjoy spending time in nature and whenever I manage to take a few days off, I usually travel back to Italy. I assume this needs no further explanation... Italy is Italy.

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