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1/2022

MPS: Maximizing Power Density

EATON: Automotive Supercapacitors

One Action Lock Series from HIROSE

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CODICO IN-HOUSE

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Quality Is Key to Success

Did you know?

... that apart from its headquarters in Perchtoldsdorf, CODICO also operates product competence centres in Munich (CODICO Deutschland GmbH), in Treviso (CODICO Italia Srl), and in Stockholm (CODICO Sweden AB)?

... that the ISO 9001 quality management system was not only introduced at the main headquarters, but also at all subsidiaries, as early as 2016?

... that CODICO is also represented at 43 branch offices in 12 countries? As a result, all CODICO customers enjoy the same high-quality professional distribution and technical support everywhere.

... that all our 196 employees are fully aware that the quality of our products and services is essential for the success of our company and thus its top priority?

... that CODICO carefully chooses and regularly evaluates its suppliers according to specific criteria, such as product quality, scope of services, or certification status?

Do you want to find out more about our Quality Management System (QMS)? Please contact

D01

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Editorial

Sven Krumpel
CEO CODICO

We are moving closer together!

Dear readers,
We are currently experiencing a new economic environment afflicted by a triple shock: Russia's invasion of the Ukraine, which is wreaking havoc in international trade, especially in the areas of energy, raw materials, and cereals. A new geopolitical world order with a completely uncertain future. And a financial shock caused by the unavoidable economic sanctions in the wake of the Russian-Ukrainian conflict, and all this against the background of an unprecedented allocation in the electronics industry as a consequence of the pandemic and the rapidly growing market.

In times of uncertainty, constants are becoming all the more essential. Remembering and applying these can give us strength and confidence. We have learned to react to crises and to solve these, while remaining strong as a team. Two years ago, we very spontaneously switched to home office. Not voluntarily, but today I can say: the New Work concept, that developed from this, works. Together, and with unbelievably great effort, we managed to meet our customers' demands and to support them in driving their projects forward, despite the crisis.

I certainly cannot predict what is still to come. Our industry is bound to feel the challenges: in production, availability, and distribution. But we will face these! And maybe we can also influence the change positively. Just as we did two years ago, we must strive to remain independent and keep the courage.

The economic impact aside, I wish to take a personal position here: CODICO stands for tolerance, responsibility, charity, and hope. I strongly condemn injustice, inflicted suffering, the ignoring of humanitarian principles, wilful and egoistic behaviour without any regard for the common good, and the loss of values. I sincerely hope that this war will end soon! Until then, we must help those who are suffering. We are moving closer together!

Sven Krumpel

DISPLAY LIFESPAN

Tips for Extension

One of the most important parameters when choosing a display is the lifespan. This parameter determines how long a display can be used - without visual loss and without having to be replaced.

How is lifetime of a display defined?

As a rule, the following definition applies: Lifespan is described as the time until the display reaches 50% of its initial brightness. When the datasheet indicates a value of 20,000 hours, after 2.3 years – of continuous operation – the display will only be half as bright as in the beginning.

Therefore, the lifespan is linked to the display's brightness. The reason why this is interesting is because when it comes to brightness, different requirements apply for different application areas. If used under sunlight, displays need to be very bright, but much less so than when they are used indoors. At the same time, their lifespan should ideally correspond to the duration of their use. Let's take a closer look at the lifespans of two very widespread display technologies.

TFT-LCD

Thin-Film-Transistor-Liquid-Crystal-Display

Thin-film-transistor liquid-crystal displays are not self-luminous, but use background lighting (backlight) to render the displayed image visible. This backlight consists of at least one, yet in most cases of several light-emitting diodes (LEDs). The light emitted from these is evenly distributed over the display area using a so-called light guide, so as to ensure the best possible illumination of the screen. TFTs use exclusively white light diodes. These LEDs determine the lifespan of the display, since they are the most critical component in this regard. In the case of industrial TFTs, the typical indicated lifespan ranges between 20,000 and 50,000 hours. As a rule, this corresponds to 30,000 to 70,000 hours, i.e. 3.4 to 8 years of operation before the display reaches half its initial brightness. The display's function is not impaired as a result.

If one takes a closer look at the datasheet, one will find out that the lifespan is subject to certain parameters. The indicated value usually applies for a temperature of 25°C (room temperature) and a relative humidity of 60%, and the LED current must correspond to the typical value according to the datasheet.

For a precise determination of the lifespan, one must therefore consider both temperature and humidity in the calculation. To do so, however, one requires the precise data on the LEDs used, and these are rarely provided. In practice, this

part is therefore largely neglected; one trusts the backlight manufacturer, who is expected to have the corresponding expert knowledge in this regard.

Which factors can reduce the lifespan of TFTs?

- **Overcurrent:** LED backlight units are very sensitive to extremely high currents, and these can dramatically reduce their lifespan. Therefore, the backlight must never be connected directly to a voltage source. The simplest solution is to limit the current with a series resistor. The data for an optimal selection can be found in the display datasheet.
- **High temperatures:** Another factor that reduces the lifespan of a display are high temperatures. In this case, too, it is advisable to check the datasheet for the maximum permissible operation temperatures.
- **Vibration:** Though backlights are compact units, vibrations can cause mechanical stress and thus reduce the display's lifespan.

Tips for extending the service lifespan of TFTs

- **Reducing the current:** When the current through the LED is reduced, brightness decreases as well. At the same time, however, the display lifespan will increase. If the readout becomes too dark, one can change to a display with a higher brightness value. By doing so, it is possible to reach the originally intended brightness with a lower current while improving the display lifespan. The rule of thumb is: half the brightness results in double the lifespan.
- **Control via pulse width modulation (PWM):** When the current for the backlight is pulsed, the duty factor is directly proportional to brightness. One can reduce brightness in this manner and increase the lifespan.
- **Temperature management:** Where possible, the display should be installed at a sufficient distance from other heat sources. Good heat management will help keep temperatures low and will at least not diminish the lifespan of the display.

OLED DISPLAY

Organic Light Emitting Diode Display

In contrast to TFT-LCDs, this type of display is self-luminous and thus does not require any additional illumination to render the image visible. These displays use light diodes, and these determine, as we already know, the lifespan of the display. As already mentioned, the lifespan of a display is generally the time until its brightness drops to half. The differences are hidden in the details.

As the name suggests, OLED displays use light diodes consisting of organic materials. These are long-chain polymers which emit light when electrically stimulated. Through suitable doping (inserting foreign atoms into a semiconductor), it is possible to change colour and brightness. The materials of the different colours have different lifespans. In the case of yellow, the lifespan is now around 100,000h, though in the case of blue or white, the values indicated on the datasheet are still 20,000h and 30,000h respectively. The latest, 4th generation of PMOLEDs is based on a so-called thermally activated delayed fluorescence (TADF) emitter. This technology is extremely efficient, and is characterised by a longer lifespan, as well as higher brightness. As a result, displays can reach up to 200,000h, and blue OLEDs with TADF are currently under development.

As a rule, it is difficult to calculate the lifespan of OLED displays. Unlike TFTs, which have a single light source that is always on during operation, each pixel in OLEDs consists of a single light emitting diode, which can be on or off depending on the image content. Due to the dependence on the information displayed, which is determined by the user, it is more difficult to indicate a value. Manufacturers therefore use a fictitious image content, i.e. a 50% checkerboard pattern (half of the pixels is on, the other half is off), measure the reduction of brightness under accelerated test conditions, and extrapolate the lifespan. Meanwhile, some research groups are working on models and algorithms to predict the lifespan of OLEDs more precisely. Again, the indicated value applies at 25°C and, unlike TFTs, at the typical driver voltage instead of the current.

Negative effects on the service life of OLEDs

- **High temperatures:** Datasheets of passive matrix OLED displays indicate temperatures from -40°C to +70, 80, or even 105°C. Though the display will function impeccably under such high temperatures, its lifespan will be reduced significantly.
- **UV light:** Ultraviolet light has a shorter wavelength (100-400nm) and is more energy-rich than visible light. Exposing humans to UV radiation will cause health damage. Organic materials in OLED displays may also suffer damage from UV light. The decisive factor is the light-emitting layer made from organic material. High-energy radiation will damage the structure of this layer, causing light emission to diminish and a quick drop in brightness.
- **Humidity:** The organic semiconductors used are very sensitive to humidity and oxygen. Displays are so hermetically sealed, however, that no water or oxygen can reach the organic layers. Therefore, the risk of a reduced lifespan through humidity is irrelevant.

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CONCLUSION

Due to its direct link to brightness, the lifespan of a display is a factor that requires some attention. One should therefore put a particular emphasis on lifespan especially in the case of new technologies such as OLED displays. Yet there is also progress in the case of OLED displays, the primary objective being to improve the parameters by creating new, more resilient organic materials. As a result, the lifespan of modern flat displays continues to grow. TFT-LC displays require less effort in this respect. One should keep in mind, however, that the development of LED is advancing rapidly, which also benefits LED backlights.

- **Image content:** If the displayed information is static, i.e. always at the same place, as in the case of measurement values, the brightness of these pixels will drop significantly compared to those pixels that are used less often or not at all. Therefore, the lifespan of the illuminated pixels will rapidly decrease.

Tips for extending the service lifespan of OLEDs

- **Temperature management:** One should avoid high temperatures at all costs, since they have a negative impact on the lifespan of a display.
- **Protection against UV light:** To achieve adequate protection against UV light, it is necessary to minimise the intensity of UV radiation, though such measures should not have an impact on visible light. An excellent solution is the use of a polariser, which reduces wavelengths <380nm to under 1%. It is absolutely necessary to apply such a polariser in the case of displays exposed to the sun. In addition, it is recommended to protect displays against direct sunlight.
- **Driver voltage:** One must strictly comply with the specifications on driver voltage. The latter is directly related to brightness and thus to the display's lifespan.
- **Reduction of brightness:** One will usually find several data on lifespan in OLED display datasheets. These usually indicate the number of hours based on different brightness levels. At a low initial brightness, e.g. 50% of the maximum brightness, the lifespan increases at least twofold.
- **Screensaver:** In the case of OLED displays, when a pixel is not lit, its lifespan is not reduced either. In other words, when the display is not used, switching it off or using a screensaver is a good method of extending its lifespan.
- **Avoid static content:** A method of avoiding that each pixel has a different brightness is so-called pixel shifting. In this case, the image content is shifted at regular intervals by 1 pixel each time, e.g. to the right, down, to the left, or up. As a result, the individual pixels are all activated when possible, and the brightness of those pixels that would otherwise be permanently lit does not decline so rapidly.
- **Duty cycle:** Passive-matrix OLEDs are multiplexed, i.e. the individual pixels are not addressed at the same time but in a rapid sequence. This helps save wiring. Duty cycle is that fraction of the overall time in which each pixel is addressed. The smaller the duty cycle, the more driver current is needed to achieve the same brightness. When the driver cycle is high, however, less power is required. The driver current also affects the display's lifespan – the lower, the better. The display datasheet indicates which multiplex rates can be adjusted.

A01

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SMART CONCEPT

FN-LINK: IoT WiFi4 Module Solutions with BLE 5.0

FN-LINK is expanding its product portfolio of low-cost IoT solutions that support WiFi4 and BLE 5.0. These modules are characterized by the special feature that an application processor with interfaces and memory is already integrated on the modules and therefore autonomously covers the main functions of an IoT application without external intelligence. This SOM (System on Module) approach therefore allows the realization of IoT products in a particularly small form factor.

The name 6222N stands for a module family consisting of two variants that differ only in their antenna configurations. The **6222N-IMB** has an IPEX antenna connector and, at 27×30mm, is therefore somewhat smaller than its bigger brother **6222N-IMA**, which measures 7mm more in length due to its integrated PCB antenna (27×37mm). All the more remarkable is the fact that two processors, KM4 (ARM Cortex-M33 compatible) and KM0 (ARM Cortex-M23 compatible) as well as flash memory of 4MB and 512KB RAM are integrated on the modules. In addition, numerous interfaces and security features are offered, which are increasingly required in IoT applications:


6222N-IMB

6222N-IMA

J202H-I

- Trustzone-M Security
- Hardware SSL Engine
- Root Trust Secure Boot
- USB Host/Device
- SD Host
- Codec
- LCD Controller
- Key Matrix
- 1×PCM, 4×UART, 1×I2S, 2×I2C, 7×ADC, 17×PWM, max 54×GPIO

Both modules support WiFi4 in the frequency bands 2.4GHz and 5GHz and on top BLE 5.0. Another WiFi4/ BLE 5.0 module, the **J202H-I**, also has a PCB antenna, but comes along with one processor core (32 bit) and offers with 2MB flash and 276KB RAM about half as much memory as the 622N family. In addition, it only operates on 2.4GHz with a bandwidth of 20MHz. This results in a maximum data rate of 72Mbps, while the 6222N family also supports bandwidths of 40MHz and therefore achieves a data rate of 135Mbps. On the other hand, the J202H-I stands out due to its particularly small form factor of only 18×20mm. The following interfaces are available on the J202H-I:

- 1×SDIO
- SPI: 1×master/slave
- UART: maximum 2
- PWM: maximum 17
- I2C: 2 (max 400Kbps, max 3.3Mbps)
- GPIO: maximum 13
- Miscellaneous: USI, IR, I2S, ADC, PWM

All IoT modules run with FreeRTOS.
A product overview as well as datasheets can be found on our support page:
http://downloads.codico.com/misc/AEH/FN-Link

A02

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SIMPLIFY YOUR JOURNEY...

...to IoT with Intelligent Cloud Connect

THALES
Building a future we can all trust

For most companies, starting an Internet of Things (IoT) project is difficult. They just want to connect their device and then see the data in their system and make business decision based on the insight.

How hard can that be!

Instead, you have to navigate an enormously complex ecosystem and a fragmented value chain, with many development hurdles to overcome and it can take up to two years to launch a new IoT solution.

IoT connectivity is complex

Our experience is that many projects do not reach the market at all due to their complexity. Some of the hurdles/challenges that you have to consider:

- Choosing communications hardware targeting the correct geography, designing a communication protocol.
- The connectivity and SIM management platform, negotiating airtime plan with mobile network operator.
- Managing the life cycle of the SIM card and managing individual airtime consumption.
- Finding a suitable cloud database for storing and managing the device' data.
- Developing an application to visualise the data. Monitoring and managing the connected device.
- Managing security certificates, the identity of the device and enrolment into the cloud platform.

Solution to simplify the IoT journey

Most of IoT projects start by asking for a proof of concept (PoC) and for that CODICO together with THALES and their partner Eseye have made this possible by simplifying the steps, streamlining the process and reducing complexity. Eseye and THALES are fundamentally disrupting this IoT ecosystem with a collaborative IoT Connectivity Platform that cuts through complexity and reduces new product development timelines from two years to typically six months.

THALES and Eseye have combined their expertise to deliver Intelligent Cloud Connect, the world's first integrated IoT solution that significantly simplifies IoT device design and deployment.

Intelligent Cloud Connect: Streamlining IoT solution deployment

The Intelligent Cloud Connect solution enables device and equipment manufacturers to develop a single IoT product SKU for any industry that can intelligently switch between over 700 mobile networks to provide near 100% global connectivity, while offering seamless data provisioning to AWS IoT Core. The platform handles zero-touch IoT security certification as well as lifecycle device management, allowing customers to manage global fleets of devices through a »single pane of glass«. The complexity of balancing bandwidth,

The world´s first plug and play IoT solution that automatically connects to AWS.

data plans and negotiating MNO contracts is removed, so customers receive only one, carrier agnostic, message based (MQTT) bill that covers all connectivity requirements globally via AWS Marketplace.

Design and development strategy are critical to successful IoT solutions. Early technology decisions can determine the success or failure of projects. The Eseye Platform solves challenging IoT problems and positions companies for success. The solution delivers pre-installed firmware which intelligently manages security, connectivity and credentials between the device and the cloud, ensuring a consistent global »out of the box« experience. Device behaviour simplifies IoT deployment and automates global, secure connectivity into AWS IoT Core.

To simplify device application development, an easy to use Message Queuing Telemetry Transport (MQTT) client is supported by the Intelligent Cloud Connect devices. This AT command-controlled feature simplifies communication between embedded hardware in the IoT devices and the AWS IoT Core with other related IoT services. Benefits include:

- One globally deployable SKU provides instant connectivity anywhere in the world, simplifying logistics and reducing device and technical management overhead.
- Zero-touch, automatic service provisioning delivering ubiquitous global cellular network connectivity on power-up – delivering near 100% device uptime across 4G LTE, 3G and 2G networks.
- Automatic AWS cloud enrolment once device is activated – device certification and security automatically managed by AWS cloud and delivered OTA to the device.
- Eseye's agnostic mobile network profile management enables dynamic on-device and OTA network switching to ensure maximum device connectivity.
- MQTT message bundles provide simplified and scalable global connectivity management with predictable costs.
- Single pane of glass solution enables management of global device estate and billing from one intuitive user interface, while simplified lifecycle management extends device lifetime and reduces maintenance costs.
- Reduces time-to-market for device deployment, improves IoT outcomes and accelerates ROI, allowing customers to focus on delivering business value.

6 Steps to delivering a rapid, efficient and global IoT solution that works out of the box

With the Intelligent Cloud Connect solution, organisations can reduce time to market by 75% while significantly improving cost efficiency and ROI. The foundation of the solution is the groundbreaking Cinterion® PLS62-W Global IoT Module or Terminal paired with Eseye's intelligent network switching AnyNet SIM for AWS. This combination provides out-of-the-box, zero-touch secure connectivity anywhere in the world. With this device/SIM combination, developers can streamline and secure IoT development, deployment and activation from device to AWS IoT Core in 6 simple steps:

- **Purchase PLS62T-ICC:** Bundle with THALES Intelligent Cloud Connect and Eseye.
- **Set up your AWS Account:** Go to the AWS marketplace and buy an MQTT message bundle from Eseye.
- **Install Eseye´s software:** This enables security and zero -touch provisioning.
- **Create a »Thing«:** Go to your »Things« repository in your AWS IoT Core. Follow the instructions to create your »Thing« or upload a list of »Things« for mass activation.
- **Queue credentials:** Security and identity credentials are queued for submission to device on the Eseye network.
- **Switch on your IoT device:** Switch your IoT device on and voilà – a security certificate is downloaded to your device and your data is automatically provisioned via Eseye's Platform OTA to AWS.

Terminal PLS62T

Intelligent Cloud Connect – simplifying and accelerating IoT development

The PLS62 Terminal uses either RS232 or USB to connect to the host device. This is ideal for use cases where the host device is able to send AT commands. Further connectivity is provided by the expansion connector offering SPI, I2C, GPIO, an additional RS232 interface and 5V power supply.

For a completely self-contained solution, the PLS62 Terminal offers programmable embedded intelligence capability meaning an compete sensor to cloud IoT application can be realised by Intelligent Cloud Connect.

A03

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ACCELERATING TIME TO MARKET

Robotics & Intelligent Camera Products with THUNDERCOMM SOMs

Thundercomm

In Europe like the rest of the world we are witnessing an explosion in robotics and automation technologies adoption. Intense competition and an aging workforce across a broad set of industries from manufacturing to farming to logistics and retail is forcing companies to incorporate these systems to improve efficiency and speed up productivity.

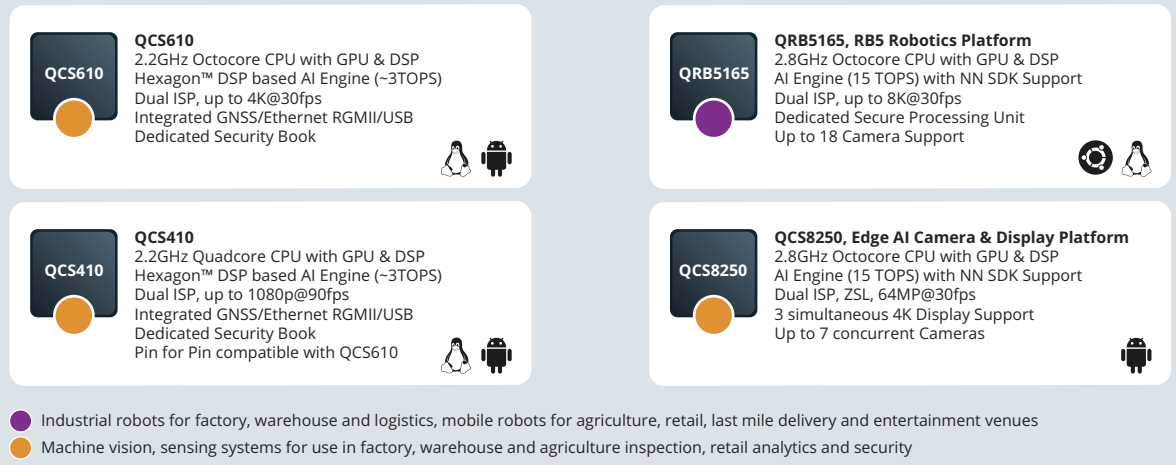
If we look at today's factories we see autonomous mobile robots assisting the human workforce in the production and assembly process, in warehouses we see autonomous guided vehicles and pick and sort robots speeding up the preparation of customer online orders and on today's farms robots are widely used to continuously monitor crops to maximize yield as well as to harvest the crops when ready for market.

All of these robots and automation systems require highly integrated system on chip (SoC) solutions that incorporate powerful computer vision, compute, AI as well as the latest wireless connectivity technologies to enable these machines to see, navigate, communicate and actuate within their environments.

In the last issue of Impulse, we offered readers an overview of some of the latest industrial grade, extended lifetime SoCs available from QUALCOMM which are targeting these very use cases. The QCS610 and QCS8250 solutions are targeted at intelligent camera applications such as retail analytics in shopping malls or QA monitoring systems in warehouses and on production lines while the QRB5165 SoC has been designed for autonomous mobile robots, service robots and drones. While these powerful SoCs are available for designers to integrate today very often customers lack sufficient development time and, in some cases, the technical resources to develop products based on these complex, multi-function SoC devices.

In order to address the dual challenges of a long design in process as well as the short time to market needs of customers CODICO has entered into a partnership with THUNDERCOMM to offer a broad portfolio of system on modules based on QUALCOMM's latest technologies. The SOMs are complemented by THUNDERCOMM's engineering, product development and manufacturing services which can be used by customers to help launch their new products quickly.

QUALCOMM Technologies Timeline for Smart Camera and Robotics Applications



Overview of some of the Smart Camera, Display and Robotics SoC platforms from QUALCOMM

Before describing THUNDERCOMM's product and services offering let's first explain the background and origins of our partner THUNDERCOMM. A US company founded in 2016 as a joint venture company between QUALCOMM and ThunderSoft, a software leader and pioneer in the deployment of the Android OS. THUNDERCOMM is focused on the industrial, retail and consumer markets where they leverage QUALCOMM's market leading SoC, wireless connectivity and audio technologies and their long standing relationship with the semiconductor market leader to develop comprehensive hardware reference designs, system on modules and supporting software development kits to target products in their markets areas of interest. THUNDERCOMM also leverage multi-disciplinary engineering skills in OS development and optimization, camera tuning and calibration, computer vision and AI algorithm development to develop and to manufacture* complete turnkey products on behalf of their consumer, retail and industrial customers. THUNDERCOMM's headquarters is located nearby QUALCOMM's main offices in San Diego, they have grown rapidly in recent years to 1200 staff across 9 R&D centers and 16 sales offices.

As a result of their close collaboration THUNDERCOMM offers one of the broadest portfolios of QUALCOMM SoC based SOM to address everything from wearables, handheld computers to factory automation systems and services robots. From the entry level to the premium compute segment the roadmap offers increasing levels of camera and computer vision capabilities, AI processing power as well as cellular connectivity including QUALCOMM's latest 5G technology. Pin for pin compatible SOMs are also provided to enable designers to build product roadmaps around QUALCOMM SoC families.

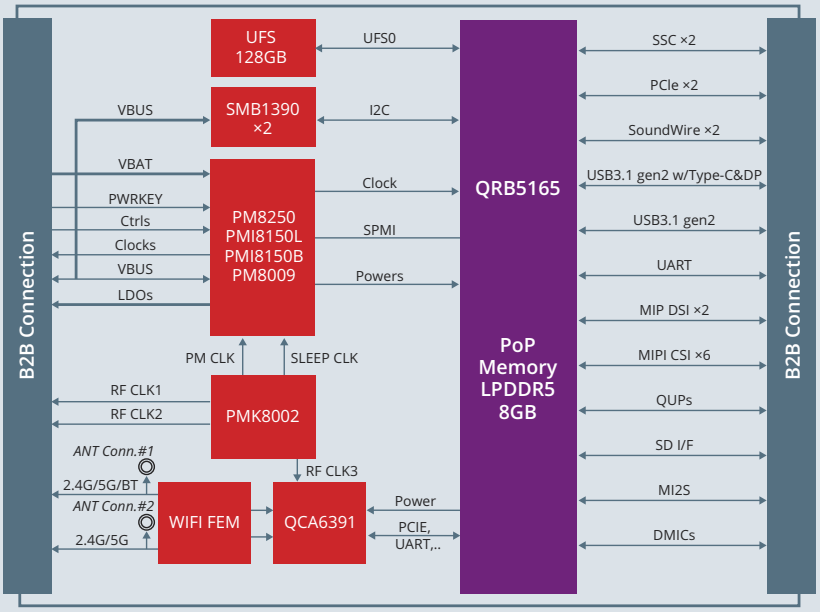
TurboX SOM – THUNDERCOMM Roadmap

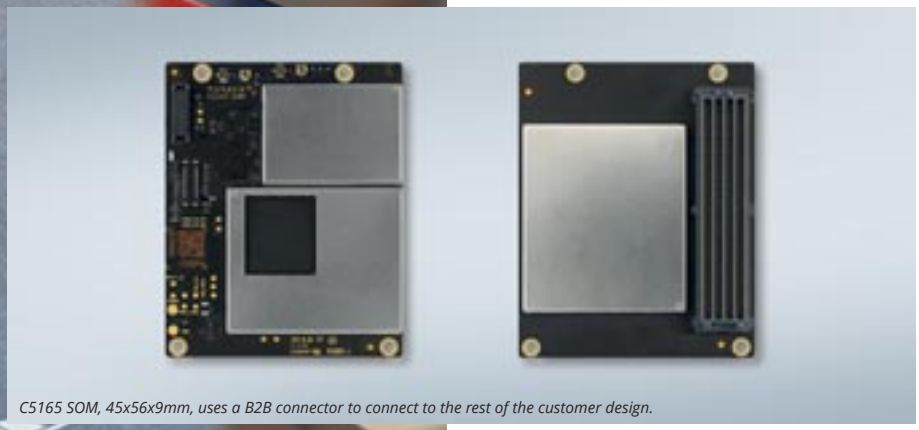
THUNDERCOMM's roadmap incorporates SOM's leveraging QUALCOMM's latest computer vision, AI and 5G technologies.

A subset of the THUNDERCOMM's SOMs targeting industrial applications is offered on an extended lifetime basis (8-10 years) as well as extended temperature ranges (-40 to 85°C) to support applications in harsh environments e.g. on farms, construction sites or mines....

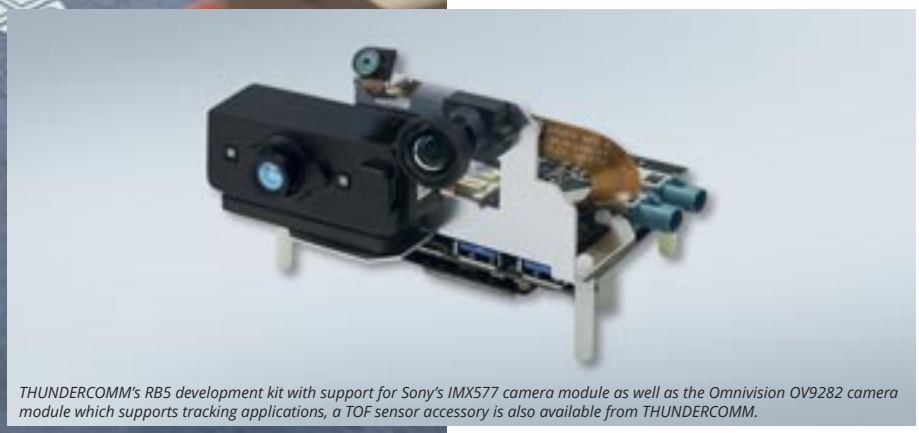
Let us take a closer look at a THUNDERCOMM SOM from the premium segment of their roadmap. Here is the hardware block diagram of the C5165 SOM which incorporates QUALCOMM's powerful QRB5165 SoC in addition to 8GB LPDDR5 RAM, 128GB UFS storage, QUALCOMM's power management ICs for the QRB5165 as well as a 2x2 MIMO Wi-Fi 6/Bluetooth 5.1 connectivity solution. Since the SOM incorporates the major components of a typical computer vision subsystem for a robot or intelligent camera within the SOM package it significantly simplifies the design in process and speeds time to market for end customers.

TurboX SOM – C5165 SOM H/W Block Diagram





C5165 SOM, 45x56x9mm, uses a B2B connector to connect to the rest of the customer design.



THUNDERCOMM's RB5 development kit with support for Sony's IMX577 camera module as well as the Omnivision OV9282 camera module which supports tracking applications, a TOF sensor accessory is also available from THUNDERCOMM.

The C5165 SOM is offered on an extended lifetime basis, a SOM variant, the C5165N also delivers extended temperature range performance for adverse environments. To enable customers to start their project quickly, THUNDERCOMM also offers a comprehensive hardware development kit based on the C5165 SOM which includes pre-integrated software support for mono and stereo camera modules and sensors such as Time of Flight and LIDAR. This hardware is supported by a feature rich software development kit which takes the QUALCOMM SOC software deliverables** and enhances them with THUNDERCOMM's in-house camera, computer vision and AI algorithm IP.

Customers adopting THUNDERCOMM SOM's for their products can also avail of THUNDERCOMM's paid for engineering services to accelerate their time to market. THUNDERCOMM has a long history of product development with some of the world's leading brands and they can bring this know-how and expertise in camera system product development and manufacturing to bear to support customers to realize their products quickly.

Please take a look at the CODICO website and sample shop for more details on the SOMs and supporting development kits from THUNDERCOMM.

A04

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**THUNDERCOMM utilize manufacturing partners including their own joint venture manufacturer BestMoments in Taiwan to manufacture turnkey products on behalf of customers.*
***CODICO supports our customers with the registration and onboarding process to enable them with access to the rich technical collateral available from QUALCOMM and THUNDERCOMM.*

THUNDERCOMM's Past Robotics Projects

MAXIMIZING POWER DENSITY

Innovative 5MHz LLC Transformer Driver from MPS

As the world strives for carbon neutrality, electric vehicles (EVs) are rapidly taking market share from internal combustion engine vehicles. However, one of the issues with electrics vehicles is range anxiety, as customers are unsure of how long they will be able to drive without the car needing to be charged. To combat this, governments around the world are massively investing in charging infrastructure.

Figure 1: Electric Car Charging Stations

Several types of charging stations are being used today, from Mode2 and Mode3 charging stations to Mode4 DC fast-charging stations that can provide up to 400kW of power (see Figure 1). These charging stations are described in greater detail below.

- **Mode2 and Mode3 (Active cables with IC-CPD and Wallboxes):** These stations provide AC power to charge an electrical vehicle. Using 3 phases Mode2 allows to charge an EV with up to 22kW while Mode3 allows up to 42kW (~75 km range per hour of charging). Note: Mode1 is no longer valid in Europe.

- **Mode4 DC fast chargers (DCFC):** This charging stations can charge an EV battery from 20% to 80% within 30 minutes, depending on the power rating (50kW to 400kW) of the charging station itself and the maximum power that the vehicle can be charged at.

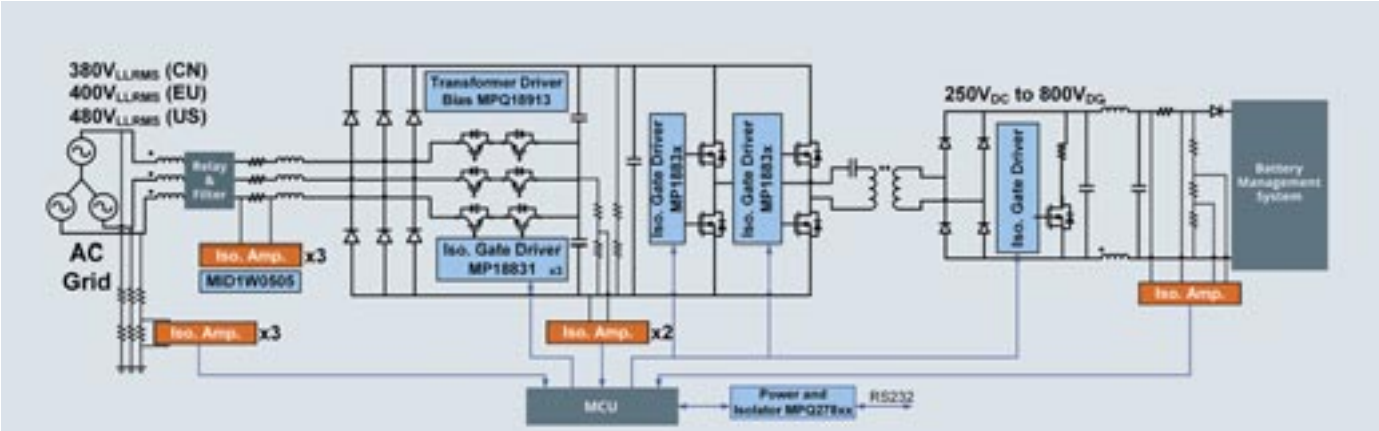


Figure 2: Block Diagram of a Mode4/DCFC Subunit

When charging at home or at work, Mode2 and Mode3 stations are sufficient. However, Mode4 and supercharger stations are necessary for people who cannot charge over longer periods of time, such as when a driver is on a longer trip where the battery's full capacity is utilized.

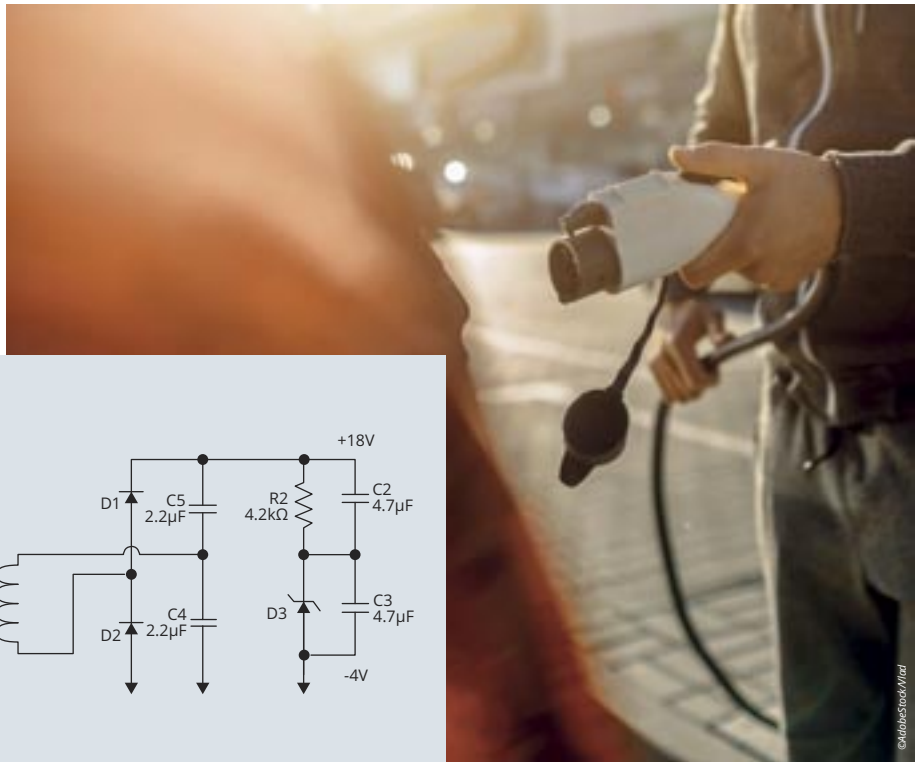
Figure 2 shows a typical DC fast-charging station block diagram to convert a 3-phase AC voltage into a 250V to 800V DC voltage to charge electric vehicles. A Mode4 station typically contains several of these subunits, each ranging from 30kW to 75kW. This diagram exhibits many of the solutions that can drive DC fast charging stations, including isolated gate drivers, isolated power modules, transformer driver bias, and digital isolator solutions with an integrated power supply.

Figure 2 shows that the DC Fast charger system is generally comprised of two conversion stages. The first stage is a power factor correction (PFC) stage, which converts the AC voltage from the power grid into an intermediate DC voltage bus between 800V and 1300V. Three-phase, 3-level rectifier/inverter topology is commonly used for the PFC stage. This particular topology refers to a three-level converter that can interface with a 3-phase power grid.

At the second stage (also called the DC/DC stage), an isolated DC/DC converter converts the intermediate DC voltage to the target voltage that is specific to the battery being charged. LLC and phase-shift full-bridge converters are common topology choices for the DC/DC stage.

Some of the challenges for designing high-power charging stations are maximizing power density, reducing cost, and reducing size. One industry-wide method to increase efficiency is to replace semiconductor MOSFETs/IGBTs with silicon carbide (SiC) FETs. This is particularly important since DC Fast charger stations have increased in power from 50kW up to 400kW. Due to the high-voltage and high-power nature of DC Fast charger systems, isolated devices are required to protect users and low-voltage control circuitry from the potential hazards and disturbances that could originate from the high-voltage power conversion circuits. Additional components can be implemented to reduce the risk of hazards:

- Isolated gate drivers for SiC MOSFETs and IGBTs, such as the MP18831 and MP18851
- Digital signal isolators, such as the MPQ27811 and MP27631
- Isolated current-sensing and voltage-sensing devices, such as the MCS1806 and MCS1803



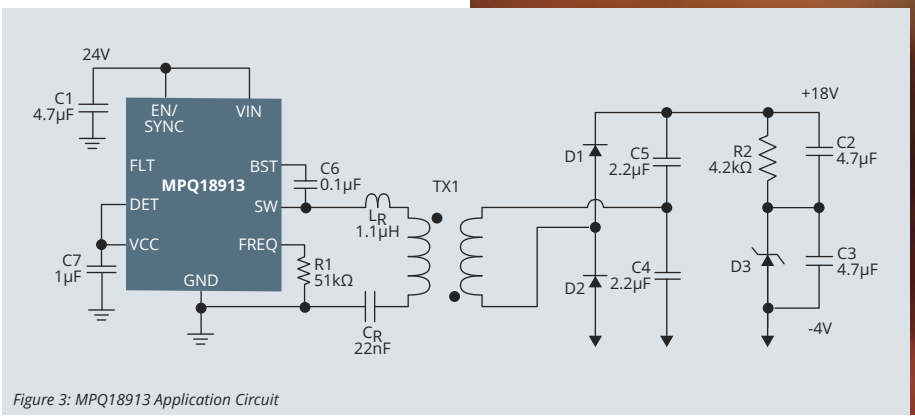


Figure 3: MPQ18913 Application Circuit

Note that isolated gate drivers require an isolated bias supply for power, and that the gate drive power supplies must be able to withstand high isolation voltages. At minimum, the gate driver power supplies must be able to withstand the intermediate DC bus voltage, and must offer low isolation capacitance to minimize disturbances from the high-voltage side to the low-voltage side.

Designing an isolated power supply for gate drivers

The MPQ18913 is a transformer driver for isolated bias supplies. This device can work with SiC FETs as an isolated bias for SiC gate drivers. Flyback topology is often used for isolated power supplies to provide an isolated 18V/-4V output that drives the SiC FET.

Figure 3 shows a typical application circuit implemented with the MPQ18913 to achieve a 18V/-4V output. The number of outputs can be configured based on the transformer used and the output voltage can be altered via the turns ratio.

The MPQ18913 can be used as an LLC converter, which is the most efficient topology for isolated gate drive power supplies (see Figure 4). These converters use a resonant LLC tank, which has a magnetizing inductor for energy transfer, as well as an additional capacitor and inductor that make the tank resonate at a certain frequency. The converter uses this resonance to achieve soft switching and ensure highly efficient power conversion. The main benefit of LLC converters is that the leakage inductance created by the transformer can be used as the resonant inductor in the tank. This eliminates the voltage spike induced by the leakage inductance, and improves efficiency compared to flyback topologies.

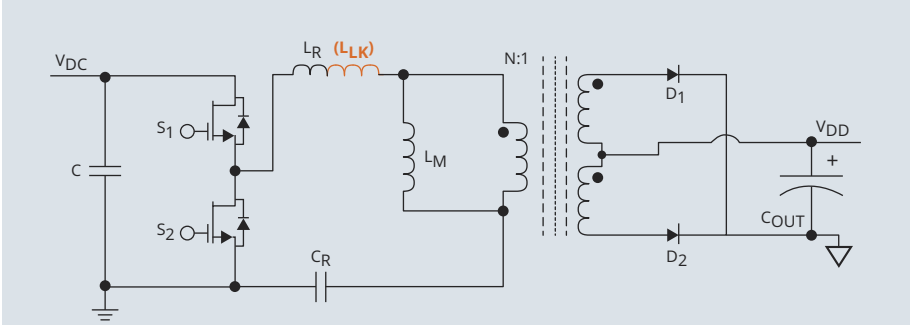


Figure 4: LLC Topology

Using the MPQ18913 as an example, the LLC resonant topology offers several notable advantages compared to a typical PSR flyback topology. One such advantage is that LLC resonant topology reduces the solution size due to the switching frequency (fSW), which can reach up to 10MHz, whereas with flyback topology, fSW stays below 400kHz. This results in a total solution size that is 40% smaller than a flyback application using a similar power level. Another major advantage of LLC resonant topologies is the fact that the isolation voltage can easily reach up to 5kV. Traditional flyback solutions only reach 1.5kV, therefore meeting more stringent isolation voltage requirements.

Table 1 compares LLC resonant topology to flyback topology.

Conclusion

High-frequency LLC power supplies are typically more difficult to implement and optimize in designs than low-frequency converters, but devices like the MPQ18913 simplify LLC power supplies with features including automatic resonant frequency detection and integrated transistors.

In addition, LLC resonant topologies reduce solution size, which increases power density for high-power charging stations such as those used for charging electric vehicles. As electric charging infrastructure continues to improve the MPQ18913, being used to bias SiC FETs, is a perfect choice in high-power charging applications, as well as in automotive applications such as on-board chargers, traction inverters, and DC/DC converters.

A05

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Table 1: LLC Resonant Topology vs. Flyback Topology

PARAMETER	LLC RESONANT TOPOLOGY	PSR FLYBACK TOPOLOGY	BENEFIT
Switching frequency (fSW)	High (up to 10MHz)	Low (<400kHz)	High frequency enables much smaller solution size
Transformer size	13µH (11×6mm)	30µH (10×10mm)	
Leakage inductance	Utilizes leakage inductance as part of the resonant tank	Leakage inductance reduces performance	In LLC, leakage inductance enables higher efficiency and prevents voltage spikes
Isolation voltage	High (up to 5kV)	Low (1.5kV)	LLC enables higher isolation voltage to increase safety
Isolation capacitance	Low (6pF)	High (Up to 25pF)	Up to 40% reduction in solution size and 20% fewer component count
Package size	2×2,5mm	4×4mm	
Diodes (including Zener diode)	3	6	
Solution size	109mm²	180mm²	
BOM components	21 components	26 components	

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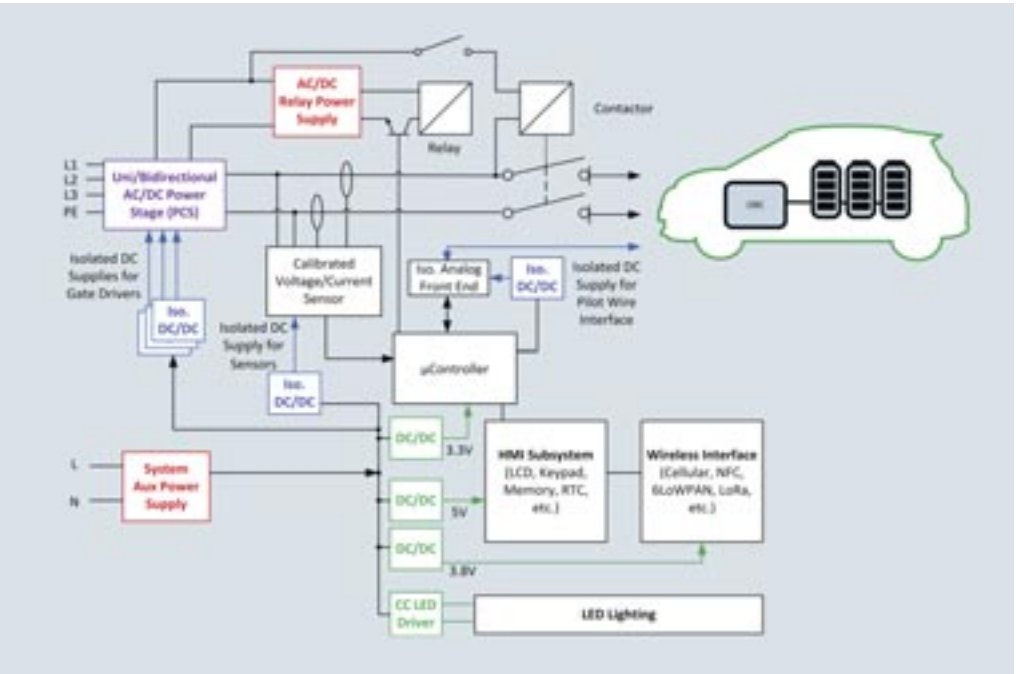
SAFE CHARGING

Power Supplies for **E**lectric **V**ehicle **C**harging

Electromobility as an alternative pathway for more environmentally friendly or at least compatible relies on smart charging technology with communicating system components. Working as an interface between the power grid, the »energy providing unit« and the energy storage of the electric vehicle, an EV-charger contains communication units and controllers as well as sensors, monitoring logic and modules for authentication to unleash the energy flow.



To ensure reliable self-powering of these charging systems, RECOM has developed specially optimised power supply modules ranging from 3 to 60 Watts meeting electrical safety and electromagnetic compatibility requirements while maintaining an extremely dense design.

Wallboxes and charging stations are often installed in environments with Overvoltage Category III (OVC III), where significant voltage dips, spikes and transients may occur due to lightning strikes via the mains supply line. The power supply units must be able to withstand these. In addition, rapid temperature changes may occur whereas the operating temperature may vary dependant on their installation locations.

The AC supply can either single-phase, or phase-to-phase conditions with 400 or 480VAC. In addition, AC/DC modules must operate highly reliable as they represent the only gate from or to the mains.

The series of 3W to 60W AC/DC converter modules come with 85–528VAC input for line to neutral connections in 100/115/230/277/400/480VAC single-phase systems or line-to-line connections in 120VAC systems. The cost-effective and fully cer-

OVERVIEW

AC/DC Power Supplies

A range of AC/DC modules suitable for auxiliary supplies in EV charging systems with a range of AC supply voltages in harsh mechanical and electrical environments.

Main features:

- Enhanced immunity and isolation Pri ↔ Sec
- Operating temperature -40°C to +85°C (90°C)
- High efficiency for reliable and compact units
- 100/230/400VAC input (incl. Phase to Phase)
- Reduced EMI Emissions with grounded output

AC/DC-Modules from 3 to 60W

- RAC03E-K/277 (OVC III)
- RAC05-K/480 (OVC III, PD3, 6kV isolation)
- RAC10-K/277 (OVC III, Peak load 14W)
- RAC20-K/OVG (OVC III, HF 30V/m)
- RACM40-K, RACM60-K (OVC III)

DC/DC Power Supplies

For isolated gate drivers, auxiliary rails and isolated communication interfaces.

Main features:

- High isolation e.g. the 4:1 input RKZE series, useful for control signal isolation
- Lowest cost isolated DC/DC converters such as the RKE series, useful for interface isolation
- Low profile, high isolation and high operating temperature SMD packages e.g. RxxCTE series, useful for high-side gate drivers
- All DC/DC converters are 100% tested and carry comprehensive safety certifications

Switching Regulators

Non-isolated switching regulators provide high-efficiency replacements for linear regulators in battery charging systems.

Main features:

- High efficiency e.g. R-78E-1.0 series peaks at 97%, 3.3V, 5V or 12V output/1A, up to 28V input, output power up to 12W
- The RPX series are complete 3A power supplies in a sub-miniature 3 x 3 x 1.45mm package
- The RPL series offer 1A to 4A outputs in a tiny QFN pinout, with up tu 20W output
- RBBA3000-50 3kW output in half-brick format

  Buck-boost converter, 9-60V input, 0-60V output. Applications include 48V to 24V, or 12V to 24V battery power conversion in EVs, and battery voltage stabilizers in charging stations for UAVs and drones

Custom Solutions

Unidirectional and bidirectional converters and inverters up to 10kW and higher in a range of platform designs. EV applications include intelligent battery charging and vehicle to grid power conversion with efficient designs giving cost and space savings.

Design topologies available include the latest CLLC type, ideal for power conversion between rectified and power-factor corrected 1ph and 3ph AC, and typical 400V EV batteries.

tified parts are available with a wide variety of output voltages; they work under industrial operating temperature from -40 to +85°C for harsh environments and are therefore the perfect companion for auxiliary supplies in battery charging and monitoring systems. These series comply with EMC standards without external filters and require minimal no-load and standby power. Many of the RACxx products are suitable for direct connection to OVC III systems.

Suitable for line-to-line connections in 220/480VAC systems, the fully-certified RECOM RAC05-K/480 series AC/DC converter modules provides an isolated 5W output at 5, 12 or 15VDC from a supply voltage ranging from 85 to 528VAC. The parts are EMC compliant (EN55032, Class B) without external components, and the operating temperature range is -40 to +80°C. The RAC05-K/480 is suitable for direct connection to OVC III systems, which makes it ideal for auxiliary converters in outdoor battery charging stations as well as general industrial use.

All available modules at glance, are illustrated in the EV online brochure and product matrix, which we are happy to send you upon request.

A06

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LOW POWER CONSUMPTION

For IoT & Wearables: XCL232 150mA Buck Micro DC/DC

TOREX SEMICONDUCTOR LTD.

Ultra-low quiescent current is important as during sleep mode in most of today's IoT & wearable applications, the supply current of the Power Management IC accounts for a significant proportion of total power consumption and this has a massive impact on battery life. Today's customers expect an increasingly longer operating time with less frequent charging. The new XCL232 device from TOREX helps in both scenarios with only 200nA quiescent power consumption!

The XCL232 series is an ultra-low power 150mA PFM step-down synchronous Micro DC/DC converter with integrated inductor. Operating voltage range is from 1.8~6.0V, output voltage is selectable in 0.05V increments between 0.5~1.9V and 0.1V increments between 2.0~3.6V.

The 200nA ultra-low quiescent current is achieved by implementing PFM control and synchronous rectification architecture , which minimises losses at low current.

An efficient step-down circuit can be configured using only 2 external caps as shown in Figure 1.

The XCL232 also features an enable pin to turn the IC on and off; in stand-by mode, all circuits are switched off, and consumption drops to a low 0.1µA. An optional CL discharge function, which rapidly discharges the output capacitor when the IC is switched off, is also available. The built-in UVLO function, the internal P-channel driver FET and N-channel driver FET are turned OFF when input voltage drops below the UVLO detect voltage level.

High efficiency at light loads

The 200nA quiescent current also contributes to high efficiency at a light-load currents, which means that the XCL232 is a solution that really helps to extend battery life in battery powered applications.

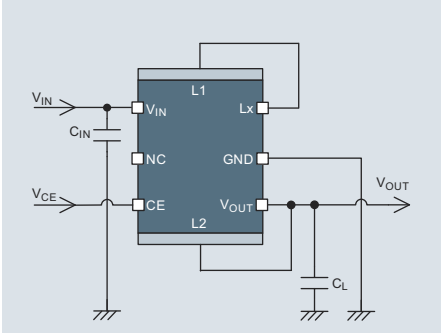

Figure 1: Typical Application Circuit

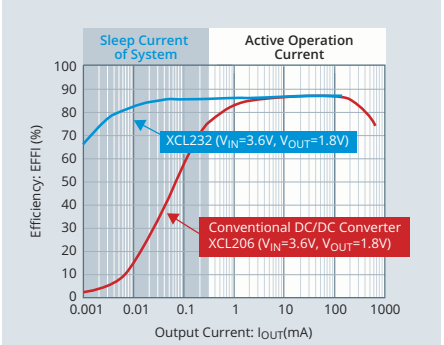

Figure 2: Efficiency vs. Output Current

As shown in Figure 2, the efficiency of the XCL232 at light load currents (in the range of 1µA~100µA), is greatly improved compared to a conventional low power PWM/PFM auto switching buck DC/DC. At 10µA, the efficiency of the XCL232 is still >80%!

Versatile step-down solution

This new step-down Micro DC/DC is ideal for use with applications powered by either single cell Li primary batteries or Li-Ion/Li-Polymer re-chargeable batteries. Figure 3 shows a typical application circuit powered from a Li-Ion/Li-Polymer cell where the XCL232 is used to step-down to 2.8V from the battery to power the low Iq MCU.

Space saving package

The XCL232 series is available in a CL-2025-03 package with dimensions of only 2.5×2.0×1.04mm (see Figure 4).

For more information on the XCL232 (including the latest datasheet) please visit:
https://www.torex-europe.com/products/micro-dc-dc/step-down-1/xcl232/

A07

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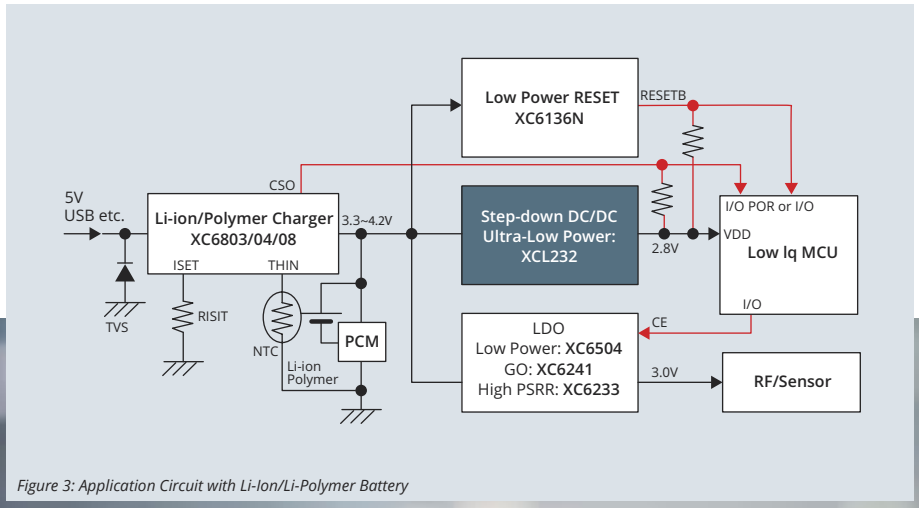

Figure 3: Application Circuit with Li-Ion/Li-Polymer Battery

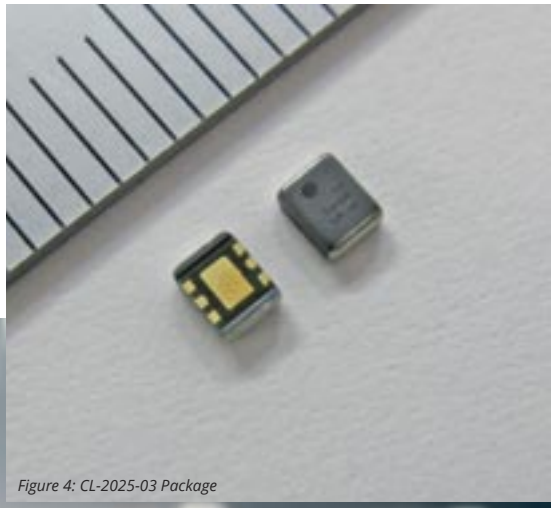

Figure 4: CL-2025-03 Package

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WIFI & BLUETOOTH

Modules for IoT Applications

With the advancement of the Internet of Everything (IoE) and with the growing use of artificial intelligence and »Big Data«, wireless radio modules are in demand to connect sensors and actuators to the cloud via gateways.

The wireless connection of the different objects to the central management system is the most effective way of networking. The area of application includes the smart home, smart building, the transport sector, applications in medicine, especially patient care, smart cities, the Internet 4.0, automated production, up to smart agriculture and in environmental protection.

Many of these segments require very compact modules and are often also battery-powered, which in turn places high demands on the ICs used. CODICO has a leading supplier for the IoT market here in SYNAPTICS.

SYNAPTICS recently acquired the WiFi Bluetooth IoT division of Broadcom and is developing client solutions for various applications based on this platform. Ready-made modules from the Taiwanese manufacturer Ampak with SYNAPTICS WiFi6 and Bluetooth 5.2 technology round off the range.

Ampak's differentiating knowlegde is in the filed of package design. They develop thin and lightweight low power consumption wireless modules for customers, from smallest 6.5×5mm SiP to high-end industrial control grade wide temperature modules; product packaging from LGA, Stamp Type, Solder Down for mass production scale to NGFF (M.2) mPCIe for flexible assembly of industrial control platforms and other industrial control standard interface types. Product digital interface includes SDIO, IIC, PCIe, USB, UART, etc. Ampak products are available according to the customer's CPU platform and operating system of choice, suitable for Windows, Linux, Android and RTOS operating systems. With the support of Ampak and CODICO's technical support team suitable products can be provided and customers advised on the selection to achieve the advantage of rapid hardware and software integration, so that customers' products can be listed in time and a full range of services is available and ready for our customers.

Ampak's modules, based on chip technology from SYNAPTICS, are particularly suitable for use in battery-powered devices. The current generation convinces with very low power consumption in standby mode, in power save mode values below 1mW are possible. This corresponds to an improvement of over 50% compared to the previous generation. Samples are available from CODICO at short notice.

A08

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FAMILY	PART	DESCRIPTION
WiFi + Bluetooth	SYN43436P	Single-Chip IEEE 802.11 b/g/n MAC/Baseband/Radio with Bluetooth 5.2 and FM Receiver
WiFi + Bluetooth	SYN43438	Single-Chip IEEE 802.11 b/g/n MAC/Baseband/Radio with Bluetooth 4.1 and FM Receiver
WiFi + Bluetooth	SYN43455	Single-Chip 5G Wi-Fi IEEE 802.11ac MAC/Baseband/Radio with Integrated Bluetooth 4.1 and FM Receiver
WiFi + Bluetooth	SYN43456	Single-Chip 5G Wi-Fi IEEE 802.11ac MAC/Baseband/ Radio with Integrated Bluetooth 5.x and FM Receiver
WiFi + Bluetooth	SYN43458F	Single-Chip 5G Wi-Fi IEEE 802.11ac MAC/Baseband/ Radio with Integrated Bluetooth 5.x
WiFi + Bluetooth	SYN43596	Single-Chip 5G Wi-Fi IEEE 802.11ac 2 × 2 MAC/Baseband/Radio with Integrated Bluetooth 4.2 and RSDB
WiFi + Bluetooth	SYN43598	Single-Chip 5G Wi-Fi IEEE 802.11ac 2 × 2 MAC/Baseband/Radio with Integrated Bluetooth 5.x and RSDB
WiFi + Bluetooth	SYN430132	Single-Chip Ultra Low Power IEEE 802.11n MAC/Baseband/Radio with Integrated Bluetooth 5.x
WiFi 6 + Bluetooth	SYN43752	Single-Chip IEEE 802.11ax 2x2 MAC/Baseband/Radio with Integrated Bluetooth 5.1 and an FM Receiver
WiFi 6 + Bluetooth	SYN4375	Single-Chip 5G Wi-Fi IEEE 802.11ax 2x2 MAC/Baseband/Radio with Integrated Bluetooth 5.x
WiFi 6 + Bluetooth	SYN43756	Single-Chip IEEE 802.11ax 2x2 MAC/Baseband/Radio with Integrated Bluetooth 5.2 (LE AUDIO)
WiFi 6E + Bluetooth + Thread/Zigbee	SYN4381	Single-Chip Triple Combo with IEEE 802.11ax 1x1 MAC/Baseband/Radio, Integr. Bluetooth 5.2 (LE AUDIO) & Matter support
WiFi 6E + Bluetooth + Thread/Zigbee	SYN4382	Single-Chip Triple Combo with IEEE 802.11ax 2x2+1x1 RSDB MAC/Baseband/Radio, Integr. Bluetooth 5.2 (LE AUDIO) & Matter support

VERSATILE

High Current, Low Cost, Point-of-Load Converter Module for USB-C & Distributed Power Management

SILVERTEL announces the launch of the all new Ag7010, a 10A POL Converter, optimised for operation with USB-C (PD) voltages at 9V, 12V or 20V and further strengthening its reputation for producing innovative power management modules.

Designed to provide a configurable 3.0 to 12.7V output with a conversion efficiency of >97%, this small footprint, highly efficient module packs a big punch, ideal for low loss systems and well-suited for distributed power applications. The Ag7010 offers a wide input voltage range of 8V to 24V, delivering up to 10A of output current to provide a non-isolated, low noise and ripple output. Thanks to its high operating efficiency, this module is the ideal choice for USB-C Thunderbolt/Lightning interconnected systems required to run on tight power budgets.

The Ag7010 can be controlled and monitored via on-board I2C providing a very flexible and versatile power device. The module is available in a surface mount, ultra-small outline package, measuring only 37×14×7mm (L×W×H) which can be easily reflowed onto the host PCB, enabling close thermal coupling and excellent thermal management to be achieved.

In addition, the Ag7010 is equipped with under- and over-voltage lock-out, output enable, over-current and thermal protection to provide a robust and reliable power supply solution. Operating over the industrial temperature range as standard and requiring few external components, the transition from CAD to approved hardware is a very simple, low cost and risk-free step to take.

Designed and manufactured in the UK, and fully RoHS and WEEE compliant, the Ag7010 complements SILVER TELECOM's extensive range of low cost but highly featured power management modules.

Product and Evaluation board (EvalAg7010) are available from CODICO now to help design engineers make a thorough assessment of the device.

A09

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UNDERSTANDING POWER INDUCTOR PARAMETERS

Easily explained!

Modern DC/DC converter demands are largely driven by consumer applications. These applications require power inductors mainly for battery-powered devices, embedded computing, and high-power/frequency DC/DC converters. It is essential to understand the electrical characteristics of inductors to design systems that are compact, cost-effective, efficient, and provide excellent thermal performance.

Inductors are relatively simple components, comprised of an insulated wire wound in a coil. Complexity arises when individual components are combined to create an inductor with the proper size, weight, temperature, frequency, and voltage to meet a target application.

When selecting an inductor, it is important to understand the electrical characteristics noted in the inductor's datasheet. This article will provide guidance on how to select the optimal inductor for a solution while predicting the inductor's performance when designing a new DC/DC converter.

What is an inductor?

An inductor is a component in an electrical circuit that stores energy in its magnetic field. Inductors convert electrical energy into magnetic energy by storing, then supplying energy to the circuit to regulate current flow. This means that if the current increases, the magnetic field increases. Figure 1 shows an inductor model.

Inductors are formed using insulated wire wound as a coil. The coil can be different shapes and sizes, and can be wound using different core materials. The inductance is dependent on multiple factors, such as the number of turns, core dimensions, and permeability. Figure 2 shows key inductor parameters.

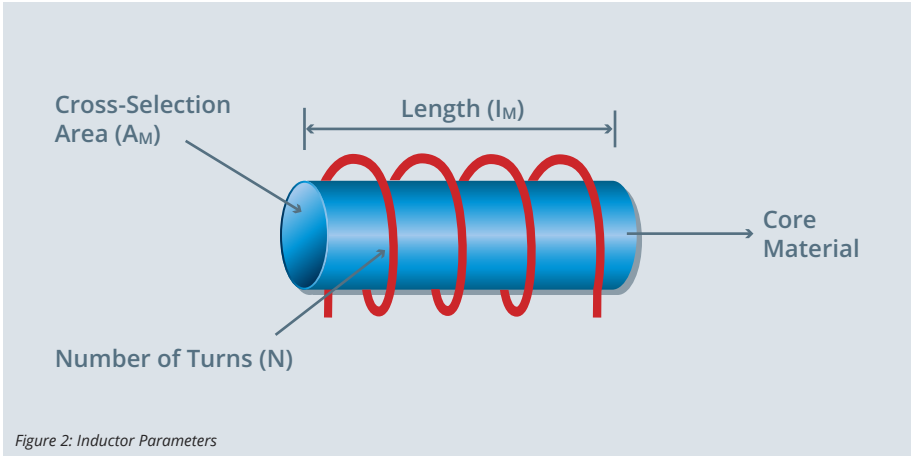


Figure 2: Inductor Parameters

Table 1: Calculating Inductance (L)

EQUATION	PARAMETER	PARAMETER DESCRIPTION
$L = \frac{\mu_r \mu_0 \times A_M}{l_M} \times N^2$	$\mu = \mu_r \mu_0$	Permeability
	μ_r	Relative permeability (core)
	$\mu_0 = 4\pi 10^{-7}$	Constant of nature
	A_M	Area of the coil (magnetic field area)
	l_M	Coil length (magnetic field length)
	N	Number of turns

Table 2: Calculating the Magnetic Flux Density (B)

EQUATION	PARAMETER	PARAMETER DESCRIPTION
$B = \mu \times H$	μ	The medium's permeability
	H	The magnetic field (dependent on the geometry, number of turns, and current)

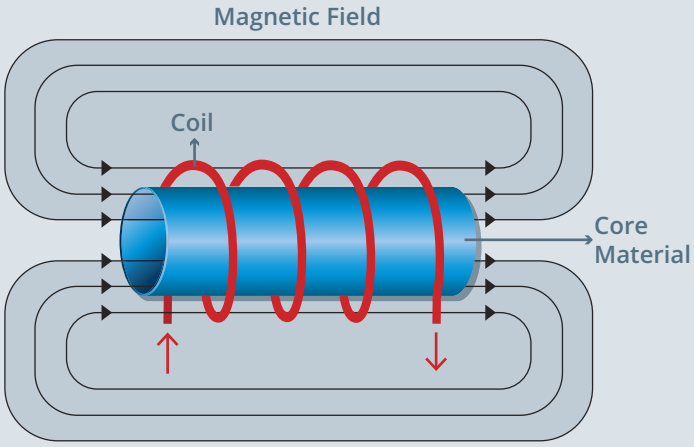


Figure 1: Electrical Model of an Inductor

Table 1 shows how to calculate inductance (L). Common inductor parameters are described in more detail below:

Permeability

Magnetic permeability is the ability for a material to respond to magnetic flux, as well as how much magnetic flux that can pass through the inductor within an applied electromagnetic field. Table 2 shows how the permeability can intensify the magnetic flux density (B).

Based on Table 2, the magnetic flux concentration depends on the core permeability and dimensions.

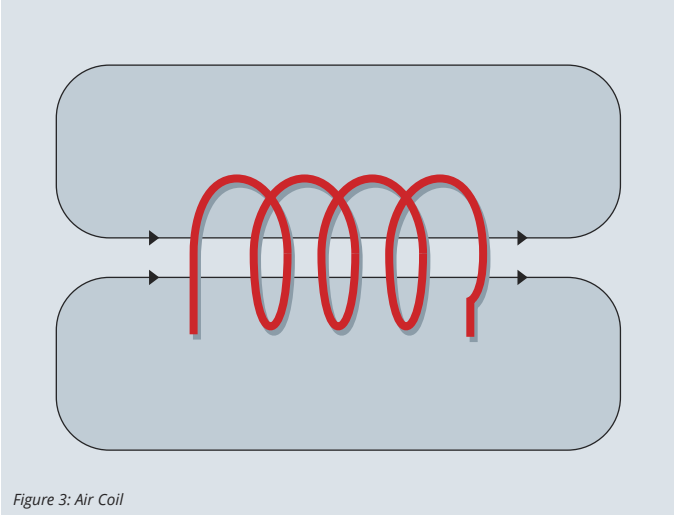


Figure 3: Air Coil

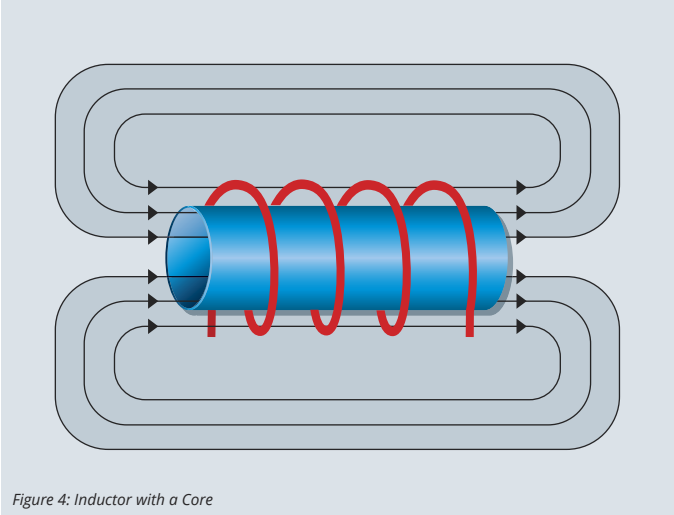


Figure 4: Inductor with a Core

Figure 3 shows a coil without a core. The air coil's permeability is a constant value (μr air) that is about equal to 1. Figure 4 shows an inductor with a core. Note that when a core is used, the magnetic flux density is intensified.

For the magnetic core, the typical permeability varies for different core materials. Table 3 lists the permeability of three different ferromagnetic core materials.

Inductance (L)

Inductance is the ability for an inductor to store induced electric energy as magnetic energy. An inductor must supply constant DC current to the output load while being driven by the switching input voltage.

Table 4 shows the relationship between the current and the inductor's voltage. Note that the voltage across the inductor is proportional to the change of current with respect the time. First, determine the inductance range for your design, keeping in mind that inductance is not constant across operating conditions. Inductance can change as frequency increases, which requires special consideration for applications with higher switching frequencies. Inductor manufacturers typically test inductance at frequencies between 100kHz and 500kHz, since most DC/DC converters operate within this range.

Table 3: Magnetic Core Permeability

CORE MATERIAL	NOTATION	PERMEABILITY
Iron	μr FE_{BASED}	50 bis 150
Nickel-zinc	μr NiZn	40 bis 1.500
Manganese-zinc	μr MnZn	300 bis 20.000

Table 4: Calculating the Inductor's Voltage Drop

EQUATION	PARAMETER	PARAMETER DESCRIPTION
$v = L \times \frac{di}{dt}$	v	Voltage drop across the inductor
	$\frac{di}{dt}$	Rate of change for the current

Table 5: Calculating Cooper R_{DC}

EQUATION	PARAMETER	PARAMETER DESCRIPTION
$R_{DC} = \rho \times \frac{l}{A}$	ρ	Resistivity
	l	Length
	A	Cross-sectional area

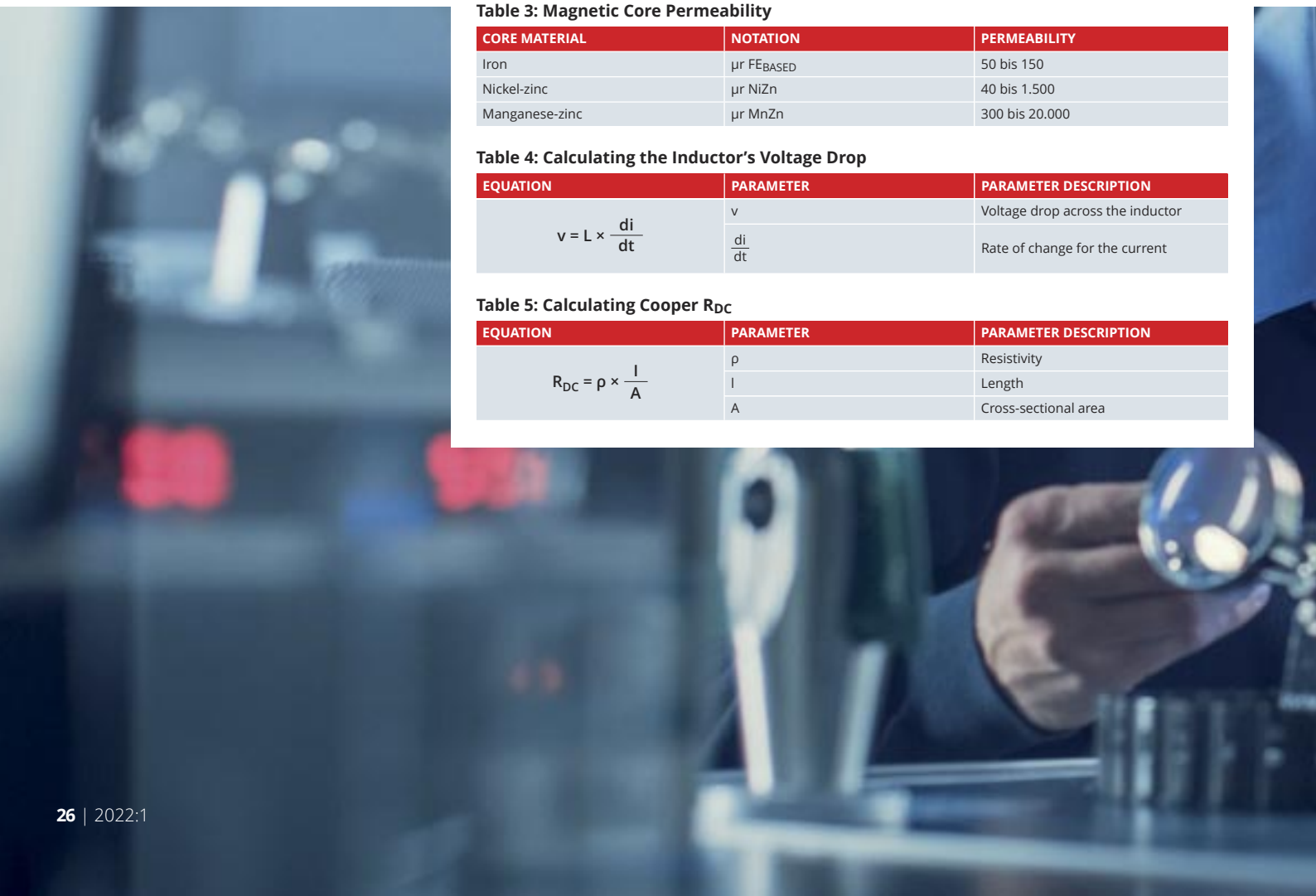


Table 6: Comparison Cross-Sectional Area Round vs. Flat Wire

DIMENSIONS	TYPE OF WIRE		COMPARISON	CROSS-SECTIONAL AREA
1mm Diameter	Round			$A_{ROUND} = \pi r^2 = \pi \times 0.5^2 = 0.785mm^2$
1×1mm (base/height)	Flat			$A_{FLAT} = 1 \times 1 = 1mm^2$

Table 7: Round vs. Flat Wires

ROUND WIRES	FLAT WIRES
Higher inductance	Winding area is limited, maximum inductance is reduced
Higher resistance (R_{DC})	Lower resistance (R_{DC})
Lower cross-section area	Winding window completely used
More turns possible	Fewer turns possible
Lower current	Higher current

Resistance (R)

The inductor's current resistance results in heat dissipation, which affects efficiency. The total copper losses are comprised of the R_{DC} and R_{AC} losses. R_{DC} is constant regardless of the frequency, while R_{AC} is dependent from the frequency. Table 5 shows how to calculate R_{DC}.

The only way to reduce copper losses is to increase the area of the wire, either by switching to a thicker wire or using a flat wire. When using a flat wire, the winding window is completely used, which results in a lower R_{DC}. Table 6 shows the cross-section area for a round wire versus flat wire. Table 7 compares the advantages of round and flat wires. Estimate the inductor's DC copper loss (P_{DC}) with Equation (1):

$$(1) \quad P_{DC} = I_{DC}^2 \times R_{DC}$$

The copper loss (P_{AC}) is based on R_{AC}, which is caused by the proximity and skin effect, which is driven by the frequency. The higher the frequency, the higher the P_{AC} copper losses.

Core losses

Generally, the magnetic properties required for core-based inductors can be met with ferromagnetic material. Depending on the core's material, the relative permeability of this inductor ranges between 50 and 20000.

The domain structure of this material responds when a magnetic field is applied; without a magnetic field, the orientation is random. Core losses are generated when the magnetic energy changes. The domains orient the magnetic moment along the magnetic field direction. As the domains expand and contract, some of the domains get stuck in the crystal structure. Once the stuck domains are able to rotate, the energy dissipates as heat.

Ripple current (ΔI_L)

The ripple current (ΔI_L) is the amount by which the current changes during a switching cycle. The inductor may not perform properly when it operates outside of its peak current range. An inductor's ripple current is typically designed to be within 30% to 40% of the I_{RMS}. Figure 5 shows the inductor current waveform.

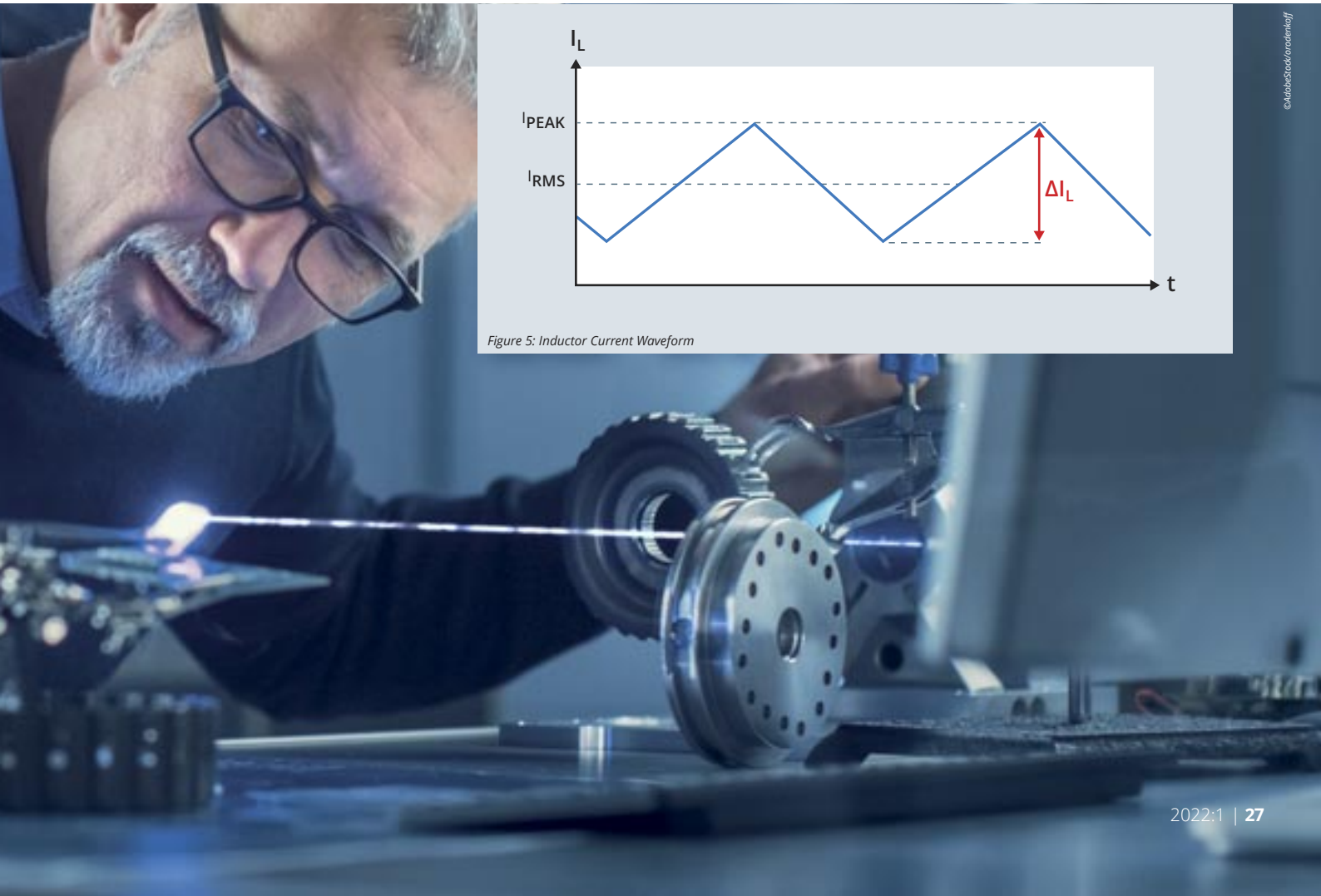


Figure 5: Inductor Current Waveform

Rated current (I_{DC}, I_{RMS})

The rated current refers to the DC current required to increase the inductor's temperature by a specified amount. The temperature rise (ΔT) is not a standard value, though it is usually between 20K and 40K. The rated current is measured at the ambient temperature. This current is provided in the inductor datasheet, and is the value expected for a final application. For applications with higher ambient temperatures, designers should select an inductor with a higher self-heating temperature.

Figure 6 shows the temperature rise in relation to the rated current. This curve can be used to determine temperature rise for any current.

The operating temperature (T_{OP}) in an application is determined by the ambient temperature (T_{AMB}) and the inductor's self-heating value (ΔT). T_{OP} can be estimated with Equation (2):

(2) $$T_{OP} = T_{AMB} + \Delta T$$

The given rated current is a good way to estimate an inductor's temperature rise. Temperature increase is also influenced by the circuit design, PCB layout, proximity to other components, and trace dimensions and thickness. Additional heat may also be caused by an excess of AC loss generated in the inductor core body and windings. Use an inductor with a larger package size if lower self-heating is required.

Saturation current (I_{SAT})

The saturation current ratings refer to the DC current that the inductor can support before the nominal inductance drops by a defined percentage. The reference percent drop is unique to each inductor. Generally, manufacturers set this value between 20% and 35%, which can make comparing inductors difficult. In datasheets, it is common to find a curve showing how the inductance changes in relation to the DC current. This curve can be used to evaluate the entire inductance range and how it corresponds to the DC current.

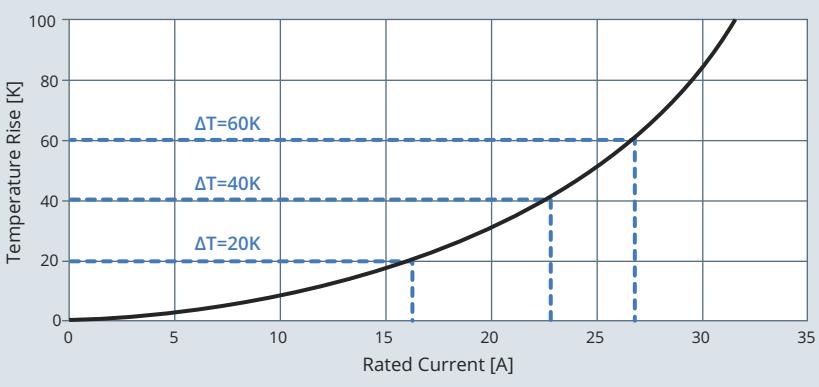


Figure 6: Inductor Rated Current Curve

The DC saturation current depends on the temperature and the inductor's magnetic material and the structure of its core. Different structures and magnetic cores can affect I_{SAT}.

Ferrite drum cores are the most common, and they are characterized by a hard saturation curve (see Figure 7). Is it critical to ensure that the inductor does not operate beyond the drop point, as the inductance drops significantly and functionality is reduced beyond this point.

Composite molded inductors have stable inductance drops across temperature changes, with soft saturation. Soft saturation provides the designers more flexibility and wider operating ranges due the gradual inductance drop.

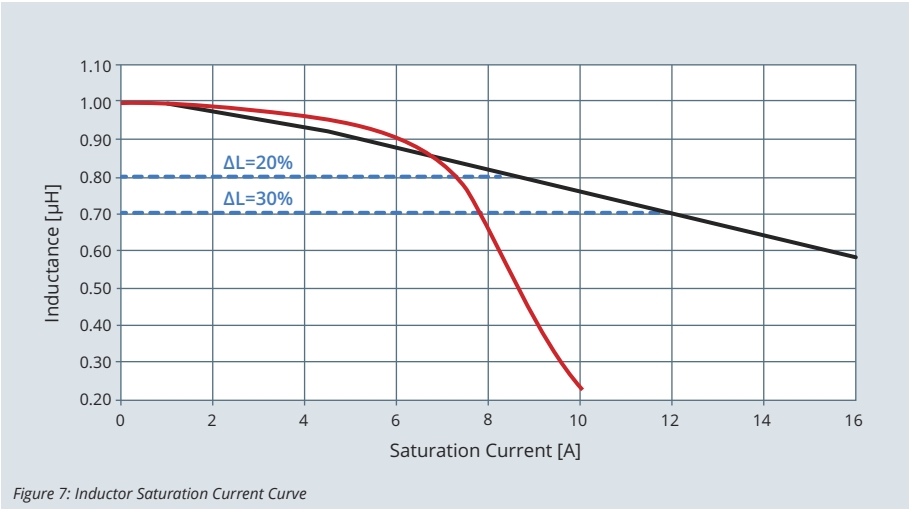


Figure 7: Inductor Saturation Current Curve

Figure 7 shows two saturation curves. The blue curve shows an example of soft saturation with a typical composite molded inductor. The red curve shows an example of hard saturation with a typical NiZn/MnZn drum core. A smaller inductance (or a larger package size) allows inductors to handle higher saturation currents.

Self-resonant frequency and impedance

The self-resonant frequency (f_R) of an inductor is the lowest frequency at which the inductor resonates with its self-capacitance. At the resonant frequency, the impedance is at its maximum peak, and the effective inductance is zero. Figure 8 shows the inductor's circuit model.

An inductor has inductive characteristics (shown as the blue curve Figure 9) up to the resonant

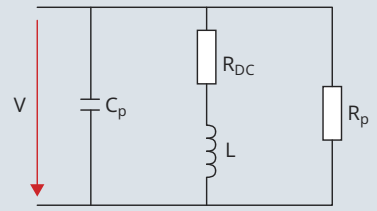


Figure 8: Inductor Circuit Model

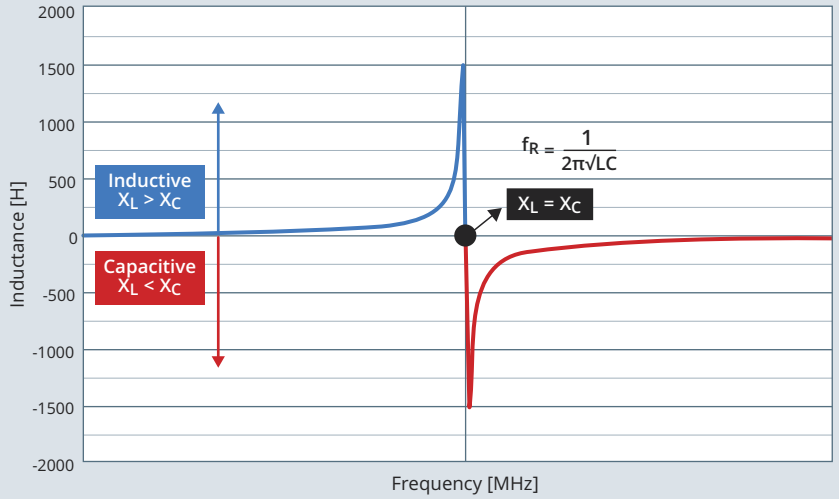


Figure 9: Inductance vs. Frequency

frequency (f_R), as an increasing frequency corresponds to a higher impedance. At the resonant frequency, the negative capacitive reactance (X_C) is equal to the positive inductive reactance (X_L), estimated by the condition in Equation (3):

$$(3)\quad X_L = X_C \longrightarrow j\omega L = \frac{1}{j\omega C}$$

Beyond the resonant frequency (shown as the red curve Figure 9), the inductor displays capacitive characteristics that correspond to a decreasing impedance. After this point, the inductor does not function as expected.

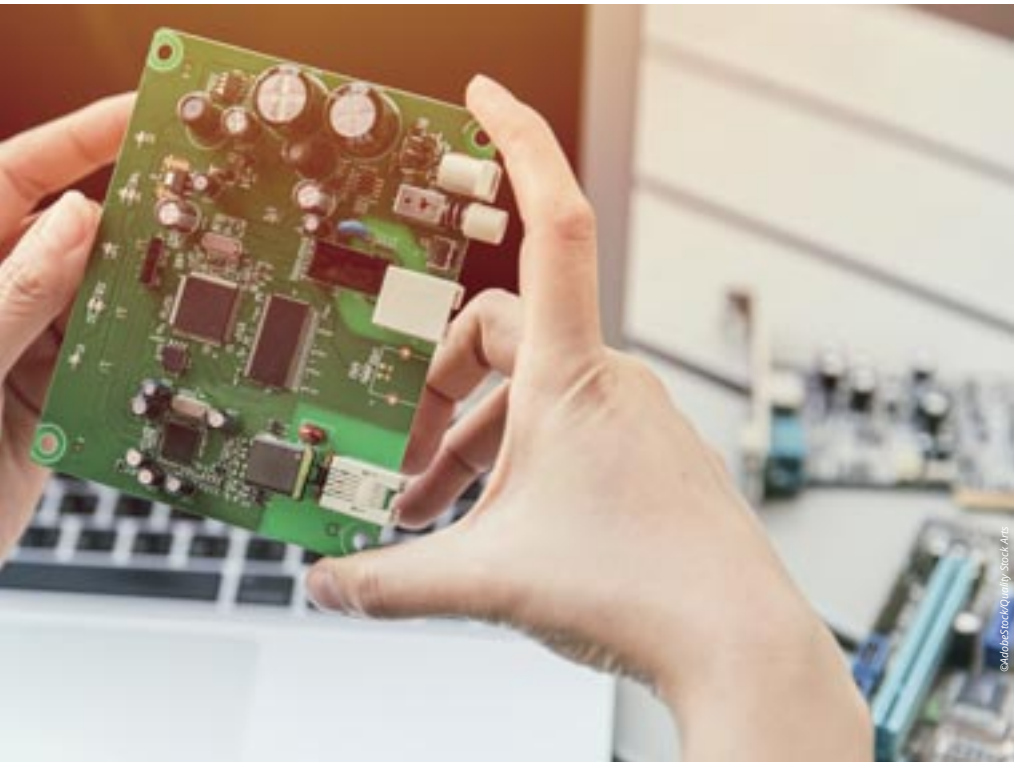
Figure 9 shows the relationship between inductance and frequency.

Selecting a cost-effective and compact inductor

It is simple for a designer to choose a sufficient inductor once they understand the basic meaning behind each parameter in an inductor's datasheet. However, if a designer knows the details behind each parameter, they can choose the optimal inductor for a DC/DC converter application, and predict how the system will perform under different conditions.

Monolithic Power Systems supplies a wide array of power inductors for applications ranging from power supplies to power converters. In particular, the MPL-SE inductor series are semi-shielded inductors covered by an external magnetic epoxy resin to improve magnetic characteristics. The molded inductor series MPL-AY, MPL-AT und MPL-AL offer soft saturation, providing stable behavior at high operating temperatures. These molded inductors feature low DC and AC resistances and can handle high currents. In addition, the molded construction reduces audible noise generated from alternating currents and pulse wave frequencies. Choose the optimal inductor based on the following criteria:

- Choose the low-profile MPL-AT molded series when height is a design restriction.
- Choose the MPL-AY molded series when an application requires a high current capability
- Choose the MPL-AL molded series for high-efficiency applications.
- Monolithic Power Systems inductors and DC/DC power converters provide an easy, complete power solution for your design.



Conclusion

There are a wide variety of inductors on the market for different applications, and it can be difficult to select the optimal inductor. For example, larger-value inductors reduce DC losses an improve efficiency, but they are physically larger and they retain more heat.

Because there is no one-size-fits-all inductor, it is vital to understand each inductor's parameters, as well as the relationships between different parameters. This can help designers determine how an inductor would perform in a particular DC/DC application, and aid in inductor selection when looking at MPS's semi-shielded inductors and molded inductors.

P01

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EMI

Magnetic Solutions for Noise Filtering

Electrical noise or EMI is a frequent challenge for engineers designing high-frequency electronic products and powerline circuits. Although noise problems have been around for a long time, but they have become more acute with the exponential growth in the number of electrical and electronic devices and the increasing importance of wireless communications.

Two main forms of electrical noise include conducted EMI (electrical disturbances produced by inadvertent physical contact of conductors) and radiated EMI, which is caused by inductive coupling between circuit elements in close proximity.

Regardless of its form, EMI interferes with the operation of devices and equipment, often resulting in equipment malfunction, latent or catastrophic failures, and costly downtime on operations at industrial and commercial facilities.

Mitigating electrical noise in modern applications

In contrast to differential mode (DM) disturbances, common mode (CM) noise refers to electrical noise that flows in the same direction in a pair of lines. Some common sources include differences in potential between grounds, stray RF signals, power inverters, and DC switching of motors. Conducted noise in power lines can also interfere with radio and TV reception. Magnetic components such as inductors and chokes can provide EMI filtering in electric circuits. Common-mode chokes are magnetic elements that block high-frequency noise common to two or more data or power lines, while allowing a specified low-frequency DC signal to pass through. Some essential considerations for selecting CM chokes include high power density, high current ratings, as well as a wide range of impedance and inductance values.

These factors all depend on the amount of noise attenuation required, frequency range and current handling specifications. Due to rapid miniaturization and space constraints in modern applications such as IoT devices, wearables, and portable consumer electronics, electronic components must be small enough to fit into component dense PCBs. Thus, CM chokes with small footprints are ideal.

EATON's solutions for common mode filtering

ECM (EATON Common Mode) chokes are suitable for high-performance EMI filtering in various industrial, energy, medical, and consumer applications. Examples include Industrial IoT equipment, motion controls, smart meters, solar/wind generators, charger controllers, diagnostic equipment, remote monitoring, high-tech consumer products and battery-powered devices.

EATON ECM is a new line of common-mode chokes consisting of two families; ECMT and ECMS. ECMS are offered in three families; ECMS1V0704, ECMS1V0905, and ECMS1V1306, while the ECMT products come in three families; ECMT1V17, ECMT1V20, and ECMT1V24. ECMT1V17 and ECMT1V20 are available in both horizontal and vertical configurations.

ECM are offered in several through-hole and surface mounted sizes from 7 to 24mm. EATON ECM provides a complete range of inductance, impedance and current ratings, while delivering high-performance noise filtering in today's high-frequency and power line circuits. Both ECMS and ECMT offer an optimal combination of filtering options, from high-voltage isolation to EMI immunity ideal for a wide range of commercial applications. EATON ECM can perform reliably in -40 to +125°C operating temperatures.

	INDUCTANCE RANGE	RATED CURRENT	RATED VOLTAGE	HI-POT[2]	PIN OUT
ECMT1V1717S	1mH - 85mH	1A - 0.3A	250VAC	1500	7×8mm
ECMT1V1717H[1]					
ECMT1V2023S	2mH - 60mH	1.5A - 0.4A	250VAC	1500	10×13mm
ECMT1V2023H[1]					
ECMT1V2429S	5mH - 30mH	1.4A - 0.6A	250VAC	1500	10×13mm

[1]horizontal type; [2]VAC Coil to Coil, 2s, 5mA

	IMPEDANCE RANGE[3]	RATED CURRENT	RATED VOLTAGE	PACKAGE SIZE[4]	HEIGHT[4]
ECMS1V0704	70Ω - 3kΩ	15A - 0.9A	80VDC	8×6.5mm	3.8mm
ECMS1V0905	300Ω - 2.7kΩ	6A - 2A	80VDC	10×7.5mm	4.8mm
ECMS1V1306	230Ω - 1kΩ	10A - 6A	80VDC	13×11.3mm	6.4mm

[3]typical; [4]max

Benefits

Complete package size offers greater flexibility across a wide range of applications using small and large products reducing board size or adding more power in the same size.

- High current capability, up to 15A
- Suppression of common-mode noise up to 100MHz
- EMI immunity in various applications
- Ideal for noise suppresion over a wide range of frequencies
- Suitable for use in high-voltage signal lines
- Improves application reliability under a wide range of environmental conditions
- Suitable for a wide range of applications

P02

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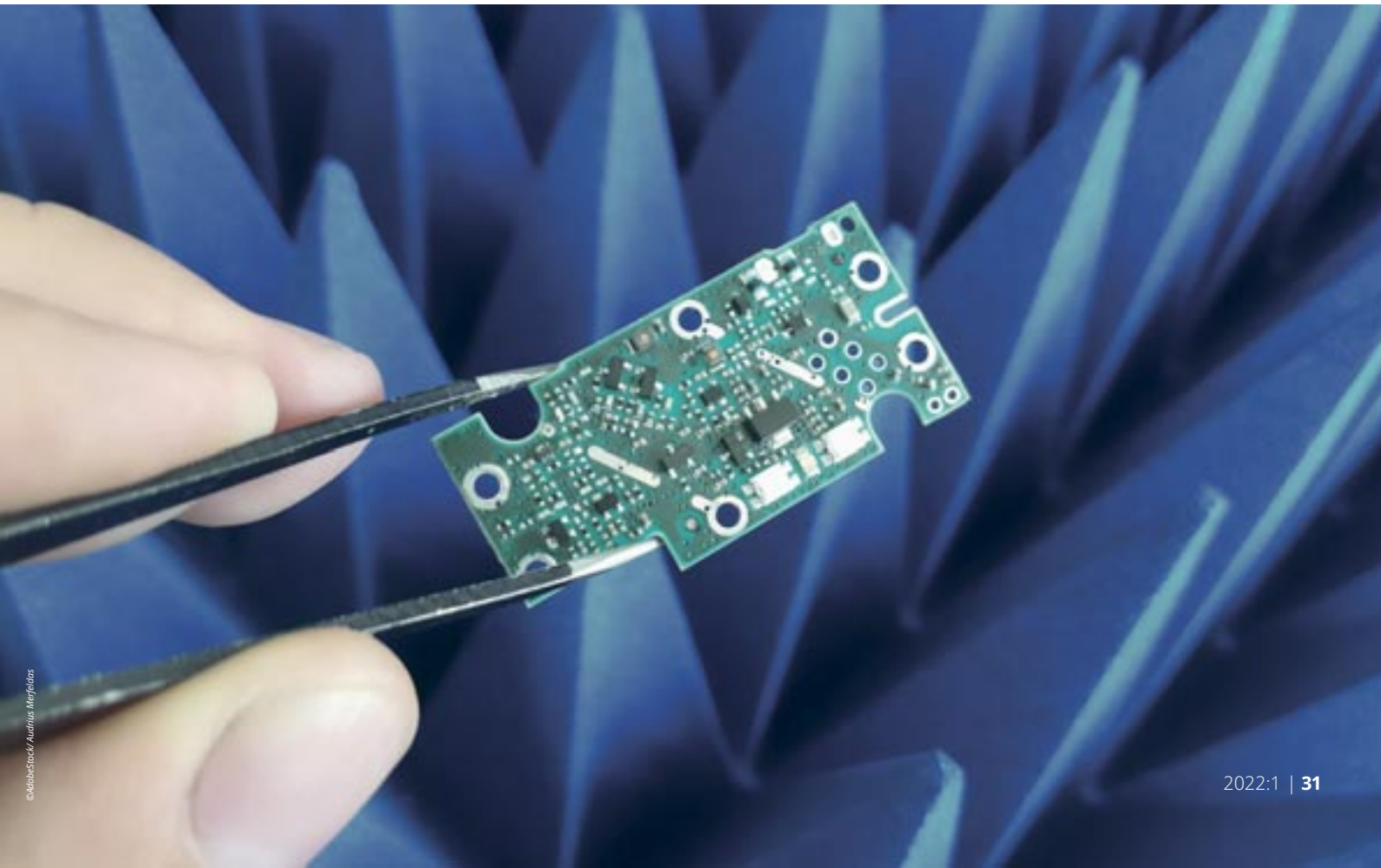

SUPER-CAPACITORS

For Automotive

Using Electric Double Layer Capacitors (EDLCs, Supercaps) instead of or in combination with batteries is an advantageous solution for optimising costs, service life and runtime. They are maintenance free and can achieve a design lifetime of up to 20 years.

In 2021, EATON introduced its first AEC-Q200 certified double layer capacitors. TVA-series is a 3V cylindrical cell with a capacitance range of 25 to 100F, suitable for automotive applications, offering high reliability, low resistance and long life. It is shock and vibration tested according to MIL-STD-202G and UL recognised. TVA can be the sole source for energy storage or used in combination with batteries to meet system requirements. They are adapted from the highly reliable TV family, which has been produced since 2016. Automotive-grade TVAs are ideal for delivering high-density power in modern vehicles (e.g. boardnet stabilisation, electric door locks, e-call and video recorder backup power). The operating temperature is -40 to +65°C, which can be extended to +85°C.

Features & benefits

- 3V operating voltage for high power and high energy
- Stored energy 31.3 to 125mWh
- Ultra low ESR of 11 to 18mΩ for high power density
- Large capacitance of 25 to 100F for high energy density
- AEC-Q200 qualified (meets EATON's internal AEC-Q200 test plan)

VOLTAGE/CAPACITANCE	MAX. DIMENSIONS
3V / 25F	16.5×28.4mm
3V / 35F	16.5×38mm
3V / 60F	18.5×42mm
3V / 100F	18.5×60.5mm

APPLICATIONS

- E-latch: To unlock doors and trunk in case the battery is disconnected
- E-call backup and video recording in case of an accident
- Board net stabilisation:
  To maintain voltage during high current loads
  To backup equipment such as truck trackers, tachographs during ignition off cycles, etc.

For more details, samples or a quotation kindly contact:

P03

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FIRST ON THE MARKET

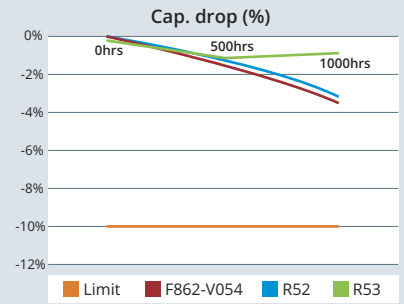
Miniaturised THB Grade IIIB X2 Film Caps

Reducing the overall size of a design by increasing conversion efficiency is a common goal of power electronics designers. One way to achieve this is to use Wide Bandgap (WBG) semiconductor devices.

WBG devices can operate at higher switching frequencies and higher temperatures than traditional semiconductors. Their use enables a reduction in the size of passive components, resulting in a more compact design, and increases the power density per volume of the converters, making miniaturisation mandatory. WBG devices also operate with extremely high voltage slew rates producing more high-frequency emissions. Meeting the electromagnetic compliance (EMC) requirements of regulatory agencies is becoming more and more complex for designs using WBG semiconductors, and electromagnetic interference (EMI) suppression capacitors play a crucial role. They must be miniaturised, to realise the benefits of smaller overall designs, but at the same time must meet high-reliability requirements under critical electrical and environmental conditions.

The KEMET R53 series X2 polypropylene film EMI suppression capacitors are uniquely positioned to meet these demanding requirements. It's a first to market X2 technology in terms of combined THB grade IIIB level, miniaturised dimensions and the highest capacitance value.

KEMET's R53 series offers capacitance values from 0.1µF to 22µF, lead spacing from 15mm to 37.5mm, AEC-Q200 qualification, and long-life stability in harsh environmental conditions. Its volume is on average 60% smaller than competitive X2 class capacitors, enabling a smaller PCB area, reduced weight, lower costs, and improved reliability. R53 is well suited for AC/DC converters in onboard chargers for xEVs, smart grid hardware, EMI filtering in Variable Frequency Drives (VFDs), LED drivers, and high energy density applications such as capacitive power supplies. R53 series exceeds previous solutions and meet the IEC-60384-14 humidity robustness test with a class IIIB classification. R53 achieves 1,000 hours during an accelerated life test under 85°C and 85% relative humidity at its rated AC (310V) and DC (560V) voltages.



Capacitance Change, 100nF pitch 15mm; test conditions 85°C/85% RH/240VAC

Specification

- Rated Voltage: 310VAC 50/60Hz
- Recommended DC Voltage: ≤ 630VDC
- Capacitance Range: 100nF to 22µF
- Pitch of leads: 15 to 37.5mm
- Approvals: ENEC, UL, cUL, CQC
- X2 class (IEC 60384-14)
- THB grade IIIB: 85°C, 85% RH, 1,000 hours at 310 VAC acc. to IEC 60384-14
- THB grade IIIB: 85°C, 85% RH, 1,000 hours at 560 VDC acc. to IEC 60384-14
- Operating Temperature Range: -40 to +110°C
- Low halogen content according to JS709C
- 100% screening factory test at 1,900VDC
- Self-healing properties
- Automotive (AEC-Q200) grade

For more details, a quotation or samples please contact:

P04

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GRADE	TEST CONDITION A	TEST CONDITION B
I	40°C/93% RH 21 days	85°C/85% RH 168 hours
II	40°C/93% RH 56 days	85°C/85% RH 500 hours
III	60°C/93% RH 56 days	85°C/85% RH 1,000 hours

CALCULATING CAPACITOR LIFETIME

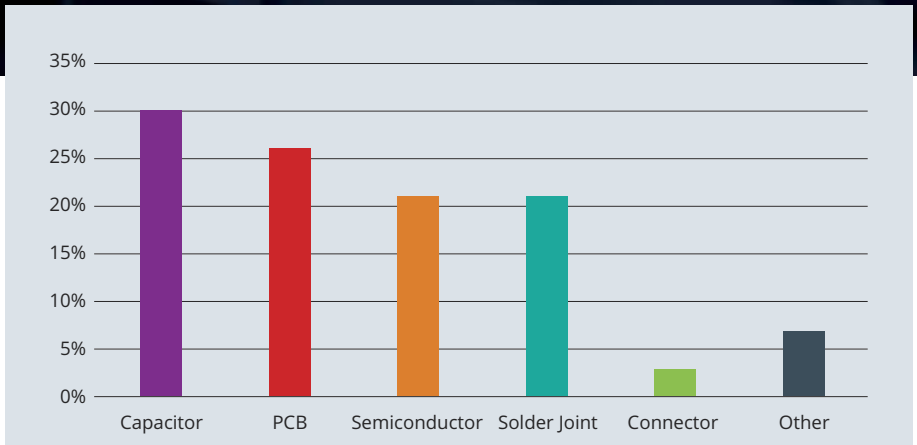


Diagram 1: Error frequency in power electronics

The 1/2021 issue of Impulse provided an overview on the general topic of Electric Vehicle Supply Equipment (EVSE). It specifically focused on the DC link as the key element within the application. The following article will deal with the topic of DC link capacitors, with a particular emphasis on reliability and lifetime extension in EVSE equipment and power electronics.

The reason for taking a more detailed look is that the DC link capacitor is a component with the potential of becoming the greatest source of error in the entire system, due to its strong thermal and electrical load. As shown in diagram 1, the exact error rate here is 30%.

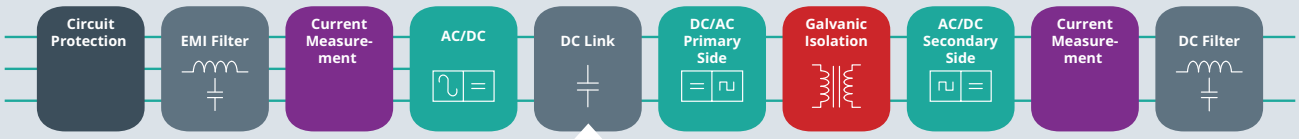
What are DC link capacitors for?

The DC link or the intermediate circuit capacitor decouples the primary side from the secondary side. Illustration 1 shows the basic structure in EVSE. The DC link capacitor block is the fifth from the left, the seventh is the galvanic isolation that separates the primary from the secondary side. The primary and secondary sides are to the left and right of the galvanic isolation.

Since both the primary and the secondary currents are different during operating time, the difference between the currents must be balanced by the DC link capacitor. As a rule, current loads are created by transient processes, such as changes in the speed of an engine.

Determining the lifetime

This is not about the total failure of the product, but about how long the product still remains within tolerance. One should take a critical approach at manufacturers here, since there can be a wide spread in this regard. At RUBYCON, capacitors are specified to allow for a 0% tolerance when determining their lifetime. If we briefly touch upon the issue of temperature influence, one can use the following formula: The lifetime of a capacitor drops by half when the temperature rises by 10K. This simple consideration, however, is not enough.



DC Link: KEMET C4AQ series, PANASONIC EZPV series, RUBYCON VXK series (Snap-in) and BHW series (Radial)

Illustration 1: Basic structure EVSE

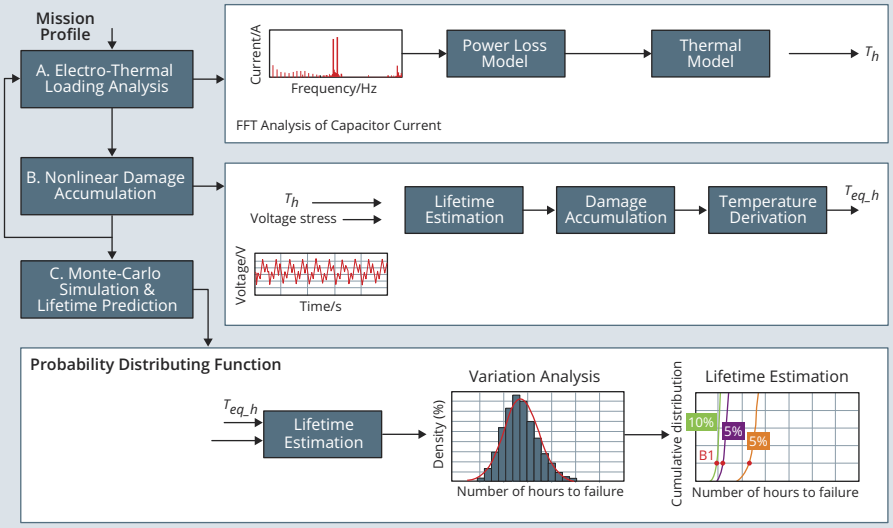


Illustration 2: Process steps for the lifetime calculation

As already mentioned at the beginning, the capacitor is the component with the highest failure rate. We will now take a look at the calculation of the lifetime of a capacitor step by step, and eventually provide all parameters we require to recommend the most suitable component. Developers will want to influence two parameters: the electrothermal lifetime modelling for the dimensioning of their capacitor, and the multi-objective optimisation of the capacitor with regard to costs, size, efficiency, and reliability.

The calculation of the lifetime in turn provides for two possibilities for predicting the lifetime:

- Constant load
- Long-term forecast based on a mission profile

Under conditions of constant operation, a simple model is used, where only the influence of temperature and voltage is included. The formula is as follows:

$$L = L_0 \times \left(\frac{V}{V_0}\right)^{-n} \times \exp\left[\left(\frac{E_a}{K_B}\right)\left(\frac{1}{T} - \frac{1}{T_0}\right)\right]$$

The long-term forecast based on a mission profile can consider significantly more parameters, so as to optimise the design of a capacitor in terms of price and performance. Such a consideration includes parameters that can simulate changing environmental conditions, such as ambient temperature, air humidity (is relevant for film capacitors but not for AL-E types) and vibrations. User behaviour is also taken into account, such as load changes and mains fluctuations. A load change is, for instance, a spontaneous change in the speed of an electric motor.

The last item to be considered here are parameter changes of the capacitor, e.g. the influence of the equivalent series resistance throughout the service life. This is relevant because, as the ESR value rises, the capacitor's temperature rapidly increases, resulting in a deterioration of the estimated lifetime. The process steps are described in Illustration 2, provided here by CODICO.

Which parameters do we need for a complete mission profile?

- Applied voltage
- Humidity profile over time for a film capacitor
- Current over time with a very precise resolution; we will be happy to provide information on how precise the resolution must be. The latter depends on the application, since a motor for a sports car has different requirements than the motor of a sluice gate at a power plant.
- Temperature in or on the compensator: it is possible to build a capacitor containing a temperature sensor so as to obtain precise results already in the prototype phase.

Subsequently, the collected temperature profiles are standardised on the basis of the nominal temperature to achieve comparability and allow for an overall calculation.

As a small inspiration, I would like to refer at this point to an experiment carried out by researchers at the Aalborg University in Denmark. Researchers Haoran Wang and Huai Wang examined a DC link bank consisiting of 3×3 AL-E capacitors, and established that the load distribution in the DC link capacitor surface is uneven. It is evident here that the arrangement of the capacitors has an influence on the load of the individual capacitors, and that these in turn »age« at different speeds, i.e. their lifetime declines. Illustration 3 shows the 3×3 capacitor bank with the same capacitors 470uF/450V. Illustration 4 shows how the capacitors generate less heat through optimised capacitance values.

This is due to an optimised load distribution within the capacitor bank. It must be noted that the arrangement included four 750uF/450V AL-E capacitors, four 620uF/450V AL-E capacitors, and one 390uF/450V capacitor. One must consider whether the increased logistical effort of integrating different capacitors is justified. From a thermal point of view, this definitely results in an improvement without the need for a redesign. Should you have any further questions, please do not hesitate to contact us!

P05

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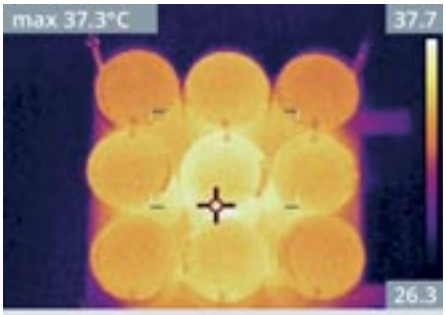


Illustration 3: Same 3x3 capacitors

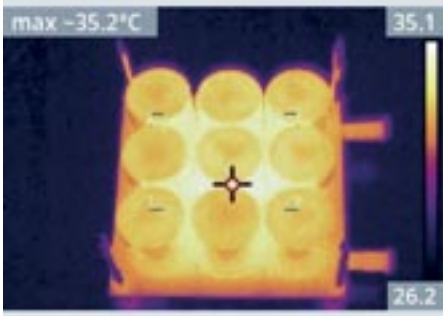


Illustration 4: Load-optimised arrangement of capacitors

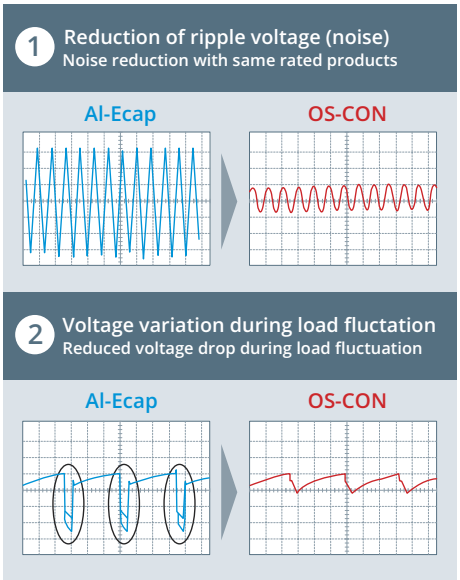
POLYMER CAPACITORS

Why and Where to Use

Panasonic INDUSTRY

Why should you still consider polymer capacitors for your industrial application instead of hybrid caps?

Hybrid capacitors are, of course, a push product due to their great properties, mainly driven by the automotive industry. This leads to a situation we are currently struggling with – availability. As some suppliers are not able to catch up with expanding the production capacities as fast as the demand and orders increase, we recommend considering polymer aluminum solid capacitors, such as OS-CON from PANASONIC In-



dustry, for your application, as a replacement for e-caps and hybrid capacitors. Compared to Al-electrolytic capacitors, the advantages are space savings and a possible reduction in parts count.

PANASONIC's OS-CON family offers a very low ESR of down to 5mΩ, high ripple current capability of up to 7.5A r.m.s. and very long guaranteed life times of up to 20,000hrs @105°C in compact dimensions. The general rule of thumb is »10 times increase of the life time by each 20°C temperature reduction«. So, for example, a 1,000hrs at 125°C specified product has 100,000hrs at 85°C. Another advantage is that the ESR is stable over the temperature range. Especially for low temperatures below zero degrees, OS-CON technology brings advantages related to miniaturization and function due to the still very low ESR. Voltage range extends from 2 to 100V with capacitances of up to 2,700µF. Both THT and SMD versions are available and the rated temperature ranges up to 125°C.

Suitable functions for OS-CON are smoothing in power supply circuits, backup and by-pass capacitor, or LC filter circuits.

Highlights

- 16V/1,000µF/10×12.6mm/12mΩ/5,400mA r.m.s./-55...+105°C/20,000hrs./SMD (SVPT series)
- 16V/47µF/5×4.4mm/25mΩ/3,200mA r.m.s./-55...+105°C/5,000hrs./SMD (SVPG series)
- 16V/330µF/6.3×10.4mm/6.5mΩ/7,500mA r.m.s./-55...+105°C/5,000hrs./SMD (SVPG series)

Key takeaway

- Very low ESR and high ripple current capability in compact dimensions offers miniaturization and possibly part count reduction
- Long guaranteed lifetime, especially in the industrial temperature range
- Best suited for low temperatures below zero degrees due to solid polymer which keeps the ESR almost stable

For more details, a quotation or samples please contact

P06

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APPLICATIONS

- IGBT gate drive capacitor in power supply for motors
- Output filter capacitor of measurement board in smart meters
- In-/Output smoothing capacitor in power supplies generally
- Voltage noise filter capacitor of motor driver for panning at surveillance cameras (using OS-CON keeps a clear image at minus temperatures)

PMLCAP EVOLUTION

Future Snubber Capacitor Solutions

RUBYCON's new PMLCAP »MH series« is a product designed for snubber applications. But what is actually PMLCAP? This product might not be widely known though this capacitor is already used for many applications that require stable characteristics. It is even used (and still working) for seismometers inside NASA's Mars InSight lander, launched in 2018.

PMLCAP is a technology from RUBYCON that consists of a multilayer polymer with a uniform dielectric and no magnetic material. It is a non-polarised capacitor, and the possibility to replace similar »layered capacitors« like MLCC and film capacitors.

PMLCAP advantages

- No piezoelectric effect
- No DC-bias capacitance change
- No electro-distortion and much lower Coulomb force to cause squeal
- No risk of short circuit, smoke or fire due to cracks or PCB bend
- Wide temperature range up to +125°C
- Smaller size and weight: 90% smaller than film caps and 95% less weight than same-size MLCCs
- Very stable capacitance: capacitance change rate within ±5% at -55 to +125°C

In terms of size and electrical specification, PMLCAPs are midway between MLCCs and film capacitors. For the same capacitance, they are ten times smaller compared to metallised film capacitors. MLCCs can be slightly smaller than PMLCAPs. However, PMLCAPs do not have undesirable characteristics like MLCCs, such as DC bias characteristic or piezoelectric effect.

Apart from the size, there is no risk of short-circuit with PMLCAPs due to its self-healing properties. Even if an overvoltage pulse is applied and a short circuit occurs, the current is concentrated on the shorted part. The resulting heat causes the metal electrode to vaporise, thus restoring the insulation.

A challenge for PMLCAPs is the higher voltage. In the past, PMLCAPs were only available up to a voltage of 100V, which was already sufficient for audio applications. However, the technology is also suitable for higher voltages, resulting in large film capacitors being replaced by smaller solutions. As the electronics market requires more and more high voltage and high current capacitors, RUBYCON has accelerated its PMLCAP development to extend the voltage range.

MU series

The existing MU series range was expanded by recently adding 200V availability. This series is currently used in many applications. Even with our customers, this product replaced MLCC or film capacitors thanks to its size and its stable characteristic in applications ranging from stable consumer goods to automotive usage.

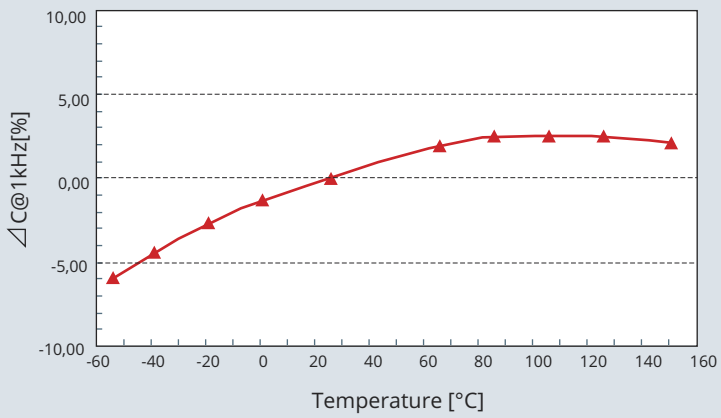
Basic specification of MU series

Temperature range: -55°C to +125°C
Rated voltage: 16~63V, 100V and 200V
Rated capacitance: 100pF to 22F
Size: 1608 (1.6×0.8mm), 5750 (5.7×5.0mm)
Capacitance tolerance: K(±10%) and M(±20%)
Humidity resistant: 40°C, 95% RH, 500 hours

MH series (NEW)

The new MH series is the first series suitable for higher voltages up to 500V. Currently, 250V 1.0µF and 500V 0.22µF are available for wider use. The MH series retains all the PMLCAP advantages mentioned above. By replacing film capacitors, the MH series certainly saves space and reduces the risk of smoke or fire from a short circuit. X7R MLCC may be smaller, but considering the capacitance drain due to DC voltage and the

Picture 1: VMH series size comparison with same spec film capacitor



Picture 2

need to connect multiple MLCC in series or parallel, the space requirement could be larger compared to PMLCAPs.

Basic specification of MH series

Temperature range: -55°C to +125°C
Rated voltage/capacitance: 250V/1.0µF and 500V/0.22µF
Size: 8271 (8.2×7.1×1.8mm)
Voltage proof: 150% of rated voltage (1min)
Insulation resistance: 300MΩ/µF or more
Humidity resistant: 40°C 95% RH 500 hours
Samples and MP: Available on request

Typical applications:
- All snubber circuits
- Industrial inverters (Low and High voltage)
- EV inverters

Next target: Power Film Caps

Of course, RUBYCON's final target is a much higher voltage and higher capacitance. The ultimate objective is to replace the power film capacitors used inside the inverters of electric vehicles. For high voltages with high current applications, big box-size film capacitors are currently used. Since PMLCAP can miniaturise the size of film capacitors, however, if PMLCAP reaches such high voltage in future, size and weight will shrink to 1/10 like a cigarette carton shrinking down to a cigarette pack. Such size and weight can significantly improve your driving efficiency.

Another novelty - Ceramic Packaging

Unfortunately, the weakness of PMLCAPs is humidity. Currently, MS series exist for 85°C and 85% humidity resistance. Unless they are hermetically sealed, they still need to consider moisture environments.

Now RUBYCON has come up with a new idea of PMLCAP hermetic sealing, i.e. to seal the whole PMLCAP with a ceramic package, like crystal oscillators. With this packaging, PMLCAPs become ultra-stable. The temperature characteristic of capacitance will be less than ±5% (See Picture 2). It actually increases the capacitance value in higher temperature ranges. Of course, de-rating for DC-bias is not a necessity.

Size is still a question: currently, 3.2×2.5mm (3225 size) is available because this size is the usual size for ceramic packages used in crystal products. Depending on the customers' requirements, bigger sizes are also being considered.

Basic specification

Temperature range: -55°C to +175°C
Rated voltage/capacitance: 10V/0.47µF and 63V/1000pF
Capacitance tolerance: J (±5%)
Size: 3225 (3.2×2.5×1.8mm)
Humidity resistant: 40°C 95% RH 500 hours
No de-rating needed
Samples: Available

Your inputs are very welcome

PMLCAPs are already widely used in certain markets, especially for audio applications. As described in the above introduction, however, there is much greater potential behind PMLCAPs. This will depend on your capacitor requirements. RUBYCON is always willing to provide samples for your new project.

Even for the purposes of new product research, RUBYCON always welcomes input from customers. MH series is only at the start, and has the potential to replace today's snubber capacitors.

Remember the following advantages of the MH series:

- Eliminates short-circuit risks
- 1/10 size compared to same-spec film capacitors
- Low ESL, suitable for high frequency usage

If you are interested in receiving specifications and samples for any products in this article, please ask your nearest CODICO contact, or send me an e-mail. We are looking forward to your inquiries and inputs.

P07

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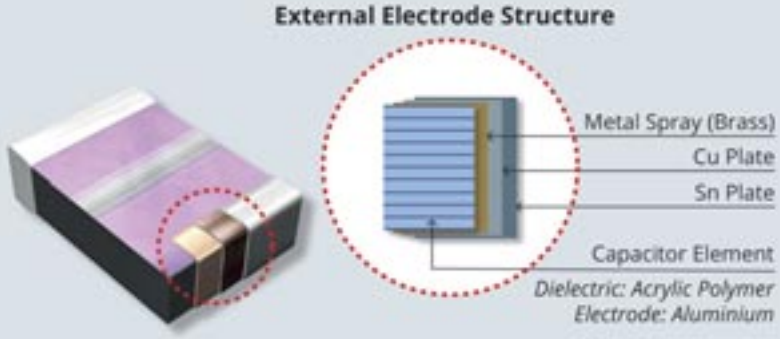


Picture 3: Structure of MH series

Source: RUBYCON

BEST SOUND

DSO531SHH: Best Phase Noise Reduction, Best Audio Sound!

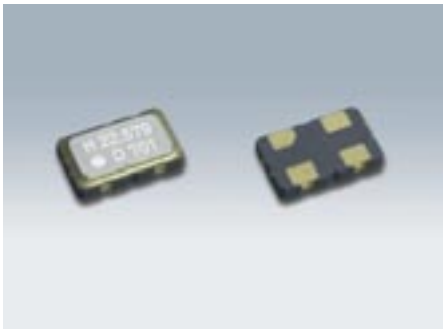
KDS DSO531SHH is an ultra-low phase noise SPXO developed and widely used in audio DACs. We will introduce this product with an explanation of why phase noise is so important for oscillators.

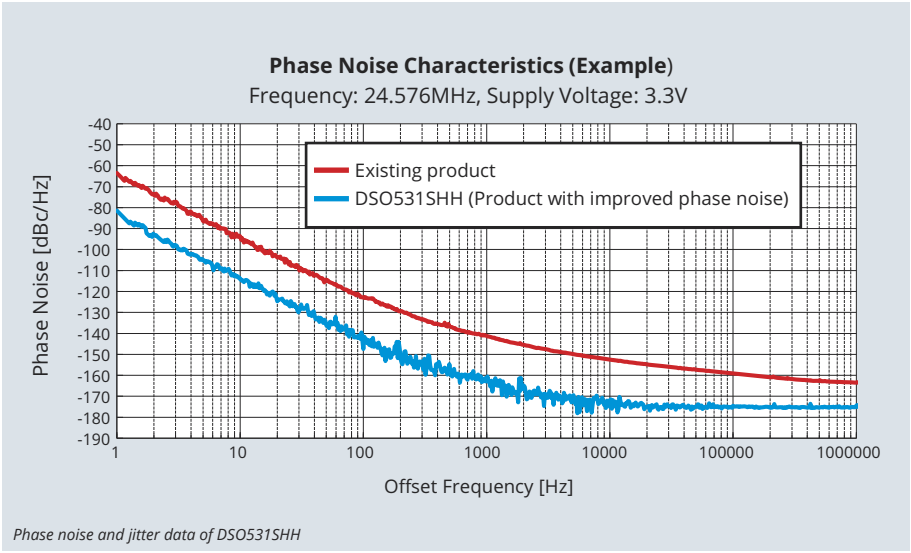
In audio electronics applications, it's not so difficult to perceive differences in quality. If you change the speakers or headphones and listen very carefully, you will most probably feel the difference in the sound. Yet this does not only happen with a change of the complete hardware. Even simple passive electronic components inside the hardware like capacitors, inductors, resistors, switches, etc. can have an impact on your audio sound. The quality of these components might not directly improve the sound. Good quality components, however, will certainly allow you to understand the sound that audio designers had intended.

The crystal is one of the passive components which strongly affects audio quality. It is used as the clock source of many microcontrollers, though the most effective one is that of the digital-analogue converter (DAC). To convert digital to analogue data (sound), you need an accurate timing (clock) signal coming from the crystal. Though we simply refer to them as »crystals«, there are various types and brands to choose from. Well-known product types are OCXOs or atomic clocks used in ultra-high-end audio equipment.

These products have a very accurate frequency tolerance at ppb level. TCXOs and simple package crystal oscillators (SPXOs) with tolerances at ppm level are also used to convert digital music data into beautiful sound.

Better frequency tolerance means you can get the clock frequency very close to the one you exactly aim for. Frequency tolerance thus affects





Phase noise and jitter data of DSO531SHH

ITEM	UNIT	DSO531SHH Product with improved phase noise	EXISTING PRODUCT	IMPROVEMENT	CONDITION
Phase Noise	dBc/Hz	-77.9	-63.7	**-14.2**	Offset: 1Hz
		-111.5	-92.2	**-11.3**	Offset: 10
		-141.9	-123.3	**-15.1**	Offset: 100
		-159.2	-140.2	**-18.7**	Offset: 1,000
		-182	-151.4	**-21.2**	Offset: 10,000
		-175.2	-158.6	**-13.6**	Offset: 100,000
		-175.3	-162.9	**-7.7**	Offset: 1,000,000
Phase Jitter	ps	0.07	0.27	**-0.2**	BW: 12k～5MHz

audio quality: converting 44.100Hz digital audio data with a 44.000Hz clock will result in some data losses and errors. This only shows how you convert data files, but audio sound data changes with time, so each moment of each sound becomes one single data. Therefore, we need »short-term« stability to support conversion.

In a manner of speaking, frequency and tolerance are like »long-term« stability. But then what is »short-term« stability?

Phase noise importance

»Short-term« stability is often defined as phase noise or jitter, i.e. crystal oscillation is not perfectly stable. Even within one second, each wavelength cycle inside a frequency differs slightly. The tolerance of this cycle is called jitter, using time units like nano/pico/femto seconds. Jitter defines the discrepancy from the ideal cycle. However, measuring jitter exactly in terms of time is difficult, so often phase noise is first measured and then referred to as index to show this »short-term« stability. So what is the key determinant for a better phase noise for crystal oscillators?

There are 3 parameters:

- Better Q-factor of the crystal blank
- Higher signal level
- Lower noise performance of the oscillation circuit

The Q-factor plays the most important role here. An improvement of the overall phase noise behaviour can best be achieved by reducing the phase noise near the carrier frequency. The Q-factor is related to this phase noise near the carrier frequency, so a crystal blank with a better Q-factor will lead to a reduction in phase noise.

The blank's Q-factor depends on the quality of the synthetic quartz crystal. Furthermore, it depends on the crystal seeds which are the base for growing synthetic quartz. KDS is one of the few suppliers who operate their own autoclaves to grow synthetic quartz crystal.

Over time, KDS has been improving Q-factor crystals and produces the best quality seeds to create high Q-factor crystal blanks.

A higher signal level also helps to reduce phase noise due to the simple S/N ratio. Yet each crystal blank has a drive-level limitation: If you input too high power, the crystal will exceed its frequency tolerance and presents the risk of a different oscillation mode. Therefore, you always need to achieve a balance between higher signal and the crystal's drive level limitation.

Nevertheless, the crystal is only one component inside the application. The entire electronic circuit design, including the crystal oscillation circuit, will affect the total phase noise. To maintain a better phase noise, KDS recommends the following points from a supplier point of view:

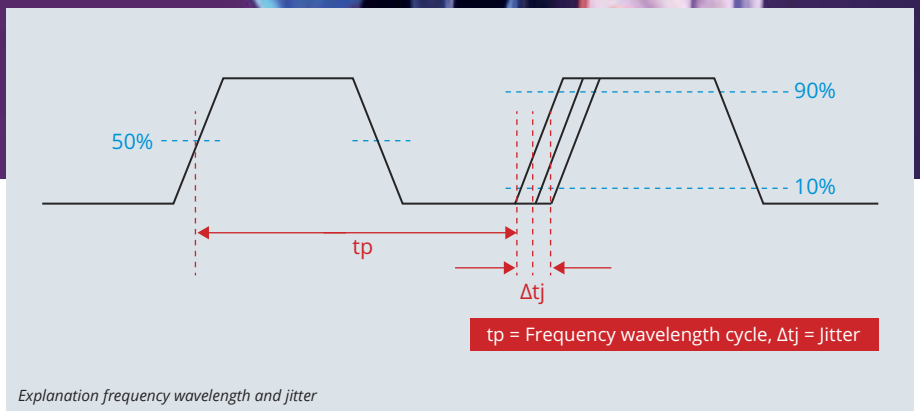
- Secure a high Q-factor of the oscillation circuit. The total Q-factor of the oscillation loop is related to the crystal's Q-factor and ohmic losses in the oscillation circuit.
- Higher signal level within the crystal drive level allowance: The higher the signal level, the more favourable the noise characteristics. Yet the crystal must be used within drive level allowance.
- Frequency multiplication using a PLL circuit will cause a degradation of phase noise.
- Minimise noise from other components and select the components that have low noise figure (NF) and flicker (1/f) corner frequency to minimise thermal noise, shot noise, and flicker (1/f) noise from the semiconductor.
- If necessary, place a bypass capacitor in close distance to the power supply and GND to restrict noise.

Introduction: DSO531SHH

KDS DSO531SHH was developed for the audio market with a focus on excellent noise performance. The oscillation circuit layout inside this oscillator was designed to cause less noise. Moreover, the IC used inside the oscillator was optimised with regard to crystal parameters for oscillation level and negative resistance. This innovative approach has reduced phase noise level dramatically by 10 to 20dB, even compared to currently low phase noise models. RMS jitter was reduced approximately to 1/3 by reviewing the circuit design. These design reviews have contributed to excellent sound quality improvements in digital audio equipment.

This large 5.0×3.2mm (5032 size) ceramic package also has an impact. Compared to major packages like 3.2×2.5mm (3225 size) and 2.0×1.6mm

Grown synthetic quartz crystal at the KDS Nishiwaki factory



Explanation frequency wavelength and jitter

(2016 size), signal effects caused by thermal fluctuation and mechanical vibration were improved. In addition, a bigger cavity inside the package renders the crystal design more flexible to prevent deterioration of phase noise close to high-drive. As a result, one gets stable characteristics throughout the entire audio band.

The available frequency of DSO531SHH ranges from 20MHz to 50MHz. Major frequencies like 22.5792MHz (for audio 44.1kHz) and 24.576MHz (for video 48kHz) are already widely used. Higher frequencies like 45.1584MHz and 49.152MHz are being developed as well. Frequencies over 50MHz like 90.3168MHz and 98.304MHz are not available, though they will be covered with the smaller type DSO321SHH currently under development.

CODICO has many solutions

CODICO offers a wide range of crystal solutions for audio applications. The tolerance levels of DSO531SHH and DSO321SHH are ±25...50ppm, corresponding to standard crystal oscillators. For tighter tolerance items, we offer other products such as TCXOs and OCXOs.

If you are interested in any of the above products, don't hesitate to contact us. CODICO can recommend several products that match your requirements.

P08

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DSO531SHH Electrical Specification

ITEM	UNIT	SPECIFICATION
Output Frequency Range	MHz	20 to 50
Frequency Stability	x 10^{-6}	±50 / -40 to +85°C
		±30 / -20 to +70°C
Supply Voltage	V	+1.8 to 3.3
Current Consumption	mA	+2.7 / Vcc=1.8V
		+7.7 / Vcc=3.3V
Symmetry	%	45 to 55
Output Waveform		CMOS
0 Level Output Voltage /1 Level Output Voltage		0.1 Vcc / 0.9 Vcc
Load Condition	pF	15 max.
Phase Noise (Output Frequency: 24.576MHz)	dBc/Hz	-160 typ. / Vcc=3.3V , Offset 1kHz
		-172 typ. / Vcc=3.3V , Offset 100kHz
		-158 typ. / Vcc=1.8V , Offset 1kHz
		-166 typ. / Vcc=1.8V , Offset 100kHz
Output Control		Enable / Disable Control (3-state)

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GREEN ENERGY

New Relay Generation Series 117

APPLICATIONS

- Charging devices for electric vehicles such as wallboxes, mobile car charging boxes, on-board chargers
- Use in photovoltaic inverters
- Industry & building management applications

CODICO's relay partner SONG CHUAN introduces the new 117L series: a high-performance, space-saving single-pole relay with normally N/O contact and a contactgap of ≥2mm. Small size means a space requirement of only 34×19mm on the PCB, yet the 117L is capable of carrying 55A at 105°C and 66A at 85°C.

SONG CHUAN is continuously working on new innovative relays for high-quality applications. Several years ago, SONG CHUAN decided to focus on the development of relays for green energy applications. Special design measures were taken to achieve high shock and vibration resistance. This feature makes the 117 series perfect for use in charging equipment. Thus, the 117L is ideally suited for mobile car charging boxes – casually called »charging cables« – but it is also ideally suited for use in the on-board charger (OBC unit) installed in the electric vehicle. Here it is used for phase detection and safe disconnection. High inrush currents of up to 230A according to IEC 62752-2016 – charging cable-integrated control and protection device for charging mode 2 of electric road vehicles (IC-CPD) – make the 117L interesting not only for electric vehicle charging equipment, but also for a variety of other industrial applications. The relay is UL/CUL and TÜV approved, it is RoHS compliant and due to its high temperature resistance up to max. 105°C ambient temperature, it is ideally suited for use under harsh environmental conditions.

SONG CHUAN always listens to market and customer requirements, which is why further variants such as coil systems with lower energy consumption or relays with higher switching capacity are planned.

For further information please contact

P09

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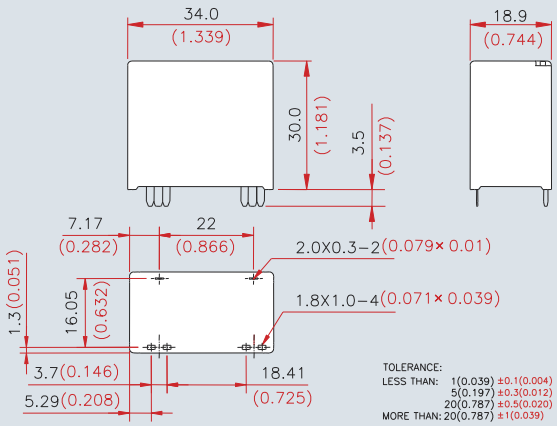
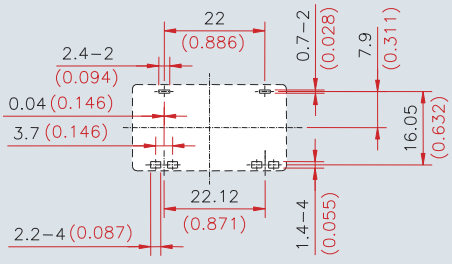
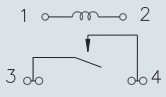
Outline Dimensions



PC Board Layout (Bottom view)



Wiring Diagram (Bottom view)



Industrial Market: ComboLock®

For demanding applications requiring secure internal wire to board connections, typically between internal circuit boards for Power, Control and Communication.

The compact design of the AMPHENOL ComboLock® Wire-to-Board connector meets the growing demand of miniaturisation thanks to this hybrid connector which integrates signal and power current into one connection system.

ComboLock® allows simpler assembly and cable management. The connector system offers a hybrid 1.00mm pitch signal and 3.00mm pitch power configuration with an active latching feature for secure mating retention.

The connector has nominal current carrying capacity of 10A/pin max. for power and 1.5A/pin max. for signal. Power wire sizes range from 26AWG to 18AWG and for signal wire sizes from 30AWG to 24AWG. ComboLock® is available from 5 to 9 positions for signal and 2 to 8 positions for power in vertical and right-angle configurations with surface mount termination.

- Positive locking system for secure mating retention
- Power and signal in one connector
- Compact design for space constraint applications

The ComboLock® is ideal for the industrial market.

S01

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The Hybrid & Medium Power Solution

ComboStak & PowerStak

Amphenol
COMMUNICATIONS SOLUTIONS

AMPHENOL's ComboStak® and PowerStak® are compact, hybrid (signal and power) and power board-to-board connectors. Both series provide high signal and current density with a wide range of stack heights.

ComboStak® combines existing, BergStak® 0.8mm pitch signal pins with 2.00mm pitch power blades. It is a symmetrical board-to-board connector with an even number of power contacts at both ends of the connector and signal contacts in between.

PCIe® M.2 Gen 5 Card Edge Connectors

High density, high performance, high speed: 32GB/s with 67 contacts on a 0.5mm pitch!

AMPHENOL's PCIe® M.2 Gen 5 Connectors provide 67 contacts on 0.50mm pitch. It occupies less board space, offers more connector height options and supports higher data rates compared to PCIe® Mini Card connector. It is designed for PCIe® Gen 5, making it suitable for tablets, laptops and low profile storage and server applications. PCIe® M.2 connectors also support higher data rate transmission with both single and double-sided modules.

- Various connector height and keying options
- Accepts angled insertion of add-in module cards
- Provides both right angle and vertical orientation for M.2 Connectors. Right angle option is available, the design of vertical option is ongoing.

S03

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FEATURES

- High current carrying capacity with miniaturised shape to save space and cost
- Up to 20A per power blade
- 2 to 10 power blades on 2.0mm pitch
- 6 to 140 signal pins on 0.8mm pitch
- Reliable 4 contact point power contact design
- Signal speed is up to 12Gb/s
- 5 to 20mm stack heights (1.0mm increments)
- Self-alignment for blind mating
- Meets USCAR-2 V2 Shock & Vibration

PowerStak® is a compact, space saving power version with a 4 point contact system to support current ratings up to 20A/pin.

Both connector series are with high temperature LCP material in order to support operating temperatures up to 125°C. It supports secure blind mating and automatic assembly due to the scoop proof housing with ±0.9mm misalignment tolerance.

ComboStak® and PowerStak® are ideal for applications in Mobile Networks, Datacenter, Industrial and Automotive.

S02

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USB4

Universal Serial Bus (USB) is one of the most popular interconnect standards. Ease of use along with its rapid evolution to meet the ever-increasing data, speed and power delivery requirements are the reasons that created an undeniable position for USBs among other input output connectors.

From a pen drive you plug into your laptop to sophisticated data center requirements, to high-speed devices that support modern infotainment in a smart car to rugged USBs that can withstand the harshest of conditions on an industrial floor, USB connectors are used everywhere.

With the advent of compact reversible USB Type-C connectors, its popularity gained further momentum. It is today widely used in sleek tablets, smartphones and other advanced portable devices. To meet the most advanced application requirements that demand exceptional data and speed performance, USB has released a new protocol that meets enhanced data transmission rates at shorter intervals - the USB4. This new technology combines Thunderbolt™ protocol specifications with the earlier architectures like USB 3.2 and 2.0 marking the next generation performance of USB devices.

Key features of USB4 connectors

USB4 supports multiple data and display protocols while simultaneously doubling the maximum aggregate bandwidth. This new architecture allows optimal data transfer by dynamically differentiating multiple end devices. USB4 leverages on the Type-C interface, which is already in use as the external display port in many devices, so as to allow the host to scale up on display related data allocations.

This new protocol is also backward compatible with its predecessors like USB 3.2, USB 2.0, and Thunderbolt 3, helping each other to make use of the maximum capacity of both the connected devices. This new specification supports two-lane operation and doubles the bandwidth to improve performance over USB Type-C cable and is offered in both 20Gb/s and 40Gb/s transfer speeds.

AMPHENOL USB4 connector range

Meeting all the USB4 specifications, AMPHENOL's USB4 Gen3 Type-C connectors are compatible with Thunderbolt 4 and have a high-speed data transmission rate of up to 40Gb/s. Designed with excellent copper alloy, the terminals provide high power delivery of up to 100W and an extended 5A current rating. The USB4 Type-C connectors feature power charging, tunneling USB, PCIe® data transfer, and DP video and audio capability

in a single Type-C connector. The USB Type-C interface is retained for enhanced user experience with reversible plug and cable orientation making it an ideal choice for emerging applications. USB4 Gen 3 Type-C connector supports DisplayPort protocol to drive multiple 4K UHD at 60Hz. They are also backward compatible which means all-in-one simplicity between device connections.

AMPHENOL's USB4 Type-C is structurally efficient and features a middle plate with an enhanced wiggle-free sidewall, which maximises the contact area and stabilises contact performance, as well as minimises the possibility of signal intermittence and that of wear and tear. The extended side-wall plate at the corner of the tongue protects it from damage caused by inserting a non-Type-C plug like a Micro USB. The grounding sidewall provides better EMI protection and the added dimple at the inner shield ensures a perfect plug-in position.

These high-speed USB connectors are ideal for applications in Storage, Notebook (Laptops), Tablet, Docking, Peripherals (Monitor/Display, Projector), Automotive Infotainment, and Home Entertainment.

S04

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Discover the One Action Lock

HIROSE introduces the FH72 series of flat printed circuit connectors (FPC) for industrial applications: 0.3mm Pitch, One Action Lock, Top Contact, FPC Connector

A unique one action lock allows a FPC to be inserted into the connector without opening the actuator. This can be done with one hand or by automated machinery to save valuable assembly time and reduce mating failure.

Furthermore, the FPC is easy to insert into the connector due to the wide entry point. High retention FPC force is achieved by the robust locking mechanism. This firmly retains the tabbed FPC into position to secure mating. The correct placement of the FPC can be visually inspected through small openings in the top surface of the connector.

The FH72 series is designed with an integral molding structure that has no gaps to prevent solder wicking. The small pitch of 0.3mm saves space on the board, which is ideal for smaller applications. Ideal applications are wearable devices, smart home applications, medical devices and others.

Key features

- Number of contacts: 11, 15, 21, 31
- Pitch: 0.3mm
- Height: 0.9mm
- Rated current: 0.2A
- Operating temperature: -55 to +85°C
- Voltage rating: AC/DC 30V

S05

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DP SERIES

Terminal Blocks Effectively Solve Various Wiring Problems

Has the use of industrial equipment in the age of Industry 4.0 kept pace with the rapid development of industrial automation?

The deployment of industrial equipment still requires a lot of manual labour, e.g. assemblers, electricians, wiring workers and welders. Due to the increase in automation, the shortage of skilled labour and the rise in labour costs, the following three major challenges arise:

- Wiring is becoming more and more complex and the difficulty of wiring continues to increase
- Too many devices in a limited space
- Unstable quality results in potential equipment damage

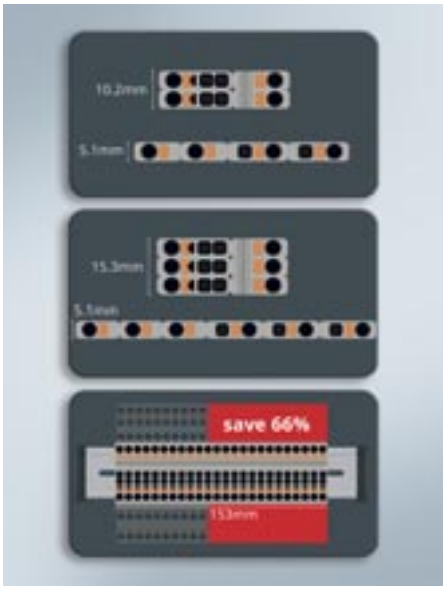
DINKLE's DP series is the perfect solution to these three challenges:

Push-In Design makes wiring easier

DINKLE's DP series fully adopts Push-In Design. Solid wire and wires with ferrule can be inserted directly without any tools, which improves the installation efficiency by more than 50% and dramatically reduces wiring time and labor costs.

Multilayer terminal block design to maximise space utilization

One double potential layer terminal block can replace two single-layer potential terminal blocks, saving 50% space. One terminal block with a three-layer potential layer can replace three pieces of terminal block with a single-layer potential layer. The DINKLE DP series can have up to 6 touchpoints, which can save up to 66% of space.



International safety standard certification

DINKLE has been constantly developing products with higher standards than the industry requests. The DP series has obtained professional certifications such as UL, VDE, RoHS, TÜV, CSA, ATEX. It adopts PA66 and high-standard insulating materials to achieve the highest flame retardant grade UL94 V0 to ensure continuously stable operation in extreme environments ranging from -40 to +120°C.

S06

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HIGH LEVEL

HIROSE CX Series – USB Type C Connectors

The CX series connector conforms to the next-generation USB standard Type-C™. It is expected to be widely adopted as a standard interface in various devices in the consumer, industrial machinery & automobile market.

This compact sized USB connector features reversible insertion, speeds up to 10Gbps transmission. Quick charge is possible by applying USB Power Delivery (PD).

Developing Type-C receptacles to meet diversified needs

HIROSE Electric has developed a new addition to the CX Series of Type-C connectors, CX90BW-16P, a 16-position top-mount receptacle supporting IPX4 and CX90W6-16P with IPX8 performance.

The USB Type-C connector, with a rotationally symmetrical design that can be inserted without worrying about contact direction, has become increasingly popular and is used in a variety of applications. As a result, specification requirements, including waterproof performance, durability and demands for 16 pin variations, are diversifying. To meet these needs, HIROSE has developed two types of Type-C receptacles with a waterproof level so that it can be used safely even in environments with exposure to water splashing. The CX90BW-16P is a top-mount receptacle – a connector soldered to the top side of the PCB. The CX90MW6-16P is a mid-mount type that fits in a hole cut in the board. Since it does not take up space for mounting, it contributes to the height reduction of equipment. In addition, the unique design of the internal parts enables a high PCB retention force. Retention force can be further enhanced by screwing the connector to the board after mounting using the screw holes in the shell.

	CX90BW-16P	CX90MW6-16P
Board Mounting Style	Top-Mount	Mid-Mount
No. of Pos.	16 pos.	16 pos.
Waterproof	IPX4	IPX8
Heat Resistance	105°C	105°C
Quick Charging	✔ (6A)	✔ (6A)
Transmission Rate	USB2.0 (480Mbps)	USB2.0 (480Mbps)

Both the CX90BW-16P and the CX90MW6-16P have a high heat resistance of 105°C and a high current capacity of 6A for quick charging.

Suitable applications are factory automation controllers, servo amplifiers, industrial robotics, servers, programmable logic controllers, security systems and many more.

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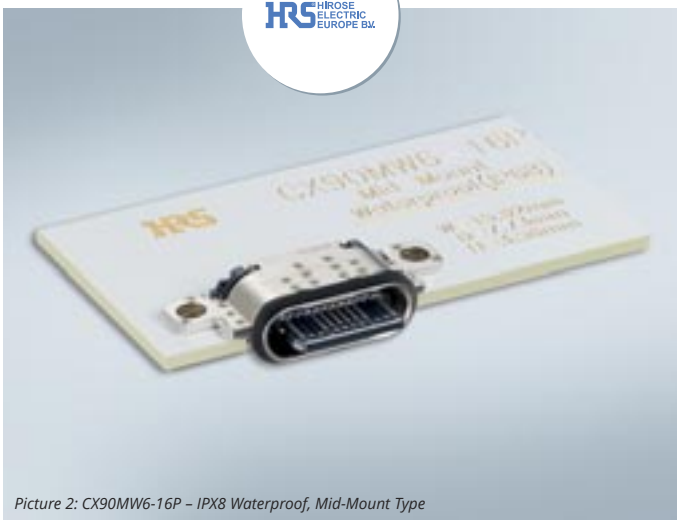
Picture 1: CX90BW-16P – IPX4 Waterproof, Top-Mount Type



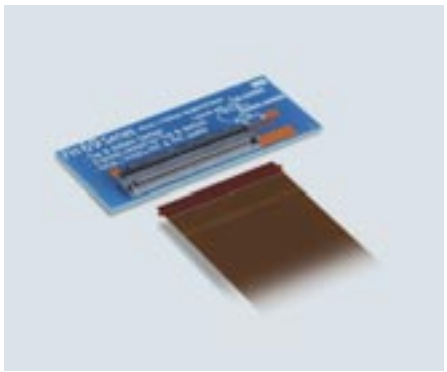
Picture 2: CX90MW6-16P – IPX8 Waterproof, Mid-Mount Type

TOP & BOTTOM CONTACT

Back Flip FPC/FFC Connector for Automotive

Highly reliable connector ideal for car infotainment & sensor connection.

The number of indicators and displays installed in vehicles is constantly increasing as more and more electronic systems are installed in vehicles and the transition to digital cockpits takes place. As a result, multifunctional connectors are required. FPC/FFC are generally used for the internal connection of displays. In order to meet the board layout restrictions resulting from the increased number of installed displays, connectors that are resistant to upward FPC/FFC routing are required.



In addition, products with both top and bottom contacts that can be connected regardless of contact direction are sought after when using general displays equipped with single-sided FPC/FFC.

Furthermore, in applications that are closely involved with automated driving, connectors for internal connections are required to have high automotive quality, such as 125°C high heat resistance, high vibration resistance, and dust intrusion prevention, in order to improve electrical connection reliability.

To meet all these needs HIROSE launched their FH69 series, a back flip FPC/FFC connector with automotive quality and the industry's first top and bottom independent two-point contact design. By having contacts on both the top and bottom, there are no restrictions on the FPC/FFC contact direction, eliminating the need to use multiple connectors, allowing for flexible board design, and reducing component management.

The two-point contact design with independent spring properties ensures high contact reliability. Even if dust gets caught in one contact point, the other contacts remain connected.

Furthermore, the back flip design prevents unexpected actuator opening due to upward FPC/FFC routing stress.

The newly developed FH69 Series was released with 60pos. Development of the below pin count variations is planned.

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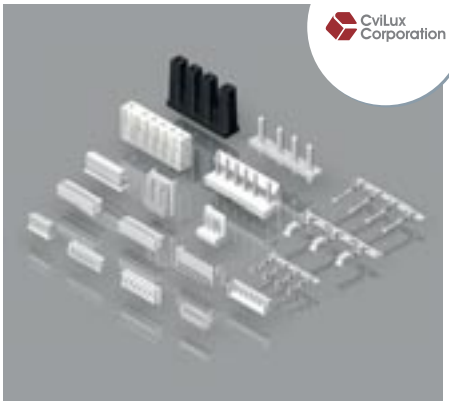
CLEVER WIRE-TO-BOARD SOLUTIONS

CVILUX's extensive product portfolio in the field of wire-to-board connectors has a lot to offer.



CVILUX offers a variety of different configurations for pitch sizes from 0.60 to 5.08mm. Pin counts and cross-section ranges go from 2-60 poles or AWG18-34, depending on the series. The optimal solution can be found for almost any application:

- PCB headers and housings in various pitches starting at 0.6 mm
- Available with standard delivery time
- Vertical and horizontal configurations
- Single and double row designs
- Interchangeable with existing market standards

CVILUX is certified according to ISO9001, ISO14001 and IATF16949. We will be happy to assist you in selecting a suitable solution.

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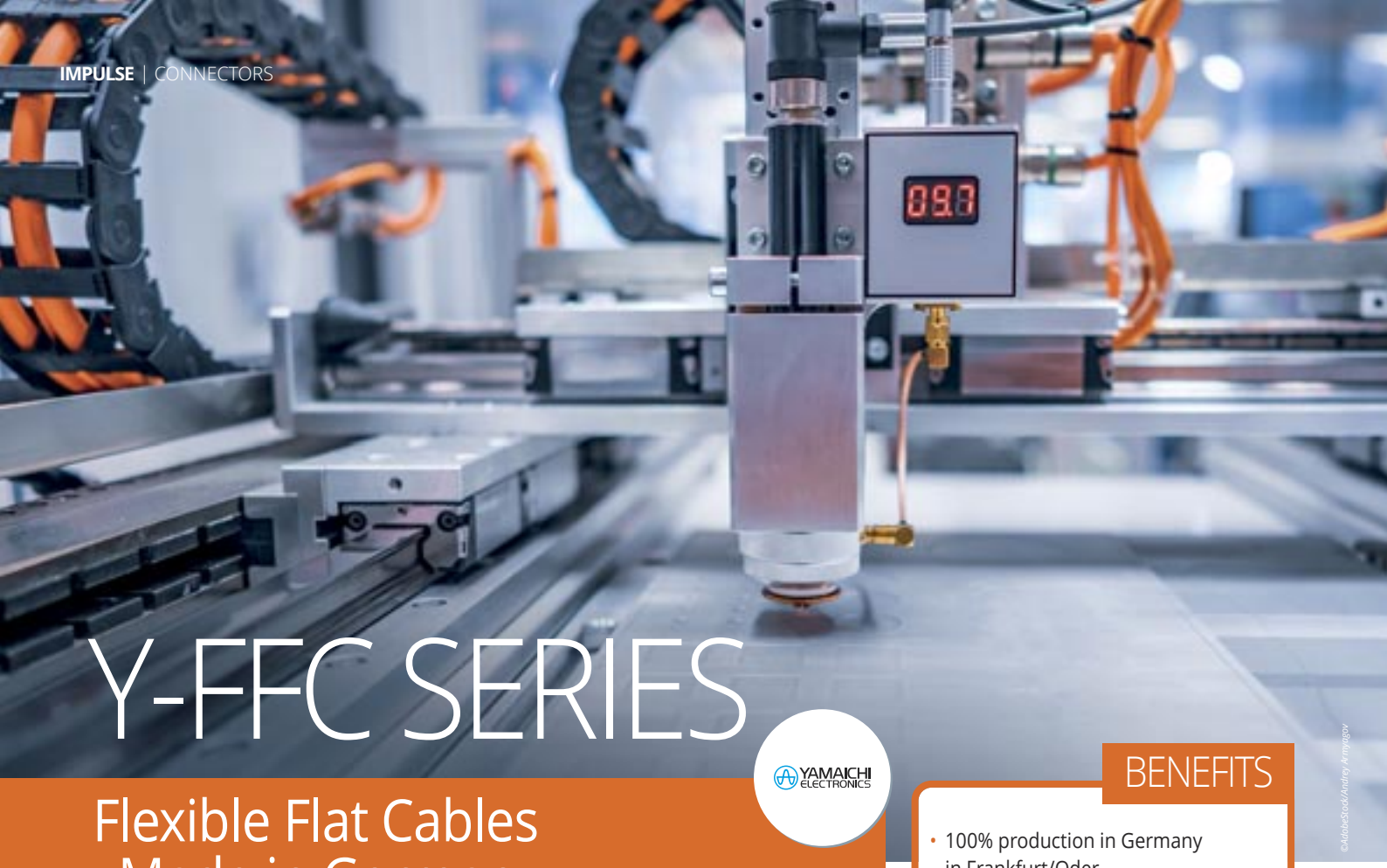
	CI44	CI15	CI01
Pitch	1.25mm	1.50mm	2.00mm
Pin Count	2-16 (single row)	2-15 (single row)	2-16 (single row) 6-34 (dual row)
Current	1A	1A	2A (single row) 3A (dual row)
Voltage	250V AC for 1 minute	50V AC	800V/500V AC for 1 minute (single row/dual row)
Operating Temperature	-40 to +85°C	-25 to +85°C	-25 to +105°C
Wire Size	AWG 28-32	AWG 26-32	AWG 22-30
			



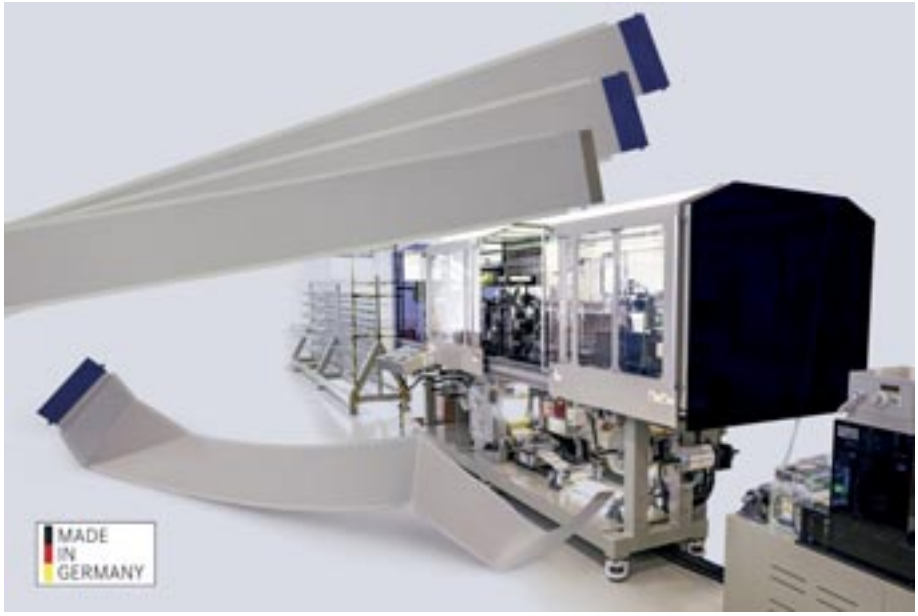
Y-FFC SERIES

Flexible Flat Cables »Made in Germany«

YAMAICHI ELECTRONICS

YAMAICHI Electronics now also offers FFC from its own production in Frankfurt/Oder. Series production has already started.

YAMAICHI is primarily known as supplier of a wide range of connectors and test contactors. The extensive product portfolio also includes board-to-cable connections, such as the Y-Lock system or non-ZIF connector series. The cable side to be used – i.e. a flexible flat cable (FFC) – has been purchased by the customer from other manufacturers. In order to be able to respond even better to special customer requirements and to be able to offer a complete system of connectors and cables, YAMAICHI has decided to introduce its own FFC series, the Y-FFC.



BENEFITS

- 100% production in Germany in Frankfurt/Oder
- Customised production, e.g. with shielding, folding etc.
- Available as complete system with FFC connectors from YAMAICHI or others
- Short delivery times

The location of the in-house FFC production is the YAMAICHI production in Frankfurt/Oder, where up to now e.g. cable assemblies or test contactors, as well as the industrial circular connectors Y-Circ, are manufactured.

YAMAICHI has invested in state-of-the-art lamination lines, as well as punching and folding machines. FFC's for YAMAICHI connectors or other applications can now be manufactured in Frankfurt/Oder.

YAMAICHI can respond to a wide variety of requirements such as pitch size, number of lines, lengths, surfaces, plug faces or folds. Special customer requests such as shielding or punching holes or slots in the FFC are also possible. Intensive and automatic optical process monitoring ensures compliance with tolerances.

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Y-SPE: Industrial Single Pair Ethernet

THE FUTURE STARTS NOW

YAMAICHI Electronics offers Y-SPE, a new series of connectors for Industrial Single Pair Ethernet (SPE) according to IEC 63171.

The new series initially includes both IP20 sockets and M12 sockets with IP67 protection for PCB mounting in accordance with IEC standards 63171-2 and -6.

Single Pair Ethernet offers the possibility of efficient data transmission from the sensor to the cloud. The increasing need and ability of machines, devices and also components in the production environment to communicate poses challenges to the previous Ethernet. Especially for systems with cable distances >100 m, there were only few possibilities in terms of Ethernet.

Due to the large range and the uniform communication level, Single Pair Ethernet is therefore generally considered the key in the transition to IoT and Industry 4.0. Transmission takes place via only two and no longer via four or eight contacts. Due to this fact, it is possible to build smaller connectors than the previous RJ45. The same applies to the cables. Instead of two or four pairs, only one pair is needed. This saves space, raw materials, weight and money.

To additionally ensure the supply of power, SPE offers the possibility of using Power over Data Line (PoDL) – similar to Power over Ethernet (PoE). However, the limit here is approx. 60W. Only the two existing stranded wires are necessary for use. For components that require more energy, hybrid connectors have been entered as a draft standard, for example in 63171-7 for M12. So YAMAICHI also offers first prototypes for this if required.

If a customer-specific design is preferred instead of a standard-compliant layout, the customer can of course also be supported in the realisation.

YAMAICHI's connectors offer the possibility to be part of SPE from the beginning and to benefit from the advantages. There is a free choice from the standardised systems.

BENEFITS

- Future-oriented technology in preparation for Industry 4.0
- Both mating faces available (IEC 63171-2 / -6)
- Space and weight saving
- 90° and 180° sockets in IP20 and IP67 (IEC 63171-6)
- 90° socket (IEC 63171-2)
- Customised solutions possible

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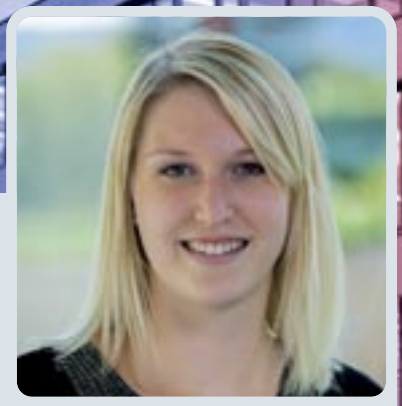
The CODICO TEAM says hello!



Ines Andrä

I have been part of the CODICO family for the last five years. I began in inside sales for passive components in 2017, and I am in charge of some sections of the German market. What really inspires and really delights me is the daily contact to customers and suppliers. Quite a few things have changed for me in the last 5 years. I have also been in charge of the Nordics and Baltics since 2019, which I very much enjoy because of my special relationship to Sweden. In 2020, the market had a lot of challenges in store for us, but there was also an additional, completely new task awaiting me: I was entrusted with the management of inside sales for passive components. With a heavy heart, I had to relinquish a few of my German customers as a result, but I learned a great deal on the new job in return.

Prior to my professional career, I studied in Kufstein, Tyrol. During my bachelor's degree, I spent a semester in Sweden, of which I have very fond memories to this day. I finished my in-service master's degree in Eisenstadt (Burgenland) in 2018. I enjoy doing sports in my free time. I play badminton and spikeball with some of the colleagues, and I also enjoy jumpstyle. (Yes, some of you are now probably checking on Google or youtube to find out what on earth is spikeball and jumpstyle.) We own a small bungalow at a bathing lake not far from where we live, and this is where go to totally relax. The garden needs some attention, too, but it's the kind of work that helps me switch off. What's even better for switching off, however, is travelling.

I am very happy that CODICO put so much confidence in me from the very beginning, and I am curious to see what the next years will bring. Being part of the CODICO family is very important to me, and I am already looking forward to a long journey together.

Questions? Just contact me anytime. Stay safe!

D02

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Caroline Gapmann

I began my professional career in a street lighting manufacturer based in Vienna's 23rd district. I started with an apprenticeship as industrial management assistant and remained employed there for a total of 7 years. Due to internal restructuring in the group, I was given the opportunity to expand my professional horizons and embark on new paths – and that's is how I became part of the CODICO family in late 2017. At CODICO, my first post was initially (as with my previous employer) in order processing. My customer focus is predominantly in Germany, though I am also in charge of MIELE as one of our key accounts. CODICO puts a great emphasis on a professional and comprehensive training, and, first and foremost, on a respectful behaviour among its staff. There are a lot of processes going on in the company, and always something new to learn. Boredom is out of the question here :o). Even on a particularly tough working day, you always have your cherished colleagues around for a chat or just to go out and get some fresh air in our company's own »Central Park«.

It's great to be a member of the CODICO family, and to be occasionally surprised by small and big gestures – like a chocolate bunny for Easter or a bouquet of flowers on your birthday.

My home is not too far from our company, which is located in the beautiful wine region of Perchtoldsdorf. One gets a lot of leisure time opportunities here, like long walks through the vineyards after work, or hiking tours in one of the nearby mountains during the weekend. We are surrounded by a scenic landscape, and the beautiful city of Vienna is not far away either. I love this area here, and I believe it offers everything one can possibly need. My small furry flatmate, a gorgeous white grey black tomcat, follows me around at every step and turn, breaking the monotony of work in home office. Not to forget the regular cuddling, of course!

On the whole, one can safely say that I really appreciate being part of CODICO, having already learned so much after these turbulent and instructive four years and, most of all, having brought such great customers on board.

D03

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Thomas Egger

I am very happy to have the opportunity to tell you a bit more about myself and the path that led me to CODICO. I joined the CODICO team in February 2017 and I am absolutely convinced that I made the right decision back then. As a Saxon, I bring another small piece of the puzzle into a team full of different cultures and different languages and advise our customers in the east as well as the north of Germany in their search for suitable passive components. I live with my wife and 12-year-old son in the Karl May town of Radebeul, just outside my native city of Dresden. The region is known for the porcelain city of Meissen and the unofficial title of "northernmost wine-growing region in the world". My attention, however, belongs less to wine and more to the football development of my hometown club SG Dynamo Dresden. Unfortunately, the successful times were several decades ago, but true to the motto "We have a dream", I hope to be able to combine my joy of football with my joy of travelling again someday. Games against Milan, Liverpool, Vienna or Madrid are in the past - but the next two European Cup games No. 99 and 100 I have firmly booked for myself ... ok, enough dreaming – back to me: In 1992, I started an apprenticeship as a communications electronics technician and subsequently completed a correspondence course to become an electronics technician. Professionally, an interesting fact has accompanied me from the beginning: I always took on jobs that I had initially ruled out for myself. During my apprenticeship, I realised that my interest in finding faults in electrical circuits was rather limited. I was never the real "tinkerer", but promptly found myself in a repair centre for radio relay technology. In this job, I later also took on the function of team leader until I was offered within the company to contribute my affinity for customer service in the internal sales department. Should I really take this step? Nothing ventured, nothing gained, so I started my sales »career« at a medium-sized EMS. I quickly got used to working in the office, but I didn't envy anyone who was regularly on the road to visit customers in person. And then it happened as it had to: I ended up in field sales, first for a metalworking company in the field of railway technology, now for an internationally active company based abroad. I would never have thought that possible either. But sometimes you should dare to take the plunge, even if I'm more drawn to warm beaches on holiday. A common thread runs through all my activities so far: I have always had to deal with customers! It is a great advantage that I have been able to get to know many sides of a customer-supplier relationship. My experience helps me to find common ground with my counterpart on many issues. We are all people with personal goals, and the foundations of any cooperation are mutual understanding and trust. Only these factors make the puzzle complete and make it possible to bring joint projects to success together. So - let's have a go at it!

D04

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Bianca Wurglits

My first day at the company was the 2nd of May 2017. One thing I still remember very well is the warm welcome I received from everyone. Especially from my mentor at the time. Yes, at CODICO every rookie gets a mentor assigned to them: they are there to support them if any uncertainties arise, and always have a sympathetic ear for their concerns. I find this to be a wonderful idea. I started in order processing, where I was in charge of the customer regions UK, Nordics, and partly Austria, Germany, and Switzerland. I always hugely enjoyed the daily contact with our national and international customers and the close collaboration with our colleagues from Sales.

After around 1½ years, I was given the opportunity to change to a new area, Material Planning. Since I am a great fan of new challenges, I seized the opportunity without hesitating. I found the idea of being a customer myself and getting to know the opposite side very appealing. Today, I can safely say that this decision was spot on! I extremely enjoy having to plan for a new demand every day, or to completely reschedule already assigned goods. Being responsible for the right goods being in the right place at the right time and in the right quantity is very often a huge challenge, but that's exactly what I find appealing. I find great pleasure in the daily collaboration with our manufacturers, since only a positive, respectful mutual approach can help us succeed together. The last couple of years have been particularly challenging due to the Covid-19 situation, where more precise work and especially quicker responses became extremely important. A particularly positive experience I can draw from this is the opportunity I had during these harsh times to overcome numerous obstacles together with very experienced colleagues who have worked at CODICO for many years. All these lessons will be extremely helpful in the future, too!

Though my job is great fun, I very much enjoy my free time as well. During the winter season, skiing is my absolute favourite. In Austria, we have mountains right on our doorstep. I already stood on a pair of skis at the tender age of four, so a regular visit to a ski slope comes as a reflex. Apart from skiing, travelling is definitely another passion of mine. I find it absolutely thrilling to visit new countries and to get to know wonderful places. Of course, there's plenty of things to do and see here in Austria, too. I often go out in the city for a pleasant dinner with friends, or for a few cocktails in one of Vienna's bars. During the summer, I enjoy going to concerts, festivals, in-line skating or cycling tours, or driving to one of Austria's numerous lakes. Thank you for reading my introduction and for getting just another glimpse into our CODICO family.

D05

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