

ENGLISH

C O D I C O <sup>®</sup>

impulse <sup>2/2020</sup>



# Key Components in Cars: KDS Oszillators

MPS: Simple BLDC Solutions

AICC: Industrial Ethernet

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## 24 | Stable & Secure Communication

Today, the worldwide volume of data transfer is growing inexorably. Cloud access, 5G boom, smart home, etc.: All these systems have made our lives a lot more comfortable, but they have also significantly increased data transfer. For automotive products we offer the solution: KDS crystal oscillators (XO) with differential output.

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# CODICO: 25 Years of Quality Management

»Taking part in the certification process again and again underlines the quality standard of the company. With its ongoing integration of the demanding ISO 9001 standards into its customer, process and employee orientation, CODICO has demonstrated both perseverance, consistency and willingness, while at the same time demonstrating that the focus is on continuous improvement of performance. Quality creates trust and trust ensures long-term success,« says Andreas Bürgmayr, qualityaustria network partner and auditor.

## A view back

The decision to implement a certified quality management system at CODICO in 1995 was not an easy one. The team was small and the ISO standard quality management system consisted of 20 elements that corresponded to the standard processes of the manufacturing industry from development, production and assembly to customer service.

## The right decision for a service company?

A very clear yes. Because the quality thinking was already strongly pronounced at that time. Thus the knowledge in this field was deepened and our activities were harmonised with a corresponding standard. Even then, certification meant more safety for our customers. Not only the standard, but also our quality management has developed over the past decades.

Both have adapted to the increasingly extensive and complex requirements. The safety of our processes and the possibility of monitoring and improving processes have made a significant contribution to the success of the company.

We are very proud of this visionary decision we made 25 years ago and look forward to finding solutions together with you and to growing with the new challenges.

D01

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Sven Krumpel  
CEO CODICO



25 years  
ISO 9001  
certified

# Editorial

## Staying human in times of booming digitalisation.

In recent years, a lot has been said about digitalisation and the benefits it brings. Yet often there was just a lot of talking, and little was done. Then came 2020 – and digital innovations were implemented at breakneck speed out of pure necessity, enabling companies to stay in business and survive.

I am a great friend of digitalisation, and CODICO has been taking steps in this direction for many years, something we were able to use to our advantage in 2020. To be honest, however, we are still in the middle of it: some digital topics are still in the planning phase, like, for instance, the topic of virtual trade fairs! We would have loved to welcome you to our booth at the electronica trade fair this time of the year. And now? Will we be meeting each other only in the digital space in the future? Are the days of exciting trade fair events already history? Since these days I am particularly interested in these topics, and now that the limitless advantages of digitalisation are being praised to heaven, I will dare turn the idea on its head: What is physically possible? What are the limits of digital expansion?

You cannot digitalise humaneness and human intimacy! I don't want to miss all the emotions, the random conversations, the spontaneous communication possibilities. It may sound appealing to virtually present product information, but communicating with virtual visitors in a chat-room will feel impersonal, because there is no alternative to face-to-face communication. We will miss the authenticity, the trust, and of course, the neuronal processing of the communication messages. All the digitalisation possibilities now available to us will not be able to replace human interaction! I hope we will make the best possible use of the current digital advances in the coming years, without losing focus of how important it is to be human. We took all those social opportunities for granted, now I miss them.

D02

▼ Sven Krumpel

# LEAKAGE CURRENT SENSORS

## For Charging Stations



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### Every household has one

Most people are familiar with the residual current device (RCD) from their fuse box in the basement. Though one will find several old buildings still equipped with safety fuses and cabling without earth wire, they are becoming increasingly rare. This is fortunate, since the task of the safety fuse or the circuit breaker is limited to protecting the powerlines from overcurrent, i.e. it constitutes a fire protection measure. The RCD, on the other hand, directly protects humans against

fatal electric shocks. It compares whether the amount of current flowing out of the circuit is equal to the amount that flowed in. Any deviation points out to the presence of a leakage current which may be flowing, e.g. into a person.

The residual current device usually switches off at 30mA leakage current, and the alternating mains current becomes potentially lethal for humans above 50mA. Statistics demonstrate how important a modern electrical installation is for

the protection of occupants. While the VDE registered over 250 lethal electrical accidents in Germany in 1970, this number had dropped to just 43 by 2018. Incidentally, 34 out of the 43 fatalities were men, who like to tinker with electrical installations, but obviously lack the necessary caution and care – who needs a voltage tester, when the tip of a finger will also do?

### Safety when charging an electric car

A major shift in transportation is already on its way, and the race seems to be decided: passenger cars with combustion engines will be replaced by PEVs (plug-in electric vehicles). The market for charging stations and wall boxes (electric vehicle supply equipment) is developing accordingly, and in some cities public charging columns are springing up like mushrooms. As electric vehicles increasingly become a mass phenomenon, the sales figures for wall boxes are also set to explode, since garage owners will of course want to comfortably charge their cars overnight or at the company car park, so they can start with a »full tank« each morning or after work. As a result, public charging columns are only relevant for long-distance travelling, and the traditional excursion to the filling station for petrol and diesel car owners will become a thing of the past.

KEMET FG-R05-3A



One should not allow safety to take a back seat, however, since, during charging, enormous currents in the two-digit ampere range flow into the batteries and, in future, from the batteries (vehicle-to-grid) back to the grid. Isolation errors can also cause leakage currents in the cables or the car, and humans and animals need to be protected against these.

This problem was addressed in Europe and some other parts of the world with the standard IEC 62752:2016 (In-cable control and protection device for mode 2 charging of electric road vehicles (IC-CPD)). The standard for mode 2 charging with a charging cable does not only require detection and switch-off in case of AC leakage currents > 30mA, but also for DC leakage currents > 6mA. As a result of the integrated leakage current protection in the charging station or the cable, the home installation only requires an inexpensive type A RCD.

### Integrated and future-safe solution in compliance with the standards

The FG-R05-3A is the first sensor of a series put on the market by KEMET, which is IEC 62752-compliant and offers an integrated solution in a very small space. Further models with the same functionality and in different form factors will be introduced into the market until the end of 2020 to meet the requirements of different mechanical installation situations in AC wall boxes and charging cables.

As of January 2022, an additional standard will govern mode 3 charging with AC wall boxes (IEC 62955:2018 Residual direct current detecting device (RDC-DD) to be used for mode 3 charging of electric vehicles). The changes affect the triggering thresholds, since the maximum possible charging current according to the standard will rise to above 100A. With regard to DC leakage current, the threshold remains at 6mA, but it increases to 60mA for AC.

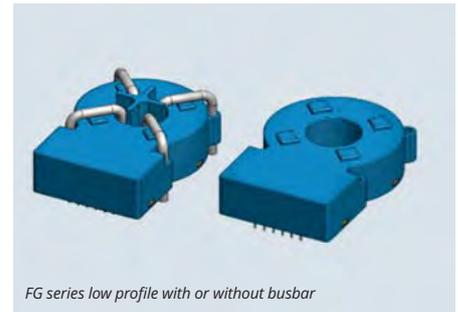
The corresponding sensors in compliance with the standard are already under development at KEMET and will be available in time. These will be designed for a maximum current of 40A for three-phase systems and 80A for single-phase systems, reaching a charging power of approx. 22kW. The sensors will be fully compatible with their mode 2 versions, both mechanically and electrically. Therefore, you can already begin

designing with the currently available sensors in mind, so that, when the new standard enters into force, you can switch to the new sensors in time with a simple BOM change, without having to modify the layout.

### Structure and function

The sensor consists of a coupling coil and an ASIC that integrates the evaluation electronics. It is soldered on the PCB as a THT component, and the charging cable passes through a hole in the sensor. If the inductively inductively detected total current is not zero, leakage current is present, pointing out to an isolation error in the charging cable or the car. The leakage current in the coil detunes an oscillator, and the electronics will measure the respective high and low times of the resulting output signal. One can thus determine not only the absolute value of the leakage current but also its direction, which is a very valuable piece of information for error diagnosis. The electronic system is supplied with 5V and reports on 5V logic outputs when the AC or DC leakage current threshold is exceeded, so that the corresponding relays can be switched out to disconnect the charging cable. In addition, an analogue output was integrated, which linearly

PARAMETER	SPECIFICATIONS
Part Number	FG-R05-3A
Compliance	Model 2 of IEC62752
Dimensions	38×31×13mm
Sensing mechanical	∅12.6mm for 4x10mm <sup>2</sup>



FG series low profile with or without busbar

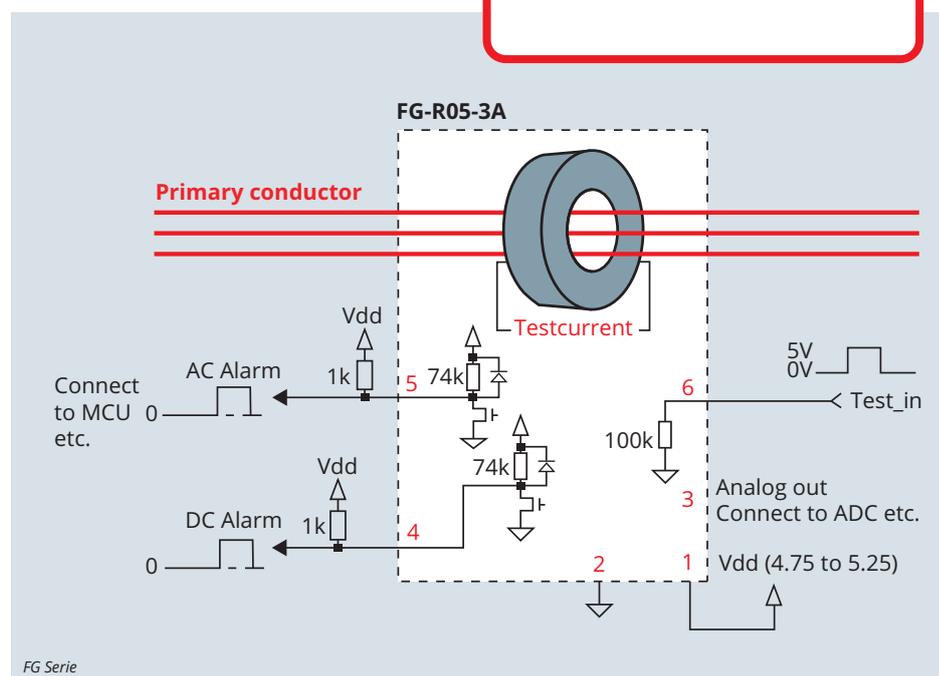
reads the DC leakage current and – superimposed with 50Hz – the AC leakage current, thus allowing the charging controller to monitor the leakage currents. As a result, it is possible to react already before the threshold stipulated in the standards is exceeded, e.g. to trigger maintenance in time before the charging column will have to be put out of service. This is an added value one should not underestimate.

A01

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## CONCLUSION

RCDs by KEMET not only allow you to meet the requirements of global standards for the safety of e-mobility charging stations, they also provide you with a compact, integrated, and future-safe solution and, thanks to their intelligent evaluation electronics, with valuable additional information.



# BUCK MICRO DC/DC

## With Integrated Inductor for Automotive Applications

Modern vehicles now contain many Electronic Control Units (ECUs) and each ECU has data fed to it electronically via a network of sensors located throughout the vehicle measuring everything from temperature to tyre pressure.

In addition, today's vehicles have more intelligence and more connectivity than ever before. All of this requires additional power and that power has somehow to be managed efficiently which requires the latest smart power management solutions. TOREX has recently launched three new Micro DC/DC modules to meet these needs. Each module is an integrated coil step-

down DC/DC solution offering high levels of performance and reliability for demanding and space constrained automotive applications such as sensors, cameras, small control modules, telematics, infotainment & HMI.

The XDL601/02 (5.5V 1.5A Buck Micro DC/DC), XDL603/04 (18V 500mA Buck Micro DC/DC) and the XDL605/06 (36V 600mA Buck Micro DC/DC) provide a superior thermal performance thanks to their exposed thermal pad package and minimised radiated noise (EMI). These are amongst the World's smallest AEC-Q100 qualified buck DC/DC solutions. As example, the XDL601/02 has a total solution size of only 30mm<sup>2</sup> (Figure 1). With all three Micro DC/DCs, an efficient step-down circuit can be configured using only 2 external caps as shown in the example below (Figure 2).

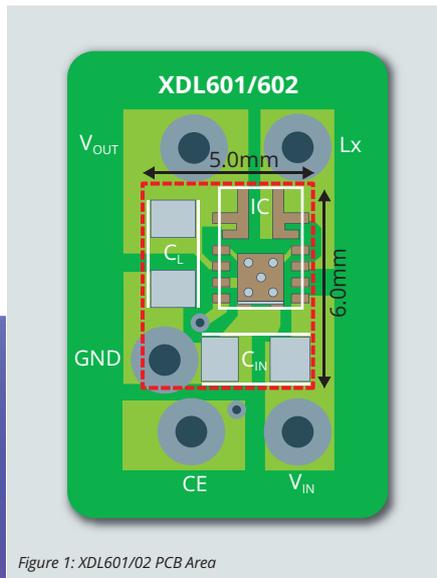


Figure 1: XDL601/02 PCB Area

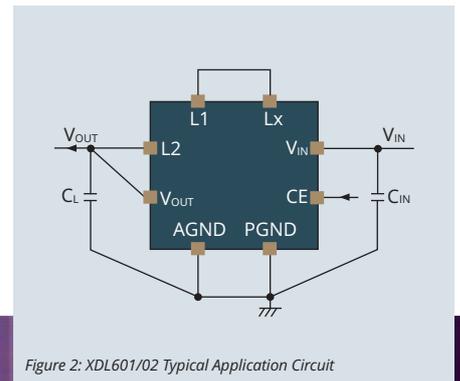
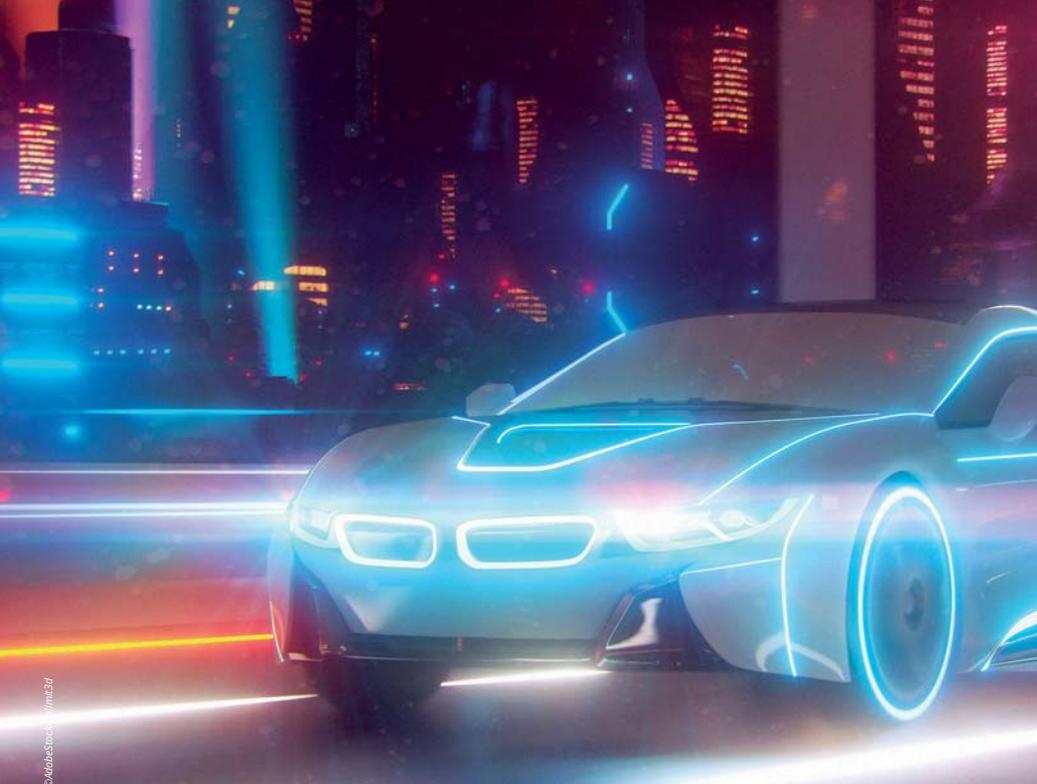
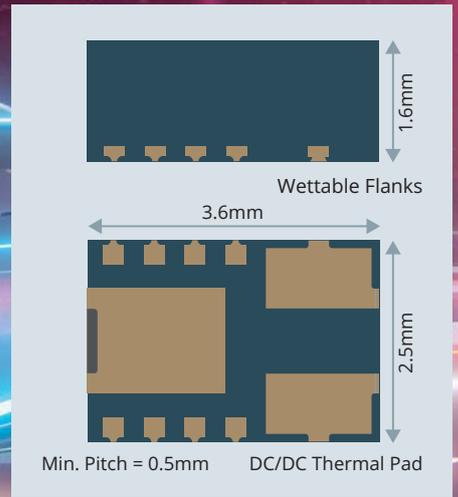


Figure 2: XDL601/02 Typical Application Circuit





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SERIES	OPERATING AMBIENT TEMP.	CONTROL METHODS	OPERATING VOLTAGE (Max. Rating) Output	VOLTAGE	ACCURACY	OUTPUT CURRENT	OSCILLATION FREQUENCY
XDL601	-40~105°C	PWM	2.5~5.5V (6.2V)	0.8/1.0/1.1/1.2/1.25/1.3/1.35/1.5/1.8/2.5/3.0/3.3V	±2.0%	1.5A	3.0MHz
XDL602		PWM/PFM					
XDL603	-40~105°C	PWM	3.0~18.0V (20.0V)	Externally Set (1.0~15V)	±1.5%	500mA	2.2MHz
XDL604		PWM/PFM					
XDL605	-40~105°C	PWM	3.0~36.0V (40.0V)	Externally Set (1.0~5.0V)	±1.5%	600mA	2.2MHz
XDL606		PWM/PFM					

All our XDL buck Micro DC/DC are AEC-Q100 (Grade 2) qualified. A small table with all the variants and features follows here. These new XDL Buck Micro DC/DCs are all available in the same ultra-small, high reliability package, the DFN3625-11B,

which measures 3.6×2.5×1.6mm (Figure 3 and Figure 4). The DFN3625-11B Package has wettable flanks that can achieve a 100% Automated Visual Inspection (AVI) success rate, which lowers the inspection time required. In addition, the package heat dissipation is enhanced with the use of large DC/DC thermal pads that contribute to high levels of reliability (Figure 5).

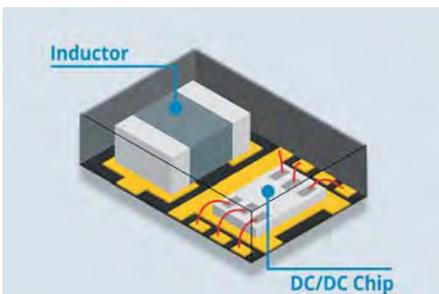


Figure 3: Package Dimensions & Internal Structure



Figure 4: DFN3625-11B Package External Structure

**Thermal Metric Data**  
JEDEC JESD51-7

Ambient Temperature (°C)	Power Dissipation Pd (mW)	Thermal Resistance (°C/W)
25	2100	47.62
105	420	

Board Mount (Tjmax = 125°C)

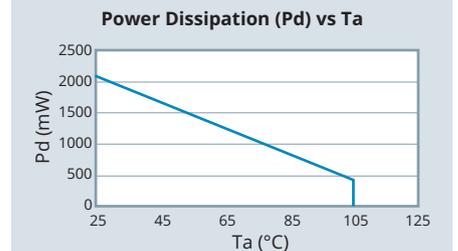


Figure 5: Power Dissipation & Wettable Flanks

These new XDL Buck Micro DC/DCs also provide improved radiated noise performance. Fig.6 compares the near magnetic field radiation generated by the XDL series Micro DC/DC and compares this with the performance of a TOREX buck DC/DC

with external coil (Test Conditions:  $V_{IN} = 5.0V$ ,  $V_{OUT} = 3.3V$ ,  $I_{OUT} = 300mA$ ). For more information on the XDL601/02/03/04/05/06 (including the latest datasheets) and all other AEC-Q100 qualified product as LDOs, DC/DC Converters & Voltage Detectors please contact us.

A02

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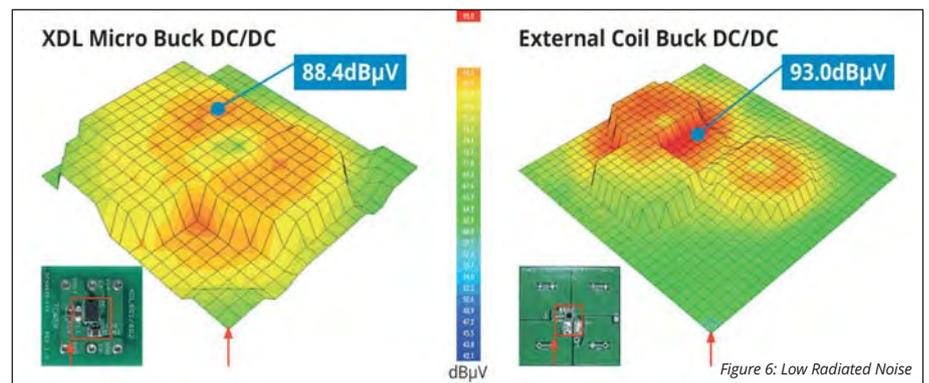


Figure 6: Low Radiated Noise



## Contact Cooled Medical Power Supply



RECOM introduces a highly compact 4"×2" 230W innovative base-plate-cooled power supply for 2×MOPP medical, household, industrial and ITE applications.

The new, compact 4"×2" RACM230-G series power supplies from RECOM support up to 160W continuous output power and 230W for several seconds for loads with peak demands, without fan cooling. With forced air, depending on model, line input and ambient temperature, 230W is available continuously. Outputs available are 12V, 24V, 36V, 48V and 54V nominal with conversion efficiency up to 92% and an operating temperature range of -40 to +80°C.

International safety certifications include 2× MOPP (250VAC) medical, household, industrial and audio/video/ITE for operation up to 5000m altitude with universal 80-264VAC input, enabling worldwide-compliant operation. Standby power consumption is less than 500mW. Additional features as standard include a smart fan output.

For flexibility, the RACM230 series is available as an open-frame design or in an enclosed metal housing. For higher output power, up to 550W, the new RACM550-G series is also available with similar or enhanced specifications with even higher power products in the pipeline.

Samples of both series are available via CODICO.

**A03**

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Contact cooled power supply with 230W peak power on 4"×2"

# GO GREEN

## Get More From Your PoE+ PD Solution!

SILVERTEL, the Welsh manufacturer of miniaturized PoE (Power over Ethernet) plug and play modules, announces the launch of its IEEE802.3at compliant Ag5412 PD (Powered Device) addition, to complement their immensely popular Ag5300 range of PD modules.

Aimed at developers of Ethernet equipment requiring the full 30W power delivery afforded by the .at standard, such as high power security cameras, digital signage, access control systems, wireless gateways, VoIP phones and terminals. The Ag5412 provides more useable power thanks to improved efficiency, where losses are reduced by 50% to provide lower running temperature, an ability to tolerate higher ambient temperature conditions which were previously inaccessible and full power delivery over the industrial temperature range (-40 to +85°C). The Ag5412 module got launched in August 2020 and will soon be joined by both, a 24V and 5V output variant.

The modules are pin-for-pin compatible with the Ag5300 range and available in the same Single-in-line format that allows PoE+ solutions to take up less real estate. Designed and manufactured in the UK, this latest product from SILVERTEL adds to the range of IEEE802.3at modules which boast *»...the smallest PD module solutions in the world«.*

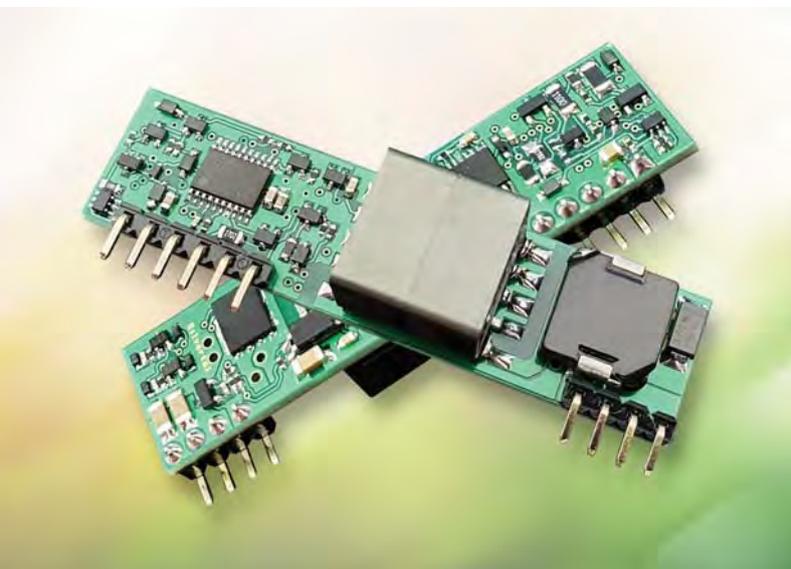


Silvertel

The Ag5412 is a Class 4 PD, which provides up to 30W of power by displaying the correct class pulses to a IEEE802.3at PSE. A complete high efficiency DC/DC converter is included, that generates a nominal 12V output, which can be adjusted down to 10.8V, or up to 12.8V. Additional features include 1500V isolation (input to output), over-load-, short-circuit- and thermal protection. Ag5412 evaluation board as much as the Ag5412 itself is available together with a wide range of application notes from CODICO's Sample shop now.

A04

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# Power Giant Delivers up to 1200W

COSEL

COSEL's all new little big giant offers an astonishing 1200 Watt output power and comes in dimensions as little as 117.3×86.8×12.7mm (L×W×H).



The on board print module is currently available in two output voltages of 28V and 48V, another 12V variant is on the horizon. The product can be used in various set ups including parallel operation where nine (9) modules are capable of delivering up to 9750W in total.

Despite its high efficiency of up to 92%, the TUNS1200F can still operate up to +100°C from an industrial rock bottom of -40°C. Various Options including adjustable output voltage (via VTRM) or constant current operation (ITRIM) combine two different products in one case. The product also comes with standard options such as Power Good, Remote Sensing, Remote On/Off and many more.

COSEL's on-board power giant delivers up to 1200W

High isolation of medical grade of 2×MOOP with 3000VAC and 1×MOOP of 2000VAC making it not only a perfect fit to industrial applications but also for medical devices (MDR). The safety approval list has it all, including UL62368-1, EN62368-1, C-UL (equivalent to CAN/CSA-C22.2 No.62368-1), ANSI/AAMI ES60601-1, EN60601-1 3rd, C-UL (equivalent to CAN/CSA-C22.2 No.60601-1) and the family complies with IEC60601-1-2 4th. Samples can be ordered via CODICO now.

A05

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# BAR-TYPE DISPLAYS

Have you ever been in a situation where you wanted to use a display for a new design because it would simply look much better, but none of the standard display sizes would fit the purpose? Though it would be possible to use a monochrome display in this case, you still think that colour would really be the icing on the cake? Some requirements just can't be covered by the known display sizes. So how about a display whose dimensions don't correspond to the standard formats?

## Explanations

Let's take a look at the category of bar-type, letterbox, or stretched displays, whose designations already provide clues as to their respective appearance. As a rule, the above displays are long and narrow. Therefore, the aspect ratio does not correspond to the legacy format of 4:3 from the first generation of screens, or even the 16:9 or 16:10 aspect ratio commonly used today for wide displays. Instead, the narrow side is made even narrower, resulting in formats with aspect ratios of e.g. 2:1, 8:3, 15:4, or 16:3.

We distinguish between two production methods for displays of these special sizes. They are, by the way, special, because these displays usually do not make the most efficient use possible of the mother glass. Under normal circumstances, one would try to obtain as many displays as

possible from a glass substrate with an absolute minimum of waste. Therefore, display sizes are adjusted to the glass substrate. The diagonal screen measurements known today are the result of the given size of the original glass substrate. The size of the mother glass in turn largely depends on the machinery available.

But let's go back to the production methods: Of course, it is possible to manufacture an unusual-size TFT display like any other standard display. The initial costs, however, are very high – initial costs for development are around 50,000-100,000 Euros – and they usually cannot be distributed over a large quantity as in the case of standard sizes. Some companies are not deterred by that, and they invest the money required to have a customised display. These are referred to as 'native' or 'mask' displays.

The second method of obtaining a TFT LCD in the right size is the following: One chooses a standard display that is at least partly suitable, and then cuts it to the desired size. This may sound more like DIY, but it is exactly how it is done in practice. Of course, the cutting process requires comprehensive know-how, and the entire procedure takes place in a cleanroom environment. The display must be cut at the right position, not with millimetre but with micrometre precision.

At the same time, one must pay attention to where the cut is made, so as not to sever the control lines for the drivers. When choosing a suitable candidate, it is also important to check where the driver ICs are located, so as to achieve the desired result. After cutting, it is necessary to properly and permanently seal the section so as to guarantee long-term stability. Essentially, it is possible to use any TFT LCD for this purpose, provided that the necessary requirements are met.

Moreover, this approach is more cost-effective for small to medium quantities. This method had a bad reputation in the past. With the advancement of technology and the acquired expertise by the manufacturers, however, this manufactu-

SIZE [INCH]	RESOLUTION [PIXEL]	MODULE SIZE [MM]	INTERFACE	BRIGHTNESS [CD/M <sup>2</sup> ]	GLASS TYPE	VIEWING ANGLES [°]	TEMPERATURE RANGE [°C]
0,96	80*160	13,5x27,9x1,5	SPI	500	IPS	80/80/80/80	-20 /+70
3,9	480*128	105.5x37.0x4.6	RGB	350/500/1000	TN	65/50/65/65	-20 /+70
3,9	480*128	105.5x38.8x2.9	RGB	550	IPS	80/80/80/80	-20 /+70
4,6	800*320	120.7x54.7x2.9	RGB	350	TN	65/65/50/60	-20 /+70
5,2	480*128	140.4x49.9x3.0	RGB	350/500/850/1100	TN	65/55/65/65	-20 /+70
6,3	800*256	165.0x67.0x6.8	LVDS	500	TN	70/60/70/70	-20 /+70
6,5	800*320	164,9x72,46x3,7	RGB	330	TN	70/70/50/60	-20 /+70
6,86	480*1280	66,7x181,0x4,7	MIPI	600	IPS	85/85/85/85	-20 /+70
8,8	480*1920	231.3x64.3x4.8	MIPI	600	IPS	85/85/85/85	-20 /+70
10,25	1280*480	265.2x109.8x7.0	LVDS	800	IPS	85/85/85/85	-30 /+85
12,3	1280*480	317.0x125.0x14.1	LVDS	1000	TN	70/60/70/70	-20 /+70
12,3	1920*720	313.8x132.2x13.3	LVDS	700	IPS	85/85/85/85	-30 /+85
19,0	1920*360	502.8x124.4x12.8	LVDS	700	IPS	89/89/89/89	0 /+50
28,0	1920*357	733.8x165.3x20.8	LVDS	700	IPS	89/89/89/89	0 /+50

ring method is absolutely equal to the first approach and in any case industrially feasible. The displays produced in this manner are referred to as »cut«. The definition of their size is also often expressed as 1/2-cut or 1/3-cut, meaning that one half or one third of the original display is used. Unlike the past, where only large sizes were used as the basis for cut displays, the significantly improved handling of this technology has increasingly shifted the focus toward smaller displays.

## Available displays

Which sizes are available?

Our Table provides an overview of the sizes available at CODICO. There is a wide range of displays from 0.96" to 28", and many of these sizes have developed into a quasi standard in the meantime. They are supported by several manufacturers, which increases their long-term availability. In some cases, especially with mask displays, this availability is even longer than with some standard displays. Depending on market demand, new sizes are also being developed. Our partners, for instance, are planning displays measuring 2.0" (320\*130 pixels), 2.86" (376\*960 pixels) or 7.84" (1280\*400 pixels). In essence, the products described here are industrial displays, i.e. all parameters are geared toward industrial use, which also includes the temperature range. The only exception are the largest sizes. This is due to the large displays from which they originated, and which have a limited temperature range.

They are controlled using the well-known RGB or LVDS interfaces. Recently, due to the base type, we have also seen the emergence of displays

using a MIPI DSI interface. For the smallest member of this group, the 0.96" TFT, an SPI interface suffices to transfer the contents at sufficient speeds.

Several types offer the advantage of large viewing angles by using IPS technology. Another plus factor is their good brightness of up to 1,000nits across the board, which makes these displays readable under direct sunlight. All versions can be fitted with projected capacitive touch sensors, allowing for the implementation of interactivity in the final product.

## Applications

Where can such displays be used?

Imagine, for instance, a 19-inch rack with an installation height of just one height unit (1U = 1¾" = 44.45mm). If you want to accommodate a display here, it is impossible to take a standard size, unless you settle for a monochrome LCD or OLED display; TFTs are out of the question. The 3.9" TFT, on the other hand, has maximum outer dimensions of 105.5x38.8mm for a display surface of 95.0x25.3mm, so it fits perfectly. Though two height units (2U = 3½" = 88.90mm) could accommodate a standard 4.3" display, an 8.8" display measuring 231.3x64.3mm with a resolution of 480x1920 can make quite an impression. Combining such a display with a projected capacitive touch sensor would result in a state-of-the-art solution.

The share of these displays in the automobile industry is increasing exponentially. The 12.3" type can be found in large quantities as information display on the dashboard. 8.8" and 10.25" versions are used as virtual mirrors, displaying video

feed from external cameras. The 12.3" display size is also used as a side mirror for lorries. The readability of these displays is improved by a circular polariser, so that they can also be viewed by drivers wearing polarised sunglasses. Cameras also deliver feed that covers the blind spot, helping to increase safety on the road. In household appliances, the control panel often provides limited space for a display, so that before making only scarce use of the space available, a bar-type display is often installed for optimum utilisation of such »real estate«.

Another major field of application are all types of information displays, for instance those showing advertisements in elevators, or in public transport, where users receive passenger information alongside additional distraction. POS terminals and cash registers are also fitted with letterbox displays. Another field of application for this type of displays are slot machines, where, again, the main focus is on information (here on the player deck) and advertisement. Moreover, new areas of application are opening up in medical technology, where devices must be designed to be visually appealing, and where the available space for a display may be limited.

All in all, this type of displays, which previously existed in the shadow of the standard displays, seems to have a whole range of applications after all. In case you are now interested and are thinking of using one of these formats, we will be happy to advise you.

A06

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# SIMPLE BLDC SYSTEM SOLUTIONS

Angle & Current Sensors, BLDC Drivers & Power Supply From one Source



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Applications using brushless motors have seen a significant increase in recent years. The advantages of BLDC motors, such as high power density, wide dynamic range, less maintenance, and compact size are appreciated by developers and designers alike. In addition, the initial drawbacks of BLCD motors, such as additional components, complex system structures, and higher costs have been reduced, so that the overall balance today is positive for BLDC users.

## The problem

In addition to a growing number of applications with BLDC motors, this broader market acceptance also brings with it several experienced and new users of this technology. There is a highly diversified range of applications being implemented for these motors, with individually adjusted components.

This has a considerable impact on the development of BLDC systems: instead of using conventional individual components like in the past, the trend today is moving toward a bespoke implementation. The advantages of this customised implementation are adapted solutions with optimum performance and minimum material use, as well as optimised costs. In addition, it is possible

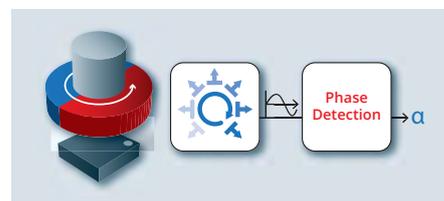
to accommodate extended requirements arising from the application environment. These would include, for instance, the collection of additional data for condition monitoring and predictive maintenance. What is important for users is a flexible and freely combinable solution platform that allows for a simple implementation and broad scalability.

## Flexible sensors

A BDLC motor is usually equipped with sensors for the commutation. In the past, these were often conventional discrete Hall effect sensors, which detected the rotor position of the motor in a simple yet – unfortunately – inaccurate manner. The only information available was on three detection phases, along with a block information.

A more precise absolute position of the shaft or the rotor period were not available, nor were high-resolution speed or direction information.

With the MagAlpha sensors of the MA1xx, MA3xx, and MAQ43x series by MPS, this additional information – also desirable for extended control – is now available in a monolithically integrated angle sensor. Using the proprietary SpinAxis™ technology by MPS, these sensors can directly read a magnetic rotor and also detect the rotor position and the rotor movement via a magnetic dimensional scale. In addition to diametric magnets, it is also possible to use ring magnets with the appropriate number of pole pairs. All MPS sensors for BLDC applications are packed in a small QFN-16 3x3 casing and use a uniform, standardised pin configuration for power supply and signals.



The position of the sensor can be chosen flexibly: either at the end of the shaft, next to the shaft, or even tilted at a 90° orthogonal angle. The internal Hall-effect sensor frontend detects the magnetic field and processes it directly in the component. The classic standard signals for BLDC motor applications are provided: the UVW commutation signals and, at the same time, the incremental ABZ quadrature signals. In addition, an absolute SSI interface and an embedded SPI interface deliver absolute angle information as a digital data item. Due to the high bandwidth of the signals, it is possible to measure high rotational speeds even at high resolutions.

Moreover, current sensors can be optionally positioned at the power unit of the BLDC system. Depending on the system structure, the current sensors are used for direct current measurement of the motor phases. In addition, it is possible to monitor the consumption of the power supply. These can be easily integrated with the isolated Hall-effect current sensors MCS180x from MPS. Here, the analog ratiometric output signal has established itself as the standard interface. To reduce waste heat, the inner resistance of the current sensors has also been minimised. As a result of the galvanic decoupling, interference and voltage fluctuations from the regulator are already eliminated. The phase currents of the BLDC motor are regulated accordingly on the basis of this sensor information.

## Energy systems

The BLDC system is supplied with direct current. AC/DC and even DC/DC converters are required here to supply the different voltage and power ranges. MPS' broad AC/DC and DC/DC product range offers various families such as inductors (MPL), voltage regulators (MP/MPQ), and highly integrated power modules (MPM) for the power supply of the BLDC system.

The power drivers of the BLDC systems are in charge of the power conversion to the motor. This requires high efficiency in combination with a compact size. The MeshConnect™ packaging technology by MPS has a decisive advantage for higher power densities in smaller sizes.

The core element of the BLDC system is the intelligent control. Depending on the requirements, it can spread itself across different control circuits and process the corresponding sensor signals in

real time. Numeric performance in these applications spans a very broad range. As a result, control systems range from simple to highly complex ones, since the application and its requirements will determine the control's performance features.

From the point of view of a semiconductor manufacturer, solutions with a high market acceptance are attractive for implementation in an integrated circuit. The eMotion System™ MP6710 by MPS is the corresponding controller component that can be easily integrated and flexibly interconnected.

In the case of particularly highly-integrated and common solutions, the functional units of the BLDC system can even be integrated in one component. The integrated MP6570 BLDC motor controller combines all essential functional units such as regulator, power stage, and angle sensor in a single component.

## Services portfolio

As a result of a high level of individuality, scalability, and ongoing innovations, BLDC systems often feature a huge variety of regulators. MPS products such as angle sensors, current sensors, BLDC pre-drivers and BLDC power stages can be successfully combined and applied thanks to standardised interfaces and protocols.

Despite high cost pressure, BLDC applications are also attractive in the automotive sector.

MPS offers the corresponding AEC-Q100 certified angle sensors of the MAQ43x series. In accordance with the user requirements, these are packaged in QFN-16 3x3 enclosures with wettable flanks for automatic optical inspection (AOI).

Suitable DC/DC products from the MAQ43x series are also available.

A07

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## CONCLUSION

The requirements of the BLDC motor applications determine the components to be used. As a result of their standardisation, MPS products can be used for a wide function and performance range from a complete system, a kit part set, and even in combination with other manufacturers. The corresponding assemblies of the various functional units are available for evaluations. MPS and CODICO also provide samples and technical design-in support.



# EFFICIENT POWER SUPPLY DESIGN



## For Ancillary Systems as EVs Embrace a Range of Bus Voltages.

Technology based on a 400V bus is well established within the EV market. However, high performance automobiles and commercial trucks and vans where higher acceleration and increased load-carrying power respectively are required, are increasingly using an 800V bus system.

Also, to save space and weight and to increase power delivery, 800V is now starting to be adopted for more conventional vehicles. As well as powering the drive train of the vehicle, the main power bus must also support a host of other functions. This article will consider efficient power design for these ancillary systems within conventional 400V systems and emerging 800V bus EV architectures.

400V systems have the advantage of operating at the same voltage levels that are commonly encountered in commercial offline power conversion. However, 800V systems require a shift in technology or innovative circuit design to support lower voltage applications effectively. A buck converter architecture would seem to be the simplest solution for lower power applications when working with a high input voltage. However, it becomes increasingly difficult to get an input-

to-output voltage ratio above 30 with a buck converter. The ratio between maximum and minimum power delivery is also limited. This is due to the minimum On-time limit for the controller and the power switch. Ignoring component resistive losses, the ratio of input voltage to output voltage is determined by the duty cycle of the switch, i.e.:

$$\frac{V_{IN}}{V_{OUT}} = \frac{1}{D} = \frac{T_{ON} + T_{OFF}}{T_{ON}} = \frac{1}{T_{ON} * f_s}$$

- V<sub>IN</sub>* = Input voltage
- V<sub>OUT</sub>* = Output voltage
- D* = Duty cycle of the converter switch
- T<sub>ON</sub>* = On-time of the converter switch
- T<sub>OFF</sub>* = Off-time of the converter switch
- f<sub>s</sub>* = Switching frequency of the buck converter



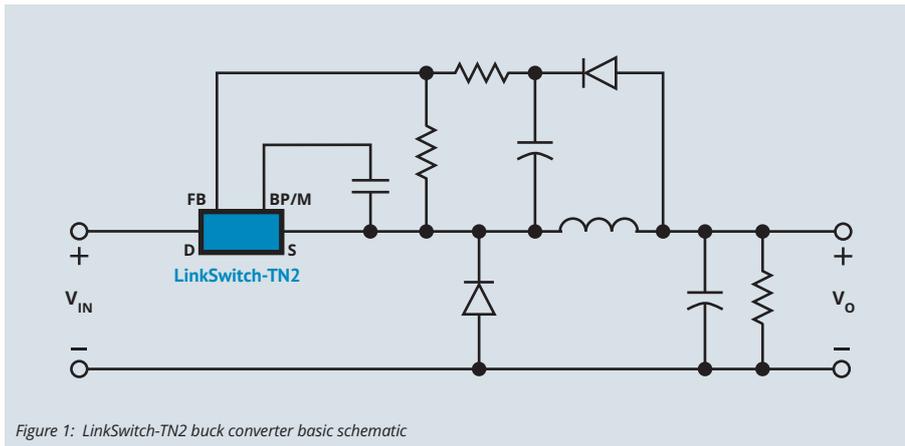


Figure 1: LinkSwitch-TN2 buck converter basic schematic

Considering a typical high input voltage buck converter, the minimum On-time is around 500ns and switching frequency is ~60kHz. This results in a maximum achievable input-to-output voltage ratio of 30.3. Therefore, in this example the converter could just about deliver 12V from a 400V source. However, it could not provide 12V from an 800V bus - 24V would be the minimum output voltage. More, the efficiency of a buck converter drops when operating with high input-to-output voltage ratios. If the ratio is 2:1 or 3:1, >90% efficiency can be achieved; at around 30:1, 70-80% is a realistic expectation.

Therefore, flyback converters are often a more suitable choice for applications requiring a high input-to-output voltage ratio experienced in both 400V and 800V EV systems. Primary and secondary inductance can be set to match the voltage requirements of either side, resulting in a wider duty-cycle and higher system efficiency. The practical maximum power for a flyback design in this situation is approximately 100W. Above this power level, transformer leakage inductance losses and primary switch voltage stress becomes cost-prohibitive. Other topologies such as the various half-bridge and full-bridge configurations are best suited for higher power.

### Supporting Applications from a 400V Rail

POWER INTEGRATIONS has a number of automotive qualified parts that are appropriate to consider. For a low power (360mA output current), low cost, buck converter with an integrated 750V MOSFET, the company has the LinkSwitch™-TN2 LNK3206GQ (the »Q« denotes automotive qualified). The LinkSwitch-TN2 can also be configured as a flyback converter, delivering up to 7W if required (Figure 1).

For higher power applications, POWER INTEGRATIONS offers the InnoSwitch™3-AQ INN3977CQ flyback converter controller. This has an integrated 750V MOSFET switch and is capable of delivering up to 35W in an automotive environment.

The unique InSOP package houses both primary and secondary side controllers that communicate via POWER INTEGRATIONS' magneto-inductive coupling technology, FluxLink™. This allows precise control of the output voltage and current without the use of optocouplers, while providing reinforced isolation with a >4000V withstand.

Optocouplers tend to be avoided in automotive applications due to their relatively short lifespan. For high efficiency, the INN3977CQ directly controls a synchronous rectifier MOSFET on the secondary side (Figure 2).

One application where the INN3977CQ is used is in the 30W Emergency Power Supply (EPS) for traction inverter MOSFET or IGBT drivers. This power supply keeps the traction inverter going should the onboard 12V battery fail while the vehicle is being driven. The EPS performs the required safety function specified in the international standard ISO26262 'road vehicles - functional safety.' In the event of failure, the InnoSwitch3 IC draws power directly from the high power battery bus. In order to provide an additional margin, the EPS must operate from the 400V battery rail down to approximately 30V.

### Delivering Auxiliary Power from an 800V Rail

As mentioned previously, devices derived from AC mains controllers are well suited to 400V battery applications, but an 800V battery powered electric vehicle requires significantly higher voltage capability. Remember, 800V is not the limit voltage seen by the switch: an 800V rail is typically prescribed a limit voltage of 800 plus 15% to allow for battery voltage-lift during regenerative braking or during normal charging. This increases the voltage to 920V.

If the application requires a flyback converter, an additional voltage of approximately 120V must be added to allow for the reflected output voltage across the transformer and the transformer leakage-inductance spike. This takes the voltage up to approximately 1040V. If we then allow for

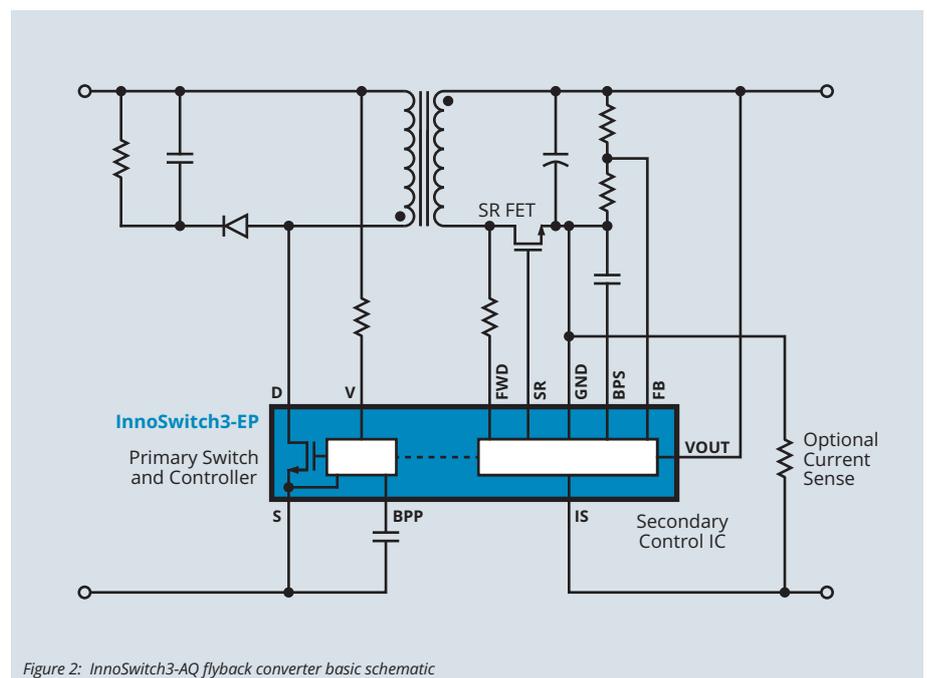


Figure 2: InnoSwitch3-AQ flyback converter basic schematic



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20% derating, a 1.3kV minimum breakdown voltage is required. This can be achieved using a flyback or buck control device with an external 1.5kV automotive-qualified MOSFET – but this is a rare spec for current devices. Also, a direct feedback connection from secondary to primary will probably be required in order to avoid the use of optocouplers, negating the isolation benefits provided by the flyback converter.

One solution offered by POWER INTEGRATIONS is to use StackFET™ topology with the Inno-Switch3-AQ application previously discussed.

Here, an additional 500V MOSFET is connected in series with the INN3977CQ primary switch. A capacitor/resistor/Zener network ensures that the bus voltage is shared appropriately between the two devices. This arrangement has several advantages. The effective switching device resistance is doubled compared to the single 750V device (assuming similar RDS(ON), less than half of that presented by a comparable 1,5kV MOSFET with similar current.

Switching losses are mainly capacitive and are proportional to the square of the applied voltage.

So, losses in a device switching at 800V are four times higher than for 400V. Two devices in series, equally sharing 800V, will therefore dissipate half the switching loss of the single device (Figure 3).

In addition, the power dissipation is shared between the two devices. This design spread the heat more evenly over the entire PCB, reducing overall device temperature. This technique can be implemented using a single board design for either 400V or 800V applications, StackFET components being omitted for the 400V system. Operation down to 30V input (at reduced output power) can be achieved and full power is available from 200V up to maximum rail voltage.

There is a move to 800V operation for some vehicles, yet existing 400V systems must also be considered. Solutions for driving from the higher bus voltage at both these levels already exist and have been proven in actual systems.

For more information on POWER INTEGRATIONS products, reference designs and support information please visit [power.com](http://power.com).

A08

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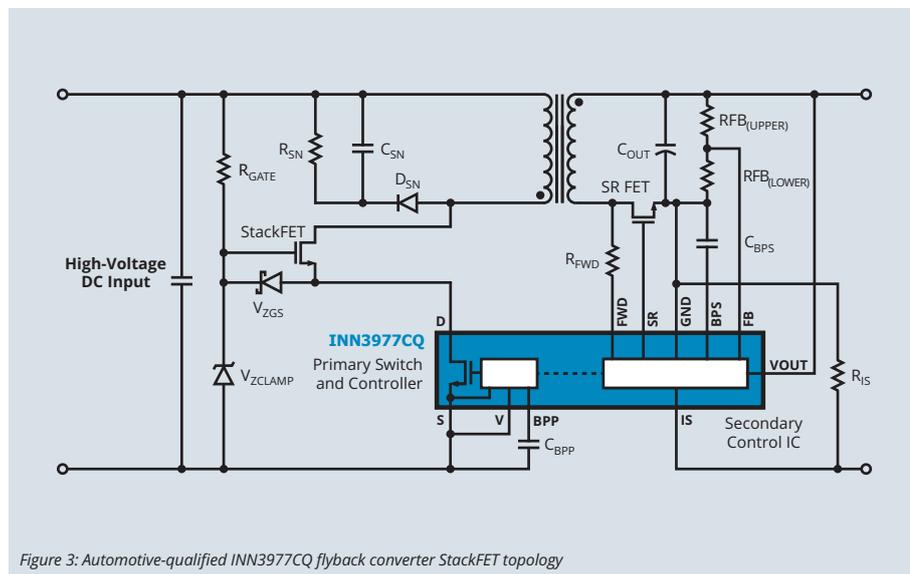


Figure 3: Automotive-qualified INN3977CQ flyback converter StackFET topology

5G



## Innovating Modules for a Hyper-Connected World

All the hype in the marketplace has been about the high speed, low latency and connection density of 5G and everyone's right to be excited. However, to harness the power of 5G, devices need to be able to connect to the network and for that 5G modules that contain 5G modems are needed. QUECTEL has been at the forefront of this development and was the first company to create a portfolio of 5G modules, which are accompanied by supporting evaluation board (EVB) kits and a range of 5G antennas.

Leading innovation in 5G isn't simply about bringing a module to market, it's about understanding what customers want and offering them true choice backed by outstanding customer support. Only by doing this can companies harness the power of 5G to drive their businesses forward. QUECTEL has this at the heart of its mission and therefore has created not only the industry's first 5G module but also the broadest portfolio of modules on the market.

With our five global R&D centers we are uniquely positioned to support our customers as they implement 5G modules into their devices and work on making the business models of the future a reality. 5G is a revolution in connectivity and QUECTEL has the expertise to enable customers to take advantage of all the benefits 5G offers. 5G introduces wireless connectivity performance at a never before seen level. The sheer speed it enables is the first impact. 5G begins with a peak data rate of 10Gbps compared to 4G's 1Gbps –

and this will increase with further as the technology develops.

Second is the low latency of less than 1ms, compared to 10ms with 4G. Third is the connection density 5G is able to support of one million connections per square kilometre, compared to 4G's 100,000 connections per square kilometre maximum density.

### QUECTEL 5G solutions

QUECTEL has led 5G module development, having designed a portfolio of 5G module families that feature Qualcomm's Snapdragon x55 5G modems. In the Sub-6GHz category, QUECTEL offers the RG500Q and RM500Q family. While, in the mmWave plus Sub-6GHz category, it offers the RG510Q and RM510Q module family.

The QUECTEL RM500Q-GL is a 5G module optimized especially for IoT/eMBB applications. Adopting the 3GPP Rel. 15 LTE technology, it sup-

ports both 5G non-standalone (NSA) and standalone (SA) modes. Designed in an M.2 form factor, the RM500Q-GL is compatible with QUECTEL's LTE-A Cat 6 module EM06, Cat 12 module EM12 and Cat 20 module EM20, which will facilitate customers in their migrations from LTE-A to 5G.

The RM500Q-GL covers almost all the mainstream carriers worldwide. The module supports Qualcomm's IZat location technology Gen8C Lite. The integrated GNSS receiver greatly simplifies product design and provides quicker, more accurate and more dependable positioning capability.

The QUECTEL RG500Q is a series of 5G Sub-6GHz LGA modules optimized especially for IoT and M2M applications. Adopting the 3GPP Rel-15 technology, the modules deliver M2M-optimized peak data rates of 2.5Gbps downlink and 900Mbps uplink. The modules support both 5G NSA and SA modes, Option 3x, 3a and Option 2 network architecture, which makes it backwards compatible with 4G and 3G networks.

The RG500Q series contains the following variants: RG500Q-EA and RG500Q-NA, which address European and North American markets. It also supports Qualcomm's IZat location technology Gen9C Lite. The integrated GNSS receiver greatly simplifies product design and provides quicker, more accurate and more dependable positioning capability. Offered in the LGA form factor, the module features embedded dual-band GNSS, a PCIe 3.0 interface and a USB interface.

In addition to these modules, QUECTEL's portfolio also includes evaluation board (EVB) kits for the RG500Q and RM500Q and a RM500Q mini-EVB kit. QUECTEL also offers 5G antenna solutions.

A09

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# NEW FORCE

## The 10A and 16A Power Relays



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The world of electronics continues to be dominated by the topic of miniaturisation. The same applies to electromechanical components. Developers are constantly in search of ever tinier components. As a distributor, how can you satisfy this request and lead customers into the future?

### GQ – The next generation in the 10A and 16A class

Since the introduction of the famous and now widely used RY and RT relays 25 years ago, the market has been waiting for the next generation which would give hardware developers new features and benefits. The brand-new GQ series by GOODSKY represents the next level in miniaturisation, and, compared to the common formats in use today, the space required on the PCB can be reduced by up to 50%, since a component length of around 30mm is no longer in keeping with the times, especially in the area of smart homes.



New 3rd fully-automatic line in Taiwan

Based on the year-long partnership cooperation between CODICO and GOODSKY, a roadmap was devised for the next-generation design of a 10A and 16A relay family so as to provide the market with a smart solution to replace today's standard solutions. The GQ platform was chosen as the basis for this new family of relays.

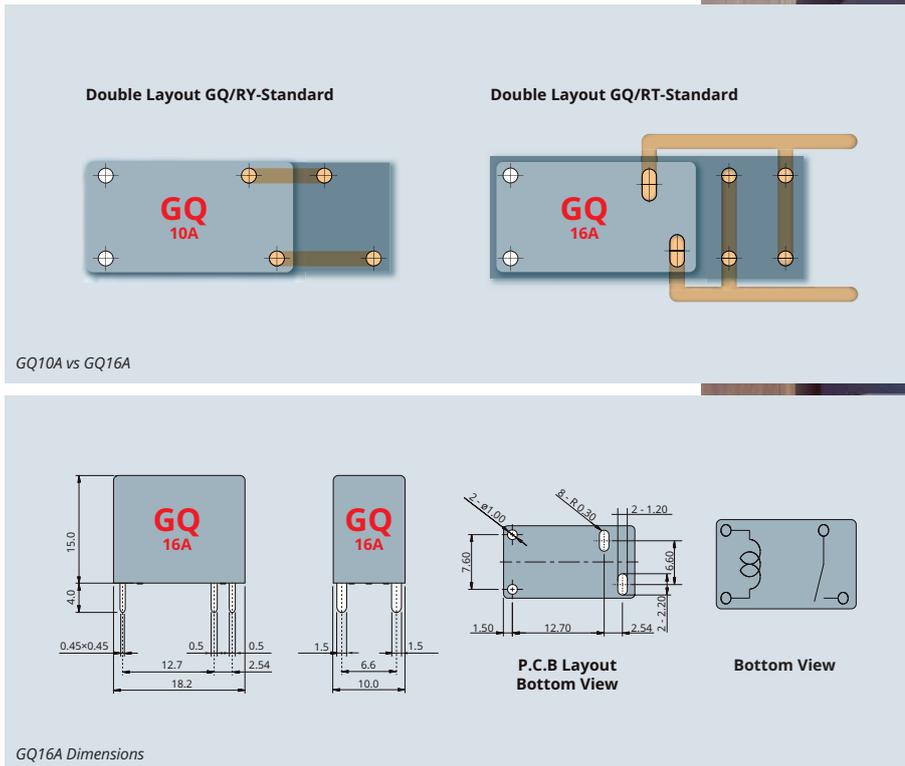
#### The objectives pursued by the specification for this next-generation series were as follows:

- Significant reduction of the required space compared to the current solution
- Reinforced insulation despite the reduced component size
- Possibility of a double layout as compared to the current RY and RT/RZ standard
- Highest permitted ambient temperatures up to 105°C
- Lower coil voltage
- Reflow version at a reasonable price
- Fully automatic production to ensure the highest reliability and quality

CODICO took up these challenges together with the developer team at GOODSKY and worked out new solutions for the internal structure of the relay around the coil and contact system. Intensive tests carried out with respect to the electrical performance for both resistive and capacitive inrush currents and inductive motor loads have shown that the new product meets the above specifications.

The required space on the printed circuit board is now a mere 180mm<sup>2</sup>. Compared to the famous and often copied RT/RZ platform, the 16A version requires up to 50% less space. The entire relay platform is now also VDE listed, in addition to existing the UL and TÜV listing, which has now been partly expanded. AgSnO + Indium contacts now provide for an excellent inrush performance. Moreover, the new platform features a reinforced insulation, is glow-wire resistant, and even more sensitive than the previous generations, with a low coil power of 200mW and 360mW.

GOODSKY's GQ platform represents the next level in miniaturisation. Its double layout allows for a quick replacement of the two previous generations so as to generate immediate cost-cutting effects. The new platform is suitable for ambient temperatures of up to 105°C.



The GQ 16A features reinforced contact pins to match the increased temperature specification. THR reflow-capable versions are offered as option, and the entire series is also available in tape and reel packaging. CODICO is ready for the future and has the know-how to best support customers with application expertise.

Moreover, our partner GOODSKY has invested in a 3rd fully-automatic production line, situated at the headquarters of GOODSKY in Taiwan. The new line is capable of manufacturing all versions (10 & 16A), and the key elements of the line were designed by the company's own engineering division, so GOODSKY covers the entire technical know-how from the product to the process in-house.

The success seen since the introduction of this new platform has proven us right. Wherever a NO contact will suffice – and this is the case in 95% of applications – designers cannot get around this new and innovative solution, since the space requirements and economic objectives are much better served than with the previous generation. From an application perspective, one could describe these as universal relays, since the platform covers all common applications in industrial settings, white goods, heating techno-

logy, smart home, and measuring and control equipment.

Just as their now outdated predecessors, we expect the GQ 10 and 16A platforms to become the top sellers of the decade. A successful pro-

duct of this class is very much capable of »surviving« for 20 or 30 years.

P01

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	GQ 10A	GQ 16A
Contact form	1 NO	1 NO, reinforced pins
Max. switching capability	10A 250VAC, 10A 30VDC	16A 277VAC, 16A 24VDC
Inrush Rating	TV-5	TV-8
Coil voltages	3VDC - 48VDC	5VDC - 48VDC
Nominal operating power	200mW	360mW
Ambient temperature	Up to 105°C	Up to 105°C
Protective construction	RTII, RTIII (Ex-proof optional)	RTII, RTIII (Ex-proof optional)
Insulation	reinforced	reinforced
Mounting	THT, THR	THT, THR
Packing	tube, tape & reel	tube, tape & reel
Agency Approvals	VDE, TÜV, cULus	VDE, TÜV, cULus



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# NEW CRYSTAL PACKAGE TRENDS

Did you know that cheaper glass sealing can replace seam welding in crystals?

Until 1990s, the bestseller on the crystal package market was the metal can package THT, using a spot-welding method. Meanwhile, this has become a legacy item due to the non-automatic production process and the difficulties facing quality improvement.

The metal can package solution was eventually replaced by SMD products. Today, the major sizes are 1612 (1.6×1.2mm), 2016 (2.0×1.6mm) and 3225 (3.2×2.5mm). In addition, if you want sizes like 1008 (1.0×0.8mm) or 0806 (0.8×0.6mm), there are some packages already available.

Today, there are roughly 3 sealing types for the SMD package type: Seam sealing, glass sealing and wafer level packaging (WLP). Seam sealing

and glass sealing types are technologies already used for many years. WLP is a brand-new technology, which offers greater advantages for miniaturization and less height. The Arkh.3G series by KDS, for instance, can easily reach sizes 1008 (1.0×0.8mm) and 0806 (0.8×0.6mm), the lowest height being 0.13mm. *(For more information, please check our 02-2017 issue of Impulse, »Arkh.3G«)*

The glass sealing method uses melted glass to seal the ceramic base and ceramic lid. This sealing method has a cost advantage over the seam sealing method. However, to cause glass to melt, one needs an oven. This oven generates additional frequency shifts in the crystal blank, so glass sealing was not suitable for creating tight tolerances like with the seam sealing technology.

In seam sealing, the ceramic base and the metal lid are sealed with a kovar ring. The method only applies electricity on the metal lid above the cobalt ring, so it does not need to be placed into an oven for sealing. Frequency shifts caused by the surrounding heat do not occur with this sealing method.

Therefore, seam sealing is usually suitable for tight tolerances. Glass sealing products were used for wider tolerance and as a cheaper solution, or for wide temperature range solutions, due to their similar thermal expansion as PCB.

However, our suppliers KDS and TXC now have the advanced technology to replace seam sealing with glass sealing. Contrary to other suppliers,

which can only reach  $\pm 50\text{ppm}$  in a temperature range of  $-40$  to  $+85^\circ\text{C}$ , our suppliers can achieve  $\pm 30\text{ppm}$ . This technology renders crystal products more cost-effective.

Nevertheless, the glass sealing method also presents some disadvantages. Until now, the smallest size available has been 2016 ( $2.0 \times 1.6\text{mm}$ ), while seam sealing sizes can go down to 1008 ( $1.0 \times 0.8\text{mm}$ ). Moreover, even with the same package size, glass sealing needs a greater height than the same size in seam sealing. But this has a small advantage as well, since a greater height provides more space inside, so the crystal frequency in glass sealing can be lower than with seam sealing.

Another issue is EMI. Seam sealing is strong against EMI because the metal lid is connected to GND. Glass sealing does not have a metal lid, so it has no protection against EMI. However, it depends on the operation conditions of the crystal. EMI has an effect on crystals if the application is wireless communication below 1GHz. So it is fine to use for most of today's applications. Even wireless communication like 2.5GHz WiFi or Bluetooth can use glass sealing. Only in subGHz wireless applications it is better to consider seam sealing.

	GLASS SEALING TYPE	SEAM SEALING TYPE
	 <i>DSX211G</i>	 <i>DSX1612S</i>
Package	Ceramic Base / Ceramic Lid	Ceramic Base / Metal Lid
Sealing Method	Glass Sealing	Seam Sealing
Available Size	From 2016 size	From 1008 size
Overall Stability (-40/85°C)	Competitor: $\pm 50\text{--}60\text{ppm}$ Our suppliers: $\pm 30\text{ppm}$	$\pm 30\text{ppm}$
Advantages	Lower costs Wider frequency range Wider temperature range	Less product height EMI resistance Easier down-sizing

Apart from those reasons, seam sealing also has an advantage for extremely tight tolerances. It can be produced with fewer effects on the crystal blank, so the crystal engineer can accept a slightly more aggressive frequency tolerance specification.

Due to those reasons, seam sealing will still remain in the market, though the share of glass sealing will increase. Nevertheless, it will be limited to special applications which need tighter tolerance or EMI resistance. Especially oscillators,

which have an IC inside, need to use seam sealing.

The market is still misunderstanding glass sealing as a cheap solution but not suitable for tight applications. As explained, most seam sealing applications can be replaced by glass sealing products. For more information, please contact us.

P02

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# EXTREMELY RESILIENT

## Hybrid E-Cap News Fireworks



SUN Electronic Industries Corp. (SunCon), Japanese high quality electrolytic capacitor manufacturer, and inventor of hybrid e-caps, introduces a variation of new products of their hybrid cap portfolio. The pipeline is full of miniaturized and high ripple current components.

Completely new in their line-up is the smallest dimensions of 5×6mm, which will extend the 4,000h/125°C standard series HVPF. This case size will be able to handle a rated ripple current of about 450 to 600mArms@100kHz/125°C (tentative specification).

Voltage Range: 16 to 63V  
 Capacitance Range: 8.2F to 47µF  
 ESR: 80 to 200mΩ

Miniaturized HVPC-series (4,000h/125°C) provides higher capacitance per case size as well as higher ripple current capability compared to HVPF. SUN is adding the dimensions of 6.3×6 and 6.3×7.7mm to this product range, which allow a reduction of the PCB size and a low profile design.

Voltage Range: 25V, 35V  
 Capacitance Range: 56 to 150µF  
 ESR: 30 to 60mΩ  
 Rated Ripple Current: 1,200 to 1,800mArms@100kHz/125°C

SUN is not only adding new, smaller dimensions to offer the possibility of miniaturization. They are also going to increase the capacitance per case size of the high ripple current HVPX-series

(4,000h/125°C). Focus is on the voltage range of 50 to 80V in the dimensions 8×10.5, 10×10.5 and 10×12.5mm. Capacitance will be increased by up to 70% in the same case size. Thus, for higher voltage applications, you e.g. will have 100µF/63V or 56µF/80V available in dimensions of only 10×10.5mm (tentative specification).

Capacitance Range: 33 to 180µF  
 Rated Ripple Current: 2,000 to 3,500mArms@100kHz/125°C

### High temperature, high ripple current, long lifetime = FVF series

Special materials make FVF-series an outstanding product. It combines high temperature withstanding with high ripple current capability and long lifetime. Sun now is extending the product range of this series.

Additionally to already available 35 and 63V versions, 25, 50 and 80V are under development. This line extension makes ultra-high ripple current capability also available for higher voltage applications. This is not only related to 150°C as these products have specified ripple currents at 125 and 135°C as well.



Another new version of FVF-series is the case size 10×16.5mm, which combines ultra-high ripple current capability with high capacitances in a diameter of 10mm. This will be available in a voltage range of 25 to 80V.

Tentative Specification 10×16.5mm:  
 Capacitance Range: 82 to 560µF  
 ESR: 11 to 16mΩ  
 Rated Ripple Current @150°C/100kHz: 1,600 to 2,250mArms  
 Rated Ripple Current @125°C/100kHz: 4,200 to 5,700mArms  
 Guaranteed Lifetime: 4,000hrs@150°C/125°C and Rated Ripple Current

#### Features:

- Highest rated ripple current @125°C, 135°C and 150°C
- Longest lifetime at 150°C with full ripple current capability in the market

P03

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# Wider Range of Film Capacitors

PANASONIC Industry has extended the capacitance range of THB-X2-capacitors.

In addition to the special THB-construction and used materials, ECQUA-series (metallized polypropylene film capacitors) benefits from PANASONIC's original in-house patterned metallization process with fuse mechanism function. Thanks to this, the capacitors provide a stable capacitance level over the full product lifetime and therefore guarantees a higher reliability of the application.

# New Size of Hybrid Caps

PANASONIC Industry added new dimensions of 10×12.5mm to their electrolytic hybrid capacitor portfolio, which are available for the high-current series ZS currently.

The ZS-series combines high capacitances and high ripple current capability in a diameter of 10mm. Thanks to the product height, this 125°C/4,000hrs item offers the possibility for miniaturization in terms of PCB size, as capacitance is increased as well.

For some time now, 10×16.5mm case size is available. Another solution with high performance, but lower profile, are the new dimensions of 10×12.5mm. The new series offers a reliable and proven alternative for e-caps in tighter spaces or tantalum capacitors in higher frequency circuits. In addition to save space, the lower ESR and higher ripple current enhance filter and DC-link circuits in for instance automotive control and powertrain applications.

As usual, these products are AEC-Q200 certified, as well as versions with vibration-proof socket are available.

Temperature Range: -55 to 125°C

Voltage Range: 25 to 63V

Capacitance Range 10×12.5mm: 100 to 470µF

Capacitance Range 10×16.5mm: 150 to 560µF

Rated Ripple Current 10×12.5mm:  
3,000 to 3,500mA<sub>rms</sub>@125°C/100kHz

Rated Ripple Current 10×16.5mm:  
3,500 to 4,000mA<sub>rms</sub>@125°C/100kHz

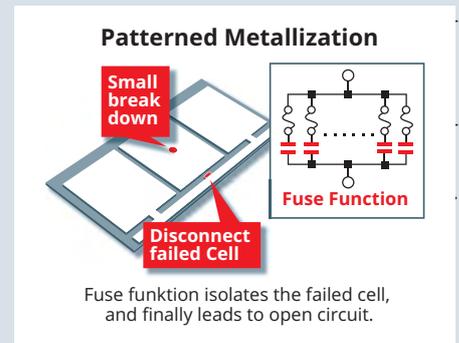
ESR 10×12.5mm: 14 to 19mΩ

ESR 10×16.5mm: 11 to 15mΩ

P04

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Panasonic  
INDUSTRY



ECQUA series even more stable!

The industrial version has available small values starting from 8.2nF. Below 100nF and above 1µF those products are 500hrs at 85°C/85%RH/275VAC tested. The range of 100nF to 1µF provides THB test reliability of 1,000hrs/85°C/85%RH/240VAC.

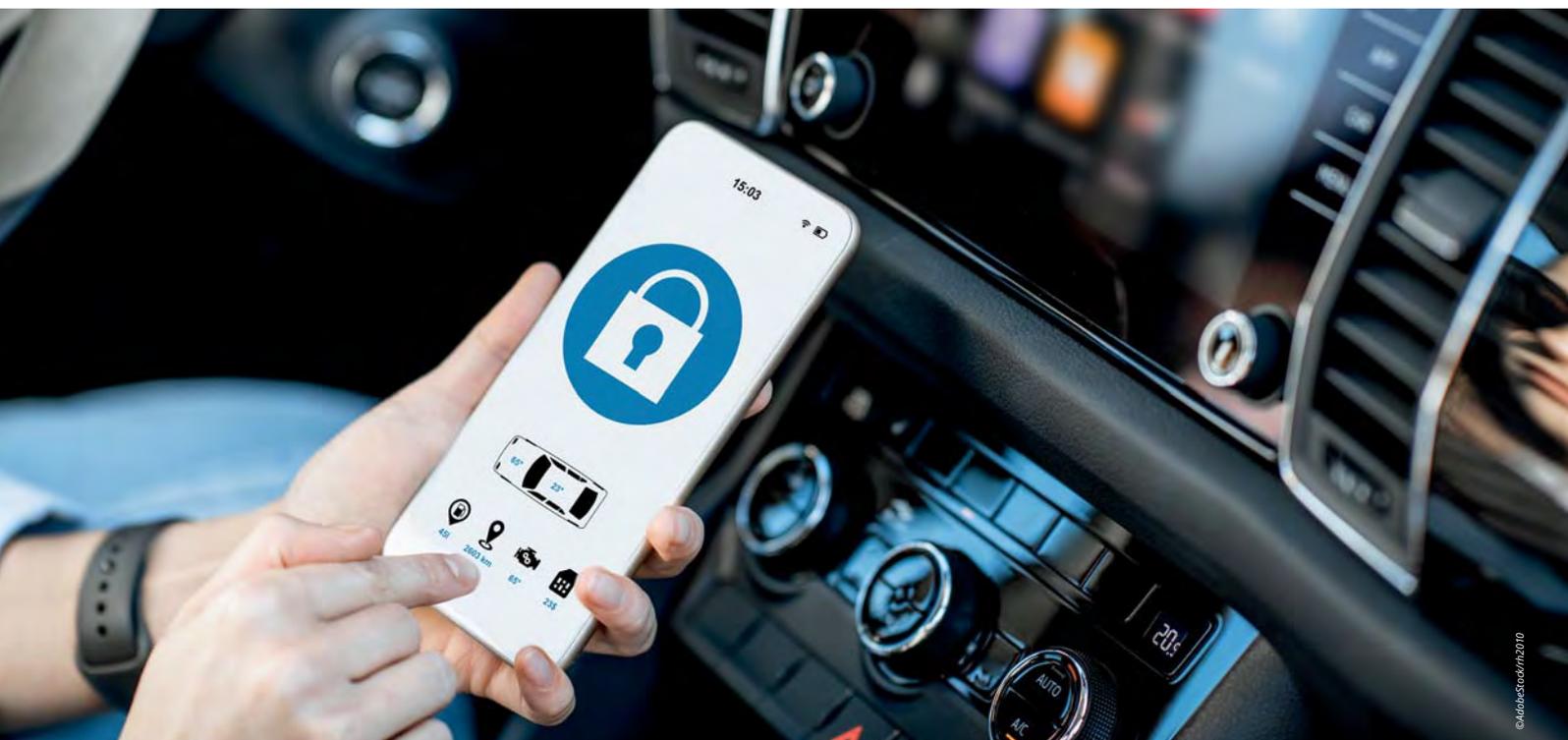
Main applications are interference suppression/ input & output filtering for industrial power supplies, home appliance, metering, DC/DC AC/DC converter, OBC and inverter application for renewable energy etc.

P05

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# STABLE & SAVE COMMUNICATIONS



## Differential Output XO Will Be the Key Component for Our Cars in the Future.



Today, the worldwide data transfer volume is on the increasing inexorably Cloud access, 5G Boom, Smart Home, Smart Factory, etc.: All these systems have made our life more convenient, but they have increased information transfer significantly.

Automotive communication is developing in a similar way. This does not apply only to wireless communications like Bluetooth or mobile connections for infotainment systems. Cable communication needed for a car's operation is also leading to an increase in data traffic.

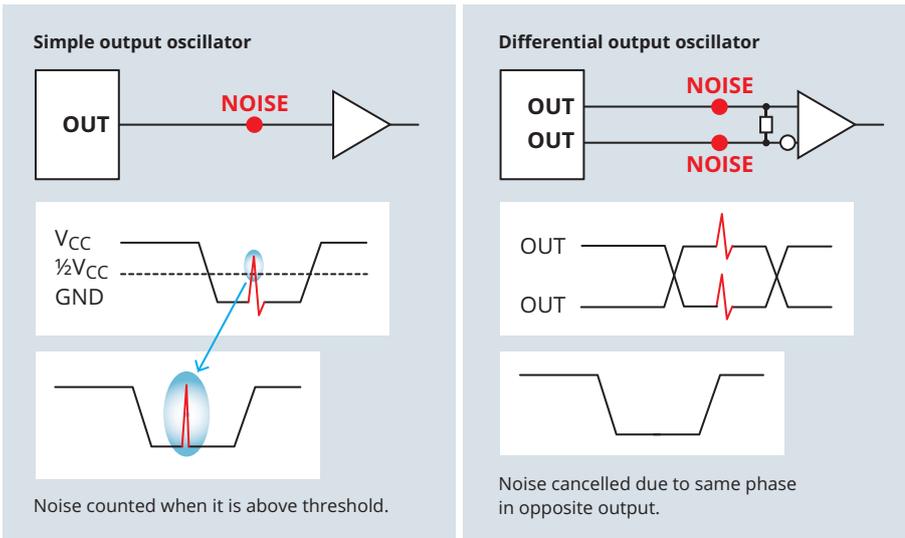
Today, several communication standards can be found in the car. LIN, CAN, FlexRay and MOST are famous ones. In addition to those, Ethernet and PCI Express are set to play a bigger role in the future.

For Ethernet and PCI Express, a 25MHz crystal unit was originally used as signal clock source. These clocks do not require tighter frequency tolerances like wireless communications. Even an overall  $\pm 50\text{ppm}$  is fine. This is the same in automotive specifications such as  $-40$  to  $+125^\circ\text{C}$ . Therefore, for an automotive node, a 25MHz crystal unit is also used, but with a wider temperature range.

However, the clock source for the Body Control Unit (BCU) will be different. This unit is the key

part for the telematics controller. Huge data transfers pass through this unit, so data loss and modification will be the bottleneck when trying to maintain high speeds. If information can't be transferred fast enough, ADAS and autonomous driving will be difficult to achieve.

So a specific crystal is required for those high data transfer clock signals. Tight tolerances like those of TCXOs are not really necessary. Nevertheless, a robust clock source is needed against noise. The solution used for those applications are differential output crystal oscillators (XO). A differential output oscillator has two opposite phase outputs. In the case of a normal single-end oscillator, any noise heading to the output line will remain. With two opposite phase out-



puts, this noise can be canceled. The noise will anyhow head to both output lines. When the two opposite phase outputs become one again, the two same noises have an opposite phase and will be cancelled.

uation in the frequency phase, noise cancelling won't work ideally. Quartz crystal is the most reliable material for low phase jitter, so this is one of the reasons why a crystal is also suitable for differential output oscillators.

The key element of these differential output oscillators is their low phase jitter. If there is a fluctuation

Our suppliers KDS and TXC have a strong footing in the automotive crystal market. They also provide

**KDS DIFFERENTIAL OUTPUT XO LINEUPS**

	LVPECL	LVDS	HCSL
3.2x2.5mm	DSO323SK	DSO323SJ	DSO323SD
Frequency Range (3225)	13.5 to 212.5MHz		
2.5x2.0mm	DSO223SK	DSO223SJ	DSO223SD
Frequency Range (2520)	13.5 to 167MHz		
Frequency Tolerance	±50ppm, ±80ppm, ±100ppm		
Operating Temperature Range	-40 to +85°C, -40 to +105°C		
Output (@3.3V)			
Output Loading	50Ω to Vcc-2V	100Ω (Output-Output N)	50Ω
I <sub>cc</sub> (@3.3V) (@212.5MHz)	45mA max.	20mA max.	35mA max.
Feature	High Data Rate, Single-End Output possible	High Data Rate, Low EMI Noise, Low Current Consumption	Reference Signal for PCI Express
Application	Base Station, Optical Data Translation, Ethernet, SONET	FPGA, Automotive Camera, Video	PCI Express

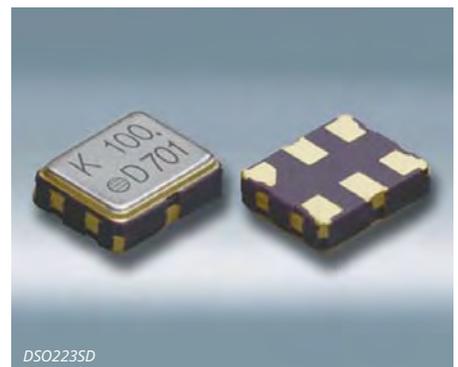


vide differential output XOs for the automotive market.

Currently, 3225 is the predominant size for differential output oscillators. KDS, however, also offers a 2520 size in the automotive temperature range. If you are thinking of minimizing your application, you need not worry about a second source. Since the competitors will inevitably follow KDS, it is also interesting to use a KDS 2520 size sample for the future. For more information, please feel free to contact us.

**P06**

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# THE CAPACITIVE VOLTAGE DIVIDER



## Who uses capacitive voltage converters and why?

Capacitive voltage dividers are mainly used in applications where no galvanic isolation by a transformer is required and a very low output power is operated at constant load. The application is designed like a resistive voltage divider, but only in the AC range, because the application does not work in DC operation.

## What are the problems?

At first sight this capacitive voltage divider seems to be a very cheap and simple solution to operate your consumer product with low power. With only one X capacitors, this consideration is also correct, however product development does not only include the consideration of the component level, but the design also needs to cover the entire product life cycle. In the first moment, buyers favour the circuit with few components, they only consider the costs, which is legitimate, because it is their task to find the cheapest solution. From a developer's point of view, it looks a little bit different, because developers do not only look at the costs, but also pay special attention to lon-

gevity, reliability and the best possible solution for the customer; according to the motto, I develop my products in a way that I would buy it.

The issue of X capacitors is critical as soon as short-term peak voltages occur. An example of this is the switch-on state, where the capacitor draws an exceptionally high current at the first moment. This current is only limited by the internal resistance of the capacitor and can be up to 100A for a short time at high uF values (in some cases a series resistor is provided to reduce these peak voltages, which lowers the efficiency). At this moment the capacitors are massively loaded and a failure of the capacitors occurs during longer operating life. This failure can be quantified with 30% of the errors. Due to the continuous loss of capacity of the capacitor over the running time, another kind of unwanted failures happen, which also fall into the category of 30% errors. The capacitor power supply has no standby state, so it has a given power consumption. It is also limited to a constant input voltage range, so a wide range power supply cannot be realized. At the latest from this moment, when the quality

manager gets his error analysis lists, he will use his veto power to stop producing this circuit. In addition, if you want to produce a quality product because the market demands it, you will follow the veto.

## What are the alternatives?

An alternative is the MP161 from Monolithic Power, this device is a non-isolated step down converter, which requires minimal input and output circuitry. This external circuit is a fuse in the primary circuit with a full bridge and the PI filter. On the output side, 4 capacitors, an inductor and two diodes must be placed.

## What are the benefits?

The advantage of this Step Down Converter is the high efficiency of the switching regulator (>80%) compared to the capacitive voltage divider (40-60%). Especially due to the energy saving regulations of the European Union capacitive power supplies are only an issue in already existing products. For new developments, these products are no longer relevant. The MP161 is suitable for almost every IOT application due to its

sophisticated architecture. The MP161 has two relay outputs, which can be used to control for example a Goodsky GQ relay, which is characterized by its small dimensions. The MP161 has an internal LDO, which can supply a micro controller even in standby mode and thus can take an »always on(line)« state.

Applications for this product would be for example roller blind control, i.e. all kinds of shading, which also includes temperature measurement and motion detection. Overall, it can be said that it is very strongly represented in the home automation industry, as these devices have to be de facto always online to provide the necessary comfort and benefit for the customer. Further applications of this product are in the surveillance sector, heating sector, car motives, industry, ... (everywhere this should be used). The advantage in contrast to the cap. Voltage divider is that dynamic loads can be connected. The internal regulator enables the different loads to be supplied with voltage with a high degree of efficiency. This feature offers the possibility to use the MP161 as a cross-platform step down converter, which corresponds to a modern and up-to-date hardware architecture.

**In contrast to this, the advantages of an HV-Buck:**

1. Longer lifetime as capacitor power supply (with appropriate design)
2. Worldwide use (wide range input)
3. <100mW Standby Power consumption
4. >80% efficiency over a wide load range
5. Significantly higher maximum load than a capacitor power supply
6. Costs approximately as low as those of a capacitor power supply

**Additional advantages of the MP161:**

1. Integrated LDO (3,3V or 5V)
2. Integrated relay drivers
3. There is an EVB for testing

**Design-In Support**

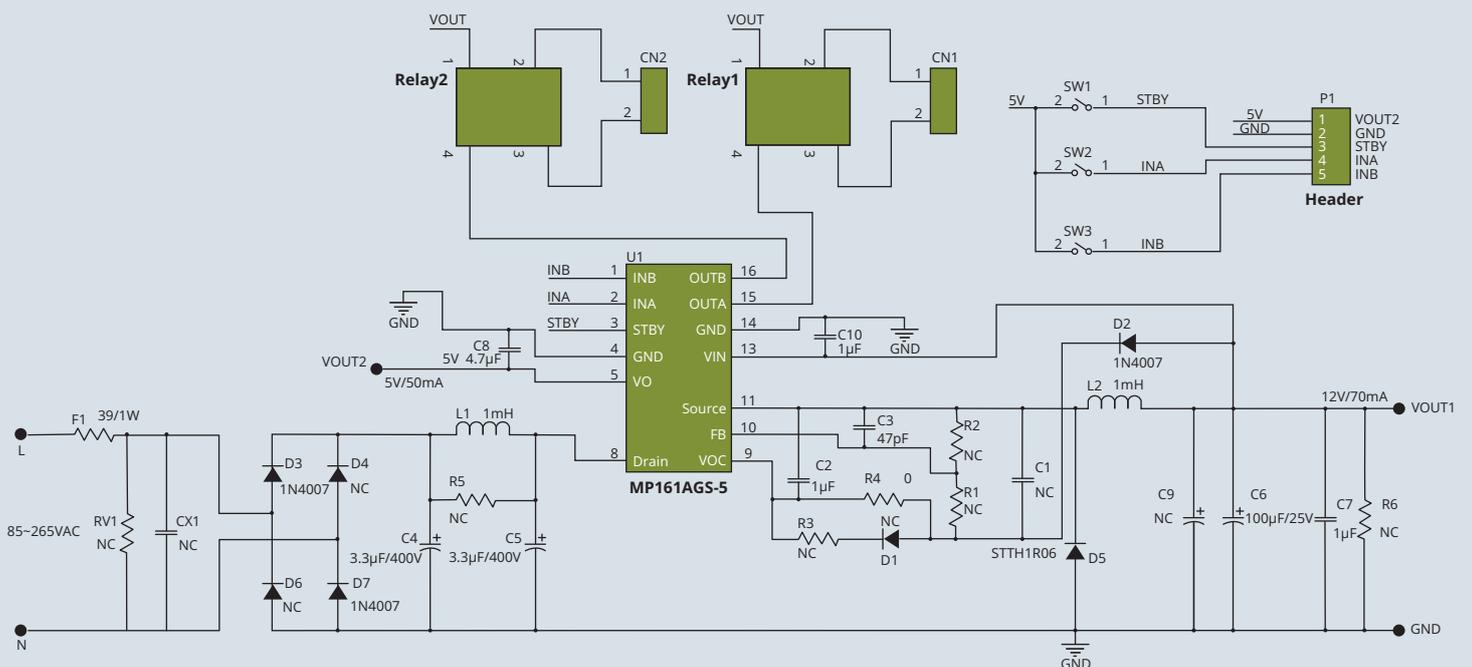
If you have any questions, feel free to contact us, with us you are in best hands. We have the possibility to fall back on our design-in competence in house, there are experts in our office in Switzerland, Germany and Austria. We are looking forward to hear from you.

P07

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# FIRST CHOICE

## Reliable E-Caps for the Automotive Market



**R**UBYCON is the No.3 E-cap manufacturer in the world. They are famous for their No.1 quality in the world. Their technology as well. In this article, I would like to explain the best points to select RUBYCON for automotive E-cap. There are several points why we recommend RUBYCON capacitors in automotive.

- Wider lineup – from small E-cap SMD and Radial to big size Snap-in and Hybrid capacitors
- RUBYCON Hybrid capacitors, have the highest ripple current capacity on the market
- RUBYCON SMD and radial E-caps offer a wide product range
- Good technical support at the highest quality level

### Wider lineup

There are many manufacturers producing electrolytic capacitors. However, not all are covering wider lineups, from smaller to bigger size, or lower to higher voltage. RUBYCON can offer various products concerning electrolytic capacitors. Especially in the high voltage range with 400 to 450V input side there is only a limited number of reliable suppliers. RUBYCON is one of those few manufacturers, and still develops innovative technologies to the market. Like the new Snap-in type THC series (125°C 2.000hrs) reaching the highest temperature of 125°C. Today, more and more

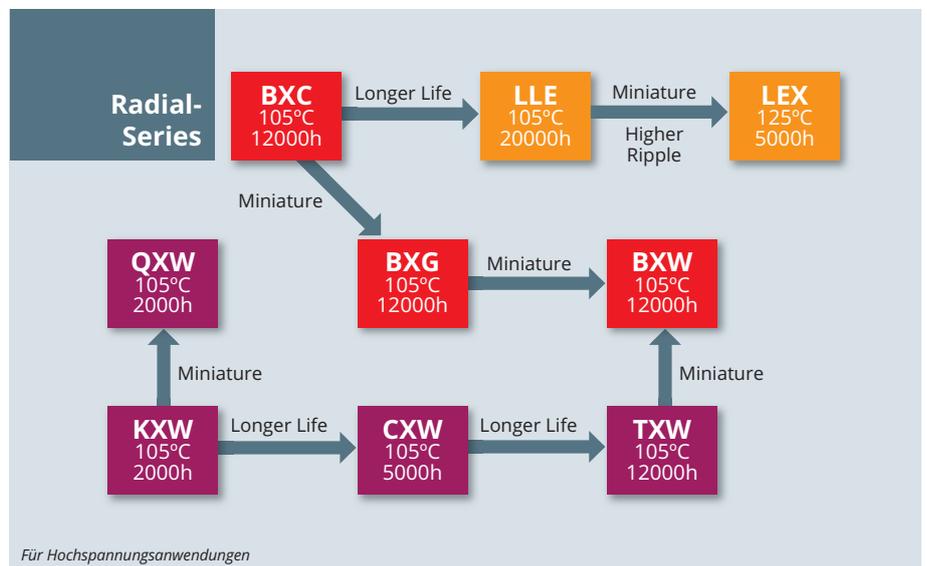
automotive applications need input filtering E-caps. The main increase comes from EV charging. For both charging station side and On-Board Charger side, they need high voltage E-caps up to 450V for power plug, but also request higher temperature together with longer lifetime. THC series will fit to those requirements.

Of course, high voltage is not covered only by Snap-in. If you need smaller size, we can recommend radial types as well. RUBYCON has increased their lineups in latest 3years. Even it might

not be updated on their website immediately CODICO always has latest information of RUBYCON. Please check with your nearest CODICO contacts, or subscribe our Newsletter for latest updates.

### Highest ripple current in the market

RUBYCON hybrid capacitors have technical uniqueness. Instead of using simple electrolyte liquid, RUBYCON selected to use non-ionic »functional liquid«. The advantages are followings:



### Good engineering support

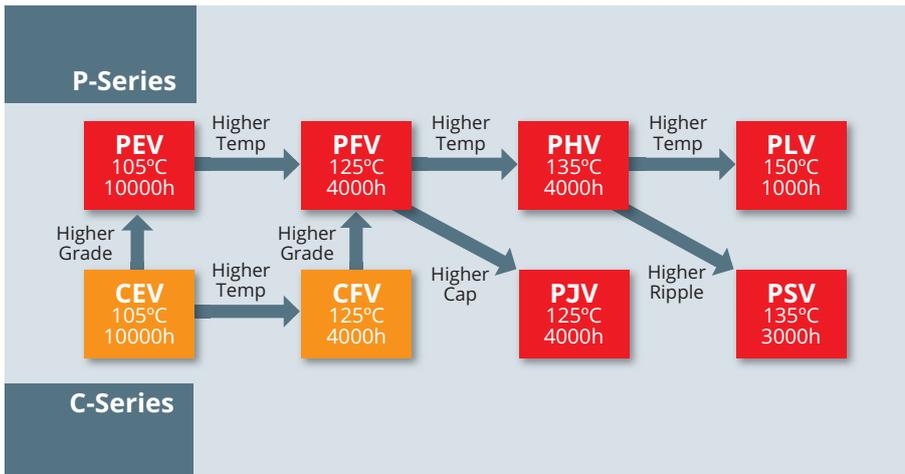
In the electronic component market, it becomes more difficult to show service and quality up-front. These are facts you will only see and experience after you started buying for your mass production. It might be too late after you had gone through all your approval processes.

To buy an E-cap in the cheapest way, you might think the easiest is to check samples at an online shop and order it. Unfortunately, this might not be the best idea. E-caps look like easy components to replace. But E-cap catalog specifications from reliable manufacturers show data in the most severe environment with plenty of margin on it. If you discuss with professional sales of E-caps, you will sure find much appropriate product series offering a cheaper solution. Therefore, for E-caps, the cheapest solution is to discuss with suppliers or their design-in distributors. The key point to reduce the cost of E-caps is to know its environmental condition like lifetime, temperature, ripple current, voltage, thermal conditions, etc. CODICO and RUBYCON engineers have a lot of knowledge on that. We are in direct contact to RUBYCON engineers every day, so you will get faster and most useful information. Good quality is slightly easier to find out rather than good service supplier. There are some markets like Automotive, which definitely need reliable and experienced manufacturer. In such market, only few suppliers are listed because they have proven engineering innovation and very high reliability. RUBYCON is one of those few suppliers.

Quality is the result of improvement attitude against many failures in long years. It cannot be created in one day, but can be destroyed quickly. For many years, RUBYCON had built their brand fame as the best quality. This fame comes from their own culture. RUBYCON's HQ is located in Nagano prefecture in Japan. Nagano prefecture is pretty countryside, and the people there are very well-known in Japan as too serious and argumentative. These characters have built RUBYCON's philosophy to provide the best quality. In addition, for engineering service they always appreciate to discuss with you. For sure, you will always find the best E-cap solution from RUBYCON.

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- Lower ESR / Higher ripple current
- Stable ESR in lower temperature
- Exceeding rated ripple current even at higher temperature
- Specification stable over lifetime  
(See more details on Impulse 01-2018: »RUBYCON's Polymer Capacitors - Hybrid Type«)

### Wide product range

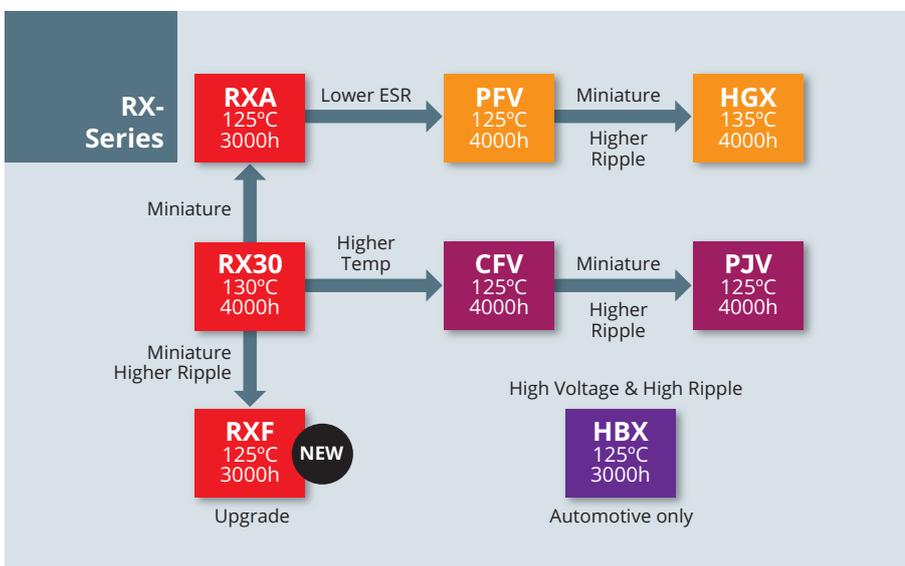
If you need a smaller size output filtering E-cap, with high ripple current but also enough capacitance, then an electrolytic capacitor will be the suitable option. RUBYCON has various series meeting your demand, and still expands their highest technical series.

Even standard PEV (105°C/10.000hrs) and PFV (125°C/4.000hrs) can accept much higher ripple current than rated one, RUBYCON has PSV series (135°C/3.000hrs) which can accept the highest ripple current in the market.

More and more automotive customers request higher ripple current in output filtering. RUBYCON hybrid technology will be the key in future. Moreover, if you do not want to consider unstable electrolytic liquid characteristic in lower temperature range, RUBYCON's hybrid will sure fit to your demand.

One example of SMD type is TSV series for 150°C/1.000 to 1.500hrs. There are no other suppliers, which accept 1.500hrs. in 150°C with SMD type. In addition, it includes highest ripple current and higher capacitance. What is surprising, there still is room to customized improvement.

This is valid for Radial type as well. RX50 (150°C/1.000hrs) and RXG (150°C/1.500hrs) can withstand 150°C, and are the top runners for highest temperature. Compared to any other competitors, RXG series offer the highest ripple current with biggest capacitance.



# SOLENOID PRODUCTS

## TSE: A New Top-Supplier



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We are happy to inform you that this year we will list a new manufacturer in our portfolio. The new partner is the result of an acquisition by our highly successful supplier TXC (Crystals).

Our new supplier is TSE (Tai-Shing Electric), develops its products in Taiwan and manufactures them at two different locations within Taiwan and mainland China. TSE was founded in 1973 as a component distribution company in Taiwan. Solenoid production was started in 2002 and TSE has been a success story since and is listed on the stock exchange since 2016.

TSE has focused on solenoid products and is one of the top suppliers worldwide in this field. For this reason we see this company as the ideal partner by our side for the future. TSE offers huge benefits for the customer in different industries such as automotive, white goods or security. TSE

offers all relevant tests for these areas, including ISO9001, ISO14001, TS16949 and, since 2018, IATF16949:2016.

The product development is located in Taiwan and in Europe there is a support department by a German speaking TSE team. So the colleagues in Frankfurt can support during the whole product life cycle.

### The Solenoid

Solenoids are simple components that can be used for various applications. The name solenoid is derived from the Greek word »Solen« which means a channel or a pipe. Solenoids are used

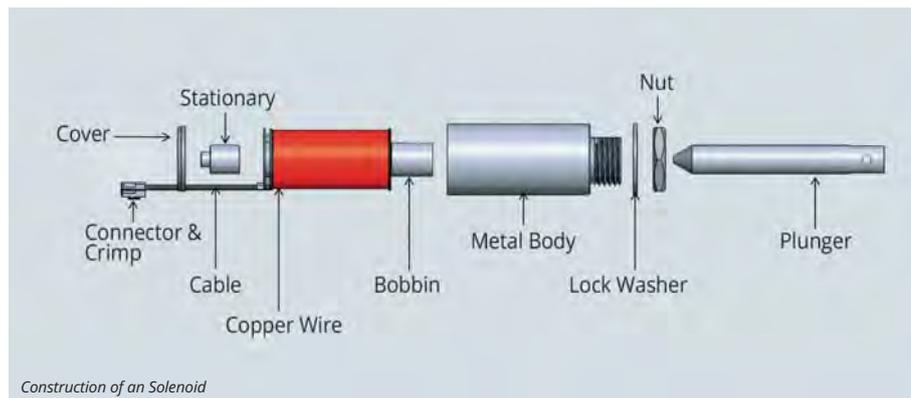
in both domestic and industrial equipments, they are available in various designs, each of them has their own specific applications. Although the application changes, their working principle always remains the same.

The solenoid simply works on the principle of »electromagnetism«. When the current flow through the coil magnetic field is generated in it, if you place a metal core inside the coil the magnetic lines of flux is concentrated on the core which increases the induction of the coil as compared to the air core.

Most of the flux is concentrated at the core, while some of the flux appears at the ends of the coil and a small amount of flux appears outside the coil. The magnetic strength of the solenoid can be increased by expanding the density of the turns or by increasing the current flow in the coil.

### Advantages of Solenoids

- High reliability
- Low cost
- Customized solution
- Good after-services
- Professional R&D team
- Good quality
- Local technical support at Europe



Construction of an Solenoid

P09

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# WELCOME AISHI

## CODICO Now Features AISHI Capacitors.



Hunan Aihua was founded in 1985. The AIHUA Group has been able to firmly establish itself in the market with the »AISHI« brand, and its share in the worldwide production of electrolytic capacitors has been increasing steadily.

The company's strength is its own aluminium foil production plants, which guarantees the production of high quality electrolytic capacitors. Production sites are located in Hunan, Sichuan, Jiangsu and Xingjiang.

Currently, AISHI ranks fourth in the the worldwide electrolytic capacitor market, and is No.1 in the chinese market. Their success is not only attributable to competitive prices. The ultimate target is to become the No.1 quality provider worldwide. They are also ISO 9001/14001 and

IATF16949 certified. AISHI's target markets include white goods, LED/lighting, industrial and new energy. For high voltage and large size electrolytic capacitors, AISHI offers a very competitive technology at reasonable prices thanks to its own film production facilities.

If you have any questions, please feel free to contact me.

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### PRODUCTS

- Aluminum Electrolytic Capacitors (SMD and Radial/THT type)
- Large sized Aluminum Electrolytic Capacitors (Snap-in, Lug and Screw type)
- Conductive Polymer Aluminum Capacitors (SMD and Radial/THT type)
- Conductive Polymer Hybrid Aluminum Capacitors (SMD and Radial/THT type)
- Multi Layer Polymer Capacitors
- Film Capacitors



# MULTITALENT HYBRID-SUPERCAP



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For engineers who are faced with the question of whether to use a battery or a supercap, EATON has the solution - a hybrid supercap that uses both, battery and supercap technology, and thus provides the advantages of both technologies in one component.

Main advantage of EATON's hybrid supercaps is the significantly higher energy density compared to conventional electric double layer capacitors of up to 10 times, which provides longer back up times.

Furthermore, they have a lower leakage current and lower self-discharge. In practice this means that the hybrid versions will discharge not in weeks (like supercaps), but months only. They also offer a higher operating voltage of 3.8V. In comparison with Li-ion batteries, EATON hybrid supercaps provide a longer lifetime, significantly higher load cycles and a wider temperature range. Additionally, they don't have shipping or storage restrictions.

Lithium-ion batteries work by moving Lithium ions in- and outside the crystal structure of the carbon anode. This process physically wears out the battery which results in a lower cycle life. The hybrid supercap stores charge electrochemically

as a thin film that builds up on the surface of the electrode, which results in a cycle life similar to EDLCs, but with lower self-discharge.

Doping the electrode lowers its potential and increases the maximum working voltage to a level

similar to that of Li-ion batteries. This construction is also free of the metal oxide that can cause Li-ion batteries to a thermal runaway when shorted or punctured, making hybrid supercaps a safer energy storage device.

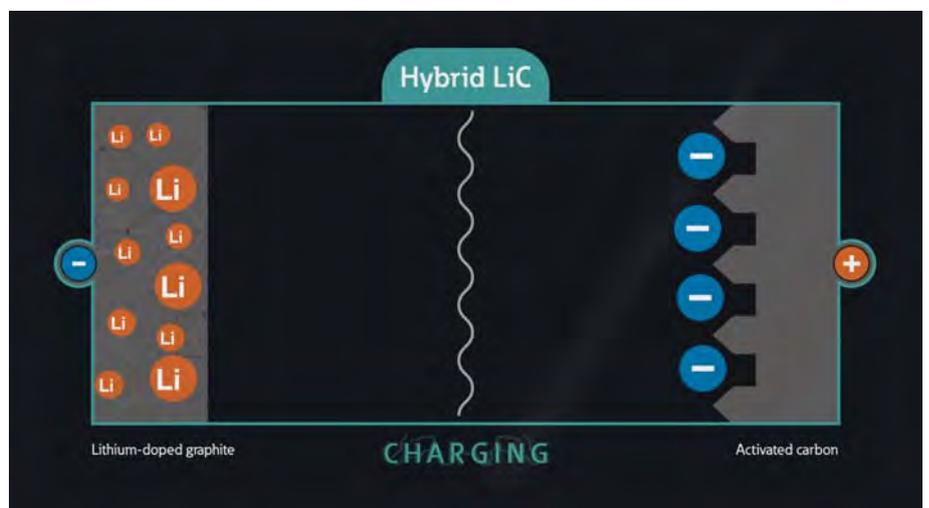
Capacitance range: 30 to 220F

Dimensions: 10.5×18 to 16.5×27mm

Operating temperature range: -15 to +70/85°C

-15 to +70/85°C (HS-series, 85°C with voltage de-rating)

-25 bis +60°C (HSL-series)





## News from RUBYCON

### Advantages compared to conventional supercaps

- High energy density provides longer back up times
- Low leakage current provides long life when used with a primary battery
- Low self-discharge maintains voltage over long periods with no charge source
- High voltage single cell better match to battery voltages
- High voltage can require fewer cells to meet system voltage

### Advantages compared to Li-ion batteries

- Long lifetime: 10 years at 20°C
- Long cycle life: 500k (HS-series), 250k (HSL-series)
- Safety: no thermal runaway – short circuit does not cause fire
- Wider operating temperature range

### Further battery disadvantages

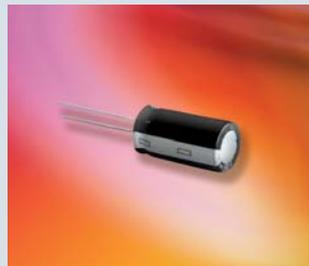
- High current recharge shortens lifetime
- Higher internal resistance limits power
- Must manage thermal load
- Require sophisticated battery management system
- Must be oversized to reach longer lifetimes of over 5 years

### Applications

- Smart Meters
- Industrial controls / factory automation
- Industrial equipment backup power during electricity down for safe shutdown and signaling
- Medical equipment alarms & battery backup/swap
- Solar powered asset tracker mounted on containers, train cars, truckloads, agricultural vehicles, construction vehicles, motor boats etc.
- Emergency lighting
- Flash memory
- RAID servers

**P11**

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### BXG series (NEW!)

**New high-voltage, high-capacitance, long-life radial (THT) E-caps:**  
**105°C/10,000 to 12,000hrs.**

This new series is a miniaturized BXC series, and it will constitute the middle range between BXC and BXW.

Application: Lighting, automotive and communications

Voltage range: 160 to 450V

Size range: 10×16 to 18×25mm

Capacitance range: 8.2 to 270µF



### LEX series (added 450V)

**High-voltage, long-life radial (THT) E-caps:**  
**125°C/4,000 to 5,000hrs.**

Application: Lighting and small base stations

Voltage range: 160 to 450V

Size range: 6.3×11 to 18×31.5mm

Capacitance range: 1 to 56µF



### TPV series (added 50V)

**SMD E-caps for output filtering:**  
**105°C/2,000hrs.**

Application: All applications

Voltage range: 6,3 to 50V

Size range: 6.3×6.1 to 10×10.5mm

Capacitance range: 47 to 2,200µF



### RXF series (added 80V)

**Wide temperature range radial (THT) E-caps for output filtering:**  
**125°C/2,000 to 3,000hrs.**

Application: Automotive

Voltage range: 25 to 80V

Size range: 10×20 to 18×30mm

Capacitance range: 180 to 1,000µF

If you have any questions, please feel free to contact your nearest CODICO representative.

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# INDUSTRY 4.0

# INDUSTRIAL ETHERNET

Amphenol ICC

The focus of Industrial 4.0 will be on intelligent machine-to-machine communication, robotics, and automation through faster and smarter networks. This is made possible with high-speed industrial Ethernet connectivity.

With the introduction of several new Ethernet standards, factory automation programs utilising Industrial Internet of Things (IIoT) connectivity now have expanded capabilities to communicate in the same language from sensors and input devices, all the way up to the cloud. Whether the requirement is for a single twisted pair up to 1km away (10BASE-T1L), or a 10GBASE-T connection (Cat6A) carrying real time inspection data over a four pair connection, AMPHENOL has a full range of Industrial Ethernet connectors to reliably help carry the load. AMPHENOL ICC offers a range of interconnect and cable assembly products which support Power over Ethernet (PoE) or Power over Data Line (PoDL), so that remote devices can be powered through the same connection that carries the signals.

### SPE: The Future of Industrial Ethernet

Ethernet is serving many modern industrial and commercial applications like smart lighting, intelligent building, IP based security systems, and factory automation with flawless data transfer capacity and current handling capabilities. Digital connectivity and modularity in industries are enabling flexible production.

### What is SPE?

Single Pair Ethernet or SPE is an advanced and much simpler form of Ethernet connectivity. It replaces the traditional co-axial twisted cable lines. SPE narrows down the earlier two or four



Product Series	Boltrack™	SPE IP20	ix Industrial™ IP20
Pairs of Cable	4	1	4
Bandwidth	250MHz	600MHz	500MHz
Performance Cable Length	Cat 5e, 100m	IEEE802.3bp 1000BASE-T1 up to 40m IEEE802.3bw 100BASE-T1 up to 15m IEEE802.3cg 10BASE-T1 up to 1km	10GBASE-T up to 100m 5GBASE-T up to 100m 2.5GBASE-T up to 100m 1000BASE-T up to 100m 10/100 BASE-T up to 100m
Max. Voltage per Pin	1800VRMS contact to contact	60VDC	60VAC
Max. Current per Pin	1.5A	4A	1.5A
PoE Capability	IEEE802.3af (PoE) 15.4W IEEE802.3at (PoE+) 30W IEEE 802.3bt (PoE++) 100W	IEEE802.3bu (PoDL) 50W	IEEE802.3af (PoE) 15.4W IEEE802.3at (PoE+) 30W IEEE 802.3bt (PoE++) 100W
Standards	Telecordia CO GR-1217-CORE IEC 61076-4-104 ANSI UL1977	IEC 63171-6	IEC61076-3-124
Shielding	360° (fully shielded)	360° (fully shielded)	360° (fully shielded)
Mating Cycles	200	1,000 minimum	5,000 minimum
Operating Temp Range	-40°C to +125°C	-40°C to +85°C	-55°C to +85°C
IP-Level	-	IP20	IP20
Latch Retention Force	50N minimum	50N minimum	80N minimum

pairs of cables to just a single pair, saving space and enabling a comprehensive array of standardized communication protocols. SPE can rely on the existing architectures and extend connection up to 1000 meters with PoDL (Power over Data Link) capability guaranteeing maximum flexibility. The key support for next generation of automation technologies like IIoT and Industry 4.0 is simplified with SPE.

AMPHENOL ICC has industry-leading technical expertise in manufacturing ruggedized & sealed high speed data interconnect products in industrial markets. They are a key supplier of Single Pair Ethernet solutions used in both industrial and automotive markets.

### Benefits of SPE Connectors

Amphenol ICC's Single Pair Ethernet (SPE) connectors bring direct Ethernet connectivity to peripheral devices like sensors, actuators, and vision system cameras that operate at speeds up to 1Gb/s and delivers PoDL (Power over Data Link) up to 50W. SPE eliminates the need for costly and complex Fieldbus protocols and conversion gateways by simplifying and standardizing existing and new industrial network systems.

These IEC63171-6 compliant industrial Ethernet connectors are mechanically robust and feature secure latching with 360° shielding for excellent performance in harsh environments. Single pair cable reduces cost, weight and space requirements compared to 2 and 4 pair cabling. These connectors come with current handling up to 4A in right angle and vertical PCB mount versions. The SPE jacks mate to field terminable plugs, providing a complete shielded interface with metal latching features and easy installation.

AMPHENOL ICC's SPE connectors are compatible with other SPE Industrial partner network products and can provide innovative flexible solutions for unique applications.

S01

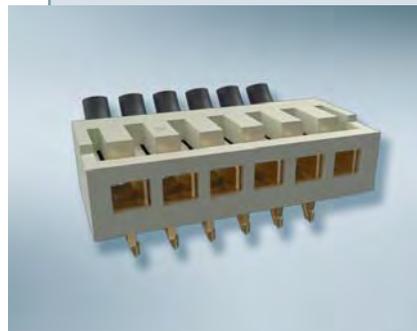
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Amphenol  
ICC

## Minitek® Board-In Connector

Single piece flexible solution for permanent wire-to-board applications.



The FCI Basics Minitek® Board-In connector system is a flexible solution designed for economical and permanent wire-to-board applications up to 3A. It is a one-piece direct solder-to-board solution that provides space and cost savings compared to a two-piece connector system. It is currently offered in 2-16 positions under 2.00mm and 2.50mm pitch sizes covering vertical and horizontal configurations.

Minitek® Board-In is ideal for applications in Consumer, Datacom, Industrial & Instrumentation and Automotive markets.



FEATURES	BENEFITS
Accepts standard through hole soldering methods	More reliable compared to hand soldering
One-piece direct solder-to board assembly	Provides space and cost saving compared to the two-piece connector system
Offered in two pitches and multiple circuit sizes	Design flexibility
Vertical and horizontal configuration	Suitable for applications with limited space
Terminal and housing locking features	Secure connection

S02

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# THE SHOW MUST GO ON



## AMPHENOL Industrial's High-Power Series HPT™

### FEATURES

The HPT Series™ is an extension of the highly successful HP Series™ and brings significant design improvements to the marketplace!

The original HP Series™ connectors have been designed to be suitable for AC power supplies where a durable latch locking connector is required. They are rated at 25A@250VAC. The connectors are keyed and colour coded for power-in (blue) and power-out (grey). But they are not »hot pluggable« and without »breaking capacity«.

The new HPT Series™ Power Connectors can be even connected or disconnected under load with a rating at 16A@250V and additional IP65 protection class. Front-end safety keying features are built into the design, eliminating the safety risks of mis-mating associated with worn out master key designs. They are equipped with an easier-to-use, innovative, patent-pending cable clamp

- 2+PE contact layout
- IP65 rated (in mated condition)
- 20A@250V (16A@250V EU)
- Quick release and lockable latch
- Vibration resistant
- High impact UV resistant material
- True Mains Connector with Current Breaking Capacity (CBC)
- Industry standard mating interface
- Jumbo versions (»J«) of the cord connectors are UL rated for 12-3 SO cord
- UL, cUL recognized components



The new HPT Series™ from AMPHENOL-Industrial

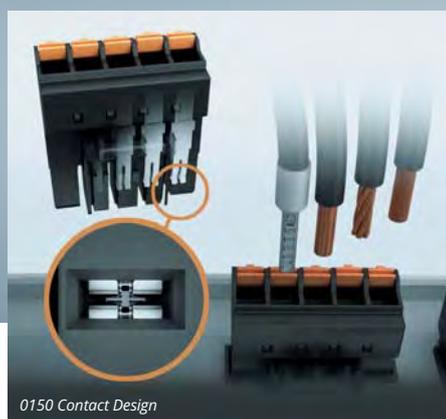
lock design and the components are fully UL recognized. Designed to be fully plug compatible with the original and latest industry standard products, the HPT Series™ is an ideal »first choice« or »drop in« replacement for power distribution interconnect needs.

The main applications are Entertainment and Broadcast Lighting, LED Video Walls, Stage Power Distribution Boxes and powered loud speakers.

S03

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# FOR ALL CASES



0150 Contact Design



0191 Series Colours

## 0150 Series: UL approval made easy

The 0150 series from DINKLE was specially developed for industrial applications and scores points wherever high currents and voltages have to be switched reliably and in the smallest of spaces. An absolute milestone of the series is the unrestricted UL rating of 600V (1000V according to IEC) for cable connectors and PCB sockets in 6.35mm pitch. The pluggable terminal blocks are also available in 5.08mm and 7.50mm pitch sizes. The connectable conductor cross-section range extends from AWG 24 to AWG 12 and allows currents of up to 20A.

Thanks to the modern push-in connection, wiring can be carried out in a time-saving manner and without the use of special tools. The tulip-shaped design of the contact spring in combination with the flat contacts in the PCB socket ensures a high level of contact reliability. The cable connectors are available optionally with cable outlet parallel



0150 Series

or 90° angled to the PCB. The innovative locking latch allow quick insertion and removal and ensure a robust connection even under strong vibrations. Supporting pins on both sides provide additional stability of the terminals on the PCB. The positioning of the retaining clips at the lower edge of the connector enables a compact and space-saving housing design. Typical applications for the 0150 Series from DINKLE are motion controllers and servo drives.

## 0191 Series: Pinstrip Terminal Blocks with compact design

The 0191 Series from DINKLE is a pinstrip version of pluggable PCB terminal blocks with an innovative push-in design.

A major advantage of this family of pluggable terminal blocks is their extremely compact design. The contact to the printed circuit board is made via space-saving pin strips with 1.3mm diameter. These are optionally available with high temperature resistant plastic for Through Hole Reflow (THR) process.

In addition to the single-row terminal block, a version with double connections is also available in 3.50 mm pitch, in which two lines are connected to one potential on the printed circuit board. Thanks to the modern push-in connection, wiring can be carried out in a time-saving manner and without the use of special tools.

Due to the modular design, Dinkle can assemble terminal blocks in different colours according to individual configuration during production. The optional cover serves both as a protection for the pins and as a lever for withdrawing the terminal block from the pin header conveniently. The 0191 series is typically used in the low voltage actuator industry.

### TECHNICAL DATA

- Pitch sizes: 3.50 and 5.00mm
- Number of poles: 2 to 20
- Nominal voltage: UL 150V/300V (IEC 160V/320V)
- Current carrying capacity: UL 2A/8A (IEC 4A/9A)
- Applicable cross-section: AWG 28 to 16 (0.2 to 1.50mm<sup>2</sup>)
- High temp. resistant pin strips for THR soldering process
- Different pin lengths
- Individual colour configurations possible

S04

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0191 Series

# BEE COLLECTION



## Small-Sized Power and Signal Connectors



Bee Collection is based on the shared concept of »Small but Strong« and consists of three brands: EnerBee, SignalBee and SnapBee. The image of the tiny, yet energetic bee represents this concept.

Each brand has its own features and provides high quality and flexibility to meet a variety of connector needs, including connection method, termination, lock requirements, plating and wire size.

**EnerBee** for power applications offers a positive lock safety design in addition to its superior performance, small size and ability to support high current and high voltage devices.

The signal cable connector brand **SignalBee** offers multi-purpose, versatile solutions that meet users' application requirements and deliver high performance in a diverse array of fields.

**SnapBee**, specialized for operability ease, adopts an original vertical mating method (Snap Lock) to increase board layout design freedom and provide excellent usability. For a wide range of connectivity solutions from power to signal, look no further than Bee Collection.

### Enerbee – Compact Size with High-End Performance

In addition to its superior performance, small size and the ability to support high-current and high-voltage devices, EnerBee offers a positive lock mechanism to meet various requirement of industrial power supply and power sources. Replacing bulky parts in the market with EnerBee

connectors allows you to maximize space-saving and achieve superior performance. Additionally, by replacing locks with the EnerBee's built-in positive lock mechanism, assembly quality and work efficiency are improved.

#### FEATURES

- Center-lock system – saves on PCB mounting space**  
 Enables high density mounting by center lock saves space for fingers to unlock the connector which is necessary for side lock contributing to high density mounting and saves valuable PCB space (all product series).
- Keying Variations – safe design**  
 Three keying and color options are available for the DF22 series. This prevents incorrect mating of the connectors when using multiple DF22's with the same pin count on the same design.
- Resin sealing**  
 Protects mounted components from moisture and other foreign matter such as dust and dirt (DF33C/DF63/DF22).
- Vertical-mating with lateral cable design**  
 Clear tactile click and wide operation space improve work efficiency (DF63SF).
- Multi-point contact structure - Secure contact and superior vibration resistance**  
 Three contact points in the lower portion have an independent spring action and allow for each contact point to position itself when mating (DF60/DF63/DF22).





## FEATURES

### • Easy Operation & Space Saving

Vertical mating prevents interference with other components on the PCB, which save space. Since the receptacle can be seen from above, the operator can align and mate the connector easily. In case of horizontal mating connector, other parts can't be placed in the front of the interface because room is needed for insertion/extraction.

### • Snap Lock Design

Unique snap lock design is strong against cable routing and provides flexible cable layout.

S05

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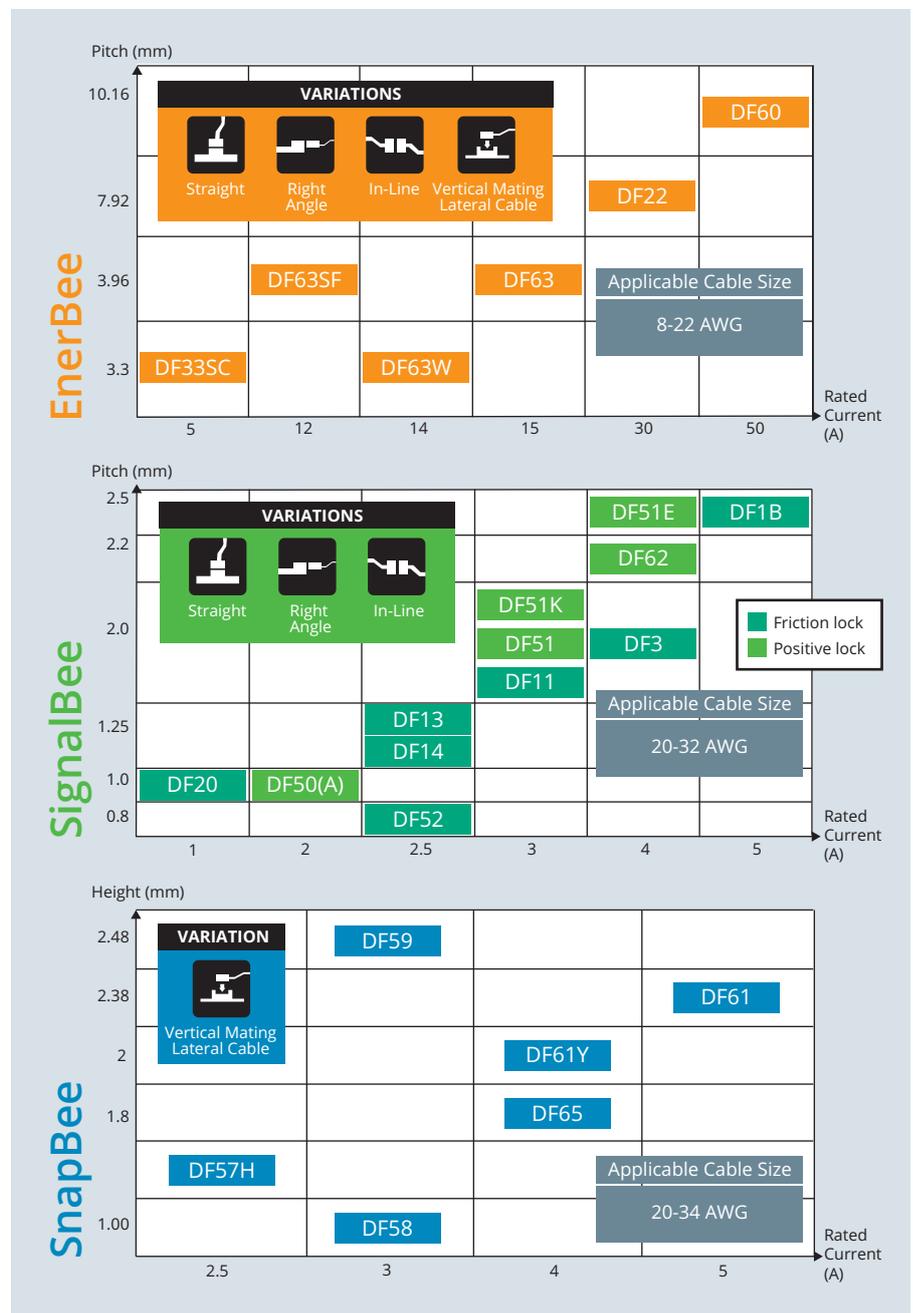
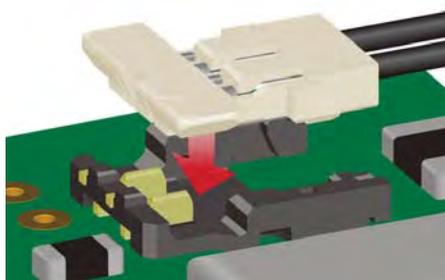
## SignalBee – Wire-to-Board, Wire-to-Wire Signal Connectors

SignalBee offers powerful and high performance in many fields including industrial machinery. Overwhelming product quality and excellent crimping technology is based on accumulated, comprehensive know-how in areas such as assembly tool development. Various options contribute to space saving and assembly labor savings. SignalBee - Your best choice for signal cable connectors.

## SnapBee – Vertical Mating Wire-to-Board Connectors

This product series is widely used in small equipment power supply applications. HIROSE has released a new cable connector brand »SnapBee« following the release of their brands EnerBee and SignalBee. In the industrial machinery market as well as in the consumer electronics market, demand for even smaller and thinner products as well as space restrictions of sets are increasing.

SnapBee offers high performance, compact design, and a vertical lock (snap lock). By utilizing HIROSE's microtechnology, they have been able to create the best selection of products to solve structural component interference and improve workability when selecting connectors.



# AUTOMOTIVE CONNECTIONS



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With its HVH-280 series HIROSE launched a new power connector for automotive applications.

The HVH-280 Series are low profile connectors with a 3-point high pressure female contact design that enables a high current capacity of 30A. There are two versions available which are waterproof or non-waterproof.

The series is designed with heat resistant materials to withstand severe temperature environments; the non-waterproof version can withstand temperature ranges up to 125°C and 120°C for the waterproof version. With this heat resistance capability the connector satisfies the needs of severe automotive requirements. Along with heat resistance, the HVH-280 Series

includes features which allow a reliable insertion of the contact and the provision of strong vibration resistance.

The non-waterproof version is equipped with a retainer which ensures that the contacts are correctly assembled into the connector housing. The waterproof version comes with a CPA (Connector Position Assurance) which makes an accidental unmating of the connector impossible. Only by intentional activating of this CPA with a tool like e.g. a screwdriver, the main locking mechanism will be operational again.

Suitable applications are converters, inverters, positive temperature coefficient (PTC) heaters, on-board charger, distribution boards and robot controller units.

## KEY FEATURES

- Contact positions: Non-waterproof: 3  
Waterproof: 2 Power, 2 Signal
- Pitch: Non-waterproof: 6.5mm, Waterproof: 9.5mm
- Rated current: 30A
- Rated voltage: AC/DC 600V
- Cable size: AWG 12-14
- Temperature range: -40 to 125°C (120°C waterproof version)
- Mating cycles: 30
- Finger protection: JIS C 0920 standard (waterproof version only)

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HEAT RESISTANT UP TO 125°C

Non-Waterproof

Waterproof

# Robust Lock: HIROSE's DF51K Series

HIROSE Electric introduced the DF51K series of robust Wire-to-Board Connectors for applications requiring more strength and durability.

A wide range of applications are suitable such as industrial machinery, medical devices, smart meters, industrial robots, and many others. DF51K connectors feature a center lock design that allows the connectors to be placed side-by-side to save space on the board. The mating operation is user-friendly and a clear tactile click confirms secure engagement and a reliable connection.

These connectors feature a strong contact lance strength which increases the contact retention in the housing and prevents the contacts from pulling loose if the cables are wrenched. Furthermore DF51K is polarized through the use of guide keys to prevent incorrect mating.

DF51K offers many variations for design flexibility. Single or double row versions are available in a straight or right angle housing with the option of gold or tin plating.

The DF51K series is part of the SignalBee product family. SignalBee consists of compact and high performance Wire-to-Board and Wire-to-Wire connectors that are designed for the requirements of industrial applications (see page 39).

## KEY FEATURES

- Number of contacts: 1 row: 2-6 / 2 rows: 4-30
- Contact pitch: 2mm
- Current rating: 2A (max)
- Voltage rating: AC/DC 250V
- Temperature: -55 to +105°C
- Cable size: AWG 22-30
- Accepts resin sealing
- UL/C-UL certified
- RoHS compliant

S07

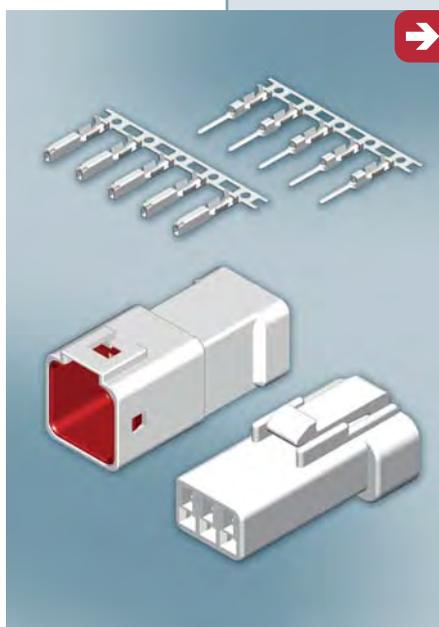
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## DF51K series: Wire-to-Board- Connector



## CPB2 series from CviLux



# CviLux: Waterproof Connectors

CviLux presents a waterproof wire-to-wire connection with its CPB2 series. Due to its compact dimensions, the series can be used well in limited spaces with IPX7 requirements.

The CPB2 series is designed with a pitch of 2mm, depending on the version, for currents of 1-3A. The number of poles and wire cross section are from 2-8 poles and AWG22-28. Both single-row and double-row versions are available. The connector series is compatible with all common manufacturers.

## Anwendungsbereiche

- White Goods: Refrigerator, Washing Machine
- Automotive: Lamp and Side Mirror
- Railway: Inner and outdoor lighting system, low current power system
- Industry: Automation Equipment
- Lighting: LED lamp, Outdoor Lighting

## SERIES CPB2

PITCH (mm)	ROW	PIN COUNT	WIRE AWG	CURRENT RATING	IP
2.00	Single Row	02, 03, 04	AWG #22-26	1A-3A	IPX7

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# NEW BENCHMARK



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## M12 Push-Pull According to International Standard

The push-pull version of the M12 connector with inner locking from YAMAICHI Electronics is the very first M12 push-pull design, which has been defined as an international standard (IEC 61076-2-012). Therefore, M12 push-pull design-ins are possible now for M12 push-pull systems, without using proprietary solutions

The cable-side connector engages deep into the device socket from the inside with locking hooks. As a result, the push-pull system requires only the same installation space as a common M12 connection with screw locking. With this technology, it is possible to completely insert the M12 socket into the device, e.g. to integrate it into a distribution box, aligned flush with its housing. The system is IP65 IP67 water and dust proof and uses independent sealing concepts for screw-type and push-pull connector.

Thus, the mixed usage of the connectors is possible in a reliable way. The particularly long locking hooks of the cable connector are supported by the threaded segments of the device socket. This makes the system mechanically extremely robust. In addition, this offers significant advantages when subjected to torsional loads and rotational forces. This means the user takes advantage of all the benefits of the push-pull locking system: considerable time saving, miniaturisation, blind and tool-free contact mating with simple handling – all in accordance with the standardised M12 specification.

### Standardisation brings security

During the international standardisation, industry-standard requirements regarding device integration and functionality were introduced and taken into account. This ensures the ideal basis for cross-manufacturer compatibility, which has already been proven between different manufacturers.

The fast implementation of the IEC 61076-2-012 in less than 2 years is further evidence of this.

### Fully backward compatible

The wall-mount socket can still be mated with conventional M12 connectors with screw locking. Therefore, users are not necessarily dependent on a special cable connector and thus remain flexible.

S09

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THE  
STANDARD  
IEC 61076-2-012  
★★★

M12 with  
Push-Pull locking



# All Good Things Come in

# THREES

**A reliable Board-to-Cable System with FFC »Made in Germany« for Automotive Applications!**

The Y-Lock series is a board-to-cable system and available in 3 different versions. In the last years the renowned system has proven itself. It is successful in diverse automotive applications. The FFC (Flexible Flat Cables) suitable for the connector are produced in YAMAICHI Electronics' own factory in Germany.

The non-ZIF-based connector system is especially outstanding for its locking system, which works without opening or closing a flap or drawer and without actuating an unlocking mechanism. In the current version 1, the interlock is provided with a ratchet hook on the housing of the connector, which engages behind the supporting tape of the FFC/FPC. Both contacting and removal of the FFC are very simple using a defined pull-out force.

## Positive features of version 1 retained

The Y-Lock version 2 retains all the positive features of version 1, but also offers some interesting new features. An additional plastic stiffener has been added that is mechanically assembled with the FFC. The stiffener then engages with the connector. This new system makes guiding the FFC and inserting the FFC into the connector more convenient. The pull-out force for the FFC has also been increased from about 10N to about 25N.

Another advantage of the Y-Lock series is the greatest possible security of the contact coverage between FFC pads and connector. The contact coverage is provided by the FFC guide rails in the connector. This facilitates even more the FFC guiding by the stiffener which positions the FFC. That makes it simply impossible for the FFC to



YAMAICHI Y-Lock Connector

## Y-Lock Pullforce

### Various pin counts

Version 2 of the Y-Lock Pullforce is available as 18 and 50-pin variant with a pitch of 0.5mm and a connector orientation of 180°. Other pin counts and design variants are available upon request. This allows the practical expansion of the already wide range of version 1. Version 1 is available in pitches of 0.5 and 1.0mm as well as with 12 to 30 contact pins in 90° and 180°. Currently version 3 is available as 20-pin version with 1.0mm pitch or as 10-pin version with 2.0mm pitch. The series are enhanced continuously by new pin-counts.

### From own production in Germany

YAMAICHI Electronics offers the matching FFC's for all 3 versions, with or without additional stiffeners. Samples of all versions including the FFC are available upon request. The FFC (Flexible Flat Cable) is manufactured in the own factory in Frankfurt (Oder) in Germany.

### Experience in automotive industry

YAMAICHI Electronics designs, manufactures and distributes various automotive connectors for applications like e.g. infotainment, camera systems, car computing, antennas, TV, navigation, radar and lidar as well as battery management systems, etc. The automotive connectors are produced in ISO TS16949 certified manufacturing sites.

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be crooked, which is always a possibility when using ZIF connectors. That means there is no danger of a lack of contact coverage.

### Version 3 with additional locking

Version 3 is equipped with additional locking mechanisms for an even better contact reliability in critical applications. The additional lockings are realised by lateral and frontal latches. Besides of the additional lockings the version 3 is identical to version 2.

The Y-Lock concept is particularly suitable for space-critical installation situations, permitting secure connections even in the absence of visual contact – whether you are using manual or automated insertion. Due to the robust design this version is particularly in demand for battery management systems.

### Increased load capacity of all 3 versions

All 3 versions were specifically designed for the needs of applications subject to increased requirements, such as automotive or industrial applications. For example, increased load capacity in terms of both vibration and shock and harsh climatic requirements over a temperature range of -40 to +105 °C were considered. Qualification was therefore based on the demanding LV 214 automobile standard.

# MAGICSHARK™

## The Strongest Connector!



© AdobeStock/Andreas Izatt

The brand new MagicShark™ series is a miniature wire-to-board connector system with an enhanced locking mechanism that indicates the completed mating process with an audible click. It is the perfect connector for pure power or data transmission and is also available in a hybrid version.

The MagicShark™ series from BELLWETHER is designed for space-saving applications and due to its robust construction it can be used in environments with strong vibrations. With the optional SMT fitting nails no additional holes in the PCB are required. A DIP version with even higher retention force is also available.

### Enhanced locking mechanism

The MagicShark™ series uses an angled slide-in design with two main and two secondary locking latches to prevent incomplete mating during assembly and unintentional disconnection during operation. A four-directional wrenching force greater than 3kg is required to separate the two connector halves.

### High-Current Capacity

Thanks to the dual-contact terminal design, the MagicShark™ connector can transmit up to 4.5A on a single power line in a limited space. To meet different requirements, the series is available in three types with 2 to 20 contacts:

- Hybrid version for power + signal
- Power only
- Signal only

### Ultra Slim Low Profile Design

The MagicShark™ connector has a very low profile design with a mating height of only 2mm. The hybrid version uses a 1mm pitch for signal lines and a 1.50mm pitch for the power lines. Crimp contacts are available for wire cross sections from AWG#32 to AWG#24.

### Applications

- Notebook PC
- Tablet PC
- Mini PC
- Portable Device
- Industrial Usage
- Servers
- Automotive
- White Goods
- Power Tools
- P.O.S.



VIDEO

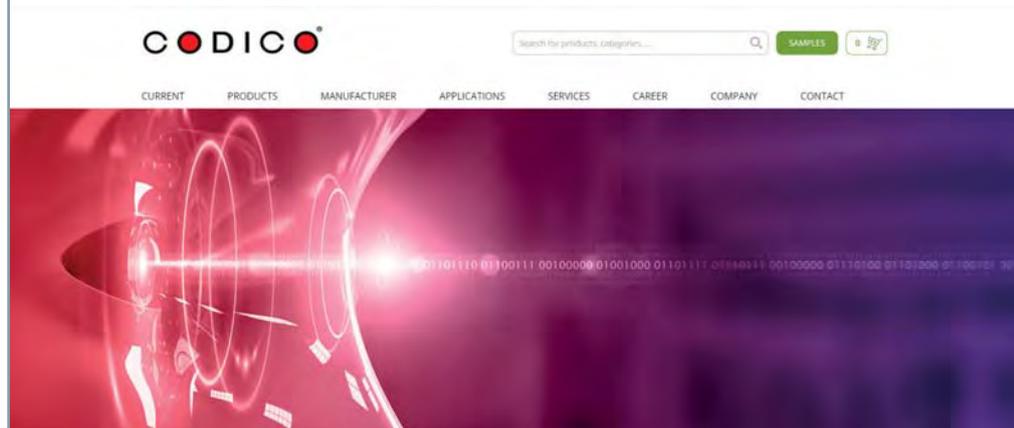


We also support individual cable harnesses with UV glueing directly from BELLWETHER and look forward to your request.

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# LOOK!



## Our New CODICO Website is Online!

We are growing! Not only in the number of sites or employees – the online sector in particular is expanding, too. Similar to the electronics industry, online technologies are also advancing at a breathtaking speed. New mobility concepts are emerging, and the issue of cybersecurity is becoming increasingly important, too. In late 2019, we decided to relaunch our website to make CODICO fit for the future.

The official kick-off for the online project came on 3 December 2019. After an intensive design phase lasting several weeks, we began with the actual implementation in March, rebuilding the CODICO website from scratch.

During planning, the topics of usability and user experience were at the forefront of our thinking. Therefore, one of the biggest highlights of the new Internet presence was the »fusion« of the website and the sample shop. Where the website and the shop were clearly separated in the past, visitors to our new website will find everything in one place: the suitable samples and evaluation boards in combination with all relevant information such as product details, manufacturer information, and news.

Another new feature are product recommendations, aimed at better supporting potential buyers in selecting the right components. Numerous filter options also facilitate the selection of the right sample online. *»Moreover, they will always find the right contact persons, that is, real specialists who will take care of all queries using their expert know-how«*, says CODICO CEO Sven Krumpel, describing the company's modern online presence. Our customers can now quickly and easily rely on CODICO's support already at the beginning of a project.

For all those searching specifically for certain products or information, the most essential feature

at the heart of our new website is a state-of-the-art search function, which leaves nothing to be desired and quickly leads to the right result.

Being a design-in-distributor, the application takes centre stage for us, and this priority is also reflected on the website. Built on a high level of technical expertise from our sales engineers and product managers, we created a whole new section around the topic of applications.

The challenge for our website project consisted in creating a new, modern look and feel and achieving a better user experience with numerous functions, yet without losing CODICO's unique recognition value.

### Find out for yourself!

A lot of information and more than 5,000 samples await you at [www.codico.com](http://www.codico.com). We wish you a successful online experience!

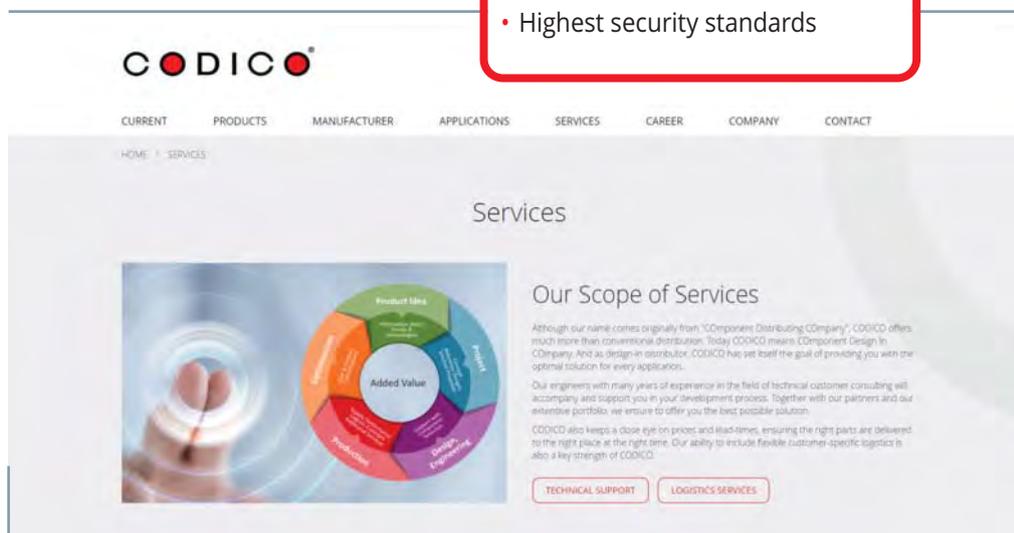
For further information:

**D03**

➤ Astrid Piller, +43 1 86305 241  
[astrid.piller@codico.com](mailto:astrid.piller@codico.com)

### Features

- More than 5,000 samples online
- All relevant information available at a click
- Interesting news
- Important information around applications
- Technical know-how in CODICO's White paper
- State-of-the-art search function
- Informative platform for potential employees
- Modern look and feel
- Highest security standards



# The CODICO TEAM says hello!



## Antonello Rosa

My name is Antonello Rosa, I am 38 years old, and I joined CODICO in April 2016. I worked for several years at Sumida Italia, where my father was the owner. Let's say I grew up on bread and inductances.

I consider CODICO to be a super company, nothing is left to chance, and it is very well structured. From the first day, the colleagues have been really helpful and kind to me, making me feel immediately as part of this company that I now consider my second family.

In CODICO, I am in charge of the sales of passive components for the whole Italian market. This gives me the opportunity to reconcile one of my passions, i.e. to travel and visit new cities in my BEAUTIFUL ITALY. And, being also a good food taster, I can try typical dishes from every region and city.

In addition to traveling, which I think everyone likes, I like to call myself a sportsman. I practice a lot of sports in my free time, and I'm passionate about martial arts since I was 6 years old - I grew up with the 80s movies by Jean-Claude VanDamme. I am currently practicing Brazilian jiu jitsu, and I should be able to get the purple belt at the next exam. I love the mountains and snowboarding in winter. I put my first pair of skis on when I was 4 years old, and when I turned 22 I switched to snowboarding. Every day I train at the gym and share this passion with my girlfriend: we are each other's personal trainer.

To conclude, I consider myself a lucky and privileged person, and for this reason I'll always take a positive look at the future.

D04

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## Alexander Steiner

In life, time and again you achieve milestones that you later look back to with pleasure. Especially as a young individual, these milestones often come at much shorter intervals - final examination, first job interview, and eventually your first job. In my case, this job interview led me to my first working day here at CODICO on June 21st 2016. I was overwhelmed with mixed feelings of pleasant anticipation and motivation, yet also a bit of nervousness and excitement. After that first working day, all that was left was the pleasant anticipation and the motivation.

I was assigned to accounting from the very beginning. The job of an accountant requires a good aptitude for numbers and, above all, a great deal of accuracy. Fresh out of secondary school, I had to work hard on that accuracy. It was not always very easy, but a kind team helped me improve and progress. Many people believe that accounting only consists of routine activities, and that one gets bored quickly. I can prove exactly the opposite. Constantly striving to find new improvements, that's what makes work interesting. I particularly appreciate the ability to work in projects as a team, and together with other departments. Our current project, which involves a partially and fully automated booking of incoming invoices and has absolutely enthralled and kept me busy for several months now, keeps surprising me with new challenges that make my daily work routine more diversified and exciting.

Outside work, I also try to stay level-headed. This is the reason why I agreed on a part-time scheme so that I could do voluntary work on the side. The Bible is a book that has fascinated me since my youth. Reading the Bible and following the advice it gives has helped me achieve a happy and fulfilled life. It is my wish to pass on this feeling to others as well, so I work as a voluntary Bible teacher to help as many other people as possible. Since such an activity must also be organized and also requires accounting, I work as an external collaborator in the Central Europe branch office of Jehovah's Witnesses in Selters, Germany. It fills me with joy to be able to follow this path together with my girlfriend! In order to stay fit, it does not suffice to stay mentally active, so one should not neglect sports. Beach volleyball, football, table tennis, ... so far there is hardly any sports I haven't been able to take pleasure in.

Joy brings strength! - Some people think that only recreation can bring joy, but I can attest that having a job and a hobby you engage in with full motivation will bring you new joy every single day.

D05

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## Irina Groiss

I have been working at CODICO for 4 years now, and I am very happy to introduce myself to you. As some of you may already know, I was born in Moscow, though I have taken roots in Vienna in the meantime, where I live with my husband and my two sprightly teenage daughters since 2001. I graduated in German philology in Moscow, and in addition to my mother tongue, Russian, I also speak German, English, and French; perhaps I will learn a couple more in the future. In addition to my main studies, I completed a two-year study course in export management at the University of Economics and Business Administration in Vienna, because I was interested in international trade. Prior to CODICO, I worked at a few other companies in the pharmaceutical and medical technology sector, where I always had to deal extensively with customers and acquired a lot of experience in different departments: in customer service, order processing, and marketing. After that, I took a daring step into independence, putting myself to the test as a director of a language school for children and adolescents.

At CODICO, I work in back office sales, so I am responsible for the entire area of pre-sales: offers, registrations, samples, price negotiations, project monitoring, and many other activities make up my daily work routine. The tasks involved are very diverse, which makes my day-to-day job very exciting, leaving absolutely no room for boredom. In the beginning, I was in charge of Switzerland, then France, Belgium, Spain, and Portugal were added from 2017 until mid-2019, and now I am concentrating on Switzerland again. What I missed in many other companies and I have come to greatly appreciate at CODICO is the very friendly and informal atmosphere among colleagues, which delighted me from the very beginning. In addition, I find the language diversity and the international team at CODICO just fantastic.

As to my interests outside work, I must admit I am a city kind of person. After all, I come from a city that now counts more than 10 million inhabitants, and I love spending my free time chatting with my friends over a cup of coffee or strolling through the streets of Vienna. I enjoy visiting exhibitions and museums, also I like going to the theatre and the movies, too. In the winter, I like skiing with my family. I did not learn how to ski until I came to Austria, but now I don't want to miss it for the world, so I look forward to the next ski season. Winter sports are generally my thing, since, as a child, I was on ice practising jumps and pirouettes almost every day. I still remain loyal to ice figure skating, but nowadays as a spectator. You will meet me in the gym two to three times a week, where I prefer doing group sessions like Deepwork, HIIT, Tabata, or Zumba. As a family, we like solving puzzles in escape rooms, we play badminton, or travel to Finland in February to drive snowmobiles, go ice fishing, or take a ride with the huskies. In the summer, I enjoy lying on the beach reading a nice book, preferably a crime or science fiction novel. Reading books always helps me calm down and unwind. Perhaps one day I will be reading books by my older daughter

D06

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## Yasunobu Ikuno

Thank you very much for reading this Impulse until this last page! I also like this page to know how my colleagues are enjoying their lives. I hope you will enjoy mine as well. My name is Yasunobu Ikuno, I am 36 years old and live in Monza, Italy. People call me Yasu, so please just call me Yasu when you see me. I was born in Japan, I grew up and graduated in Japan. Why someone like me lives in Italy and works for an Austrian company? I also sometimes wonder how fate has brought me here. Life is full of unexpected things, and if you have the chance to step into another adventure, I suggest you better take it.

I joined CODICO in 2016, and I am working as a Product Manager of quartz crystal and electrolytic capacitors. My job is to set strategies for those components and to promote them together with my colleagues. As our group leader says, »Think of yourself as a supplier, you owe it to your product.« This is how you can outline my role in the company. I think there are two types of personal development in the company. You can either grow quickly, or you can simply allow growth. You will grow anyway through your work. Only the company environment can change it's speed. CODICO is giving me a wonderful environment. That doesn't only apply to interior environment, because the best environment is represented by the human relationship between colleagues and superiors. Before I joined CODICO, I was a contact window at a Japanese supplier for CODICO. I often heard about CODICO from Matteo, my former and today's colleague who joined CODICO before me, about inside of the company. He persuaded me to join. I really had »EN縁« which means "relationship by chance" in Japanese. »EN« has another pronunciation with letter "EN 円" (circle). All our relationships are connected to our future like a circle, I sincerely appreciate this preciousness. (Also »EN 円« is the letter of YEN. Relationship makes your profit.)

Outside of my work, I'm spending my time with my family. My wife Rika, I often joke to my colleagues that I'm her poor slave, is the cutest and most delightful lady, I've ever met in my life. We have got to know each other in Milano, and married in Paris in 2017. We have a 2 year-old son, Ryuki, who brings us a lot of joy everyday with sometimes real loud noises. We like to travel around Europe. Rika works as a travel writer, and one of my hobbies is photography. Last year, we visited the region of Alsace for the first time and we were very surprised to see so many beautiful towns there. Europe is an amazing region where you can find many wonderful places and cultures. Another hobby of mine is playing music. Together with my friends, we do sessions and sometimes record our original songs. Playing music is fun. You can play music even when you get old. There are a bunch of musical instruments, you will never get tired of playing them. In this year's situation, it became quite difficult to do those activities. Though, rainy days never stay. Now is the time to reconsider our situation, and prepare for the boost restart when everything is settled. I'm looking forward to see you soon for another »EN縁«. Thank you very much for reading my introduction.

D07

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