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ELEKTRONIK

GIVE THE VIRUS NO CHANCE

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ELECTRONICA TRENDS

The main challenges for
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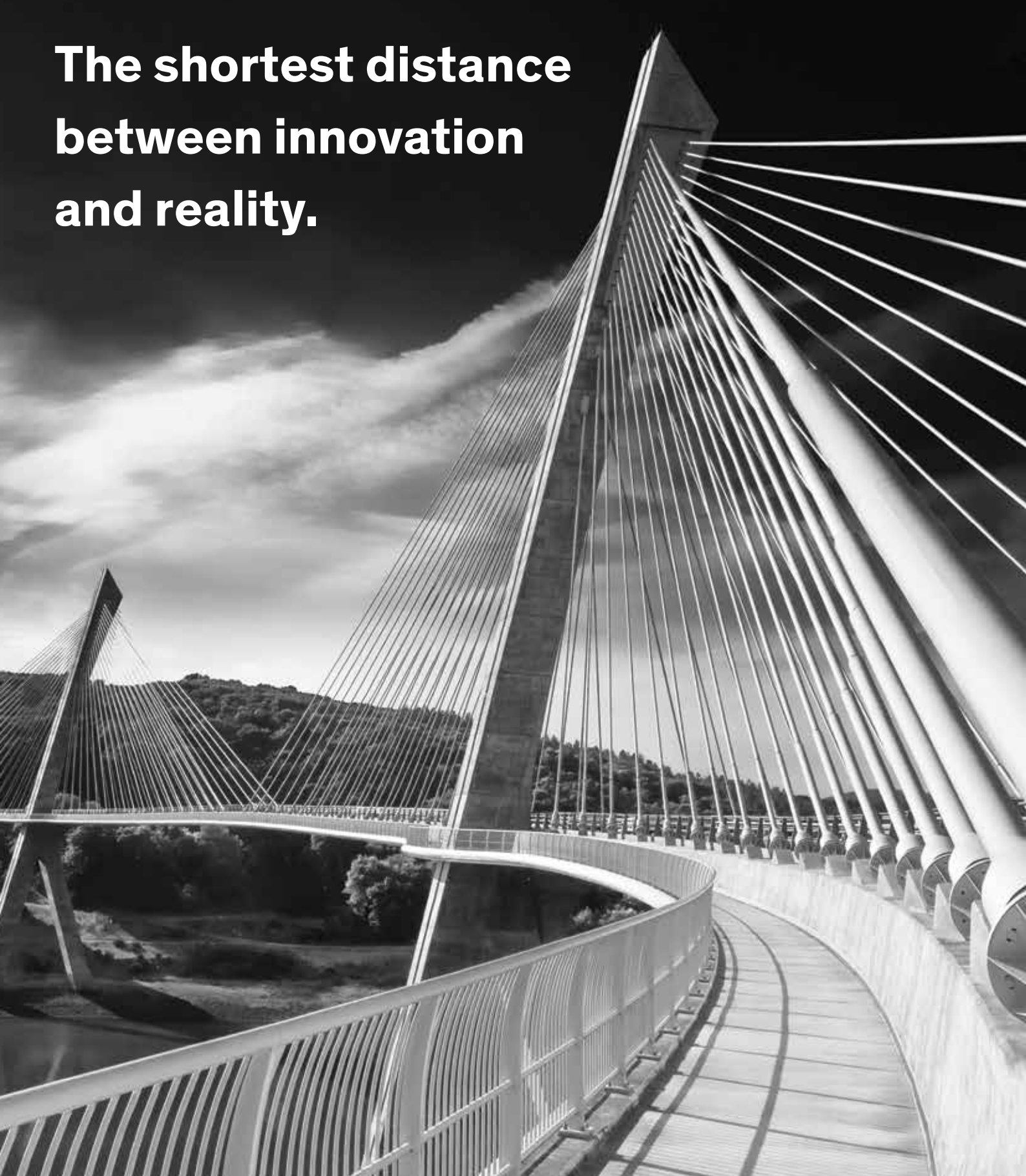
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**The shortest distance
between innovation
and reality.**





Bernhard Haluschak, Chief Editor E&E: The electronics industry is characterized by a strong pressure to innovate. The Internet of Things (IoT) is at the heart of this. It is the motor for constantly new developments that shape or change our daily activities. This is why I ask the question:

WHICH IOT/IIOT TRENDS WILL SHAPE US IN THE COMING YEARS?

The combination of artificial intelligence (AI), machine learning (ML) and the Internet of Things (IoT) or Industrial IoT will accelerate the digital transformation in companies enormously and generate real added value in the form of new business models. The basis for this will be created by networked data acquisition systems that automatically and intelligently evaluate the data.

Another important technology in connection with IoT/IIoT is Digital Twins. These allow physical devices and even entire production environments to be modeled in a virtual environment. This allows real-time simulations to be carried out and thus processes, products or services can be analyzed cost-effectively and trimmed for efficiency.

Edge computing in the form of embedded systems will become more and more powerful in the future, because the amount of data supplied by IoT systems and sensors will far exceed the data channels of conventional cloud computing. Moving computing capacity, including data analysis, to the edge of the network improves performance, minimizes latency and reduces costs.

In addition, the expansion of 5G technology gives IoT/IIoT an enormous performance boost. This will enable companies to process large amounts of data via wireless transmission in almost real time. Decentralized edge computing in particular will also benefit from this.

A MILESTONE IN HMI

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 IO-Link



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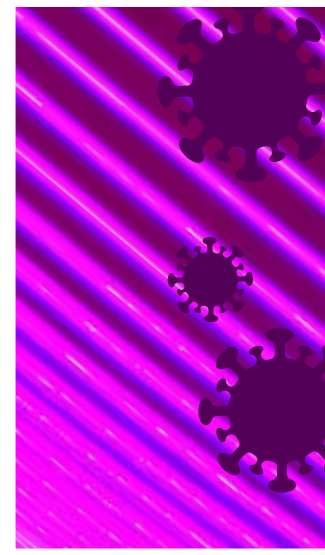
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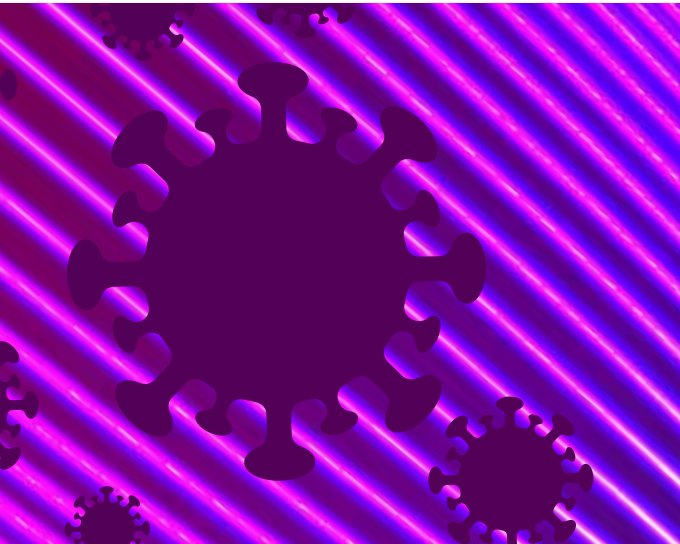




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IN THE SPOTLIGHT

LIDAR EXPERIMENTS IN THE ANTARCTIC

HOW HEALTHY IS OUR ATMOSPHERE?

In a peninsula far, far away, a laser shoots into the sky to study the Antarctic atmosphere at Concordia research station. The Light Detection and Ranging instrument, or LIDAR, is a remote sensing technique that uses laser light to study an object.

TEXT: Bernhard Haluschak, E&E, based on the material of ESA PHOTO: European Space Agency

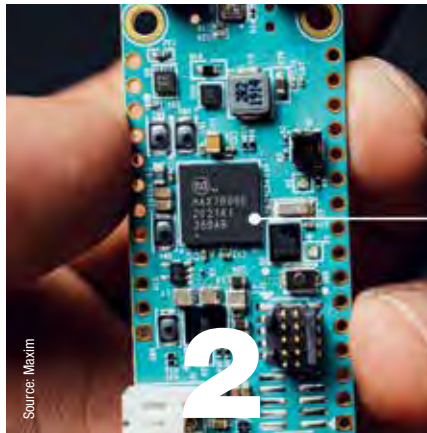
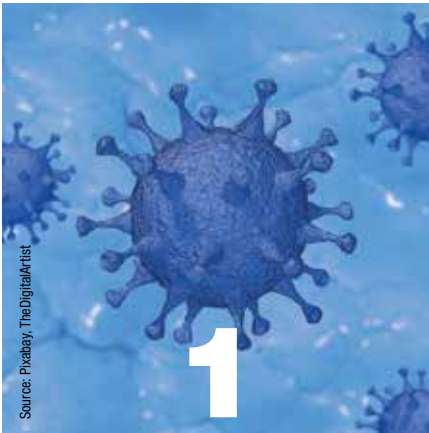


A pulsed laser beam is aimed at the target and properties of the resulting scattered light are recorded by sensors. Using these measurements, researchers collect information about the atmosphere, including density, temperature, wind speed, cloud formation and aerosol particles. LIDAR and SONAR (sonic detection and ranging) instruments help monitor the Atmospheric Boundary Layer, the 1 km thick bottom layer of the troposphere where changes on Earth's surface strongly influence temperature, moisture and wind. These changes to Earth's surface are largely caused by human activity. Increased greenhouse gas emissions are raising temperatures and the release of chlorofluorocarbons is thinning the ozone layer, particularly in the Polar Regions. The station operates two LIDAR instruments. The one imaged is the smaller of the two, located 500 m south of the station. A laser beam is emitted daily for one minute every five minutes during the winter period. Atmospheric physics and chemistry is one field of research undertaken at Concordia to assess the Antarctic climate and overall climate change.

6

HIGHLIGHTS

Facts, trends and news: What has changed in the industry?
UV-LEDs against the corona virus has been developed, a low power chip for IoT devices with AI support has been found and a new safety software for autonomous vehicles has been created.



Agents against Sars-CoV-2

Inactivation of viruses

The Japanese company Stanley Electric has proven the effectiveness of one of its LEDs against the corona virus. Tests were carried out together with a university. Bacteria and pathogenic microorganisms can also be killed by irradiation with this UV light. However, the wavelength of 265 nm used damages human cells and should therefore not be used for disinfection.

Learn more: industr.com/2434666

1

Accelerator chip for neural networks

Enabling IoT devices

Maxim is developing a low power accelerator chip that will enable IoT devices to process artificial intelligence at the Edge. The chip increases the run-time of battery-powered applications and should also enable complex AI applications. At the heart of the chip is specialized hardware designed to minimize the power consumption and latency of convolutional neural networks.

Learn more: industr.com/2537055

2

Forecast of traffic situations

Autonomous driving

For autonomous vehicles to be able to participate in road traffic, they must not endanger others. A new safety software has now been developed at the Technical University of Munich that is designed to prevent accidents by permanently predicting different variants of a traffic situation up to six seconds in advance. The software calculates all possible movements for each road user.

Learn more: industr.com/2534192

3

Quadlock standard interface

Automotive Connectors

Yamaichi develops a system based on the VW standard interface Quadlock and improves it in several ways. With the Y-Quad, an automotive interface that has been established at VW for years, was optimized. The underlying technical specification defines a PCB connector with up to 52 contacts, which in mixed assembly from Ethernet signals up to power pins fulfill various tasks.

Learn more: industr.com/2537048

4

Milestone in printable electronics

Organic transistors

Researchers at TU Dresden have taken a decisive step towards the broad application of flexible electronic systems with the development of organic printable transistors. Thanks to the transistors, it may be possible in the future to realize sophisticated electronic functions such as RFID or high-resolution flexible displays completely with organic components.

Learn more: industr.com/2535031

5

Billion dollar business on the electronics market

Purchase of ARM

The GPU manufacturer Nvidia buys the British company ARM for 40 billion US dollars. This merger is to create a leading computer company in the age of artificial intelligence. According to Nvidia, ARM will continue to exist after the transaction with its name, brand and headquarters in Cambridge and the headquarters will be expanded with a center of excellence for AI research.

Learn more: industr.com/2534160

6

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ODOR ELIMINATOR

A breath of fresh air

If the nose is facing olfactory challenges and an extensive supply of fresh air is not possible, filters are used. UV-supported, photocatalytic models are particularly effective. Rutronik's first odor eliminator demonstrator uses this technology, too.

TEXT: Maria Alejandra Salazar Martinez und Alain Bruno Kamwa, Rutronik

PHOTOS: Rutronik; iStock, saicle, Max2611

Many odor components are volatile organic compounds (VOC), such as hydrocarbons (e.g. methane), alcohols (e.g. ethanol) and organic acids (e.g. acetic acid). They are in many objects, cleaning products and cosmetics, are excreted by living organisms and formed during various processes, such as the decomposition of organic substances without oxygen (putrefaction). VOCs can not only cause unpleasant odors, but also impair health, well-being and performance. Conversely, air free of pollutants means a great improvement in quality of life and health.

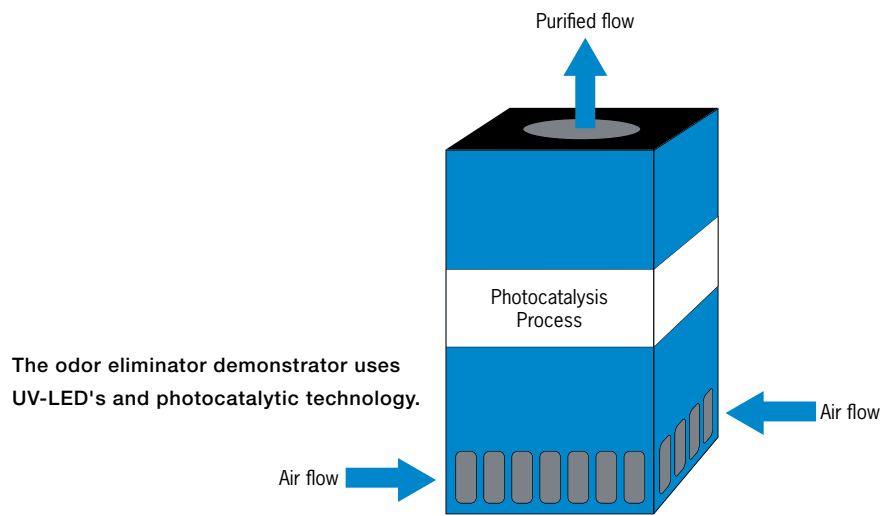
Methods for clean air

Where supplying with fresh air to reduce the concentration of VOCs is not possible, effective air purifiers are an important measure. Some of them not only filter unpleasant odors and pollutants, but can also neutralize gases and destroy pathogens. Based on their mode of operation, different classes of devices can be distinguished: Air washers guide the air through water rollers. This causes dust particles to adhere to the water film, filtering from the air. Air washers are also called humidifiers, since there is a transfer of water molecules to the ambient air

during the process. Ionizers produce negatively charged particles that attach themselves to positively charged particles in the air. This increases their mass and they sink to the ground. A considerable disadvantage of ionization is the formation of ozone, which is harmful to health in higher concentrations. Filter systems guide the air through several filters. Due to their large surface area, they adsorb unwanted particles, pathogens and odors. Currently the best known are the HEPA filter (High Efficiency Particulate Air Filter) and the activated carbon filter (e.g. for water filters). In addition, the filter acts as a reducing agent that can absorb ozone or chlorine. Photocatalytic filters use titanium dioxide plates, irradiated with UV light (UV-assisted titanium dioxide photo catalysis, UVTP). This process produces free radicals that decompose organic material such as VOCs, but also bacteria and viruses.

Light against pathogens and odors

The UV-supported TiO₂ photocatalysis has already established itself in water and wastewater treatment, especially to ensure the quality of drinking water. In air purifiers, they are still not very common. Especially the construction industry and some



cities use it to reduce toxic pollutants in the air. Recent findings indicate that UVTP also suits to ensure the microbiological safety of food.

Danger recognized, stench banished

That this type of photocatalysis is also extremely effective against odors explain two studies conducted by the Japanese Kanagawa Institute of Industrial Science and Technology (KISTEC) using a UVTP-based odor neutralizer. The Japan Food Research Laboratories confirmed the results. In the studies, acetaldehyde, a gas with acrid odor, was led into a 36-liter tank until a concentration of 10 ppm was reached. Then the activation of the odor neutralizer took place, accompanied by measuring the concentration over a period of 60 minutes using a photoacoustic multi-gas monitor. The result: After 14 minutes, the acetaldehyde content was only 0.1 ppm, after 23 minutes it was still 0.05 ppm. Several repetitions of the procedure followed, always with the same course. For comparison, the institute used an ionizer in the same setup. Thus, the acetaldehyde concentration could only be reduced by 40% within one hour. Without any use of air purification, about 95 % of the acetaldehyde was still present after one hour.

An almost identical picture created the same experiments with ammonia (odor of urine), methyl mercaptan (odor of excrement) and formaldehyde (odor of harsh detergents). Only in the test series of hydrogen sulfide (smell of decay and sulfur) and trimethylamine (fish smell) did the odor neutralizer have to be used for a longer time to achieve a comparable result. However, after two hours, almost none of these VOCs could be measured here either. As UV source the UVA-LED NDU-1104ESE-365 from Stanley with a wavelength of 365 nm proved to be the most effective model in the studies. UVA-LEDs with 385 nm and 395 nm neutralized significantly less VOCs. Their drive current of 500 mA also makes the NDU1104E-

SE-365 more effective than other models with lower values. This is because the light output increases with the current.

Odor eliminator

Based on these findings, Rutronik has developed an odor eliminator demonstrator. At the bottom of its cuboid housing (48 mm × 48 mm × 60 mm) the air flows into the device. A fan ensures that the air moves through the housing from bottom to top. In the process, it flows through a photocatalytic filter located between two UVA LEDs with a wavelength of 365 nm and a drive current of 500 mA. To determine the VOC content, Rutronik uses the SGP MOX sensor from Sensirion, mounted next to the LED and based on the so-called chemisorption of gases in the presence of oxygen. In this process, the undoped O₂ atoms of the metal oxide (MOx) form a bond with the odor molecules. The electrons released during this reaction lead to a change in the electrical resistance of a film of metal oxide nanoparticles. In this way, the sensor detects a wide range of VOCs and other gases that are crucial for odors and the quality of indoor air.

If the number of VOCs exceeds a certain value, the activation of the LED follows. The irradiation time depends on the type and quantity of VOCs. As an option, the sensor readings can also be displayed so that users can always read the air quality. The odor eliminator's lithium-ion battery, which has a two-hour operating time, can be recharged from a standard household outlet, a PC and car chargers. This makes it mobile and flexible in use. This means that companies can try out its effect anywhere, whether in public or mobile toilets, in the garbage room, in the canteen kitchen or in the gym. The Rutronik odor eliminator is still in the trial phase - but if it proves to be suitable for practical use, it would be an important step in combating unpleasant and harmful odors. Then air fresheners, scented trees and room sprays can pack in. □



Interview about Rutronik's way to become a problem solver

„From Distributor to Developer“

The distribution industry is currently reinventing itself. In recent years, Rutronik has transformed itself from a component supplier to a developer and solution provider. In an interview with E&E, Andreas Mangler, Director Strategic Marketing at Rutronik, explains what distinguishes the company and describes where Rutronik wants to be in some years.

TEXT: Bernhard Haluschak, E&E PHOTO: Rutronik

Rutronik is one of the leading broadliners. What is the secret of your success?

Courage, innovative strength and long-term planning - our greatest advantage is that Rutronik's management pursues a long-term strategy in which, regardless of the current market situation, investments are also made in projects that can be expected to return on investment after three years. This forward-thinking approach provides security both internally to our employees and externally to our customers and partner companies. They greatly appreciate Rutronik for this long-term reliability. Moreover, we can offer high flexibility and individual solutions, which is essential especially in times of crisis.

Rutronik is evolving from a distributor to a developer - what motivates Rutronik to realize products itself?

In this way, we can show what else Rutronik has to offer. We see ourselves as a source of ideas and innovators for the electronics industry. This enables us to offer solid support for faster realization of their own products, such as our RUTDevKit-STM32L5 for AI-based applications running on an MCU platform. Bringing a product to market requires many small steps, all playing a crucial role. Since we are developers ourselves, we see the needs and challenges of our customers with completely different eyes. This of course gives us a competitive advantage.

This certainly requires a lot of appropriate knowhow. Where do you get it?

To make us attractive for skilled workers, we have intensively studied our employer branding. We also offer employees interesting extras such as flexible working hours, support with relocations or the organization of daycare places. At the same time, we are taking advantage of "new work" and are relying on specialists who live abroad, too. Of course, it is also important for us that our employees establish a connection to the company. We support our colleagues as far as possible from the very beginning according to their individual orientation. We also constantly provide "supply" internally, because we see our educational mission as an investment in the future of the company. This year, 14 young people have started an education or dual study program at Rutronik.

You have already presented the odour eliminator, which is a real "problem solver", both for professional and private use. For which other current challenges does Rutronik offer solutions?

Currently we are particularly proud of the first development kit created by Rutronik, the already mentioned RUTDevKit-STM32L5. It enables hardware and firmware developers to realize proof-of-concepts within a very short time. The focus is on security and data protection, short latency times, low energy consumption and sufficient memory resources. The data generated by (I)IoT >

„We see ourselves as a source of ideas and innovators for the electronics industry.“

- > devices are increasingly evaluated on MCU platforms in the application or close to the MCU-based embedded system. This is especially true in industrial environments, either for security reasons or because of the required latency. For the implementation of this Edge-KI or Edge Intelligence we have developed our own Development Kit. Of course, all components come from our portfolio. Currently we are investing a lot of work force in possible applications of UVC LED and required solutions, like matching DevKits. The discussion about viruses like Covid-19 has led to a real hype about UV-C. It is a chemical-free, highly efficient solution. Absorbed by bacteria, viruses, spores and germs, it breaks their DNA/RNA bonds. Reproduction is impossible then. Especially when used against multi-resistant microorganisms, such as the dreaded "hospital germ" MRSA (Methicillin-resistant Staphylococcus Aureus) or corona viruses, UVC is highly recommended. The effect of UVC on microorganisms is not an invention from 2020 but this year helped to force the use of significantly more efficient and environmentally friendly LEDs, replacing the previous fluorescent tubes. The low-pressure gas discharge tubes emit UV radiation by means of mercury vapor. Due to their lack of energy efficiency and the use of environmentally harmful materials, the classic "tubes" banned in accordance with EC Regulation 245/2009 [34]. We have an extensive portfolio of well-known LED manufacturers. With this and thanks to our highly qualified employees, we can offer the optimal product for almost all needs - whether for new installations or the conversion of fluorescent tubes to LEDs.

How do market segments such as medical technology benefit from your innovations?

There is still potential, especially in the medical sector. Networking, automation and miniaturization are only a few of the key points that should be mentioned. Offering solutions to the challenges of modern technologies, such as edge intelligence, significantly accelerates the development process. In the worst case, this decides on the lives of patients.

Do own developments shape the future of distribution?

For Rutronik, this path is part of the long-term corporate strategy, as we see two major advantages: On the one hand, the possibility of effectively supporting our customers on the challenging journey from idea to marketability offers an additional point in our service portfolio. On the other hand, we become an innovator who is active and not only influenced by the developments of others.

In which electronics sectors do you think there will be a lot of movement in the next months?

Through discussions with customers, we see great potential for development in the field of ventilation systems. The German government's Corona package includes 500 million euros in funding, for the conversion and upgrading of ventilation and air conditioning systems in public buildings by 2024. Here, manufacturers will be faced with a number of inquiries and challenges. Though the activated carbon filter is currently still best known, we recommend photocatalytic filters that use, for example, UV-assisted titanium dioxide (TiO₂) photocatalysis due to their higher efficiency and, above all, better cleaning effect against pathogens. □





REASONS FOR POSITIVITY IN THE ELECTRONICS SECTOR

Looking Ahead to 2021

2020 has been a challenging year, to say the least. Although the pandemic has shaken multiple sectors, with some businesses going into survival mode, the electronic components industry has remained resilient. Many manufacturers switched their production output completely. One for example, who is making parts for hand-tools, for instance, reinvented itself completely and began supplying to the healthcare market. It is this resilience and agility, replicated many times globally, that is synonymous to our industry.

TEXT: Mark Burr-Lonnon, Mouser Electronics PHOTOS: Mouser; iStock, DrAfter123



The electronic components industry should enter 2021 on an upwards trajectory.

Even during a pandemic, design engineers have continued to innovate to create smarter products that address specific needs of today. Although production was paused in many businesses, designers have still been sourcing new components and starting new projects. As an essential business, Mouser's business activity throughout this year has remained strong.

With the changes brought on by the pandemic, many of us have experienced extended periods of working from home. Whilst posing challenges, there have also been some benefits. Once upon a time, it would have been unheard of not to have a meeting with a supplier face-to-face but now this has changed dramatically.

Now, using video conferencing software packages is second nature to most of us. Meetings are easier to set up and are sometimes even more productive. Extended teams within Mouser come together more frequently too, which can only be a benefit to the business.

I am sure as more collaborative communication and development platforms begin to deploy, many further opportunities in the electronics sector will emerge.

What's next?

The electronics industry has had to adapt. As an online global distributor with a large inventory, Mouser has dealt well with the sudden changes. While remaining flexible and agile today, we can also begin to look forward. New business opportunities will emerge, as the world starts to get back on its feet and many of these will be technology driven. Admittedly predictions for next year will be difficult, given the recent inclement times. However, in the short term, four areas will undoubtedly have an impact on our sector.

5G rollout

Although it is taking a lot longer to arrive than many of us expected, I hope to see rapid progress with 5G infrastructure.

With more base stations going live and other equipment developed, there will be a surge in demand for relevant electronic systems and components. Mouser is well prepared for this rise with high inventory levels valued at more than \$860 million. New 5G phones now being launched will help drive this process as infrastructure looks to catch up with hardware in phones.

Automotive

The automotive industry has been hit hard this year. But there are signs of recovery for 2021 as pent up demand helps lift the market. I believe this momentum will continue. Looking further ahead, vehicle electrification will likely speed up and push to the next level of autonomous driving. How the industry will be structured in the longer term remains unanswered. For instance, will the OEMs and tier 1s remain the big players, or will new rivals emerge? Whatever happens, there should be a multitude of exciting opportunities for the electronics industry.

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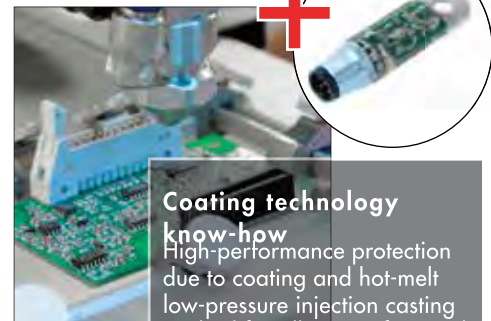
Multipass

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Remote healthcare

For sure, this sector has changed forever. Ready access to GPs via online services is here to stay. This sector will continue to embrace smart technologies, such a sensor-based remote patient monitoring. Electronic innovators, both of components and equipment as well as their suppliers, will help play a critical role in this transformation.

Content is king

As an online business, web analytics are core to digital intelligence. Over the past few months, we have seen some interesting patterns and trends on our visitor data. It is fair to say that as more engineers are working from home, online consumption of technical ‘how to’ information has increased.

In particular, the pages on Applications & Technologies online-sites are popular resources for engineers seeking technical guidance on how to apply new technolo-

gies. Providing easy access to pertinent, well written technical content will be more critical than ever before.

Cautious Optimism

Considering the unpredictability of 2020 across many industries, we remain cautiously optimistic looking ahead. At Mouser, we have experienced steady growth this year with global sales up around 7.5 per cent, and there are hopes for a good final quarter to take this over 8 per cent, which gives us confidence in the future. Our industry has proven to be incredibly resilient in these tough times, and Mouser has persevered.

The electronic components industry should enter 2021 on an upwards trajectory. For Mouser, we will continue doing what we do best: supplying engineers and small- to medium-sized production buyers with the newest products and technologies and helping our customers with best-in-class service, helping them to innovate without delay. □



BEST PRACTICES FOR POWERING USB4

Powerful energy supplier

The power landscape is getting simpler with industry convergence on USB Power Delivery (PD) standards, and with good implementations USB4 can continue that trend. Ensuring the best possible charging experience across multiple new use cases will depend on several application design decisions.

TEXT: Fionn Sheerin, Microchip PHOTOS: Microchip; iStock, alashi

The main purpose of the USB4 development is to double the data rate compared to USB 3.2 (40 Gbps compared to the prior 20 Gbps) and to enable support for Intel's Thunderbolt protocol. USB4 will exclusively use the USB type-C port, the oval-looking port with the blade down the center famous for accepting cables even when they are inserted upside down. While inserting the cable may be getting simpler, the charging technology behind for USB4 ports must now include USB PD, which adds complexity. Prior generation USB specifications using the type-C port had an option to allow for PD; USB4 requires it.

Power Delivery Required in USB4

The PD specification was revised to include new messages to discover and transition to USB4 mode, but the power schemes are the same. They use a single-wire 300 kHz bus on one of the Configuration Channel (CC) lines of the USB type-C interface for the host and device to discover and negotiate the power and data they will be transferring. The other CC line assumes the role of "VCONN," a dedicated power source for the electronic marker, an identification circuit inside the USB cable. The power delivered between USB ports is transferred on a separate set of wires within the connector (labeled "VBUS"). When two PD devices connect, they use the CC wire to detect each other, communicate power capabilities (which voltages, and how much power at

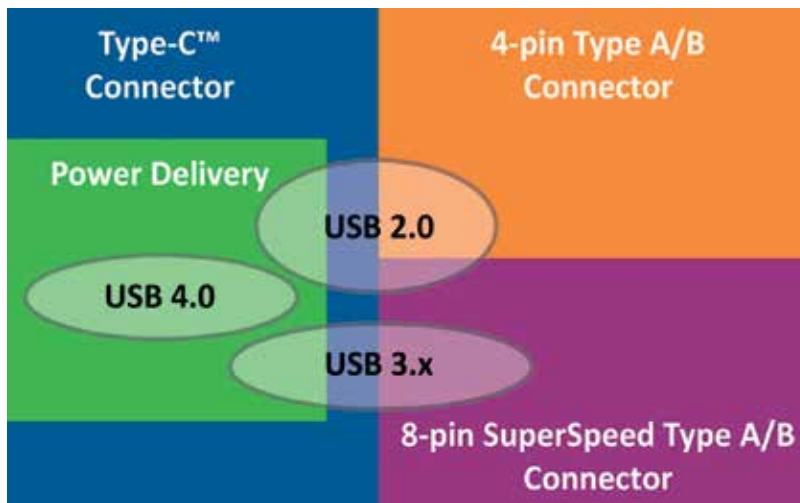
each voltage), understand which device should source or sink power, negotiate how much power to deliver, and then provide that power on VBUS. This 300kHz digital signal is also used to identify that the USB connection can support a USB4 link, so there is no way to implement USB4 without this communication. USB4 ports are not required to supply or receive any power beyond a minimum 5V / 900mA; but they must support PD communication to function as USB4.

Historical Power on the Universal Serial Bus

To look at the charging user experiences in USB4, it is helpful to understand the history of power across the USB connector. The Universal Serial Bus was originally meant for serial data communication, with a maximum of 100mA of current in the cable. USB 2.0 specifications were limited to 500 mA in the VBUS line; this was suitable for powering basic computer peripherals. USB 3.0 standards increased the current limit to a 900 mA, but with portable devices converging on a single connector for data and power, it was not enough.

The USB committees released the battery charging (BC) specifications, ending with the BC1.2 specification in 2010, allowing 1.5A (7.5W); and at that point, many smartphone manufacturers gave up on being USB specification compliant. This led to a proprietary charging protocol free-for-all, using voltage levels set on the D+ and D- lines (USB data lines): 2V on one line and 2.7V on the other might give a 10W charge; 2.7V on both data lines might signal a 12W charge; 3.3V on each line would trigger a charger to provide 20V (which could be damaging, if applied by mistake).

These methods were not interoperable, and results were unpredictable. In addition, the data lines used to decide charging levels were no longer available for data. A port can trans-



USB Data and USB Power Relationships - USB 2.0 can exist on any USB cable, with or without power delivery on a type-C cable. USB3.x requires a cable with additional superspeed lanes, with or without power delivery on a type-C cable. USB4 can only exist on a type-C connection, with Power Delivery communication. Power Delivery can only exist on a type-C connection but does not require data.

fer files, or it can charge faster, but not both. Anyone who has ever experienced a phone dying while charging - that port was possibly a data connection supplying 500 mA under the USB 2.0 specifications.

This issue motivated the first PD specification (revision 1), creating a universal standard for charging at alternate voltages (more than 5V) using traditional 4-pin USB cables. Maintaining backwards compatibility required adding a handshake signal to the VBUS line itself, which was complicated to implement and the whole thing was scrapped without significant adoption. The USB-IF would prefer everyone forget this spec was ever written and practically speaking, everyone should. This approach is no longer valid or supported.

Today, there are PD versions 2.0 and 3.0, and the included programmable power supply (PPS) specifications. These were created alongside the USB type-C port, with added signal connections. The differences between version 2 and 3 are mostly in the CC communication details. Both are backwards compatible with prior USB implementations (excluding PD revision 1) and the user experiences will be the same.

Devices negotiate charging profiles, potentially down to 20mV increments (under PPS implementations). PD capable devices can (but are not required to) support up to 100W of power transfer within the specification (5A at 20V). The proprietary schemes to advertise alternate charging profiles using the data lines are explicitly forbidden, but USB type-C also allows for simplified 1.5A and 3A charging at 5V (recognized by resistors on the CC pin, instead of the digital signal). Type-C ports do not require PD, but PD does require a type-C port, which is where USB4 changes things; USB4 uses PD communication to enable the USB4 mode.

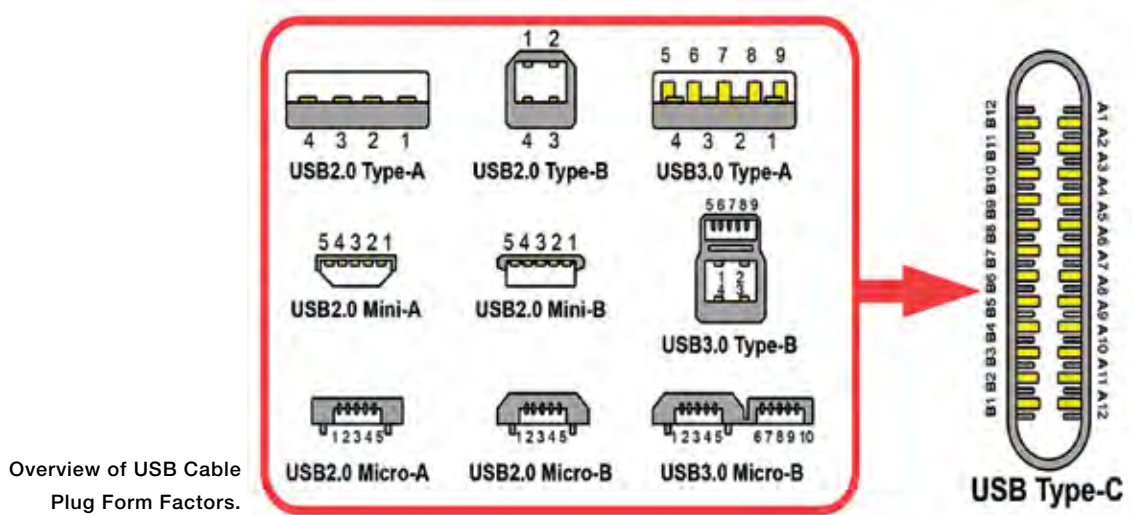
While new devices will follow the new streamlined specifications, the complexity in USB charging comes from all of these legacy standards, all of which still exist on older ports, and a new USB4 port may be connected to any of those existing legacy ports.

Use Cases and User Experiences

Trying to maintain five generations of backwards compatibility creates a complicated landscape of possible power connections. It leaves a big question about what happens to all the older USB ports and cables, and users may still be wondering "will it charge?" Fortunately, ignoring the proprietary specifications, most of that history falls into just a few possible user experiences. While they will all charge, they may not all charge quickly. There are fundamentally four use cases to consider in the context of USB4:

- A legacy charging port connects to a USB4 type-C device using an adapter cable
- A USB4 type C charger connects to a legacy port using an adapter cable
- A USB4 type C port connects to a non-USB4 type C port with a C-C cable, and places a resistive divider on the CC line
- Two type-C ports connect with a C-to-C cable, and communicate on the CC lines; either or both could be USB4 devices

In terms of USB standards, the 8-pin Apple Lightning connector carries the same signals as a legacy USB 3.x cable. USB4 ports connecting by type-C to Lightning adapter cables will behave similarly to type-C to micro-B, or type-C to type-A cables, in terms of power functionality. The following is a summary of what to expect with each charging use case:



Overview of USB Cable Plug Form Factors.

Legacy Charging Port Using an Adapter Cable

Legacy ports like the type-A and type-B ports may have been created before the Type-C specifications (see figure 1). There wasn't, and will not be, a requirement for these ports to implement any specific faster charging scheme. A USB 2.0 port could default to 500 mA charging, or a USB 3.x port could default to 900 mA. The good news is that most newer USB ports do support BC1.2 and will provide 7.5W. It doesn't matter what kind of adapter cable is used, the USB4 or type-C device connected into the legacy charge port cannot draw more than 7.5W of power without violating the USB specifications.

USB4 Charging Port Using an Adapter Cable

In cases where a USB4 charging port is connected to a legacy device, a few possible outcomes could happen. The USB4 port could advertise 1.5A using BC1.2 standards, and the cable could carry 7.5W. If the USB4 isn't set up to support the extra overhead of BC1.2, the USB4 port will need to default to 500mA for a USB 2.0 data connection, or 900 mA for a USB 3.x data connection. This will lead to some user frustration, as the fanciest USB port may result in the slowest charging when used with adapter cables.

USB4 to Non-USB4 Type C - Resistive Dividers

If either the power provider or consumer is using the type-C resistive divider method to advertise power capabilities, that will dictate the power transfer. The USB4 device will not be able to communicate on the CC lines, but it will still recognize the attachment, the provider/consumer relationship and the current limit (1.5A or 3A) using current sources or resistors connected to the CC lines. The bus voltage will stay at 5V,

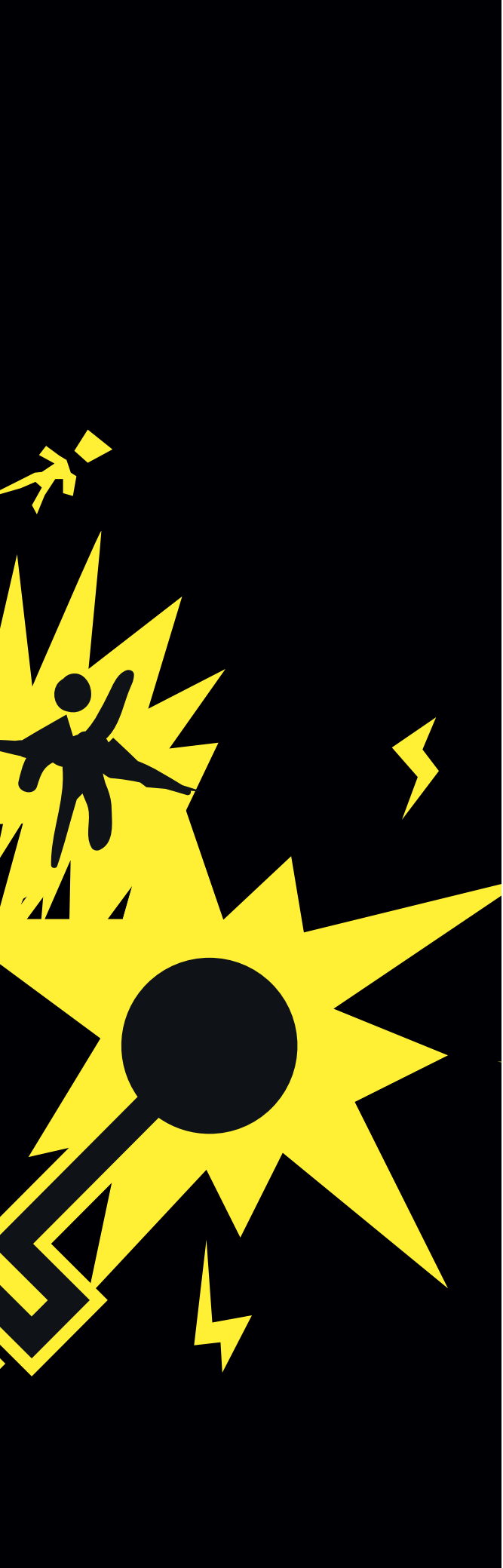
and the load device will be able to draw power up to 7.5W or 15W. Since the device knows it isn't in PD mode, it may indicate that it is not fast charging for a clear user experience.

Type-C to Type-C, with PD Communication

This is potentially the most capable USB4 connection in terms of power transfer, but the exact results will vary. The two connected devices will negotiate a power contract based on their capabilities, up to 20V and 5A. Part of the negotiation is the role as a provider or consumer of power. It is possible to connect two power consumers, who would negotiate not to transfer power (and this is a valid use case for data transfer between portable devices). Provider ports may be marked with a battery symbol, so in many cases users will know which ports on a dock or a laptop are setup to provide power. In that case, the port providing power must be able to supply at least 1.5A at 5V (7.5W, same as BC1.2) to use a USB-IF approved charging logo. Higher power levels are not guaranteed to be available even in a type-C port labeled with a charging icon. Since the power contract could be any power level from 7.5W to 100W, the user will only know what is happening if one of the devices reports information about the contract (indicating a power level or fast charging connection). This use case certainly has the potential to create unpredictable and frustrating user experiences, but with good reporting and good user interfaces, this could also be a perfect user experience.

The addition of USB4 will add a lot of bandwidth and capabilities to the USB applications that can use them, but USB 2.0 and USB3.x will continue to live in applications that can live with less data transfer. The power use cases will multiply, but with smart application design this does not need to create bad user experiences. □





AUGMENTED REALITY WEARABLES

How ESD protection works efficiently

The smaller intelligent devices become, the more sensitive their internal structures are to electrostatic discharge (ESD). This also applies to glasses that superimpose digital information on images of the real world. Such Augmented Reality (AR) wearables must be protected against damage from ESD during the development process. This is because inadequately protected wearables can incur high costs for repair, replacement, shipping and compensation. Moreover, the reputation of the manufacturer suffers as a result. Circuit designers should therefore consider five recommendations early in the design process to improve the safety, performance and reliability of wearables.

TEXT: Todd Phillips, Littelfuse PHOTOS: Littelfuse; iStock, higyou



Products like the SP1020 from Littelfuse pack robust ESD protection in a very space-efficient 01005 package ideal for applications like AR glasses where there is very little board space available.

Those of us who wear vision correction glasses are used to seeing the world through lenses. New technologies will allow a virtual world to be layered on top of the real world that we normally see. The lenses will become displays that allow us to see the “real” world that is augmented with overlaid information and images, creating an Augmented Reality (AR).

An example would be the integration of navigation into the AR glasses to allow a user to walk through town with turn-by-turn instructions (visual or verbal) to help them easily get to their destination. Other examples include facial recognition, fitness tracking, first-person photos and videos, as well as health-sensing and travel applications.

Wearable devices and their users can be safeguarded with advanced circuit protection technologies and board layout strategies. The following five recommendations help to build circuit designers a more reliable IoT ecosystem.

Small Form Factor

Today’s ESD diodes offer a variety of performance benefits for Augmented Reality applications led by a small form

factor. The following recommendations for the selection and configuration of ESD diode technologies will help design engineers optimize their future circuit designs.

Choosing Unidirectional or Bidirectional Diodes

ESD diodes are available in unidirectional or bidirectional configurations. Unidirectional diodes are typically used for DC circuits, including pushbuttons and keypads, as well as digital circuits. Bidirectional diodes are used in AC circuits, which may include any signal with a negative component greater than $-0.7V$. These circuits include audio, analog video, legacy data ports, and RF interfaces.

Whenever possible, design engineers should choose unidirectional diode configurations to improve performance during negative-voltage ESD strikes. During these strikes, the clamping voltage will be based on the forward bias of the diode, which is typically less than $1.0V$. A bidirectional diode configuration provides a clamping voltage during a negative strike that is based on the reverse breakdown voltage, which is higher than the forward bias of the unidirectional diode. Thus, the unidirectional configuration

can dramatically reduce the stress on the system during negative transients.

Determine Diode Location

Most circuits do not need board-level ESD diodes at each of the IC’s pins. Rather, the designer should determine which pins have exposure to the outside of the application where user-generated ESD events are likely to occur. If the communication/control line can be touched by the user, it could become a pathway for ESD to enter the integrated circuit. Typical circuits include USB, audio, buttons, switches, RF antennas, and other data buses. Incrementally adding these discrete devices will take up board space, so it is important to reduce their size to fit 0201 or 01005 outlines. For some wearable applications, there are also space-saving multi-channel arrays available. It is generally recommended to put the ESD device as close to the ESD ingress point as possible, which is typically defined as the connector or the I/O.

Routing of ESD Trace

To protect the IC’s pins with an ESD diode, there are several key considerations for trace routing - from I/O to ground. Unlike lightning transients, ESD

Low-capacitance bidirectional discrete TVS diode arrays, including the SP3522 Series, provide symmetrical ESD protection for high-speed data lines when AC signals are present. They are also designed for consumer electronics such as fitness bands, smartwatches, smartphones, tablets, and eReaders.



does not unleash a large amount of current for a long duration of time. To effectively handle ESD, it is important to move the charge from the protected circuit to the ESD reference as quickly as possible. The length of the trace - from the I/O line to the ESD component and from the ESD component to ground - are the overriding factors, not the width of the trace to ground. The length of the trace should be kept as short as possible to limit parasitic inductance. This inductance would result in inductive overshoot,

which is a brief voltage spike that can reach hundreds of volts if the stub trace is long enough. Recent package developments include μ DFN and Wafer Level Chip Scale Packages (WLCSP) outlines that fit directly over the data lanes to eliminate the need for stub traces entirely.

Understand HBM, MM, and CDM Definitions

HBM, Machine Model (MM), and Charged Device Model (CDM) are test

models for characterizing the ESD robustness of the integrated circuits that run the portable device or wearable including the processor, memory, and ASIC. They are used by the semiconductor supplier to ensure the robustness of the circuits during manufacturing. The current trend is for suppliers to reduce the voltage test levels since it saves die space. Additionally, most electronics manufacturers have provisioned for ESD and have countermeasures in place during the assembly process. □



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USE OF WLAN 6 AND 5G IN INDUSTRIAL AUTOMATION

RADIO TECHNOLOGIES IN COMPETITION

The industry has high expectations for 5G radio technology, a technological megatrend that is revolutionizing data transmission in factory automation. Against this background, many users are asking themselves whether WLAN will continue to be needed for industrial communication.

TEXT: Dipl. Ing. (FH) Jürgen Weczerek, Phoenix Contact **PHOTOS:** Phoenix Contact; iStock, peepo

With WLAN 6, which is standardized according to IEEE 802.11ax, a new WLAN generation is currently also coming onto the market, which offers numerous interesting functions for industrial automation. Does WLAN thus prove to be an alternative to private 5G networks?

The fact is that 5G has the potential to have a lasting effect on factory automation as a company-wide wireless communication infrastructure. The first test installations have already been made and several plant operators are planning to equip their factories with 5G as early as 2021. For this purpose, Phoenix Contact has

developed the first industrial 5G router for local 5G industrial networks together with Quectel and Ericsson. Real-time capable industrial 5G networks based on Release 16 and 17 are expected to be available from 2022 if everything goes as planned, so the opinion of the experts.

With the industrial Wireless LAN technologies, a radio technology is available that has been successfully used for wireless data transmission in various industrial sectors and applications for more than 15 years. WLAN networks are therefore available in many factories and can be easily updated and expanded.



New WLAN features

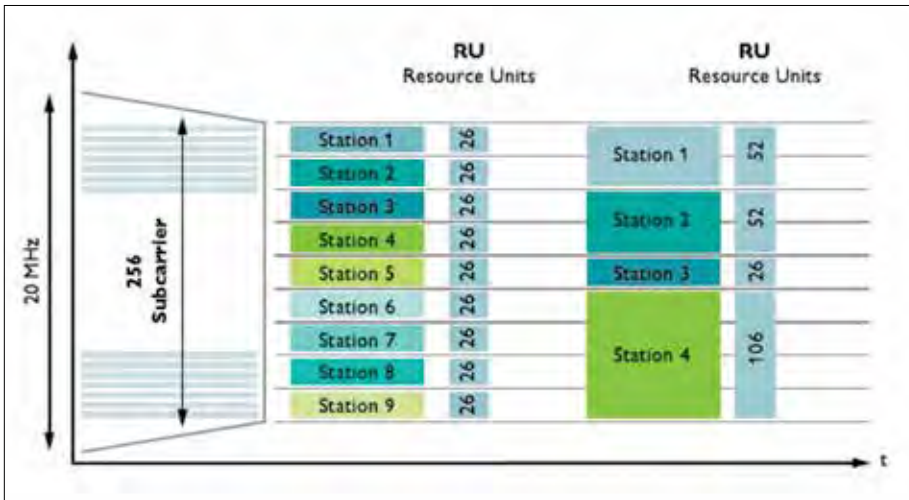
Version 6 of the new WLAN standard has been available since this year and contains numerous technologies that users are familiar with from current mobile phone standards.

As with 5G, the advantages of WLAN 6 compared to previous versions are greater data throughput, lower latency and higher network capacity with the ability to serve significantly more clients simultaneously. From an industrial point of view, WLAN 6 is essentially characterized by the following new features:

Simultaneous communication with several participants:

The data transmission OFDM (Orthogonal Frequency Division Multiplexing), which is currently standard for WLAN, allows parallel communication with only one subscriber. By using the OFDMA method (Orthogonal Frequency Division Multiple Access), which originates from the mobile radio sector, the transmission channel can now be divided into sub-channels - so-called Resource Units (RU).

A 20 MHz wide WLAN channel comprises up to nine Resource Units (RU), which can be distributed to different WLAN



WLAN 6 now also offers the function known from mobile telephony, dividing a transmission channel into several sub-channels in order to communicate with several subscribers simultaneously.

subscribers. In this way, simultaneous communication with up to nine WLAN subscribers is possible. This works in both uplink and downlink. With wider WLAN channels, there are correspondingly more resource units available, for example 37 RU at 80 MHz. Especially in industrial transmissions, where mainly small data packets are forwarded, OFDMA enables a considerably higher number of subscribers, shorter latency times and better efficiency and thus also a higher network capacity.

Theoretical gross data rate up to 10 GBit/s: Due to various optimizations, WLAN 6 should be able to achieve gross data rates of up to 10 GBit/s - at least theoretically. Compared to WLAN 4 with a maximum transmission rate of 600 MBit/s, this represents a significant increase. Compared to 5G, WLAN 6 is on an identical level. To what extent such data rates are relevant in industrial practice remains to be seen. However, it can be seen that the wireless standard still has considerable reserves for future requirements.

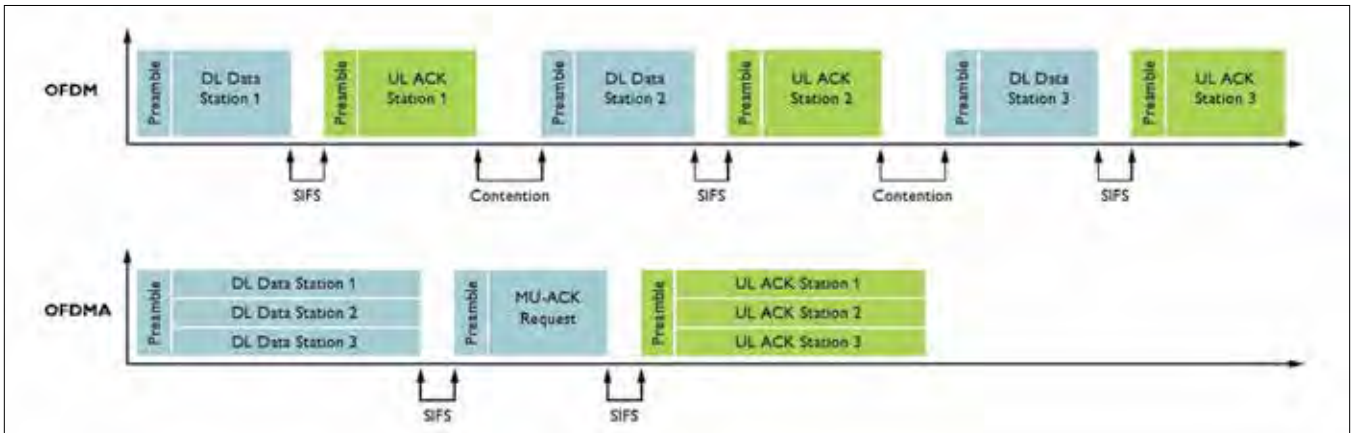
Energy-saving data exchange: Especially with TWT (Target Wake Time), it should be possible in the future to communicate with low-power IoT devices via WLAN in an energy-saving way. Data exchange will only take place at scheduled times. In between, the participant can "sleep" to save energy. The rest period between two data transfers may last many hours. This lowers the energy requirement and reduces the utilization of the communication channel.

Interference-free coexistence of the WLAN modules: One of the challenges of WLAN transmission is that only a limited number of channels are available. With a constantly increasing system density, several neighboring access points must therefore use the same channel and thus inevitably influence each other. Previously, this meant that one subscriber could transmit and all

other WLAN devices had to wait on the channel. With BSS (Base Service Station) coloring and Spatial Re-Use, WLAN 6 now supports a mechanism for the interference-free coexistence of WLAN modules at high device density. Due to a better use of the radio spectrum, higher data rates, shorter latency times and a higher network capacity should be achieved.

The "coloring" of data frames by BSS-Coloring allows devices to distinguish transmissions in their own network from those in neighboring networks. In contrast, Spatial Re-Use introduces the use of adaptive power and sensitivity thresholds for channel-free detection. In this way, a radio channel can already be re-used if the signal of a neighboring radio cell is still perceived on the specific channel, but the built up connection to the own cell is still very good.

Full performance with the 6E version: The new WLAN functions reduce the problem of mutual WLAN interference. Compared to 5G, which has a protected frequency range for private campus networks, WLAN does not have these exclusive frequency bands. Therefore QoS (Quality of Service) cannot be guaranteed. To solve this problem, WLAN 6E was introduced at the beginning of 2020. The new standard according to IEEE 802.11ax fully exploits the advantages of the 6 GHz spectrum. For this purpose, WLAN 6E uses the frequency range between 5.925 GHz and 7.125 GHz. The USA has already released the entire 1.2 GHz. The United Kingdom (UK) has also announced its intention to make 500 MHz available. In the European Union/Germany, it is expected that around 500 MHz bandwidth will be made available in 2021. Since older WLAN standards cannot use the 6 GHz band and therefore don't have to take appropriate devices into consideration, WLAN 6E can achieve its full performance. Because of the large spectrum, many WLAN systems can then be operated in parallel without mutual interference.



Especially when communicating small data packets with many participants OFDMA proves to be more efficient and the achievable latency times are shorter.

Initially somewhat higher technical effort

The technical performance of 5G and WLAN 6(E) is basically comparable for industrial automation applications. Typical applications such as automated guides vehicles (AGVs) and mobile robots will in future be technically feasible with both 5G and WLAN 6(E). Ultimately, it is the user who decides which wireless technology to use. The choice of wireless standard will probably not be determined by the wireless technology itself, but by the entire network infrastructure. In addition to numerous interesting technical features, the use of private frequency ranges is proving to be 5G's greatest strength. However, these are not available everywhere in the world. Because WLAN 6(E) can operate on the 6 GHz band, WLAN also has a frequency range exclusive to WLAN 6E applications. The wide bandwidth of WLAN 6(E) with 500 MHz to 1.2 GHz means there is room for more WLAN systems per area and mutual interference due to frequency overlap is thus significantly reduced.

The setting up of private 5G networks currently requires a somewhat higher technical effort and complexity in the start-up phase. Therefore, the necessary investments for an industrial 5G network will initially exceed the costs of a WLAN 6 solution. Against this background, 5G will initially be economically viable as a company-wide wireless backbone network for the realization of various communication tasks, especially in large factories and facilities. The broad installed base, globally well-harmonized frequency ranges, downward compatibility with older WLAN standards and thus the comprehensive availability of cost-effective terminal devices as well as the application knowledge available among service providers and operators speak in favor of the further, even parallel use of WLAN. Moreover, private industrial frequencies for 5G are not yet available everywhere in the world but will come soon.

Conclusion

Both 5G and WLAN 6(E) will be of great importance for industrial data transmission in the future. For this reason, Phoenix Contact is investing in both wireless standards, on what concerns WLAN particularly in version 6(E). As one of the pioneers of the global initiative 5G-ACIA (5G Alliance for Connected Industries and Automation), Phoenix Contact is actively shaping the standardization of 5G in industry. Since 2020, the first industrial 5G router for local industrial applications in a private 5G network has been offered, which was developed in cooperation with Quectel and Ericsson. □

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KEEPING HARMONICS IN CHECK WITH ELECTRONIC VOLTAGE SENSORS

Tame Harmonics

From wind turbines to railway traction systems, the protection of critical motors against abnormal situations has always been vital. With increasing amounts of energy supplied by renewable sources such as wind power, it is also vital that motors receive a high quality power supply.

TEXT: Damien Leterrier, LEM PHOTOS: LEM; iStock, Max2611

One of the key considerations is to ensure the reliability and safety of the system when converting the primary voltage from a DC to an AC system, and to do so in all environmental conditions and temperatures. The increasing demand for green energy is one of the drivers of the adoption of wind power. Wind turbines commonly use a variable speed controller that works with the power electric converter to connect the generated power to the grid. However, a common problem of power electronics is the generation and emission of harmonic currents, which dramatically reduce the quality of the injected current.

Various types of filters are used to reduce the harmonic distortions to acceptable levels. These filters can compensate for the harmonics of non-linear loads and are usually installed close to

the point of distortion. One of the more common techniques is to use an Active Power Filter, which repairs the distorted waveform by injecting an anti-harmonic waveform.

An anti-harmonic signal waveform is then generated using the p-q theory as a reference signal for APF switching. Clarke transformation is used to transform the three-phase coordinates into equivalent two-phase α - β coordinates for voltage and current. In a high current/high voltage system, the demands on the sensor are relatively high, with a requirement to bring the measured voltage to the controller in a safe and insulated manner.

The DVC 1000 family of electronic based voltage sensors from LEM offers this high level of insulation, up to 4.2kV. Its modular design also allows it to be installed as close as possible to the load,

ensuring it can fit into restricted spaces. In railway applications, the auxiliary converter which brings power to loads such as fans, blowers, lighting or battery chargers needs to perform stringent monitoring of the harmonics. In particular, it is very important not to re-inject any signal back to the tracks at a 50Hz frequency, which could result in disturbances to track equipment and a consequent risk to safety. This is why the converters are often coupled with a voltage sensor which monitors the signal and plays an important role within the safety loop.

As previously mentioned, protecting the motor is a permanent requirement. In particular, most electric drives incor-

porate an inverter circuit which rectifies AC into a high-voltage DC signal. Called a DC-link, this serves as a power supply for circuitry that generates drive signals to power the motor. The DC-link voltage must be continuously controlled. Under certain operating conditions, a motor can act as a generator and deliver a high voltage back into the DC-link through the inverter's power device and/or the recovery diodes. This high voltage adds to the DC-link voltage, and the IGBTs (insulated-gate-bipolar transistors) driving the motor can be stressed by a high (and potentially damaging) surge voltage. An isolated voltage sensor is then necessary to monitor voltage back to the control application, which will shut down the whole application safely in the event of an overvoltage.

As well as overvoltage conditions, under voltages can be just as dangerous.

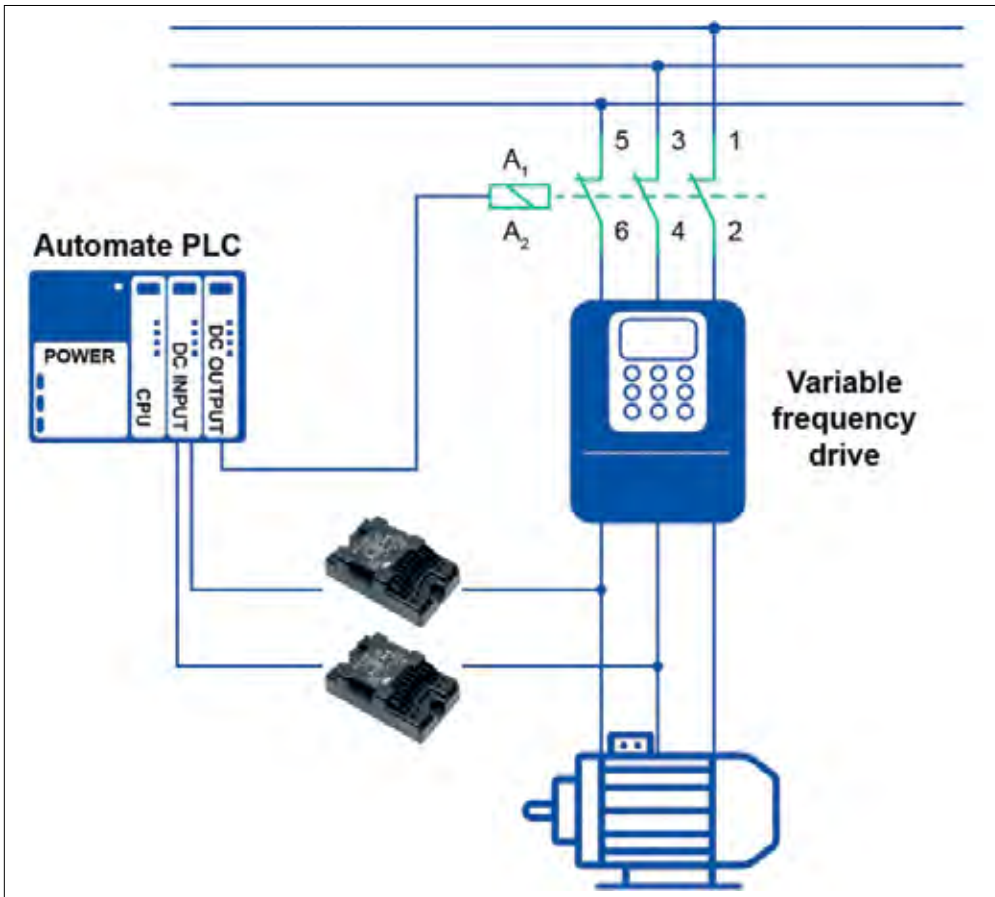
If we consider a 600V rated drive, the overvoltage should be around 1000V while undervoltage would be around 400V.

The same sensor should be capable of being used between these two limits. There are several conditions that could lead to a voltage drop, but the most common one is the loss of one phase. Having said that, the voltage sensor can be located at the AC input side of the rectifier, or directly at the DC-link. Installing a voltage sensor on both sides will bring more information and will be safer for the system.

Motor drives are not the only application that require galvanic isolated voltage sensors. Other applications such as solar inverters and UPS also require these functions to ensure the protection and safety of the application. For such cases, a voltage sensor must accurately measure the DC-link voltage and pro-

vide isolation between the high-voltage side and the low-voltage controller side. The question is, when do we need isolated voltage sensing and when should we choose a non-isolated sensor or simple resistance divider? There are two reasons to use such a sensor:

First case: When the microcontroller, which hosts the AD converter, is not referenced to the same point (so DC-) as the voltage measurement (the resistive divider). Care is needed to delineate between different grounding in the system. By isolating both the signal to measure and the microcontroller, we can avoid damage to the system from events such as inductive spikes or lightning strikes.



Isolating with a DVC1000 allows existing control elements to monitor power applications.

Second case: The second question is, what safety regulations are in place that require an actual isolation barrier rather than simply relying on the attenuation network? Often, for safety certifications, resistive attenuation is not enough to ensure safe grounding of the system. The voltage sensing then needs to go through an isolated channel in order to ensure an adequate safety barrier.

When the whole system is being designed around different equipment in place, adding the safety requirements, without defining specific equipment, can be more cost-effective by using the existing devices (such as a controller or a PLC) to do the monitoring. In this particular case, the DVC 1000 offers the necessary easy-to-use voltage sensing with the appropriate isolation to the specific control application.

This direct sensing will be even easier using the standard interface (+/-10V or 4-20mA) of the DVC 1000, which is compatible with the standard analogue inputs of the controller. The versatility of the DVC 1000 to measure AC and DC will allow a wide range of very different applications.

For higher integration, the DVC 1000 is also available in a PCB mounted version, for further space saving. Likewise, the panel mounted version, the DVC 1000-P, is self-sufficient and does not require additional components. With installations becoming ever smaller, LEM developed a new technology for these voltage measurements. Based on the isolating amplifier technology, these developments gave rise to the DVC series. To complete its range of digital voltage sensors offering smaller dimensions,

LEM has developed a new voltage sensor for measuring voltages up to 1000V RMS nominal and 1500V peak.

To measure voltage (VP), the DVC series uses only well-known electronic components, the major one being an isolating amplifier. The voltage to measure (VP) is directly applied on the sensor primary connections through an internal resistor network and some components allowing the signal to feed an isolation amplifier.

This allows an isolated signal to be recovered and then conditioned in order to supply a voltage or a current at the sensor output connections, which is an exact representation of the primary voltage. An internal isolated DC-DC converter is used to supply the electronics on the primary side. □