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CONTENTS

- 4 Why secure GPS receivers are crucial for GNSS/INS systems
- 12 Found: the speed limit of optoelectronics
- 16 Reducing disturbance in next-gen magnetic RAM
- 20 Waterproof connectors and enclosures: check what protection you need
- 27 Flat lens extends viewing distance for 3D light field display
- 30 No unpleasant surprises in ASIC development
- 32 New technique increases chip yield from semiconductor wafer
- 38 One ring to charge them all



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WHY SECURE GPS RECEIVERS ARE CRUCIAL FOR GNSS/INS SYSTEMS

Maria Simsky, Technical Content Writer

Resilient GPS/GNSS receivers protect INS systems from jamming and spoofing.

With the growth of automation and robotisation in many industries, from agriculture and delivery drones to self-driving cars, the demand for accurate and affordable navigation is on the rise. When selecting a GPS/GNSS positioning receiver, it is crucial to understand vulnerabilities of these sensors and the effect they could have on the navigation system.

For robots and autonomous devices, availability is key to ensuring continuous and reliable service. Safety also needs to be considered for robots and drones operating close to people. GNSS jamming or spoofing needs to be detected and flagged immediately so that other sensors can take over.

Most autonomous navigation technologies include an inertial navigation system (INS), which consists of a GNSS receiver and an IMU sensor. While the GNSS receiver provides absolute positioning in terms of geographic global coordinates, the IMU (inertial measurement unit) measures heading, pitch and roll angles that give orientation information of a moving system.

Spoofing is a real threat to GNSS-based INS systems, which is mitigated most effectively by incorporating security mechanisms into all system subcomponents. However, since spoofing takes place on the level of the GNSS signal, a number of sophisticated methods can be employed within the receiver to detect and mitigate spoofing. Receivers that are designed with security and robustness in mind are resilient to GNSS vulnerabilities such as jamming and spoofing. Taking advantage of such robust GNSS technology is also cost-effective, allowing companies to focus their development on sensor fusion and navigation.

Jamming and spoofing are real

Jamming is a kind of radio interference that overpowers weak GNSS signals, causing ac-



SPOOFING IS A REAL THREAT TO GNSS-BASED INS SYSTEMS, WHICH IS MITIGATED MOST EFFECTIVELY BY INCORPORATING SECURITY MECHANISMS INTO ALL SYSTEM SUBCOMPONENTS.

curacy degradation and possibly even loss of positioning. Unintentional jamming sources include radio amateurs, and maritime and aeronautical radiolocation systems, as well as electronic devices located close to the GNSS receiver. There are also intentional jamming devices called 'jammers', which are sometimes found on board of vehicles trying to avoid road tolling.

Spoofing is an intelligent form of interference that makes the receiver believe it is at a false location. Spoofing has appeared in the news in a spectacular experiment where a Tesla car was 'misled' to take an exit from a highway rather than following the highway as it was supposed to. Consequently, both jamming and spoofing can have an adverse effect on INS systems, which make use of GNSS positioning.

How can INS get jammed and spoofed?

While GNSS provides absolute positioning, the IMU measures relative movement, which is subject to cumulative error called drift and needs regular 'recalibration'. In a GNSS/INS system, both sensors are fused in such a way that the GNSS provides regular IMU 'calibration' and the IMU provides angles and extrapolation or 'smoothing' of GNSS.

Jamming, which results in loss of positioning, means that the GNSS receiver can no longer be used as part of the INS solution. This can lead to longer INS initialisation times or a switch to dead-reckoning mode (IMU solution only), where the position would start to drift. Jamming can also result in measurement outliers, which impact GNSS/

INS algorithms (ie, deep or tight coupling). However, it is spoofing that poses the highest security risk for GNSS/INS systems. During a spoofing attack an INS solution could be 'hijacked' if the spoofer uses small increments in positioning, which can go undetected by common anti-spoofing methods.

Vulnerability of the common INS anti-spoofing method

Using sensors other than GNSS such as an IMU or odometry can help flag spoofing by detecting inconsistencies between GNSS and the other sensors. While such sensors help reduce spoofing risks, they are not sufficient to provide full protection because they only output relative positioning, which is subject to drift. For example, the GNSS/INS systems can have a drift of a meter or more when visibility of GNSS satellites is lost for longer periods. Spoofers can exploit this drift phenomenon to hijack positioning gradually, in increments comparable to the expected drift.

The diagram in Figure 1 demonstrates a common mechanism used by GNSS/INS systems to detect spoofing. The system is initialised and starts receiving new GNSS, IMU and/or odometry data, which is continuously checked for consistency.

If the spoofing attack keeps positioning increments within the allowed thresholds, which are set to allow for drift, it would go undetected by such a mechanism. That is why, for best system protection and anti-spoofing, resilience should be built into several system components on both GNSS and INS levels.

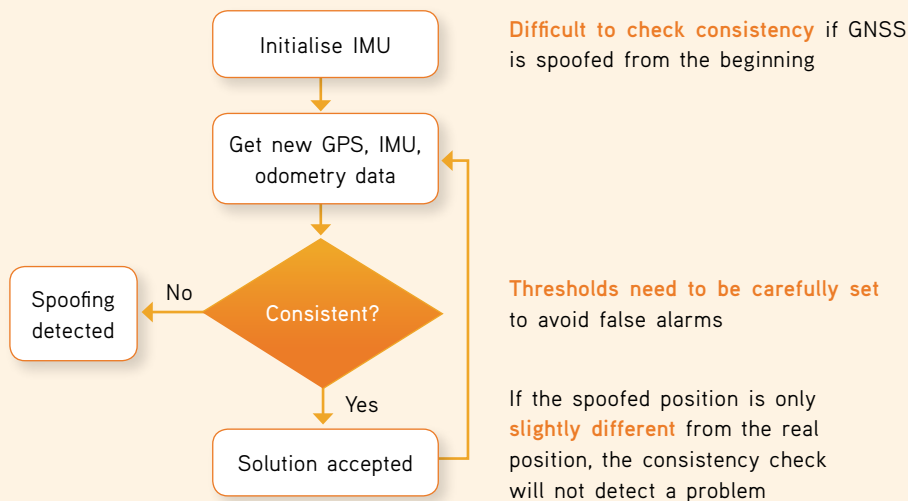


Figure 1: GNSS/INS systems commonly check positioning for outliers to detect spoofing. However, if the spoofer uses small positioning increments, which are within thresholds allowing for drift, it would not be detected by this mechanism.

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Spooing is best detected within GNSS

The vulnerability of this common INS spoofing check is shown in the road test in Figure 2, where the spoofing attack is executed gradually, in small increments perpendicular to the direction of motion. The magnitude of these spoofed increments is small enough to be below the drift threshold of the IMU, which makes it acceptable for the INS system shown by the red line.

The system shown by the orange line, with anti-spoofing built into the GNSS receiver, rejects the spoofed signal and switches to dead reckoning, which allows it to stay on the right track. If the spoofing attack is limited to a few signals, then the GNSS receiver can even avoid the attack by discarding these spoofed signals from its positioning solution.

Secure GNSS receivers protect INS systems

As shown in Figure 2, an INS system will be more resilient if the GNSS receiver can indicate spoofing or, even better, if it can mitigate spoofing by itself. Thus, when integrating GNSS/INS solutions it remains crucial to understand the role of protection mechanisms in GNSS and to select a GNSS receiver with a strong internal anti-spoofing defence system or a warning system. Septentrio receivers also provide lots of information about GNSS signals, allowing users to get insights into the spoofed signal such as time stamps and power levels.

A GNSS receiver that implements security measures in its design will include spoofing

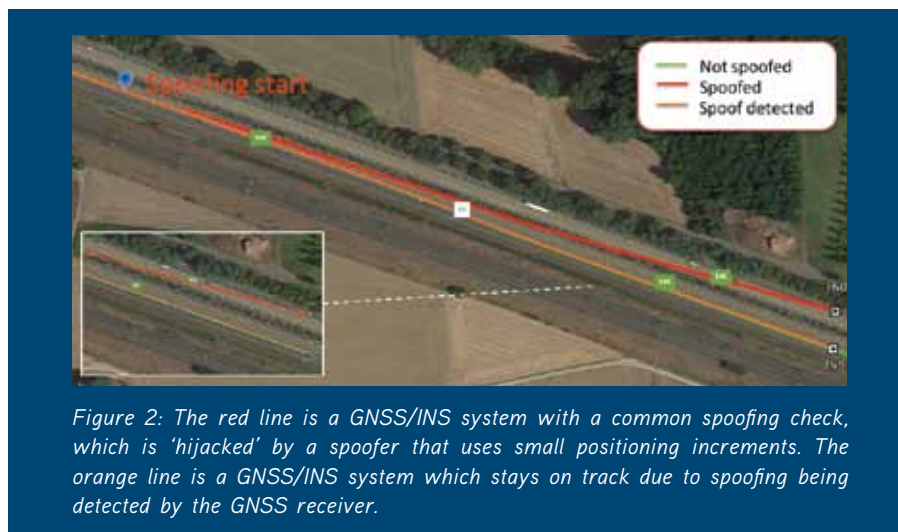


Figure 2: The red line is a GNSS/INS system with a common spoofing check, which is 'hijacked' by a spoofer that uses small positioning increments. The orange line is a GNSS/INS system which stays on track due to spoofing being detected by the GNSS receiver.

resilience at various levels. For example, the Septentrio AIM+ Advanced Interference Mitigation technology is a jigsaw puzzle of various anti-jamming and anti-spoofing components built into receiver hardware as well as software:

- Signal processing (HW): signal authentication (OSNMA), signal comparison and anomaly detection, satellite consistency check-in tracking.
- Measurement engine (SW): quality checks of raw measurements.
- Positioning engine (SW): receiver autonomous integrity monitoring (RAIM+) and proprietary algorithms.

Both the GNSS receiver as well as the INS have their own mechanisms for spoofing protection; however, the best resilience comes from the combination of detection and mitigation mechanisms working together on component level.

Maintaining security at the receiver core

As in any field affiliated with security, continuous improvement is needed to maintain effective anti-spoofing and anti-jamming mechanisms. GNSS manufacturers have a responsibility to strive for the most effective security methods in view of the increasing threats that confront today's GNSS users. By investing in GNSS receivers with built-in resilience, integrators can leave the security maintenance to the GNSS manufacturer and focus their efforts on core business and sensor fusion. In fact, the concepts discussed in this article are valid not only for GNSS/INS systems but for any sensor fusion system that includes a GNSS receiver. Smart GNSS technology protects receivers from jamming and spoofing at the core level, ensuring safe and reliable system operation.

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'LIGHTSLINGER' ANTENNA IS SMALL, VERSATILE AND EFFICIENT

As wireless communications technology continues to advance, the need for smaller, more versatile, more energy- and cost-efficient antennas is becoming increasingly important. Now scientists and engineers at Los Alamos National Laboratory have developed a new type of antenna, called LightSlinger, to meet this need.

LightSlingers use volume-distributed polarisation currents, animated within a dielectric to faster-than-light speeds, to emit electromagnetic waves; by contrast, traditional antennas employ surface currents of subluminally moving massive particles on localised metallic elements such as dipoles. Owing to the superluminal motion of the radiation source, LightSlingers are capable of 'slinging' tightly focused wave packets with high precision towards a location of choice. This gives them potential advantages over phased arrays in secure communications such as 4G and 5G local networks as well as warfighter communications and radar applications.

"We have been developing LightSlingers at Los Alamos for more than 15 years," said John Singleton, one of the two principal investigators on the project. "They were initially developed as fundamental science models for violent astronomical phenomena, but we soon realised that they were more efficient and considerably more flexible than conventional antennas of a similar size."

The LightSlingers' small size, relatively light weight, power efficiency and resiliency against abusive treatment make them more versatile than equivalent conventional antennas. In addition, the antennas can be built in unusual shapes such as flat panels, cylinders or disks that are uniquely optimised to particular situations and applications. For example, they could form part of ceramic armour applied to a tank or unmanned ground vehicle.

Several prototypes of LightSlinger have been tested in lab environments and in the field over distances of up to 76 km, three of which have been independently validated by a US telecommunications company. Los Alamos is now looking to transition the antennas to commercial prototypes that can be field tested and mass-produced by additive manufacturing and robotic processing.

Co-investigator Andrea Schmidt concluded, "Our hope is that LightSlingers will, in the near future, replace outdated base-station antenna technology around the globe and expedite the rollout of 4G."



FLEXIBLE ELECTRONICS LIGHT UP WHEN STRETCHED

Scientists at the Daegu Gyeongbuk Institute of Science and Technology (DGIST) have fabricated a flexible material that lights up brightly when stretched and/or when an electric field is applied. Their findings, published in *Applied Physics Reviews*, show promise for the development of bright, sustainable, stretchable devices for use as interactive skin displays and in soft robotics.

"Our material overcomes challenges in 'alternating-current-driven electroluminescent' (ACEL) devices that are currently under development," said Soon Moon Jeong of DGIST's Division of Energy Technology. "Current devices don't offer as much luminescence as scientists are aiming for due to issues with their design."

Soft, light-emitting ACEL devices are made by sandwiching a light-emitting compound between two electrode layers. But for the light in the middle to reach the surface and actually be seen, it needs at least one of the electrode layers to be transparent. This, however, leads to several issues depending on the type of material used, such as the electrode being brittle or difficult to fabricate.

Jeong and his colleagues overcame this and other design issues in ACEL devices by inserting stretchable silver nanowire electrodes in-parallel in between two light-emitting layers made of copper-ion-doped zinc sulfide particles embedded in polydimethylsiloxane (ZnS:Cu/PDMS). ZnS:Cu/PDMS has an attractive property: it generates light when it is deformed. This is called mechanoluminescence. By adding the silver nanowire electrodes, the device also becomes electroluminescent. In other words, applying an electric field to it causes the material to shine brightly.

"Our device is unique in that it can simultaneously produce mechano- and electroluminescence," Jeong said.

The design also allows the use of thick light-emitting layers, in contrast to previous ACEL devices that can only use layers that are thin enough to apply a strong electric field between the two electrodes. The new design overcomes this issue by inserting the electrodes as ultrathin wires inside of the light-emitting material. The thicker material produces 3.8 times more electroluminescent brightness than other ACEL devices, the researchers say.

The team next wants to improve the device's electroluminescence in response to a low electric field. To achieve this, they plan to arrange the silver nanowires in diverse directions, instead of in-parallel as with the current device.

"Our proposed structure could ... be used in large-scale outdoor billboards or light-emitting banners, due to its sturdiness against environmental factors and its simple design," Jeong said.



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RESEARCH HUB TO ACCELERATE DIAMOND-BASED QUANTUM COMPUTERS

Quantum Brilliance, a German–Australian provider of innovative quantum computing hardware and software, has announced a joint research and development hub with La Trobe University and RMIT University to enhance the computational power of diamond-based quantum computers with techniques that can transition to manufacturing systems in large volumes.

At the newly established Research Hub for Diamond Quantum Materials, researchers will focus on taking raw materials and synthesising — with atomic precision — the core quantum systems of high-performance, scalable diamond-based quantum microprocessors. The research hub is designed not only to make great strides in developing synthetic diamond accelerators, but to create a network of experts in diamond material science for future industry advancements in both countries.

The hub is already pursuing several concurrent projects that are pioneering new diamond fabrication techniques, partially funded by the Australian Research Council (ARC) and Quantum Brilliance. Complementary research is meanwhile being undertaken in Germany by Quantum Brilliance, the Fraunhofer Institute for Applied Solid State Physics IAF and Ulm University. The combination of the hub and the German research consortium is set to unite some of the world's top experts to deliver the advanced fabrication techniques required for diamond microprocessors.

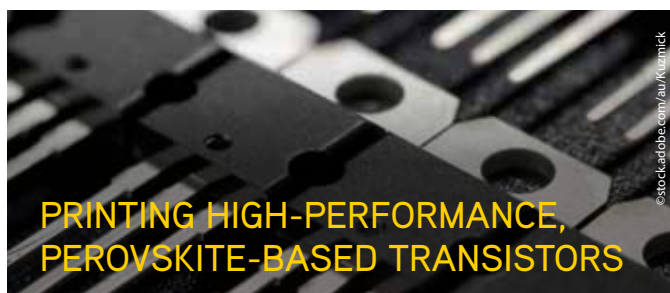
La Trobe University's Acting Deputy Vice-Chancellor (Research and Industry Engagement), Professor Chris Pakes, said the hub partnership will leverage La Trobe and RMIT's expertise in diamond growth, surface imaging and engineering, and combine it with Quantum Brilliance's strong industry experience and manufacturing capabilities.



"All three organisations have world-leading expertise and resources in diamond material sciences, making the hub well placed to develop innovative new approaches to advanced manufacturing in this important future industry," Pakes said. He added that diamond-based quantum computing is already disrupting digital platforms that underpin industries including science, health and agriculture.

"Unlike other quantum-based supercomputers sitting in large server-based formats, diamond-based quantum computers are low-cost, portable technologies able to operate at room temperature," he said. "This enables them to be used in a broad range of edge applications, which may not be possible with supercomputers, such as satellites, health environments and manufacturing."

Founded in 2019, Quantum Brilliance makes quantum computing accelerators out of synthetic diamonds. Quantum Brilliance uses the 'impurities' within the diamonds, where a carbon atom is swapped out for a nitrogen atom in the lattice of the crystal, to generate qubits, the standard bits within a quantum computer.



PRINTING HIGH-PERFORMANCE, PEROVSKITE-BASED TRANSISTORS

The printing press has long gone beyond simply printing books or documents and is expanding its influence to the realm of cutting-edge technology. Most notably, high-performance components in various smart devices have been successfully printed and have attracted much attention. Now, a new technology to print perovskite-based devices — long considered a challenge — has been proposed.

Researchers led by Professor Yong-Young Noh from the Pohang University of Science and Technology (POSTECH) have improved the performance of a p-type semiconductor transistor using inorganic metal halide perovskite. One of the biggest advantages of the new technology is that it enables solution-processed perovskite transistors to be simply printed as semiconductor-like circuits.

Perovskite-based transistors control the current by combining p-type semiconductors that exhibit hole mobilities (empty spaces created when an electron is subtracted) with n-type semiconductors. Compared to n-type semiconductors that generally

have electrons as charge carriers have been actively studied so far, fabricating high-performance p-type semiconductors — which instead have holes as charge carriers — has been a challenge.

Many researchers have tried to utilise perovskite in the p-type semiconductor for its excellent electrical conductivity, but its poor electrical performance and reproducibility have hindered commercialisation. To overcome this issue, the researchers used the modified inorganic metal halide caesium tin triiodide (CsSnI_3) to develop the p-type perovskite semiconductor and fabricated the high-performance transistor based on this.

This transistor was found to exhibit high hole mobility of $50 \text{ cm}^2\text{V}^{-1}\text{s}^{-1}$ and higher and a current ratio of more than 108, and recorded the highest performance among the perovskite semiconductor transistors that have been developed so far. The results were published in the journal *Nature Electronics*.

By making the material into a solution, the researchers succeeded in simply printing the p-type semiconductor transistor as if printing a document. Their method is said to be not only convenient but also cost-effective, which could lead to the commercialisation of perovskite devices in the future.

"The newly developed semiconductor material and transistor can be widely applicable as logic circuits in high-end displays and in wearable electronic devices, and also be used in stacked electronic circuits and optoelectronic devices by stacking them vertically with silicon semiconductors," Prof Noh said.

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FOUND: THE SPEED LIMIT OF OPTOELECTRONICS



Semiconductor electronics is getting faster and faster — but at some point, physics no longer permits any increase. So exactly how fast can electronics be?

When computer chips work with ever shorter signals and time intervals, at some point they come up against physical limits. The quantum-mechanical processes that enable the generation of electric current in a semiconductor material take a certain amount of time. This puts a limit to the speed of signal generation and signal transmission. European researchers have now confirmed that this speed cannot be increased beyond one petahertz (one million gigahertz), even if the material is excited in an optimal way with laser pulses.

Electric current and light (ie, electromagnetic fields) are always interlinked. This is also the case in microelectronics: in microchips, electricity is controlled with the help of electromagnetic fields. For example, an electric field can be applied to a transistor and, depending on whether the field is switched on or off, the transistor either allows electrical current to flow or blocks it. In this way, an electromagnetic field is converted into an electrical signal.

In order to test the limits of this conversion of electromagnetic fields to current, laser pulses — the fastest, most precise electromagnetic fields available — are used, rather than transistors.

“Materials are studied that initially do not conduct electricity at all,” said Professor Joachim Burgdörfer, from Vienna University of Technology (TU Wien). “These are hit by an ultrashort laser pulse with a wavelength in the extreme UV range. This laser pulse shifts the electrons into a higher energy level, so that they can suddenly move freely. That way, the laser pulse turns the material into an electrical conductor for a short period of time.”

As soon as there are freely moving charge carriers in the material, they can be moved in a certain direction by a second, slightly longer laser pulse. This creates an electric current that can then be detected with electrodes on both sides of the material. These processes happen extremely fast, on a time scale of atto- or femtoseconds.



IN ORDER TO INCREASE THE SPEED, EXTREMELY SHORT UV LASER PULSES ARE NEEDED, SO THAT FREE CHARGE CARRIERS ARE CREATED VERY QUICKLY.

“For a long time, such processes were considered instantaneous,” said Professor Christoph Lemell, also from TU Wien. “Today, however, we have the necessary technology to study the time evolution of these ultrafast processes in detail.”

The crucial question is: how fast does the material react to the laser? How long does the signal generation take and how long does one have to wait until the material can be exposed to the next signal? Experiments to determine this were carried out at the Max Planck Institute of Quantum Optics and Graz University of Technology (TU Graz), while the theoretical work and complex computer simulations were done at TU Wien. The results were published in the journal *Nature Communications*.

The experiment leads to a classic uncertainty dilemma, as often occurs in quantum physics: in order to increase the speed, extremely short UV laser pulses are needed, so that free charge carriers are created very quickly. However, using extremely short pulses implies that the amount of energy which is transferred to the electrons is not precisely defined. The electrons can absorb very different energies.

“We can tell exactly at which point in time the free charge carriers are created, but not in which energy state they are,” Prof Lemell said. “Solids have different energy bands, and with short laser pulses many of them are inevitably populated by free charge carriers at the same time.”

Depending on how much energy they carry, the electrons react quite differently

to the electric field. If their exact energy is unknown, it is no longer possible to control them precisely, and the current signal that is produced is distorted — especially at high laser intensities.

“It turns out that about 1 PHz is an upper limit for controlled optoelectronic processes,” Prof Burgdörfer said.

Of course this does not mean that it is possible to produce computer chips with a clock frequency of just below 1 PHz — realistic technical upper limits are most likely considerably lower. But even though the laws of nature determining the ultimate speed limits of optoelectronics cannot be outsmarted, they can now be analysed and understood with sophisticated new methods.



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The STMicroelectronics RHRDAC121 radiation-hardened digital-to-analog converter (DAC) operates down to 2.5 V for use in modern, low-power system designs that older 3.3 V parts cannot support.

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The device is QML-V qualified and comes in a hermetic ceramic package with gold or solder-dipped leads. It is also available as bare die. Designed and manufactured in Europe, it leverages ST's 130 nm pure CMOS technology and processes used over 45 years serving the space industry. Its development has been funded by CNES (Centre National d'Etudes Spatiales), the French Space Agency.

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System designers of traction power units (TPUs), auxiliary power units (APUs), solid-state transformers (SSTs), industrial motor drives and energy infrastructure solutions require high-voltage switching technology to increase efficiency, reduce system size and weight and enhance reliability. Microchip Technology has expanded its SiC portfolio with the release of the 3.3 kV SiC MOSFETs and SiC SBDs, enabling designers to take advantage of their ruggedness and performance. Designers should thus be equipped with the tools to develop smaller, lighter and more efficient solutions for electrified transportation, renewable energy, aerospace and industrial applications.

Many silicon-based designs have reached their limits in efficiency improvements, system cost reduction and application innovation. While high-voltage SiC provides an alternative to achieve these results, until now the availability of 3.3 kV SiC power devices was limited. Microchip's 3.3 kV MOSFETs and SBDs join the company's comprehensive portfolio of SiC solutions that include 700, 1200 and 1700 V die, discretes, modules and digital gate drivers.

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DESKTOP MULTIMETER

The Teledyne Test Tools T3DMM6-5-SC is a 6.5-digit digital multimeter featuring a double 4.3" TFT LCD display with a resolution of 480 x 272 pixels. The screen can be configured to display a histogram, data trends, bar graph, statistics or the traditional numeric mode.

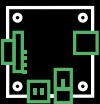
The multimeter has a wide measuring range of 200 mV–750 V for AC true-RMS voltage and 200 μ A–10 A for AC true-RMS current. Its high measurement accuracy up to 0.0005% + 0.0001% of the range for DC voltage is said to enable precise measurements.

Equipped with a 16-channel multiplexer, the device allows for the measurement of resistance (also using the four-wire method), capacitance, frequency, oscillation and temperature. It is also equipped with USB and LAN connectors with the possibility of remote control using SCPI or LabView commands. The internal 1 GB memory allows users to store large amounts of data and configuration files.

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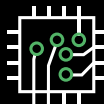
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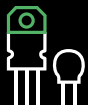
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REDUCING DISTURBANCE IN NEXT-GEN MAGNETIC RAM

SOT-RAM, a promising type of next-generation magnetic memory, could pave the way to ultralow-power electronics. However, scientists from Tokyo University of Science have identified a source of disturbance during the read operation in SOT-RAMs that compromises their reliability. Fortunately, they have also found a method to greatly reduce this disturbance by slightly modifying the SOT-RAM structure.

With the advent of the Internet of Things (IoT) era, many researchers are focused on making most of the technologies involved more sustainable. To reach this target of 'green IoT', some of the building blocks of conventional electronics will have to be improved or radically changed to make them not only faster, but also more energy-efficient. In line with this reasoning, many scientists worldwide are currently trying to develop and commercialise a new type of random-access memory (RAM) that will enable ultralow-power electronics: magnetic RAM.

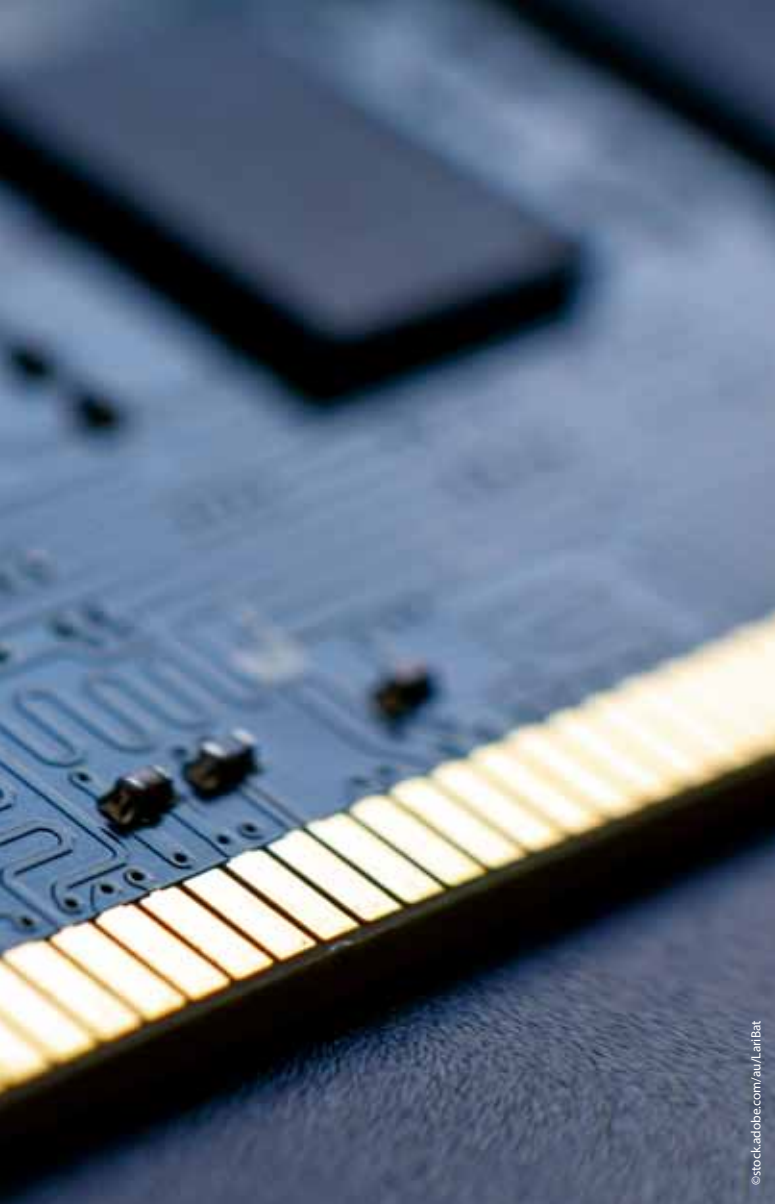
Each memory cell in a magnetic RAM stores either a '1' or a '0' depending on the magnetic orientation of the two magnetic layers. Various types of magnetic RAM exist, and they mainly differ in how they modify the magnetic orientation of the magnetic layers when writing to a memory cell. In particular, spin injection torque RAM, or STT-RAM, is one type of magnetic memory that is already being commercialised. However, to achieve even lower write currents and higher reliability, a new type of magnetic memory called spin orbit torque RAM (SOT-RAM) is being actively researched.

In SOT-RAM, by leveraging spin-orbit interactions, the write current can be immensely reduced, which lowers power consumption.

Moreover, since the memory readout and write current paths are different, researchers initially thought that the potential disturbances on the stored values would also be small when either reading or writing. Unfortunately, this turned out not to be the case.

In 2017, in a study led by Professor Takayuki Kawahara of the Tokyo University of Science, researchers reported that SOT-RAMs face an additional source of disturbance when reading a stored value. In conventional SOT-RAMs, the readout current actually shares part of the path of the write current. When reading a value, the readout operation generates unbalanced spin currents due to the spin Hall effect. This can unintentionally flip the stored bit if the effect is large enough, making reading in SOT-RAMs less reliable.

To address this problem, Prof Kawahara and colleagues conducted another study, which was published in the journal *IEEE Transactions on Magnetics*. The team came up with a new reading method for SOT-RAMs that can nullify this new source of readout disturbance. In short, their idea is to alter the original SOT-RAM structure to create a bidirectional read path. When reading a value, the read current flows out of the magnetic layers in two opposite directions



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simultaneously. In turn, the disturbances produced by the spin currents generated on each side end up cancelling each other out.

In addition to cementing the theory behind this new source of readout disturbance, the researchers conducted a series of simulations to verify the effectiveness of their proposed method. They tested three different types of ferromagnetic materials for the magnetic layers and various device shapes, with favourable results.

"We confirmed that the proposed method reduces the readout disturbance by at least 10 times for all material parameters and device geometries compared with the conventional read path in SOT-RAM," Prof Kawahara said.

To top things off, the research team checked the performance of their method in the type of realistic array structure that would be used in an actual SOT-RAM. This test is important because the read paths in an array structure would not be perfectly balanced depending on each memory cell's position. The results show that a sufficient readout disturbance reduction is possible even when connecting about 1000 memory cells together.

The team is now working towards improving their method to reach a higher number of integrated cells. They say their study could pave the way towards a new era in low-power electronics, from personal computers and portable devices to large-scale servers.

"We expect next-generation SOT-RAMs to employ write currents an order of magnitude lower than current STT-RAMs, resulting in significant power savings," Prof Kawahara said. "The results of our work will help solve one of the inherent problems of SOT-RAMs, which will be essential for their commercialisation."



3U GPU SERVER

Equipped with up to two dual-slot GPUs, Crystal Group's FG2 3U GPU server brings versatile, scalable compute power for demanding AI and high-density graphics applications into the field. A low-latency path between GPUs with a large amount of bandwidth deliver real-time compute capabilities by meshing the GPU engines for optimal data reconstruction.

The system is designed to deliver acceleration for data processing, machine learning, AI training and AI inference. Weighing less than 16.8 kg, the compact, rugged server tackles graphic-intense workloads demanding more than 20K CUDA cores and thousands of RT cores. Mission-critical applications like real-time sensor fusion, video processing and object recognition require A100 or A30 GPUs, while ray tracing platforms can use tensor cores in either the A40 or A10.

The integrated system includes one or two 3rd Gen Intel Xeon Scalable or AMD processors delivering the latest PCIe Gen4 interconnect bus. It can also be configured with ultrafast, low-latency data processing units (DPUs). Complementing GPUs with DPUs allows users to achieve high levels of data and application security, data centre and cloud application performance, and ultralow latency and lossless networking, in an edge appliance.

A dedicated air plenum and custom heat sinks optimise thermal performance for seamless, real-time operation under high computational loading. The overall configuration of the certifiable system is validated for performance, manageability, security and scalability. Engineered to meet strict MIL standards, accelerate compute-intensive workloads and provide advanced thermal management, the server is suitable for use in demanding and unpredictable situations.

Metromatics Pty Ltd

www.metromatics.com.au

AI MODULAR BOX PC

ICP Australia introduces iEi's FLEX-BX200, which is an AI hardware-ready system suitable for deep learning inference computing to help the user achieve fast, deep insights into their customers and business. The product supports graphics cards, Intel FPGA acceleration cards and Intel VPU acceleration cards, and provides additional computational power plus an end-to-end solution to run tasks efficiently. With the NVIDIA TensorRT, QNAP QuAI and Intel OpenVINO AI development toolkit, users can deploy solutions quickly.

The FLEX series offers four 2.5" HDD bays with a high-speed SATA 6 Gbps interface that can expand storage capabilities and enable fast data transfers. The equipped Intel Q370 chipset provides high-performance hardware RAID protection for the user to back up their media and critical information. RAID 0/1/5/10 can be configured from the BIOS menu to increase performance and/or provide automatic protection against data loss from drive failure.

The series supports multiple PCIe slots, including two PCIe 3.0 x8 and two PCIe 3.0 x4 slots — which are compatible with standard low-profile add-on cards — to meet different edge inference computing applications. It is integrated with the Intel Coffee Lake Desktop processor and supports an HDMI 1.4 output port delivering 4K 24 Hz with a high level of detail. A single HDMI cable carries both video and audio signals, which makes deployment particularly easy.

ICP Electronics Australia Pty Ltd

www.icp-australia.com.au



Y1 CAPACITORS

Murata's DK1 series Y1 capacitors are suitable for all AC-DC switching power supplies where a low profile is required and lead-type capacitors are too large. The capacitor uses a structure of plate-shaped terminals on a disc-shaped ceramic dielectric placed within a plastic mould to reduce the terminal, resulting in a mounted height of 2.5 mm or less for the product.

The safety-certified capacitors are placed at the side of a power line input to eliminate noise that builds up primarily in commercial AC power lines. The capacitors may also be used in compact AV equipment, LED illumination and 1U rack-mounted equipment.

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COMPUTER-ON-MODULES

ADLINK Technology introduces its latest Intel Xeon D-based computer-on-modules (COMs), available in two form factors:

COM-HPC server type and COM Express Type 7. The COMs feature integrated high-speed Ethernet, up to 8x 10G or above with up to 32 PCIe Gen4 lanes, and cutting-edge AI acceleration, while exhibiting extended temperature ratings for embedded and rugged applications.

The COM-HPC-sIDH is a COM-HPC server type D size module powered by Intel Xeon D-2700 HCC processor with up to 20 CPU cores, 30 MB cache, 512 GB DDR4 memory capacity, 8x 10G or 4x 25G Ethernet, and power consumption of 65 to 118 W. It additionally offers a module management controller (MMC) featuring an IPMB interface and a dedicated PCIe-BMC lane. In conjunction with carrier BMC, it provides users with convenient remote management functions such as serial over LAN (SOL) and iKVM.

The Express-ID7 meanwhile is a COM Express Type 7 module based on Intel Xeon D-1700 LCC processor and delivers a power envelope of up to 67 W TDP, offering up to 10 CPU cores, 128 GB DDR4 memory capacity and 4x 10G Ethernet.

Featuring Intel Deep Learning Boost (VNNI) and Intel AVX-512 for AI inference processing, the COMs with Intel Ice Lake-D are designed to fulfil on-device machine learning and deep learning processes, transforming machine vision, natural language processing and smart video analytics. In addition, the COMs feature Intel Time Coordinated Computing (TCC) and provide Time-Sensitive Networking (TSN) support — bringing CPU core control and timely synchronisation over networked devices while enabling low-latency, deterministic performance for driving hard-real-time workloads.

Built for edge and rugged AI applications, the COMs can empower system integrators to realise their IoT innovations, from edge networking, unmanned aerial vehicles, autonomous driving and robotic surgery to rugged HPC servers, 5G base stations, automatic drilling, ship management and more.

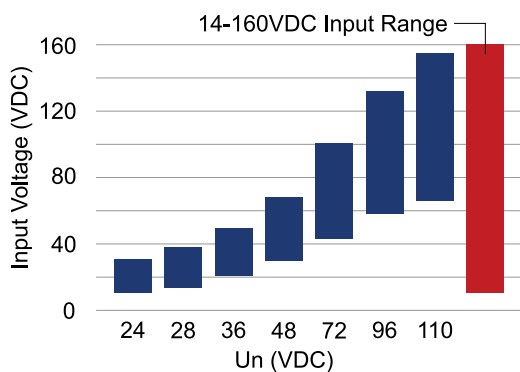
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WATERPROOF CONNECTORS AND ENCLOSURES: CHECK WHAT PROTECTION YOU NEED

Every electronic device needs some kind of protection. The level of such protection depends on the application of the equipment in question and the place where it will be used. For example, home electronics do not need to be as protected against dust and water as outdoor surveillance cameras.

Many appliances or electronic components are assigned a symbol, known as the IP rating. It provides a quick and easy way to determine the conditions under which a device can operate.

What is the IP rating?

The IP (Ingress Protection) rating classifies the degree of protection of specific equipment to the adverse effects of solids, water and moisture. Typical IP ratings are in the form of IPxx, where xx are the digits assigned to the appropriate degree of protection. The first x relates to the protection against dust (solid particle) and can take a value from 0 to 6, where 0 means no protection and 6 complete protection. The second digit relates to the protection against water and ranges from 0 to 9, where 0 is no protection and 9 means that the equipment is protected against high-pressure (80-100 bar), high-temperature (+80°C) spray downs.

Waterproof connectors and housings relevant in every industry

When choosing equipment for your company, you should pay attention to its IP rating. In this way, we can avoid future breakdowns and the associated production downtime and costs associated with replacing equipment damaged by dust or water. It is worth noting that the connectors and housings distinguished by their special resistance to water and moisture (IPx8 and IPx9) are obviously also well protected against the ingress of dust and solid objects. As the following examples show, different industries may have different requirements for the components used, but what they all have in common is the need for sealed enclosures and connectors.

The proper tightness of enclosures and connectors is very important in the production of equipment installed outdoors,

in places exposed to moisture, flooding or prolonged exposure to water. All equipment or installations must therefore be properly protected against their effects; otherwise, they could very easily be damaged.

One of the characteristics of the wood-working industry is the dust from wood processing. Equipment used in such enterprises must be dust-tight. If not, the equipment would be exposed to unwanted solids that could, in extreme cases, lead to a short circuit and permanent damage.

In the chemical industry we can also find many solid and liquid substances that can adversely affect the operation of electronic equipment. Here, too, attention should be paid to the IP rating of enclosures or connectors. Moreover, in this industry, equipment may come into contact with many substances which may affect its durability in various ways. It is therefore worth taking care not only to ensure that enclosures and connectors are tightly sealed, but also to provide



WE HAVE TO TAKE CARE OF THE TIGHTNESS OF CONNECTORS AND ENCLOSURES NOT ONLY IN PRODUCTION PLANTS.

protection against corrosion, grease and high temperatures.

The dust from stored cartons and packages is quite a common problem in warehouses. In the long term it can also have an adverse effect on electronic equipment. For example, a computer left in such a place will quickly become covered with dust, which may deteriorate heat dissipation from the housing and shorten the life of components. Similar problems can happen to automation systems, which should be protected with a proper enclosure.

We have to take care of the tightness of connectors and enclosures not only in production plants. Almost every office building is protected and monitored to some

degree. Outdoor surveillance cameras must also meet the appropriate waterproofing standards. They are mainly susceptible to dust and rain during the summer season and to humidity and lower temperatures during the rest of the year. If the camera and system components are not properly protected, faults can occur very quickly. When thinking about outdoor installations, it is also worth bearing in mind the influence of sunlight, which can significantly shorten the service life of enclosures that are not protected against UV radiation. It will depend on the material used in the construction.

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10GbE NETWORK INTERFACE CARD

Acromag's XMC633 module offers two independent 10 GB Ethernet interface ports with 10GBASE-KX4 protocol. The XMC mezzanine card mounts on VME, VPX, PCIe and other embedded computing carrier boards. An Intel XL710 Ethernet controller provides high-performance network connectivity with advanced off-load and virtualisation capabilities. The rear I/O model routes two KX4 interfaces to the P16 connector and is compatible with conduction-cooling frames.

Designed for COTS applications, the XMC module is suitable for use in defence, aerospace, industrial and scientific research computing systems. Extended temperature operation is supported for -40 to 85°C. Acromag has responded to requests for additional 10 GbE interface protocols by using the latest Intel Ethernet controller technologies, which support 10GBASE-KX4 and XAUI backplane interfaces.

The XMC module optimises network performance with intelligent off-loading, innovative virtualisation and advanced traffic direction. When paired with a Xeon-D processor, the Intel devices provide a balanced hybrid solution of compute and off-load to achieve optimal performance and reduce bottlenecks. Other features include precision timing, Energy-Efficient Ethernet (EEE) and dynamic load balancing. Advanced traffic steering capabilities should increase transaction rates and reduce latency.

In rugged systems, the dual KX4 or XAUI interface offers low-power 10 GbE chip-to-chip communication over the backplane. The four front I/O SFP+ ports support 10GBASE-SR, 10GBASE-LR, 10GBASE-T and 10GSFP+Cu connections. Software support is available for Linux and Windows systems.

Metromatics Pty Ltd

www.metromatics.com.au



RUGGED COMPUTERS

Designed and manufactured in Australia by Unitronix, REN boxes (Rugged Embedded Nodes) are conduction cooled and fully sealed, with high-end computing platforms built in. They are rugged and ready to host users' applications, taking them from the desktop and out into tough environments.

Milled from a single billet of 6000 series aluminium, the REN series are not general-purpose computers; rather, they are for use in harsh conditions where maximum protection needs to be afforded to the high-powered processing solution inside. The series thus offers an innovative way of looking at how to deploy high-end processing systems into applications such as smart cities, micro grids, rail, oil and gas, mining, AI and hydrogen plants to name a few.

Customers are engineers who are looking to design their own box, system or case. The REN provides a solid alternative that is fast to procure and deploy, suitable for rapid prototyping and testing phases of a project.

Unlike commercial-grade servers and PCs which require an air-conditioned office type environment to operate properly, the product is designed with no requirement for secondary cooling. The fully sealed REN box utilises VersaLogic's Quad Core i7 and 16 core ATOM Xeon from Intel with all the latest cybersecurity features on board, as well as the additional integration of ADLINK rugged GPU cards and ASINE rugged SSD solid-state drives.

Open design, cabling, connectors, power configurations and storage are all accommodated, giving hardware engineers the flexibility to make the system exactly as they require.

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SERVER-ON-MODULES

congatec is celebrating the world premiere for x86-based COM-HPC Server modules by announcing the availability of three server-on-module families parallel to the launch of the Intel Xeon D processor family, formerly codenamed Ice Lake D.

The COM-HPC Server modules in Size E and Size D as well as the COM Express Type 7 modules should accelerate the next generation of real-time microserver workloads in rugged environments and extended temperature ranges. Improvements include up to 20 cores, RAM to up to 1 TB, double throughput per PCIe lanes to Gen 4 speed, as well as up to 100 GbE connectivity and TCC/TSN support.

Target applications range from industrial workload consolidation servers for automation, robotics and medical backend imaging to outdoor servers for utilities and critical infrastructures — such as smart grids for oil, gas and electricity as well as rail and communication networks — and also include vision-enabled applications such as autonomous vehicles and video infrastructures for safety and security. Besides the bandwidth and performance improvements, congatec's three server-on-module families should significantly extend the life cycle of next-gen rugged edge server designs compared to common servers as long-term availability of up to 10 years is planned.

The module families include a comprehensive server-grade feature set: for mission-critical designs, they offer powerful hardware security features including Intel Boot Guard, Intel Total Memory Encryption – Multi-Tenant (Intel TME-MT) and Intel Software Guard Extensions (Intel SGX). AI applications benefit from built-in hardware acceleration including AVX-512 and VNNI. For best RAS capabilities, the processor modules integrate the Intel Resource Director Technology (Intel RDT) and support remote hardware management features such as IPMI and redfish.

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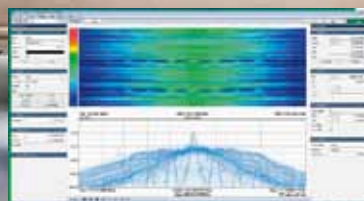
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SERIAL TO ETHERNET CONVERTER

Weidmüller has released a secure and easy-to-use serial to Ethernet converter and Modbus gateway, the IE-CS-MBGW-2TX-1COM. The device offers a 1-port RS-232/422/485 to 2-port Ethernet device server with a Modbus protocol gate-

way, allowing easy transfer of serial and Modbus data to Ethernet and vice versa.

Device configuration is performed through a secure web interface supporting HTTPS, SSH and SSL encryption to establish the security of data, coupled with an intuitive interface allowing for quick set-up of its Modbus gateway mode. It supports the operation modes of virtual com, serial tunnel, TCP Server, TCP Client, UDP and a desktop-based utility allows for the configuration of multiple devices mapped to virtual com ports.

The device features a dual redundant power supply input from 12–48 VDC, a wide operating temperature of -40 to 70°C and a rugged IP30 housing, making it suitable for operation in harsh and demanding industrial environments.

Weidmüller Pty Ltd

www.weidmuller.com.au

AUTOMOTIVE AUDIO AMPLIFIER

STMicroelectronics' TDA7901 automotive audio amplifier integrates a buck controller for class-G power switching and supports high-definition audio, for a good listening experience and high efficiency.

In class-G operation, the TDA7901 buck controller automatically optimises the voltage supplied to the bridge-tied load (BTL) power stage depending on the audio-signal level. The resulting smooth, analog sound comes with near-class-D efficiency at normal listening levels. Because the power dissipation is lower compared with a conventional class-A/B amplifier, the heatsink requirement is optimised. Integrating the buck controller in the IC contributes to the low system size and weight. It is also designed to cut the bill of materials, simplify circuit design and save developing firmware to control the voltage rail.

The product is suited to use in many in-vehicle information (IVI) systems, such as head units, smart cockpit systems, external amplifiers and more. The amplifier signals full in-play diagnostics including real-time load-current monitoring through I²S or I²C interfaces, enabling ASIL-A certification of safety-related applications like warning-tone generators and acoustic vehicle alerting systems (AVAS). A digital impedance meter is also provided, meaning systems containing the amplifier can meet the demanding requirements of automotive OEMs.

With its I²S digital input and intelligent quad-BTL output, the device delivers 4x 43 W of audio power (at 4Ω load, saturated output at 14.4 V). The amplifier has 80 kHz bandwidth to handle high-definition audio. Its wide supply-voltage range, spanning 4.5–18.5 V, prevents disruption by start-stop engine operation and general automotive electrical transients.

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ETHERNET CABLES

DIGITUS has released its DK-1743, DK-1843 and DK-TP series Ethernet cables, each of which sits in a different cable category.

The DK-1843 series cables are Cat 8.2, for use in IT centres, server rooms, etc. Inside each cable (under the foamed polyethylene sheath and tinned copper wire braid overall shielding), twisted pairs of conductors are placed — each pair has its own aluminium-covered polyester film (AL-PET) shielding. This design means the cables are distinguished by good mechanical durability and by high immunity to external and internal (cross-talk) noise.

Cat 8.2 cables are intended to work at distances up to 36 m (transmission frequency up to 2000 MHz), which is why they are not recommended for consumer or office installations. Instead, category 7 cabling should be used for these purposes, with the DK-1743 series making 10 Gbps possible (for cable length up to 100 m). The outer insulation is made of LSZH — a halogen-free material which is distinguished by low smoke emission when in contact with fire.

The third group of cables comprises DK-TP series cables from categories 5e and 6 (transfer up to 100 Mbps and in the GbE standard). They feature high-quality PE insulation, which is resistant to UV and moisture. The cables are intended for underground Ethernet installations, as they can be laid directly in the ground. The series also has high thermal tolerance, meaning the cables are suitable for temperatures from -40 to 70°C.

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ANTI-STATIC AIR KNIFE

Paper, plastic, textiles or other materials are normally electrically balanced — that is, they contain an equal number of positive and negative charges. Friction can disturb this balance, causing problems such as dust clinging to product; product clinging to itself, rollers, machine beds or frames; materials tearing, jamming or curling; sheet feeding problems; and hazardous sparks or shocks.

EXAIR's Gen4 Super Ion Air Knives remove static electricity by flooding an area with static eliminating ions — up to 6.1 m away. The laminar sheet of air sweeps surfaces clean of static, particulate, dust and dirt, dramatically improving production speeds, product quality and surface cleanliness.

The device incorporates EXAIR's Super Air Knife that minimises compressed air use by inducing surrounding airflow at a ratio of 40:1. The unique amplified airflow carries the ions to the target, making it possible to eliminate static charges in less than a half

second. Air volume and velocity are infinitely controllable from a 'breeze' to a 'blast' to gently wipe or forcefully blow away debris.

Available in lengths from 3" (76 mm) to 108" (2743 mm), the electrical ion source is shockless and there is no radioactive element. Gen4 Super Ion Air Knives have undergone independent laboratory tests to certify they meet the rigorous safety, health and environmental standards of the USA, European Union and Canada that are required to attain the CE and UL marks. They are also RoHS compliant.

Applications include surface cleaning, neutralising plastics, bag opening, printing machinery, packaging operations and elimination of painful static electricity shocks.

Compressed Air Australia Pty Ltd

www.caasafety.com.au

RUGGEDISED, 300 W, COMPACT DC/DC CONVERTERS

The WAF300 series is a compact and ruggedised range of DC/DC converters designed for harsh industrial environments, where issues such as vibration, dust or moisture may be present.

The WAF300 features 4:1 input range voltages (18 to 75 V or 43 to 160 VDC). DC outputs are available in five single outputs: 12, 15, 24, 28 and 48 VDC. Features include an operating temperature range of -40 to +100°C ambient; remote ON/OFF; OCP, OVP and OTP protection; and adjustable output voltage.

The convection/conduction-cooled panel mount package measures 152 x 102 x 39 mm. The fully enclosed and encapsulated converters comply with the stringent requirements for railway EN50155 standard and vibration MIL-STD-810F, and are UL 62368-1 approved.

Helios Power Solutions

www.heliosps.com.au



PROTECTIVE ENCLOSURES

Bopla has added two extra sizes and a variant with lid screws to the Bocube Aluminium (Alu) series of enclosures. This offers even higher degrees of protection.

All Bocube Alu housing components are made of metal and are therefore suitable for use in harsh environmental conditions. All fasteners are mounted invisibly under design covers.

Due to the integrated hinge, convenient access to the interior is enabled and wiring between assemblies in the lid and bottom is protected. The lower part has a moulded holder for a pressure compensation membrane that can be 'activated' at the factory.

Coloured hinges are supplied on request and wall tabs are optionally available. Housing covers are also optionally available, with or without a lowered surface (2 mm) for mounting input units.

A seawater-resistant (SWB) or special EMC version is available on request. A range of accessories is available, including mounting kits, quick-release fasteners, handles and pressure compensation.

ERNTEC Pty Ltd

www.erntec.net

FLAT LENS EXTENDS VIEWING DISTANCE FOR 3D LIGHT FIELD DISPLAY

Researchers from Soochow University have created a glasses-free 3D light field display system with a significantly extended viewing distance, thanks to a newly developed flat lens. Described in the journal *Optica*, the system is an important step towards compact, realistic-looking 3D displays that could be used for televisions, portable electronics and tabletop devices.

Light field displays use a dense field of light rays to produce full-colour, real-time 3D videos that can be viewed without glasses. This approach to creating a 3D display allows several people to view the virtual scene at once from different angles, much like a real 3D object. However, the focal length of the lenses used to create these views is the limiting factor when it comes to viewing distance.

"Most light field 3D displays have a limited viewing range, which causes the 3D virtual image to degrade as the observer moves farther away from the device," said Wen Qiao, team leader on the new research.

To overcome this, Qiao and colleagues designed a new diffractive flat lens by patterning nanostructures onto a flat surface in a way that focuses light. Intertwining several of these lenses allowed them to create a pixelated view modulator, the optical component that creates the various perspectives for a scene in a light field display. A 3D display that creates four views, for example, would use four of these

lenses, each of which converges the light into a unique view.

"The nanostructured flat lens we designed is just 100 μm thick and has a very large depth of focus, which enables a high-quality virtual 3D scene to be seen from farther away," Qiao said.

"Because flat lenses provide superior light manipulating capability compared to traditional glass lenses, they can be used to solve formidable problems such as limited motion parallax, crosstalk, visual fatigue and limited viewing distances in 3D displays."

After showing that the lens achieved high resolution when focusing the red, green and blue light used by LCDs to create images, the researchers incorporated them into a 4" prototype 3D light field display with viewing distances between 24 and 90 cm. The display formed a smooth horizontal parallax with a crosstalk below 26% over all viewing distances, which means there were few errors that would cause eye strain or make the image look unrealistic.

The display also exhibited a light efficiency that reached 82%, much higher than other

similar 3D display systems that have been reported. High light efficiency is important for creating a bright virtual image, especially for applications where power consumption matters, such as portable electronics.

Although the prototype exhibited a viewing angle of only 9°, the researchers say this could be enlarged to almost 180° by optimising the design of the nanostructures used to make the flat lenses. In addition to studying this, they plan to further improve the light efficiency by developing a more sophisticated design algorithm for manipulating the light beam at each pixel. They said that easier ways to fabricate the nanostructures would also be required for this type of display to be practical to manufacture.

"We developed this new technology in hopes of creating displays that could allow people to feel as if they were actually together during a video conference," Qiao said. "With the continued development of nanotechnology, we envision that glasses-free 3D displays will become a normal part of everyday life and will change the way people interact with computers."



CAN/CAN FD SIGNAL REPEATER

ICP DAS's I-7331-FD-G is a CAN/CAN FD signal repeater that can connect two or more CAN networks with the same baud rate.

Based on its signal repeat function, users can use different numbers of the product to combine tree-shaped and star-shaped CAN network topologies. When there are too many devices on the CAN network, using the repeater can increase the driving force of the CAN signal to drive more CAN devices.

The CAN side of the repeater has digital isolation of 2500 V_{rms} and the CAN side and the power side provides 3000 V DC-DC isolation protection, which can effectively isolate the noise interference between CAN networks and achieve protection of a specific CAN network.

The product can function in tough conditions as it has an operating temperature of -25 to +75°C. Furthermore, it comes with a plastic casing and a DIN-rail installation option.

ICP Electronics Australia Pty Ltd
www.icp-australia.com.au

MULTIZONE TIME-OF-FLIGHT SENSORS

ams OSRAM has released the TMF8820, TMF8821 and TMF8828 multizone time-of-flight sensors. The high-performance, direct-time-of-flight (dToF) sensors achieve a 5 m detection range, while the devices' multi-lens array widens the field of illumination.

The sensors are built using single-photon avalanche diode (SPAD) array, time-to-digital converter (TDC) and histogram technology. The sensors feature an associated vertical-cavity surface-emitting laser (VCSEL), while the high-quality lens on the SPAD supports a dynamically adjustable field of view up to 63°. The versatile sensors are designed to enable detection of the target area in multiple zones with precise measurement results. The sensors can also detect multiple objects per zone, allowing automated robots to gain additional sensory awareness and provide early alerts to potential obstacles.

The sensors perform all raw data processing on chip, and the devices report both distance information and confidence values through an I²C interface. Housed in a single compact modular package, the sensors support a range of demanding applications, including laser detect autofocus for mobile phone cameras, object detection and collision avoidance, presence detection, and light curtain applications for industrial safety designs.

Mouser Electronics
au.mouser.com



SBC

The MIO-2375 Pico-ITX SBC is powered by the latest 11th Gen Intel Core processors. It supports extended operating temperatures from -40 to +85°C and is suitable for mission-critical applications. The MIO-2375 is designed with onboard LPDDR4x memory on a Pico-ITX sized board, making it small, rugged and lightweight (under 500 g).

Advantech Edge AI Suite helps users to experience what benefits AI could bring to their business. Advantech WISE-DeviceOn provides a public and/or private cloud or on-premise set-up to implement remote management. Edge AI Suite is designed to lower maintenance effort for users who need to monitor and manage many edge devices remotely, 24/7. They also get updates over-the-air to prevent security vulnerabilities. Both pieces of software have been validated on the MIO-2375 and will be bundled into the standard OS image to speed up migration to the world of AIoT.

The SBC is a suitable option for users who want to embed AI-native design into their products, especially in the factory automation, telemedicine, smart transportation and smart city fields.

Advantech Australia Pty Ltd
www.advantech.net.au



HYBRID PROTECTION COMPONENTS

The IsoMOV protectors from Bourns enable product designers to tailor or upgrade surge protection without the need for large, low-performing alternatives.

The hybrid protection component integrates the GDT function directly into the MOV itself, providing a high level of surge protection performance and operational life. Combining both devices into a single package allows the GDT to block leakage currents through the MOV that may lead to premature failure, making the MOV inherently more robust without adding additional components into the circuit design.

The protectors enable designers to tailor the surge protection performance to their space requirements and to upgrade their MOV overvoltage protection to include the benefit of GDT isolation without a PCB redesign. Industry-standard pin layouts are said to offer a performance upgrade over same-size standard MOVs in a pin-to-pin drop-in-replacement form factor.

Applications include electric vehicle charging systems, industrial power supplies, powerline communications and high-speed information and communication technology (ICT) equipment, as well as a wide range of certain harsh environment or remote, exposed applications where repairs can be both physically challenging and expensive to perform.

element14
au.element14.com



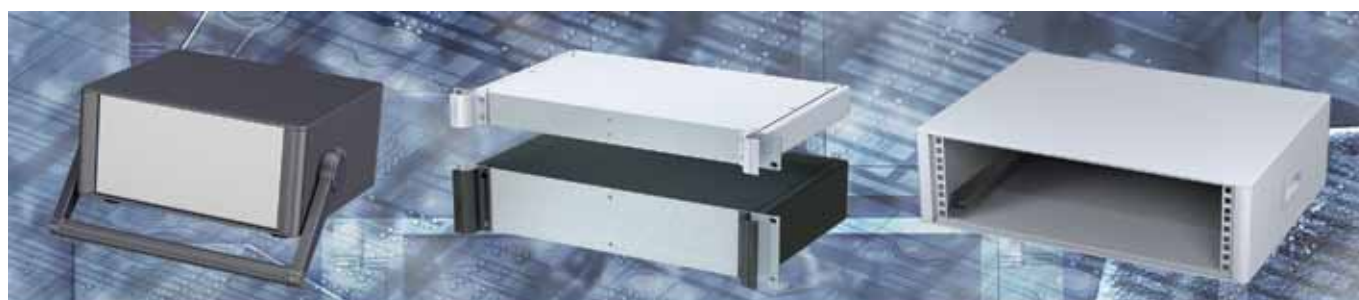
RACK MOUNT DEFENCE DISPLAY

Winmate's R21L100-MLM1FP is a 21.3" PCAP rack mount defence display. To meet the regulatory requirements of military and defence, defence console rack displays are built and tested according to MIL-STD-810G environmental and MIL-STD 461F EMC standards. Selected models support the NVIS MIL-STD-3009 night vision.

The display features a user-friendly touchscreen and physical OSD buttons for fast access to the central control located on the front panel. The display also features a built-in light sensor for auto-brightness control. The screen brightness effortlessly changes with the lighting conditions throughout the day.

Additionally, the display comes with MIL-DTL-38999 type I power input connector and, for selected models, MIL-DTL-38999 type III input/output connectors — high-performance cylindrical connectors for cable-to-panel applications in defence, air traffic control or other mission-critical situations. This makes the product compatible with existing defence systems.

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NO UNPLEASANT SURPRISES IN ASIC DEVELOPMENT

BEHAVIOURAL MODELLING GETS CUSTOMERS THE ASIC THEY NEED

When developing an application-specific integrated circuit (ASIC) with a supplier, nothing is manufactured or physically measured before the end of the entire design process. So how can you ensure that the finished product will fit seamlessly into your application without any unpleasant surprises? The answer is behavioural modelling, as explained by Dr Michael Chesterman, Senior Design Engineer at mixed-signal ASIC supplier Swindon Silicon Systems.

An ASIC allows a developer to make the leap from a proof-of-concept circuit board, populated with numerous off-the-shelf components, to a volume-optimised product. By integrating all the key circuits into a single package, form factor is improved, electrical performance is optimised and novel circuit intellectual property (IP) is hidden. At the same time robustness is enhanced, assembly is simplified and component sourcing is streamlined.

However, ASIC design is unlike many other fields of engineering, as nothing can be physically tested until the entire fabrication process is completed, some weeks after the design work is over. It is not possible to 'trial' an approach or to patch a misbehaving design once it is fabricated. Instead, the designers rely on upfront simulation to predict the behaviour of the finished article, and ensure that it meets the customer's specification. The 'SPICE' circuit simulation tools at their disposal are incredibly sophisticated, and able to model the finest details of the design, down to the behaviour of individual transistors and the tiny fringing capacitances that form between them. But this sophistication comes at huge computational cost, and a tiny fraction of the design can take hours or days to simulate in such detail.

Taking a top-down approach

A top-down approach to ASIC design is favoured, starting from the high-level requirements that have been agreed with the customer. Determining these requirements is somewhat of an art, and Swindon provides its consultancy service here: understanding a customer's wider system and recognising the most effective role for a bespoke chip. Once the requirements are established, the project's lead designer will develop a chip architecture comprising various analog and digital sub-blocks, each with their own precise specification.

At this point the essence of the design has been captured. It is now highly desirable to simulate the chip, to confirm the sub-blocks will work together, to allow the performance of each block to be traded-off and to check that the overall design will function as intended. However, SPICE simulation is still a long way off, await-

ing a team of designers to implement the blocks at the transistor level. And even with transistor-level designs in hand, it is unfeasible to simulate an entire chip using conventional SPICE: a small mixed-signal ASIC may still contain tens of thousands of transistors, and so the computational demand is impractical.

This prompts a need for a model with a higher degree of abstraction, which can be constructed rapidly from the sub-block specifications, and can run quickly at chip-level to confirm functionality. This need is fulfilled with behavioural models.

Behavioural models

A top-level behavioural model of an ASIC is composed from individual 'black-box' models of each sub-block, connected exactly as the chip architecture demands. In this context, 'black-box' signifies that no assumption is made about the inner working of the blocks: it is only behaviour at their terminals that is approximated. But what degree of approximation should be used? For this, it is important to remember that the main purpose of the models is to verify correct interaction between the blocks. Therefore, designers must write the simplest, coarsest models that are able to achieve this.

Once in place, the sub-block behavioural models serve as a valuable verification tool. While the analog blocks are being implemented, designers can use the models as a reference, comparing simulation of the model against that of the emerging transistor-level design. The top-level model allows the digital portion of a mixed-signal ASIC to be systematically and rigorously tested, by predicting its interactions with surrounding analog circuitry.

This is particularly important where digital and analog circuits work together closely, for example when a CPU is controlling various analog blocks: perhaps orchestrating analog measurements by enabling and configuring circuits at the correct times. These scenarios merit particular care in verification, as there can be many pitfalls in the sequencing of events. For example, an amplifier might be enabled before the reconfiguration of a power supply, leading to an unanticipated supply brown-out. Behavioural models of analog sub-blocks are



uniquely positioned to catch these faults, as they can be devised to 'complain' — by raising a warning or error message — when subjected to a stimulus that is out of range or otherwise invalid.

Empowering the customer

Besides its role in verifying the ASIC design, behavioural modelling can serve as a collaboration tool. The top-level model can often be shared with the customer, allowing them to interact with their proposed chip using a testbench that represents their application. All this can happen before block-level implementation has begun, validating the customer's requirements and building early familiarity with the product they have commissioned. Furthermore, for designs that incorporate a CPU, the top-level behavioural model can even host the embedded software. This allows the software to be prototyped and its interface with the bespoke hardware to be trialled, before any analog sub-block design has taken place.

Nobody wants an unpleasant surprise, in any area of manufacturing. Behavioural modelling is a powerful verification tool in a top-down ASIC design process, and its use is synonymous with first-time success. It provides the customer with deep insight into their investment, and builds confidence in its specification, all at the very earliest

stages of design. Ultimately, behavioural modelling ensures the customer gets the ASIC they need.

Swindon Silicon Systems
<https://www.swindonsilicon.com/>



NEW TECHNIQUE

INCREASES CHIP YIELD FROM SEMICONDUCTOR WAFER

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Scientists from Nanyang Technological University, Singapore (NTU Singapore) and the Korea Institute of Machinery & Materials (KIMM) have developed a technique to create a highly uniform and scalable semiconductor wafer, paving the way for higher chip yield and more cost-efficient semiconductors. Their results have been published in the journal *ACS Nano*.

Semiconductor chips commonly found in smartphones and computers are difficult and complex to make, requiring highly advanced machines and special environments to manufacture. Their fabrication is typically done on silicon wafers and then diced into the small chips that are used in devices, but the process is imperfect and not all chips from the same wafer operate as desired. These defective chips are discarded, lowering semiconductor yield while increasing production cost.

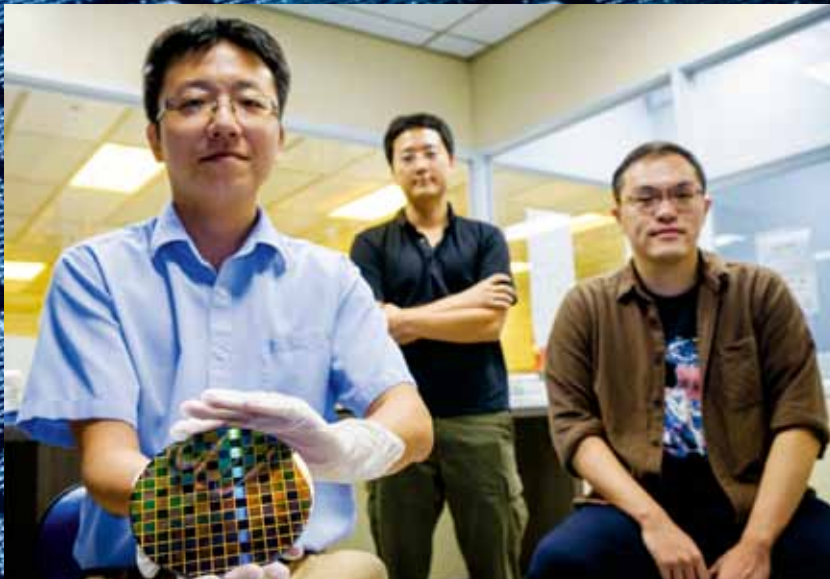
The ability to produce uniform wafers at the desired thickness is the most important factor in ensuring that every chip fabricated on the same wafer performs correctly. Nanotransfer-based printing — a

process that uses a polymer mould to print metal onto a substrate through pressure, or 'stamping' — has gained traction in recent years as a promising technology for its simplicity, relative cost-effectiveness and high throughput; however, the technique uses a chemical adhesive layer which causes surface defects and performance degradation when printed at scale, as well as human health hazards. For these reasons, mass adoption of the technology and consequent chip application in devices has been limited.

The research team from NTU and KIMM reported that their chemical-free printing technique, when combined with metal-assisted chemical etching — a method used to enhance the contrast on surfaces to make nanostructures visible — resulted



THE RESEARCH TEAM WAS ABLE TO ACHIEVE MORE THAN 99% YIELD TRANSFER OF A 20 NM-THICK AU FILM ONTO A 6" SI WAFER.



NTU's Assistant Professor Kim Munho, Kim Youjin and Liao Yikai are part of the research team.

in semiconductor wafers with nanowires (nanostructures in cylindrical form) that were highly uniform and scalable. The semiconductor also demonstrated better performance when compared with current chips in the market. Moreover, the fabrication method is fast and leads to high chip yield.

The nanotransfer printing technique is accomplished by transferring gold (Au) nanostructure layers onto a silicon (Si) substrate at low temperature (160°C) to form a highly uniform wafer with nanowires that can be controlled to the desired thickness during fabrication. The chemical-free printing technique works by triggering direct chemisorption of the thin metal films under heat — a chemical reaction that creates a strong bond between a substrate surface

and the substance that is adsorbed. This industrial-compatible technique allows a wafer to be fabricated quickly and uniformly at scale (from nanometres to inches). At the same time, the fabricated wafer is almost defect-free, meaning that few chips are discarded due to poor performance.

In lab tests, the research team was able to achieve more than 99% yield transfer of a 20 nm-thick Au film onto a 6" Si wafer. Results showed the printed layer remained intact with minimal bending during etching — a process that commonly causes layers to separate — demonstrating the uniformity and stability of the technique. Furthermore, when 100 light sensors, known as photodetectors, were fabricated into the 6" wafer, excellent uniformity of performance was achieved,

underlining the potential for the technique to be used in commercial mass production.

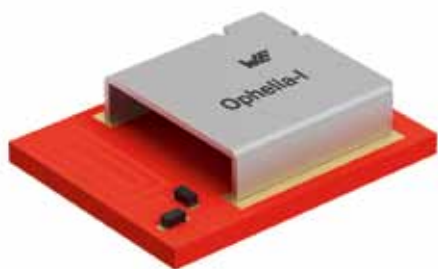
Co-lead researcher Assistant Professor Kim Munho, from NTU, said the uniformity, scalability and stability of the team's technique overcomes the main bottleneck present in existing nanotransfer printing methods. And while the printable wafer size was limited to the laboratory set-up, the team believes their technique can easily be scaled up for use on a 12" wafer — the mainstream wafer size in the current production lines of semiconductor chipmakers like Samsung, Intel and GlobalFoundries.

"The technique devised by the research team from NTU and KIMM has proven to be effective in creating wafer with excellent uniformity, which translates into fewer defective semiconductor chips," Asst Prof Kim said.

"The reality of global chip supply is its vulnerability to many external factors, including shortage of materials and unexpected events like the supply chain disruptions caused by the COVID-19 pandemic. Our newly developed method thus has potential to relieve the tension on the global chip supply in future by increasing chip yield. Moreover, chip makers may also enjoy greater cost-efficiency with higher yields."

Co-lead author Dr Jeong Jun-Ho, from KIMM, added, "The technique developed by the NTU-KIMM team is a new concept of low-cost mass production technology for highly uniform and scalable semiconductor nanostructures, which can be applied to the mass production of nanophotonics, high-performance nano solar cells, next-generation secondary batteries and others."

The research team has filed for patents in Korea and Singapore for the technique they developed. The team is aiming to scale up their technique with an industrial partner for commercialisation within the next few years.



BLUETOOTH LOW ENERGY RADIO MODULE

The Proteus-e radio module is the latest in Würth Elektronik's Proteus Bluetooth Low Energy series. The focus of the module is on basic Bluetooth functionality in order to address price-sensitive applications.

The radio module is based on the Bluetooth Low Energy 5.1 standard and includes certificates of conformity for CE, FCC, IC and TELEC. Despite the integrated antenna, the product is only 7 x 9 x 2 mm in size, which is a third smaller than the Proteus-III module. For applications with the user's own firmware development, the module is offered under the name Ophelia-I, which means a radio module as pure hardware.

The product is based on Nordic Semiconductor's nRF52805 chipset, which includes a 64 MHz Arm Cortex-M4 processor, 192 kB of flash memory and 24 kB of RAM. The maximum output power is 4 dBm and the maximum data rate is 2 Mbps. In power-saving mode, the module — which was developed for mobile applications — requires only 0.3 μ A. Connection timing, advertising packets and timing, beacons and UART can be freely configured.

Würth Elektronik offers an evaluation board for easy commissioning and testing. With its help, the module can be connected to microcontrollers for application development. The company also provides design-in support and offers firmware development services on request.

Würth Electronics Australia Pty

www.we-online.com

5G MMWAVE RF FLEX-TO-BOARD CONNECTORS

The Molex 5G15 Series 5G mmWave RF flex-to-board connectors are designed for advanced 5G applications requiring design flexibility, robust mating and minimal PCB space requirements. They provide engineers with versatility and usability while also delivering signal integrity performance of up to 15 GHz.

The connectors are available in two configurations: a two-RF signal line with a 1 A power line and an alternative option with four RF signal lines with no power. Both options are engineered using a receptacle centre shield, which isolates each row to provide good signal integrity while enabling separation for EMI shielding. Other features include a wide alignment pitch of 0.35 mm for easy mating; an overmould design to prevent pin pullout; and an armoured split nail that protects the connectors from damage during mating and allows for dual use as power or ground.

The connectors offer a maximum current of 2 A (1 A per pin max) and support 5G mmWave, sub 6 GHz, 4G/LTE or any high-speed applications that require digital RF connections up to 15 GHz. The connectors can also be combined with RF and other non-RF connection functions into a single connector to save PCB space and cost or to replace the use of multiple coaxial cables by combining them as a single board-to-board connector.

Robust mating with vertical and PCB real-estate space-saving features makes the connectors suitable for 5G communication applications for consumer, smart home and medical devices, surgical equipment and wearables, as well as various AR/VR and Industrial IoT applications.

Mouser Electronics

au.mouser.com



CONE LIQUID ATOMISING NOZZLE

EXAIR's 1/4" HollowStream liquid atomising spray nozzle provides a hollow cone spray pattern for pressurised liquids. It is applied to solve cooling, cleaning, foam breaking, rinsing and dust suppression applications for industry.

The tangential flow design is vaneless, with wide open internal features to resist clogging while producing a uniform distribution in a ring pattern with medium to large droplets. The right-angle design is compact and works well with liquids containing particulate. Liquid operating pressure is up to 250 psi.

The liquid is supplied into the body of the nozzle, creating a swirling action within a vortex chamber. This vortex produces the spray pattern when the machined nozzle breaks the liquid surface tension as it exits the orifice and moves into a controlled spray angle.

The nozzle's stainless steel construction adds to its durability and corrosion resistance. The nozzle is CE compliant and available in a variety of flow rates.

Compressed Air Australia Pty Ltd

www.caasafety.com.au



SIGNAL AND SPECTRUM ANALYSER

Error vector magnitude (EVM) is one of the main parameters to characterise the performance of a digital transmitter or receiver. The R&S FSW signal and spectrum analyser from Rohde & Schwarz is suitable for high-end measurements requiring high precision; its enhanced front end now continues the path of innovation with EVM measurement for wideband modulated signals in the mmWave range. This makes the product useful for testing any high-end communication component or systems, including 5G NR FR2 or IEEE 802.11ay/ad chipsets, amplifiers, user equipment and base stations.

With frequency, bandwidth, modulation, sensitivity and streaming requirements becoming more demanding, Rohde & Schwarz has been developing the R&S FSW hardware and software over the years to meet and exceed changing performance needs. This includes enhancements to the modified front end as well as microwave hardware optimised for frequencies above 26 GHz.



Featuring a wide internal analysis bandwidth that allows the characterisation of wideband components and communications systems, the signal analyser is suitable for 5G NR testing. Its measurement applications are designed to simplify and speed up in-depth analysis of the physical layer, allowing testing at high frequencies and wide measurement bandwidths. Users can cover all the physical layer options specified in the standard with good RF performance.

With the R&S FSW-B24U Enhanced Dynamic Front End (EDFE) upgrade of the R&S FSW, Rohde & Schwarz addresses the challenging requirements for EVM performance in the mmWave range. R&S FSW43, R&S FSW50 and R&S FSW67 models now ship with the enhancements as standard; the R&S FSW-B24U can also be ordered as an upgrade to many R&S FSW signal and spectrum analysers already in use.

Rohde & Schwarz (Australia) Pty Ltd
www.rohde-schwarz.com.au

FILTER FAMILY WITH TRIPLE PROTECTION

In control cabinets for industrial applications in the single-phase range, space is almost always in short supply. SCHURTER addresses this problem with a complete filter redesign.

The double-stage FPBB RAIL filter family requires particularly little space on the mounting rail due to the slim 25 mm housing profile, available with the option of a fuse holder or circuit breaker. In addition, overvoltage protection (varistor) can be integrated in all variants.

Despite its plastic housing, the FPBB RAIL has a high EMI attenuation due to a double-stage filter and a sophisticated PCB layout. It is therefore suitable for devices with high EMI loads such as switching power supplies or converters in the control cabinet. Typical applications are industrial or machine control systems, as well as medical, telecom and IT equipment.

According to IEC/UL 60601-1 for medical devices, versions with low leakage currents of $<80 \mu\text{A}$ (M80) or without leakage current of $<5 \mu\text{A}$ (M5) are available. All versions of the filter series feature cage clamps for particularly efficient wiring and are mountable on a DIN rail.

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Smart grid technology helps to manage network voltage

With the rapid uptake of solar PV, the low-voltage residential electricity network is being required to perform in ways it was never originally designed to perform, resulting in problems including worsening voltage regulation. Hetech, an electronics design and manufacturing company, recently teamed up with power management company EcoJoule to help resolve this issue.

Solar PV systems are generating at their maximum during the middle of the day when residential consumption is typically low; this then causes voltage rises on the low-voltage networks causing solar inverters to trip, reducing the ability of solar panels to export clean energy. This sustained delivery of excess voltage levels can also reduce appliance lifetime and efficiency.



EcoJoule's EcoVAR is a low-voltage static compensator (STATCOM) that helps utilities to manage the voltage on low-voltage networks. When the voltage is high (typically when PV output is high and loads are low), the EcoVAR sinks inductive reactive power to reduce the voltage. When the voltage is low (typically during peak load periods), the product sources capacitive reactive power to boost the voltage. Thus, the network voltage profile is flattened and the voltage swing reduced.

By improving voltages, the EcoVAR increases the ability of solar to export clean energy. The benefits can be felt throughout the whole solar/energy supply chain, with households benefiting from better energy utilisation, higher solar export volumes and lower bills.

Hetech teamed up with EcoJoule to manufacture the PCB boards for the EcoVAR and build the products ready for distribution. With many installations already complete in multiple states, the technology is predicted to continue to roll out nationally over the coming months.

EcoJoule said that the product has shown success both in Australia and overseas, stating, "Ausgrid has installed a three-phase EcoVAR unit from EcoJoule Energy at Nords Wharf, which has successfully reduced the voltage fluctuation to consumers, also preventing the potential tripping of solar systems and delivering reliable outcomes in the delivery of power.

"In the area where the EcoVAR unit has been installed there is a significant increase in the amount of solar energy that can be exported into the grid, virtually eliminating constraints on existing solar customers."

Not only is the technology improving the quality of electricity in these areas, it is also helping businesses like Ausgrid work towards a net zero future. Ausgrid's Executive General Manager of Asset Management, Junayd Hollis, said, "Ausgrid has a diverse and complex network and we are looking to use innovative technology to improve service quality for all of our communities.

"That's why we commenced these trials with the EcoVAR units, to improve customer voltage and quality of electricity supply. This is an integral part of our actions to increase hosting capacity for rooftop solar as well as other distributed energy resources (DER) and reduce costs on our network. In turn, this helps de-carbonise the grid and work towards a net zero future."

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ONE RING TO CHARGE THEM ALL

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Researchers at Aalto University have developed a wireless charging system that can charge devices placed anywhere within a ring around it.

While existing systems transfer power in a specific direction or to a specific position, the new system has a donut-shaped charging field, thus offering a more convenient and reliable design for consumer use. It has been described in the journal *IEEE Transactions on Industrial Electronics*.



The main challenge in creating an omnidirectional charger has been that the strength of the charging field changes with location. This means that devices will charge inefficiently if they are in the wrong spot or aren't oriented correctly. One approach to solve this is to create a charging field using several transmitter coils connected to several power sources, but this increases the complexity of the transmitter, making the system impractical. Other systems use feedback to properly orient the charging field, but the control systems are also complicated and expensive.

The Aalto University researchers developed the new system to address these challenges. As noted by Nam Ha-Van, the postdoctoral researcher who led the study, "We set out to create a simple, low-cost system using only a single power source."

The key to the new design is a cylindrical power coil. The wire at the top of the coil is wound in the opposite direction to the wire at the bottom of the coil, with a z-shaped bridge connecting them. Since the current flows through these windings in opposite directions, they produce complementary magnetic fields. One field flows out from the middle of the cylindrical coil, around the top winding and back in through the top; the other flows out from the middle, around the bottom coil and back in through the bottom.

This results in an even magnetic field around the middle of the charging coil. Receivers placed anywhere within that area charge efficiently, regardless of their position or orientation.

"This was just a proof of concept," said Aalto doctoral candidate Yining Liu. "Now we can work to improve the efficiency — maybe to around 90% — and also the power."

Based on simulations of the electromagnetic field around a consumer device, the researchers found that the level of exposure conformed to the requirements in safety regulations; however, further safety studies will be required before the technology can be used.

The new design complements recent work from the same research group that made it possible to transfer power to multiple, moving receivers in a charging area. The two technologies address different dimensions of the challenge of wireless charging: freedom of movement for industrial applications and free placement for consumer, tabletop devices.

40
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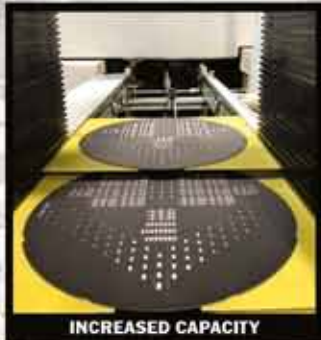
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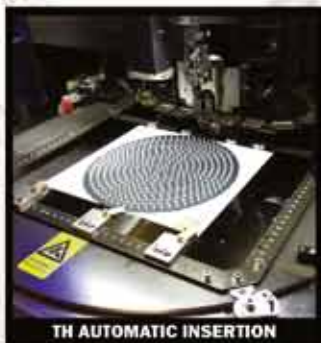
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