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COVER STORY



Control Devices is the official APEM distributor for Australia and New Zealand. APEM is one of the world's largest manufacturers of switches, indicators, joysticks and switch panels, with 65 years of human-machine interface expertise in the industrial, medical, military and aerospace markets. APEM's product development team releases new or improved products monthly; this allows APEM to effectively respond to market demands for simplified features and robust solutions, ensuring ongoing machine operation.

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World Electronics Forum 2019 Adelaide

A WEALTH OF KNOWLEDGE AT THE WORLD ELECTRONICS FORUM

Lauren Davis

From 4–6 December, the City of Adelaide played host to the 2019 World Electronics Forum (WEF) — a voluntary gathering of CEOs and directors of electronics industry associations that has taken place every year since 1995.

Meetings of the WEF are held in a different global city each year, with the only previous Australian gathering having taken place in Canberra in 2003. It was thus a momentous occasion when the 2019 event was secured by Australian industry association EIDA (Electronics Industry Development Adelaide) — one that would see a range of local and international speakers convene at the Adelaide Convention Centre to present on the topic ‘Electronics — Enabling Our Future’.

IoT and LPWANs

Of course we can’t talk about electronics and the future without mentioning the In-

ternet of Things (IoT). WEF speaker Pietro Skisa, IoT Practice Lead at Braemac, is no stranger to this topic — his company has connected over three million IoT devices in the past three years. He stressed that if you’re looking at rolling out your own IoT network, you need to consider your business case — ie, what exactly you’re trying to achieve — and then assess the various options based on their bandwidth and range.

For example, Skisa recommends a cellular network for mission-critical or outdoor applications, whereas latency-sensitive applications such as autonomous driving and remote surgery would benefit most from ultra-reliable low-latency communica-

tion (URLLC). Enhanced Mobile Broadband (eMBB) offers high bandwidth that is suitable for web browsing, video streaming and virtual reality, while massive machine-type communication (mMTC) is designed for applications such as sensing, metering and monitoring.

The complexity of your data will meanwhile play a role in determining any artificial intelligence (AI) you wish to include as part of your network, in order to utilise this data for decision-making purposes. Skisa noted that once data is collected it is sent to the cloud, and this is where the AI is typically hosted — but if your data is particularly large or complex, it will simply take too long to

Image by Brand Photography



reach the cloud, and for the AI to make a decision. The solution is thus to bring AI to the device level via 'edge computing', which Skisa recommends for decisions that need to be made instantaneously and in real time.

For those seeking to collect less complex data over a larger area, Thinxtra Network, Cloud & Services Manager Adrian Tchordjallian recommends utilising low-power wide-area (LPWA) technology. Tchordjallian says LPWA solves many of the issues that can be found in some other IoT networks — including high energy consumption for devices, short range, complexity and high cost — with a range of several kilometres and power-efficient data transmission.

The reason for this efficiency, Tchordjallian explained, is that the sensors deployed in LPWA networks (LPWANs) — recording things like movement, temperature, geolocation, etc — can transmit their data in just

a few bytes, which is far smaller than, say, a voice message of a few megabytes. Thinxtra's Sigfox network, for example, enables the user to send 4200 messages per month per device, with the capacity to only 'listen' for data when it's asked. Devices operating on Sigfox can also have up to 10 years of battery life, Tchordjallian noted, although this diminishes the more data that is transmitted.

Yet even the simplest data can have a significant impact, according to Tchordjallian, who noted that Thinxtra has already helped a variety of businesses with a variety of applications. For example, Thinxtra worked with a rental car operator to install GPS trackers in their vehicles, so the company could accurately track the vehicles in the event that they were stolen. Sensors have also been installed to monitor the capacity of public bins in West Melbourne, meaning

sanitation workers can be more efficiently deployed to empty the bins only when they are actually full. Finally, temperature-sensitive applications have benefited from sensors installed in fridges, sending alerts in the event of a temperature rise (due to a power failure, for example) and thus giving companies the opportunity to realise the problem early and hopefully save their refrigerated stock.

Manufacturing competitively

According to academic Professor Göran Roos, the implementation of smart technology — through devices such as sensors — will be critical for companies looking to continue to operate in high-cost manufacturing environments, as they will need to find ways to do things better than, cheaper than or completely different to their competitors. He noted that sensors themselves can actu-



Image by Brand Photography

what each component should be, but what it should do. If the manufacturer does not have the requested component, but they do have something that is just as viable based on the specs, they should ensure this is communicated back to the customer. The customer should be open to compromising if necessary — and the contract manufacturer, acting on the customer's behalf, should be wary of seeking an alternative elsewhere for the sake of complying with the customer's original request.

The future

It's clear that the technology of today has the ability to enable the applications of tomorrow — so long as we're constantly looking to make the most of it. This is of course dependent not only on lifelong learning from current members of the STEM profession, but also the next generation. The good news is that it appears the future is in safe hands, with representatives of the award-winning Student Robotics Club of South Australia, known as the RoboRoos, making a special appearance at the forum to talk about their mission to make rock stars out of engineers. Key to this is the club's ongoing participation in the *FIRST* robotics programs, designed to get kids of all ages more interested in STEM — the most challenging of which asks its teenage participants to build and program a 50 kg robot in just six weeks.

The RoboRoos were complemented at the forum by former students of STEM Fast Track, a mentoring program for young people looking to develop their STEM literacy as well as useful life skills such as teamwork and project coordination. Via its STEM Mista and STEM Sista programs (for young men and women respectively), STEM Fast Track uses a combination of workshops, presentations and networking events to give young people the confidence and know-how required to pursue a successful STEM career. The program's CEO and founder, Teresa Janowski, probably said it best when she stated, "We assume kids, at this age, don't want to learn this stuff. But they do. They just don't know it."

These are just a few highlights from what proved to be an extensive conference program — one that shone a spotlight on some of the ways electronics will continue to play a vital role in all our lives. The event proved an enlightening experience for those who attended — from veterans of the industry right down to the school-aged guest speakers — proving that when it comes to the possibilities enabled by electronics, there is always more to discover.

ally be very cheap — as low as 2 cents each — and that by combining them with machine learning and data analytics, companies can create profitable and useful solutions for their customers, via predictive maintenance applications for example.

Indeed, Prof Roos claims that all products must eventually become smart products — with features including monitoring, control, optimisation and autonomy — and that if your company doesn't sell smart products, you can always sell devices that help your customers' products become smart. The key, he said, is to provide value for money — which does not mean selling products at a low cost, but rather increasing their usefulness and relevance to the customer. "You want to produce the right thing, not a cheap thing," Prof Roos stated, noting that a lot of businesses go under because they produce cheap products that nobody actually wants.

Companies should also remember that sensors do not always need to be sold on to the customer, and can be utilised within the manufacturing environment itself in order to optimise production. He gave the example of a manufacturer who deployed sensors along their production line, collecting data that identified potential bottleneck issues — as a result, in less than a week they went from producing 128 units per day to 580 units per day. And given that Prof Roos claims companies should be continuously focusing on reducing costs and improving productivity, sensing solutions will play a vital role in enabling this to occur.

Manufacturers should also take care to maintain strong relationships with their customers, informing them if and when any changes are made to a particular component — a component the customer may be in the market for, and may expect to always look more or less the same. This advice came from Donald Kay, CEO of Don Alan, who warned that counterfeiting and other quality issues are unfortunately rife in the electronics industry.

Of course, there are customers out there who will unknowingly purchase counterfeit components — unlikely to work as well as the real thing — from shifty suppliers. If the manufacturer is made aware of such suppliers, they may be in a position to steer customers away from them in future. However, sometimes customers may willingly turn to counterfeit products if it seems the manufacturer is unable to match their requirements. If you were the purchasing manager for your company, and it appeared one of your favourite products no longer existed, it may be tempting to buy an apparently identical product from another source — particularly if you were making this decision with a deadline looming over you. Indeed, Kay claimed that desperation is the biggest enemy of supply chain integrity, stating, "When you're desperate, anything can happen."

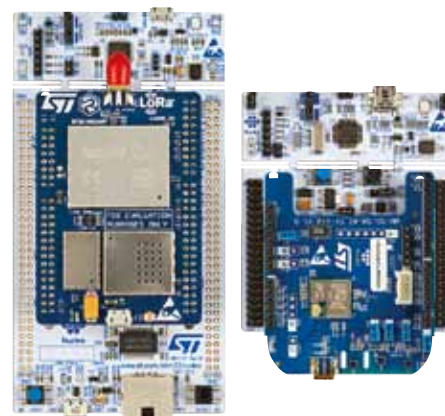
So, according to Kay, strong communication is required at all points along the supply chain: from the customer to the distributor, manufacturer and contract manufacturer. If requesting a bespoke product from a contract manufacturer, customers should be clear about their specifications — not just in terms of



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QUANTUM PROCESSOR MADE OF LASER LIGHT

An international team of scientists from Australia, Japan and the United States has produced a prototype of a large-scale quantum processor made of laser light. Based on a design 10 years in the making, the processor has built-in scalability that allows the number of quantum components — made out of light — to scale to extreme numbers.

Quantum computers promise fast solutions to hard problems, but to do this they require a large number of quantum components and must be relatively error-free. While current quantum processors are still small and prone to errors, the latest design provides an alternative solution, using light, to reach the scale required to eventually outperform classical computers on important problems.

"While today's quantum processors are impressive, it isn't clear if the current designs can be scaled up to extremely large sizes," said Dr Nicolas Menicucci, Chief Investigator at the ARC Centre for Quantum Computation and Communication Technology (CQC²T) at RMIT University.

"Our approach starts with extreme scalability — built in from the very beginning — because the processor, called a cluster state, is made out of light."

A cluster state is a large collection of entangled quantum components that performs quantum computations when measured in a particular way. Dr Menicucci continued, "To be useful for real-world problems, a cluster state must be both large enough and have the right entanglement structure. In the two decades since they were proposed, all previous demonstrations of cluster states have failed on one or both of these counts. Ours is the first ever to succeed at both."

To make the cluster state, specially designed crystals convert ordinary laser light into a type of quantum light called squeezed light, which is then weaved into a cluster state by a network of mirrors, beamsplitters and optical fibres.

The team's design allows for a relatively small experiment to generate an immense two-dimensional cluster state with scalability built in. Although the levels of squeezing — a measure of quality — are currently too low for solving practical problems, the design is compatible with approaches to achieve state-of-the-art squeezing levels.

The team says their achievement, published in the journal *Science*, opens up new possibilities for quantum computing with light.

"In this work, for the first time in any system, we have made a large-scale cluster state whose structure enables universal quantum computation," said Dr Hidehiro Yonezawa, Chief Investigator, CQC²T at UNSW Canberra. "Our experiment demonstrates that this design is feasible — and scalable."

META-OPTICS RESEARCH CENTRE COMING TO ANU

Minister for Education Dan Tehan has announced \$34.9 million in Australian Government funding to establish the Australian Research Council (ARC) Centre of Excellence for Transformative Meta-Optical Systems, to be led by Professor Dragomir Neshev and based at The Australian National University (ANU).

The centre is set to research the interaction of light with nanomaterials — technology that is often thinner than a human hair. It will translate its research into innovative technologies to be used in transport, health, security, defence, agriculture, entertainment and education.

"This centre of excellence will bring together world leaders in science, technology and engineering to deliver research that will underpin future technologies," Tehan said.

"The centre will also be an incubator for outstanding young innovators to be future leaders in the sector."

Prof Neshev said the centre will drive research in smart and miniaturised optical technologies that link the digital and physical worlds through light, making Australia a global leader in the Fourth Industrial Revolution.

"Our groundbreaking research will improve our everyday lives with the development of optical technologies that will empower autonomous vehicles, artificial intelligence, augmented reality, wearable sensors and remote sensing," he said.

"Our research will develop optical systems thinner than a human hair that monitor a driver's fatigue in cars and keep people safe on our roads. Further, it will develop smaller, smarter, faster and cheaper wearable optical sensors to better monitor our health.

"It will develop holographic displays and augmented reality for more immersive and powerful education in our classrooms and laser tech that makes autonomous vehicles better at predicting and avoiding hazards.

"And it will underpin light-based Wi-Fi — 1000 times faster than current technologies — to be used in our mobile phones and laptops."

ANU Provost Professor Mike Calford thanked the government for the funding, saying the centre will help boost Australia's economy.

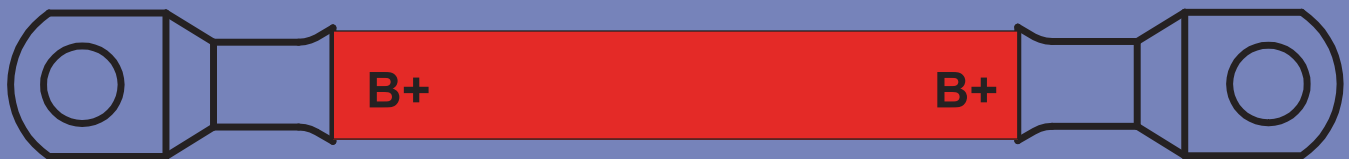
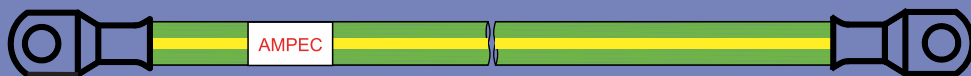
"This research centre will help revolutionise how light is used in ways that can have significant impacts for everyday Australians," he said. "This includes less invasive medical diagnostic tools that scatter light through the body to detect disease.

"This revolutionary new centre will help strengthen Australia's very own knowledge economy — setting up a global epicentre for light-based research and development that will develop the products of tomorrow, today."

The centre will see ANU collaborate with experts at four Australian universities and 20 academic and industry partner organisations from Australia, Europe, Asia and America. Together they will provide an additional \$35.4 million in cash and in-kind support.



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SILICON III-V CHIPS COULD BE COMMERCIALY MANUFACTURED

The Singapore-MIT Alliance for Research and Technology (SMART), has announced a commercially viable way to manufacture integrated Silicon III-V chips with high-performance III-V devices inserted into their design.

In most devices today, silicon-based CMOS chips are used for computing, but they are not efficient for illumination and communications, resulting in low efficiency and heat generation. This is why current 5G mobile devices on the market get very hot and tend to shut down after a short time.

This is where III-V semiconductors are valuable. III-V chips are made from elements in the third and fifth columns of the periodic table, such as gallium nitride (GaN) and indium gallium arsenide (InGaAs). They are well suited to optoelectronics (LEDs) and communications (5G), boosting efficiency substantially.

"However, integrating III-V semiconductor devices with silicon in a commercially viable way is one of the most difficult challenges faced by the semiconductor industry," noted Kenneth Lee, Senior Scientific Director of the SMART LEES research program.

"Current methods are expensive and inefficient, which is delaying the availability of the chips the industry needs. With our new process, we can leverage existing capabilities to manufacture these new integrated Silicon III-V chips cost-effectively and accelerate the development and adoption of new technologies that will power economies."

The SMART technology builds two layers of silicon and III-V devices on separate substrates and integrates them vertically together within a micron, which is 1/50th the diameter of a human hair. The process can use existing 200 mm manufacturing tools, which will allow semiconductor manufacturers to make new use of their current equipment. The new integrated circuit platform is thus highly cost-effective and will result in much lower cost novel circuits and electronic systems.

"By integrating III-V into silicon, we can build upon existing manufacturing capabilities and low-cost volume production techniques of silicon and include the unique optical and electronic functionality of III-V technology," said SMART CEO and Director Eugene Fitzgerald. "The new chips will be at the heart of future product innovation and power the next generation of communications devices, wearables and displays."

ENERGY STORAGE IMPROVED IN DIELECTRIC CAPACITORS

Researchers from Queen Mary University of London, seeking to solve a sustainable energy storage problem, have found inspiration in the most unlikely of places: the humble croissant.

Renewable and sustainable energy sources such as solar and wind are intermittent, meaning that efficient, low-cost and environmentally friendly electric energy storage systems are needed to make them of wider practical use. As noted by lead researcher Dr Emiliano Bilotti, "Storing energy can be surprisingly tricky and expensive, and this is problematic with renewable energy sources which are not constant and rely on nature."

Currently, there are three main energy storage options: batteries, electrochemical capacitors and dielectric capacitors. Dielectric capacitors typically have ultrahigh power density, making them suitable for high-power and pulse-power technologies that require the quick release of accumulated energy. Examples of this include motor drives, mobile power systems, space-vehicle power systems and electrochemical guns.

Dielectric capacitors are limited by the low amounts of energy they can currently store; the new research tackles this limitation. Inspired by the croissant-making technique of pressing and folding dough to create a layered pastry, the researchers pressed and folded a polymer film capacitor — a capacitor with an insulating plastic film — to store 30 times more energy than the best-performing commercially available

dielectric capacitor, biaxially oriented polypropylene (BOPP).

Writing in the journal *Nature Communications*, the study authors describe pressing and folding as an iterative process in which the pressing and folding cycle can be applied an arbitrary number of times. Each cycle involves a folding step, in which an approximately rectangular poly(vinylidene fluoride) (PVDF) film, produced by hot pressing, is folded, followed by a pressing and annealing step around the melting point of PVDF.

The study results are reported to be the highest energy density ever reported in a polymer film capacitor. While expensive and complex synthesis and processing routes are normally necessary to achieve high energy density in polymer film capacitors, the newly developed processing, pressing and folding is unique for its simplicity, record-high energy density and potential to be adopted by industry.

"With this technique we can store large amounts of renewable energy to be used when the sun is not shining and it is not windy," Dr Bilotti said.

Study author Professor Mike Reece added, "This finding promises to have a significant impact on the field of pulse-power applications and could produce a step change in the field of dielectric capacitors, so far limited by their low energy storage density."





CARRIER MULTIPLICATION COULD BOOST SOLAR CELL EFFICIENCY

Physicists at South Korea's Institute for Basic Science (IBS) have discovered an intriguing phenomenon, known as carrier multiplication (CM), in a class of semiconductors with extreme thinness, outstanding properties and possible applications in electronics and optics.

Published in the journal *Nature Communications*, the team's findings have the potential to boost the photovoltaics and photodetector fields, and could improve the efficiency of solar cells produced with these ultrathin materials to up to 46%.

An interesting class of 2D materials, known as the van der Waals layered transition metal dichalcogenides (2D-TMDs), are expected to create the next generation of optoelectronic devices, such as solar cells, transistors, LEDs, etc. They consist of individual thin layers separated by very weak chemical bonds (van der Waals bonds) and have unique optical properties, high light absorption and high carrier (electron and hole) mobility. Beyond allowing the option to tune their band gap by changing composition and layer thickness, these materials also offer an ultrahigh internal radiative efficiency of >99%, promoted by the



elimination of surface imperfections and large binding energy between carriers.

Absorption of sunlight in semiconducting 2D-TMD monolayers reaches typically

5–10%, which is an order of magnitude larger than that in most common photovoltaic materials, like silicon, cadmium telluride and gallium arsenide. However, the maximum power conversion efficiency of 2D-TMDs solar cells has remained below 5% due to losses at the metal electrodes. Researchers from the IBS Center for Integrated Nanostructure Physics (CINAP), aimed to overcome this drawback by exploring the CM process in these materials.

CM is a very efficient way to convert light into electricity. A single photon usually excites a single electron, leaving behind an 'empty space' (hole). However, it is possible to generate two or more electron-hole pairs in particular semiconductors if the energy of the incident light is sufficiently large — more specifically, if the photon energy is twice the material's bandgap energy.

While the CM phenomenon is rather inefficient in bulk semiconductors, it was expected to be very efficient in 2D materials, but was not proved experimentally due to some technical limitations, like proper 2D-TMD synthesis and ultrafast optical measurement. The team observed CM in 2D-TMDs, namely 2H-MoTe₂ and 2H-WSe₂ films, for the first time; a finding that is expected to improve the current efficiency of 2D-TMD solar cells, even going beyond the Shockley-Queisser limit of 33.7%.

"Our new results contribute to the fundamental understanding of the CM phenomenon in 2D-TMD," said CINAP Director Young Hee Lee. "If one overcomes the contact losses and succeeds in developing photovoltaics with CM, their maximum power conversion efficiency could be increased up to 46%."

"This new nanomaterial engineering offers the possibility for a new generation of efficient, durable and flexible solar cells."

WIRELESS DATA TRANSMISSION WITH TERAHERTZ RADIATION

Japanese researchers have developed a terahertz detector that enables extremely rapid wireless data communication and highly sensitive radar by using a frequency range that has previously been very difficult to work with. Published in the journal *Scientific Reports*, the team's approach combines sensitive electronics and a novel method for handling high frequencies to achieve the long-sought goal of using terahertz radiation for sending and receiving wireless data.

Terahertz radiation — electromagnetic waves with frequencies around 10¹² cycles per second — has long been tempting scientists and mobile phone companies alike, as the high frequency of terahertz radiation would allow more data to be transmitted per second, compared with the current standard of about 800 MHz. However, a practical terahertz receiver has remained elusive, for two main reasons. First, the electromagnetic oscillations are just too fast for conventional electronics to handle, and both the terahertz oscillator and detector have poor efficiency. Second, the thermal noise of the room-temperature detector obscures the received signals above.

Now, researchers at Osaka University have invented a novel receiver that not only overcomes these obstacles, it also reportedly set the record for the fastest error-free real-time transmission speed to date (30 Gbps). They achieved this by utilising a special electronic component called a resonant tunnelling diode.

In contrast with normal electronics — for which the current always increases at larger voltages — in a resonant tunnelling diode there is a specific 'resonant' voltage that yields the peak current. Thus, there exists a region in which the current actually falls with increasing voltage. This nonlinear behaviour allowed the scientists to synchronise the rapid received terahertz signals with an internal electronic oscillator in the device, then separate the data from the carrier wave. In the end, the sensitivity was enhanced by a factor of 10,000.

"Among all electronic-based systems, ours achieved the highest error-free wireless transmission data rate," said Yousuke Nishida, first author on the study.

Mobile phone towers are not the only places you might find terahertz radiation in the future. As noted by corresponding author Masayuki Fujita, "This technology can be put to work in a wide range of applications, in addition to next-generation 6G wireless communication. These include spectroscopic sensing, non-destructive inspection and high-resolution radar."





WHAT CAUSES DENDRITES AND WHISKERS IN LITHIUM BATTERIES?

US scientists have uncovered a root cause of the growth of needle-like structures — known as dendrites and whiskers — that plague lithium batteries, sometimes causing a short circuit, failure or even a fire.

The team, led by Chongmin Wang at the Department of Energy's Pacific Northwest National Laboratory (PNNL), has shown that the presence of certain compounds in the electrolyte — the liquid material that makes a battery's critical chemistry possible — prompts the growth of dendrites and whiskers. They hope their discovery, published in the journal *Nature Nanotechnology*, will lead to new ways to prevent their growth by manipulating the battery's ingredients.

Dendrites are tiny, rigid, tree-like structures that can grow inside a lithium battery; their needle-like projections are called whiskers. Both cause tremendous harm; notably, they can pierce a structure known as the separator inside a battery, much like a weed can poke through a concrete patio or a paved road. They also increase unwanted reactions between the electrolyte and the lithium, speeding up battery failure. Dendrites and whiskers are holding back the widespread use of lithium metal batteries, which have higher energy density than their commonly used lithium-ion counterparts.

The PNNL team found that the origin of whiskers in a lithium metal battery lies in a structure known as the solid-electrolyte interphase (SEI) — a film where the solid lithium surface of the anode meets the liquid electrolyte. Furthermore, the scientists pinpointed a culprit in the growth process: ethylene carbonate, an indispensable solvent added to the electrolyte to enhance battery performance. It turns out that ethylene carbonate leaves the battery vulnerable to damage.

Following the step-by-step growth of a whisker inside a nano-sized lithium metal battery, the researchers found that a dendrite begins when lithium ions start to clump, or 'nucleate', on the surface of the anode, forming a particle that signifies the birth of a dendrite. The structure grows slowly as more and more lithium atoms glom on, growing the same way that a stalagmite grows

from the floor of a cave. The team found that the energy dynamics on the surface of the SEI push more lithium ions into the slowly growing column. Then, suddenly, a whisker shoots forth.

In order to capture the action, the researchers integrated an atomic force microscope (AFM) and an environmental transmission electron microscope (ETEM) — a highly prized instrument that allows scientists to study an operating battery under real conditions. The team used the AFM to measure the tiny force of the whisker as it grew. Much like a physician measures a patient's hand strength by asking the patient to push upward against the doctor's outstretched hands, the team measured the force of the growing whisker by pushing down on its tip with the cantilever of the AFM and measuring the force the dendrite exerted during its growth.

The team found that the level of ethylene carbonate directly correlates with dendrite and whisker growth. The more of the material the team put in the electrolyte, the more the whiskers grew. The scientists experimented with the electrolyte mix, changing ingredients in an effort to reduce dendrites. Some changes, such as the addition of cyclohexanone, prevented the growth of dendrites and whiskers.

"We don't want to simply suppress the growth of dendrites; we want to get to the root cause and eliminate them," Wang said. "We drew upon the expertise of our colleagues who have expertise in electrochemistry. My hope is that our findings will spur the community to look at this problem in new ways. Clearly, more research is needed."

Understanding what causes whiskers to start and grow will lead to new ideas for eliminating them or at least controlling them to minimise damage, added first author Yang He. A greater understanding could help clear the path for the broad use of lithium metal batteries in electric cars, laptops, mobile phones and other areas.

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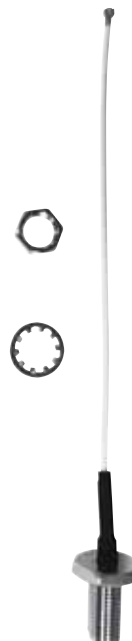
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INSIGHTS INTO INDUSTRY 4.0

Brendan O'Dowd*, General Manager for Industrial Automation at Analog Devices, answers questions and shares insights about Industry 4.0.

To what extent is the industrial market sector following Industry 4.0 guidelines?

The Industry 4.0 trend is not new. In 2016, many governments recognised that a transformation of the industrial sector through the principles of Industry 4.0 would help close the productivity gap. Especially in EMEA, the Industry 4.0 initiatives provide incentives to:

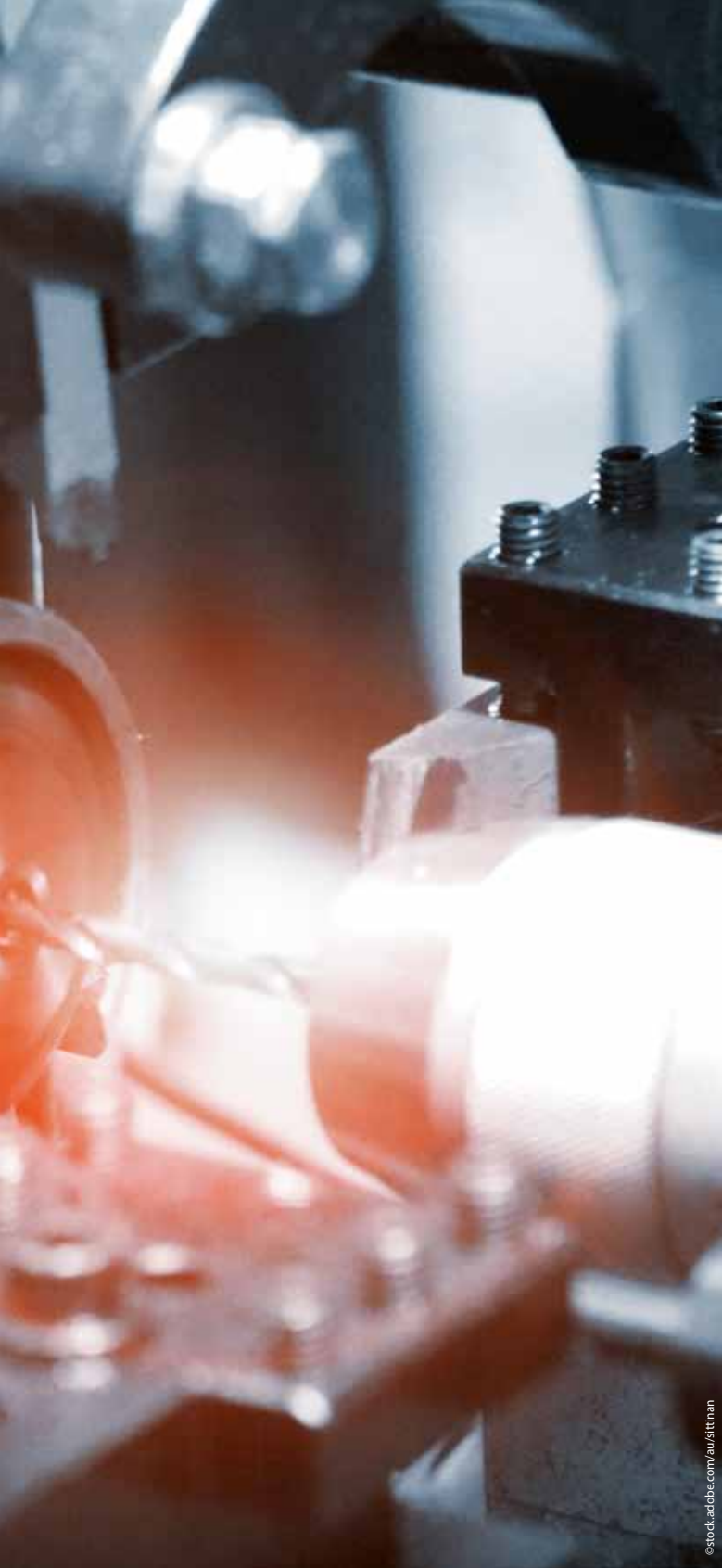
- invest in advanced Industry 4.0 technologies
- carry out relevant research and development
- improve knowledge and understanding of Industry 4.0 in factories, as well as colleges and universities.

Now it is a worldwide initiative that merges many formerly separated disciplines such as IT, design and development, production, database management, security and others.

Analog Devices, a solution-oriented semiconductor company, has seen a rise in the number of requests for technologies related to Industry 4.0, such as condition-based monitoring and Industrial Ethernet.

Despite this government-led drive to implement Industry 4.0 practices, the industrial sector faces the same set of opportunities and risks as companies do in every advanced economy. Manufacturers cannot afford to wait on the sidelines and risk missing out on first-mover advantages. At the same time, there is a risk in making big investments today that might quickly become obsolete and never pay off.

And the transition to Industry 4.0 is not simply a matter of specifying and installing equipment or even building a new factory:



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it fundamentally affects the way in which manufacturing companies operate. In particular, the need for expanded expertise in domains such as software, security and IT presents manufacturers with difficult trade-offs and choices about where to invest, who to partner with and how to ensure organisational agility.

Which is the critical element in the implementation of a digital/4.0 factory?

The critical, enabling element of Industry 4.0 is an integrated communications network that can support connectivity throughout the factory. The essence of Industry 4.0 is data, and the intelligence that you can derive from data. And you have no data to work with until you can transfer it from and between machines

and operational technology (OT) and enterprise (such as IT) computing systems.

We expect the backbone of connectivity in factories to be a deterministic Ethernet network. While a mix of Industrial Ethernet protocols are in use today, there are huge benefits to industry in standardising on the time-sensitive networking (TSN) Ethernet protocol. Manufacturers should be specifying TSN-ready solutions with a roadmap of other enhancements if they are to ensure their network investments are part of a longer-term plan.

What does the 4.0 transformation of industrial automation look like?

The purpose of investing in Industry 4.0 is to upgrade from a labour-intensive footprint to a more sophisticated automated infrastructure. Some common features of this new approach to industrial automation are beginning to become clear.

Repetitive tasks are now being performed by collaborative robots commonly known as cobots. These are smaller robots that work in collaboration with humans. While the traditional large-scale industrial robotics industry remains healthy and growing, the newer collaborative robotics market is in the early stages of growth.

A predominantly rigid and centralised control architecture is being replaced by a decentralised and flexible factory floor. Here, robots operate in tandem with many other systems, including PLC controllers and a vast array of sensors and actuators. These machines or devices are designated as either inputs or outputs. An Analog Devices innovation — software-configurable I/O — allows universal selection and configuration of many types of input and output devices. This enables customers to easily install and reconfigure their automation equipment. Manufacturers using software-configurable I/O typically benefit from an eight-week reduction in installation time, engineering cost savings and a significant reduction in factory space requirements. Factory production flows can be adapted more easily and changes that would once have taken hours can be completed in minutes.

Predictive maintenance and condition-based monitoring are helping to improve factory-wide productivity and reliability. Operating parameters such as vibration patterns can reveal early signs of wear, which can be repaired before a machine experiences any faults or downtime. This is a prime example of the importance of accurate sensor measurements, intelligent data analytics and high-bandwidth networking in Industry 4.0 systems. And successful implementation of predictive maintenance is about more than the underlying technology — it also calls for deep domain expertise in automation and industrial machine operation to develop the algorithms and software that turn machine health data into operational intelligence.

How do you see the evolution of sensors and software in the context of Industry 4.0?

Sensors generate raw data; software turns the data into actionable information. As the previous example of predictive



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maintenance illustrates, it is the integration of sensors and software that provides value in a digitised, connected factory.

In a system for monitoring machine health, sensors produce a stream of raw measurements of vibrations, temperature and other parameters. Signal processing technology makes this stream of data suitable for analysis, for instance, by eliminating noise and distortion, and linearising the output.

Software and analytics then turn the data into information by correlating data from multiple sources, detecting abnormal patterns, and identifying and locating actual or potential faults.

Integrating the two — the physical world of sensors and the digital world of software — calls for two different kinds of know-how:

- Technology expertise
- Domain or application expertise

Analog Devices has invested heavily to build domain expertise in the industrial sector alongside its expertise in analog and digital electronics. This enables it to bring valuable insights to customers as they implement Industry 4.0 programs, and to help customers understand how to apply new technology in a way that benefits their specific operation.

How, and at which level, can Analog Devices' technologies support Industry 4.0?

Industry 4.0 is about building and using cyber-physical systems to enable new possibilities. It is rooted in the ability to bridge the physical and digital worlds in new ways, a domain in which Analog Devices has been a pioneer for more than 50 years.

But Analog Devices is not a typical semiconductor company: we push the boundaries of silicon technology, investing heavily in software, systems expertise and domain knowledge within our key markets. And we combine this knowledge with an unmatched set of analog-to-digital capabilities: to sense, measure, interpret, connect, power and secure. We approach industry's challenges at the system level and help customers find the best way to deliver successful outcomes.

What would you recommend to a manager who is considering the digitisation of production facilities?

Look as far into the future as possible. It is easy to get caught up in today's hype about Industry 4.0. In fact, some investments



INDUSTRY 4.0 IS ABOUT BUILDING AND USING CYBER-PHYSICAL SYSTEMS TO ENABLE NEW POSSIBILITIES.

made today need to remain relevant 15 to 20 years from now, so it is important to be confident that new systems or technologies have a long lifetime.

This means:

- choosing scalable connectivity technology using standards-based solutions rather than proprietary systems;
- specifying sensors that are robust and have a long operating lifetime, as well as providing accurate and precise measurements.

Every move towards a more digitised, connected factory also increases the threat of cyber attack, so security is the other crucial priority for managers as they evaluate Industry 4.0 initiatives.

Optimising security requires a system-level approach instead of thinking about the requirements of any particular device or end point. Security can be delivered in a variety of ways throughout the system — within edge devices, controllers, gateways or further up the stack. Before focusing on the 'how' at any given point in the network, systems specifiers should focus on questions of where and how much.

This should consider both the threat level at each point, as well as the cost of countering the threat, with a view to adding effective security with the fewest trade-offs in power, performance and latency. A layered approach will result in a superior overall security posture.

Conclusion

Manufacturers would be wise to invest time and resources, either organically or by choosing a partner such as Analog Devices, in a system-level approach that expands security expertise beyond the machine level.

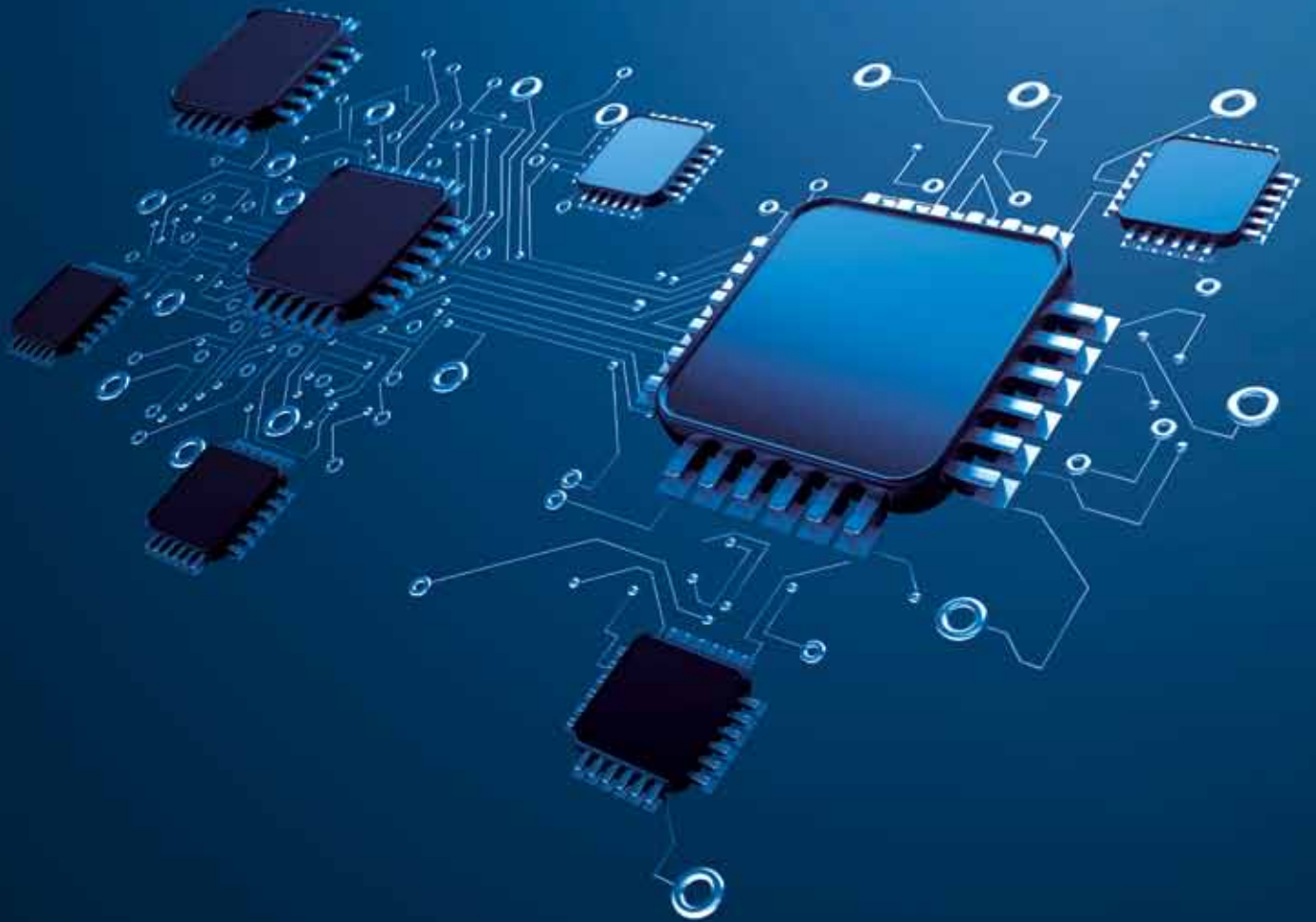
**Brendan O'Dowd has over 30 years' experience in the industry working for companies like Tellabs, Apple and Analog Devices. He can be reached at brendan.odowd@analog.com.*

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PLANETARY GEARHEAD FAMILY

The pure metal GPT planetary gearheads operate with high efficiency and can be combined with many different motors and enable various shaft configurations. Available with diameters of 22, 32 and 42 mm, they are said to achieve performance values comparable to technologies such as ceramic components.

The gearheads achieve high values for torque as well as for speed. Compared to the predecessor models, the continuous input speed has more than doubled above 10,000 rpm and can support input speeds up to 20,000 rpm in intermittent mode. The 42GPT series can sustain an intermittent torque up to 25 Nm while its length is squeezed down to 71 mm.

The gearheads are designed to be robust and to tolerate continuous as well as abrupt and sudden load changes. They are shorter than other models in the same diameter. The gearheads can be equipped with up to four reduction stages; each stage is individually optimised to achieve high power in terms of torque and speed.

As a result of the high number of available gear ratios and their uniform distribution, the motor power can be utilised optimally: a higher torque can be achieved with the same input speed and a higher speed can be achieved with the same torque. In addition, power consumption is reduced through high efficiency. The family is also particularly useful for positioning applications granted by a low backlash characteristic.

The gearheads are suitable for various demanding applications. Their compact design fits well with the BXT brushless flat motor family when size is a key constraint integrating actuators inside applications. A large selection of DC motors is also available in combination with the gearhead family. They are suitable for different types of robots — inspection, assembly, rehabilitation or exoskeletons — as well as for production and laboratory automation, packaging machines, measurement and testing equipment, or semiconductor handling.

ERNTEC Pty Ltd
www.erntec.net

LAYER 3 GIGABIT ETHERNET SWITCH

Red Lion Controls has released the NT328G Layer 3 Ethernet switch. Offering 28 high-speed ports (24 Gb, 4–10 Gb) and good wire-speed switching performance, the switch is designed to meet the current and future needs of the oil and gas, water and wastewater, energy, transportation, and video and security sectors, as well as other bandwidth-intensive industrial applications.

The Industrial Ethernet models feature a flexible mix of copper and fibre ports, allowing for a vast variety of connection options, with Layer 3 routing that provides the ability to route across VLANs or subnets — versatility that ensures scalability. The industrial-grade device's robust feature set includes network redundancy; advanced, integrated security; policy-based traffic control; and easy-to-use configuration and management, said to reduce operating costs while providing continuous monitoring of network activity.

The switch's sleek but rugged IP30 rackmount metal housing is constructed for long-life use in harsh industrial environments, including wide operating temperature conditions and hazardous locations — durability that should reduce downtime. Suitable for large-scale and/or industrial networks, the product has the flexibility to meet both present and long-term speed and media requirements.

Control Logic Pty Ltd
www.controllogic.com.au



INFRARED THERMAL IMAGE CAMERA

The FLIR E75 is a handheld infrared thermal image camera that offers sensitivity and a true 24° field of view. The easy-to-use camera can identify even the most subtle indications of building deficiencies and moisture intrusion. It is available to rent from TechRentals.

The product has an IR resolution of 320 x 240, a temperature range of -20 to 650°C and multiple image modes including infrared, visual, MSX and picture-in-picture. It also features a 4", 640 x 480 optically bonded PCAP touchscreen with 1–4 continuous zoom.

The thermal imager has a fast and precise laser-assisted autofocus and its grip, trigger and buttons have been designed for seamless one-handed operation. Avoid costly downtime by discovering areas for concern and potential points of failure with the intuitive FLIR E75.

TechRentals
www.techrentals.com.au



COMPACT LINEAR MOTOR WITH DOUBLE PEAK FORCE

With the SA / SC 38 series, Dunkermotoren presents a completely new modular concept for tubular linear direct drives.

The highly dynamic three-phase linear motors deliver up to 3690 N and accelerate at over 200 m/s².

The modular design is currently available as actuator version in the models SA / SC 3806, 3810 or 3814 with feedback variants SSI, BISS & TTL).

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The atomising nozzles can coat, lubricate, cool, treat and paint a variety of products using compressed air and liquids with a viscosity of up to 200 cP. Used with water, they are an efficient way to evenly cool hot items in an automated process. The stainless steel construction of the atomising nozzles adds to their durability and corrosion resistance.

EXAIR atomising nozzles are available in a variety of flow patterns and rates to meet the user's needs. All models are CE compliant and adjustable.

Compressed Air Australia Pty Ltd
www.caasafety.com.au

15 W DC/DC CONVERTERS

Traco Power's THN 15 series high-performance 15 W DC/DC converters are enclosed in a shielded 1" x 1" x 0.4" metal package. The design provides a fully integrated EN 55032 class A filter and no-load power consumption of 96–336 mW.

The advanced circuit design enables the product to operate in a temperature range of -40 to +70°C without derating. All models have a 2:1 input voltage range with regulated and isolated output voltages as well as remote on/off and trim outputs.

The series is UL62368-1 certified, making the converters suitable for distributed power architectures in communication and industrial electronics as well as applications where space on the printed circuit board (PCB) is critical, such as mobile equipment and instrumentation.

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FLANGED ENCLOSURES

The basis of the IIoT and the IoT is to make things smarter by making them communicate with each other. The focus here is on sensors which are embedded in the devices and which constantly gather and deliver data concerning machinery and special work scenarios or data about the entire value-added chain. The EASYTEC wall-mounted enclosure series was developed specially for these modern sensor applications, but can also be used in data acquisition systems, data systems engineering, measuring and control engineering, medical technology and health care.

EASYTEC flanged enclosures are available in two different sizes, each in two heights: 101 x 50 x 22/26 mm and 121 x 62 x 26/31 mm (overall length with flange x width x height). Off-white is available as the standard colour; on request the enclosures can be produced in other colours. The sturdy housing design, the high-quality material ASA+PC-FR (UV-resistant) and the optionally available seal for protection class IP65 allow for robust indoor and outdoor applications; these are also supported by the stainless steel screws with Torx drive.

The assembly of the enclosure is effected on the underside and is thus completely out of sight, which benefits the unit's appearance. PCBs can be installed in the top part and/or in the bottom part. Suitable self-tapping screws for mounting the PCBs are included in the accessories range.

The bottom part of the enclosure has fully integrated lugs on the short end faces. These allow the device to be quickly mounted on the wall (horizontally or vertically), but can also be used for easy installation on pipes/round profiles. A rounded recess on the underside of the enclosure visually supports the latter application on pipe systems.

The enclosures can be modified by OKW according to the individual wishes of the customer, eg, with printing, laser marking, mechanical machining for interfaces/LEDs, EMC coating on the inner side of the enclosure, assembly work and much more.

ROLEC OKW Australia New Zealand P/L
www.okw.com.au



CABLE AVOIDANCE TOOL AND SIGNAL GENERATOR

The DXL4 cable avoidance tool and signal generator from C.Scope offers an advanced combination of cable detecting and tracing performance. The system is able to successfully detect even hard-to-find pipes and cables while minimising the potential for human error. It is available to rent from TechRentals.

The DXL4 features PeakHold, letting operators quickly pinpoint the exact positions of buried services. It also features AlarmZone, which alerts users to the presence of particularly shallow pipes or cables. There is also a SwingSensor that signals the handler if the device is being swung excessively, which can compromise the accuracy of the locator.

The SGV4 signal generator can apply dual frequency without direct connection to buried services, using either a signal clamp or the simple induction method from ground level. The fully adjustable 1 W power output means deep pipes and

cables can be effectively energised and traced over at a long distance.

The cable avoidance tool and signal generator include a fully automatic daily self-test that confirms the locator is functioning at optimum level each day, avoiding periodic recalibration.

TechRentals
www.techrentals.com.au



PoE POWERED DEVICE MODULE

Silvertel has announced the IEEE 802.3bt compliant Ag5810 PD (powered device) module for Power over Ethernet (PoE) solutions. Aimed at developers of Ethernet equipment requiring up to 60 W of power, such as LED lighting, PTZ cameras, WiMAX access points, door entry systems, digital signage and thin client terminals, the product is a suitable drop-in IEEE802.3bt solution.

The product is a Type 4, Class 7 PD, which provides 60 W of power by displaying the correct class pulses to an IEEE802.3bt PSE. A complete high-efficiency DC-DC converter is included and generates a nominal 12 or 24 V output, which can be programmed down to 11 V or up to 30 V; this is especially useful for applications requiring the inclusion of battery chargers. Additional features include 1500 V isolation (input to output), overload, short-circuit and thermal protection.

Requiring just a few external components, the product is easy to use and occupies a minimum of PCB real estate. Evaluation boards are also available, as well as a range of application notes.

Fairmont Marketing
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- Curiosity Nano Base Boards feature three mikroBUS sockets to easily customize with Click boards
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Contact Information

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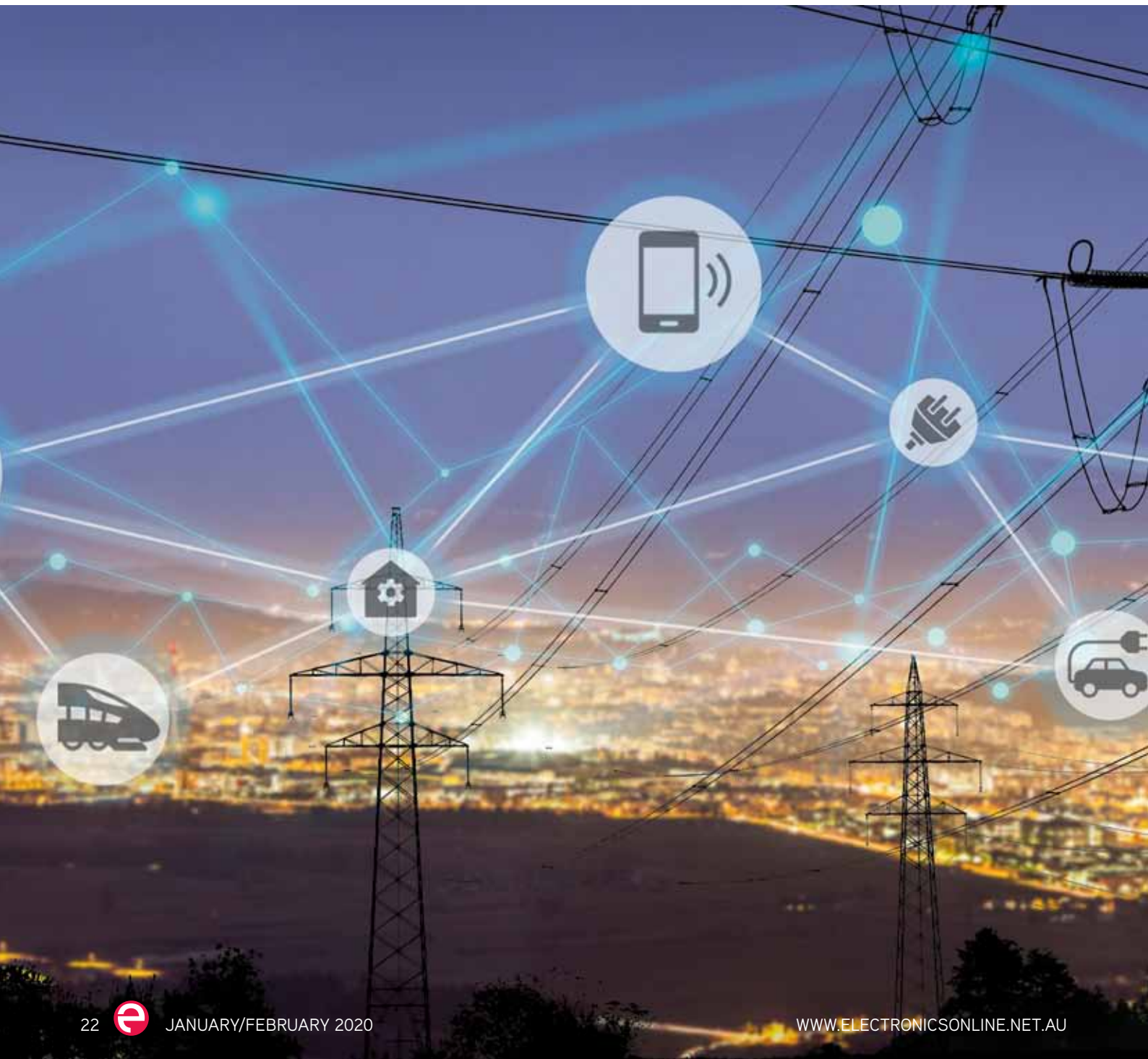
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EMBEDDED SERVER TECHNOLOGY FOR THE EDGE OF SMART GRIDS

Tencent's energy IoT partner wants to change how distributed energy production and consumption are managed by implementing a new monitoring, management and control layer of distributed edge servers. These new small and rugged but nevertheless tough and powerful high-speed devices can connect in real time to all the decentralised devices relevant for energy management.



First implementations of this new edge server layer can be found in Shanghai Business Park. They are built on real-time capable server-on-modules from Congatec, which offer a wide performance and interface scalability from Intel Xeon to Intel Atom C3xxx processors to meet the given local needs in a flexible and highly automated way.

In the information industry, the generation and exchange of data is one of the most important production factors and value drivers. This is even truer for the energy sector, as there is a massive trend away from central power generation to a distributed and highly fragmented energy grid with various energy consumers and producers. Such a comprehensive network topology raises massive real-time information and synchronisation demands to ensure optimal grid balancing.

On top of this come energy-saving aspects, for example, to reduce the costs of energy-hungry productions, to save the environment

and to protect the climate. As a result, even more information is needed to improve energy efficiency across households, factories, cities and even entire nations. Finally, there is a call for better power delivery management, which requires the installation of new services such as remote meter management to reduce costs or to offer volume-based tariffs with special peak load controls using artificial intelligence (AI) to improve user experiences and to more efficiently balance the entire power consumption throughout the day.

With all those various needs, many heterogeneous solutions for nearly every specific demand are deployed all over the world to support energy companies in achieving intelligent operational processes. But until today, there was no holistic approach in sight where all relevant energy management devices are real-time connected by local edge server platforms. Such a new local layer would be capable of managing the entire energy ecosystem of distributed power devices.

It could provide, for example, core applications for multi-energy collaboration, demand-side response, comprehensive environmental management, efficient operations and maintenance management, as well as user-centric energy services for companies such as China's regional integrated energy service companies (ESCOs). By integrating advanced technologies such as Tencent's distributed service framework (TSF) and energy IoT as well as big data analytics and visualisation, it would help ESCOs to optimise operational and maintenance efficiency and save energy.

To offer such a comprehensive service, the Chinese energy market experts from Tencent's energy IoT partner have combined the technical capabilities of the Tencent Cloud with large objects, and are collaborating with the power grid, industry-leading service providers, universities and research institutes to provide the integrated ESCOs with a service- and feature-rich edge server infrastructure. The solution is designed to support the rapid transformation of traditional energy services companies by innovating and integrating the next generation of information and energy technology. Once the service is entirely available, it will support thousands of power devices, hundreds of power protocols and online editing of common standard protocols as well as dynamic completion of common standard device types.

All this cannot be done by central clouds or central servers, as the limiting factor is a required response time below 10 ms so that the control system can accurately react to the varying power sources and sinks. In a central cloud topology, data travel times are usually around 150 to 200 ms from the source to the central cloud and back. Locally deployed edge servers can reduce data exchange times between power equipment and controls to 2–5 ms. This significantly shortens the latency and reaction times, thereby optimising the performance of smart grid applications.

That's why Tencent's energy IoT partner pushed the process to bring the cloud to the edges of the Chinese energy grid. There was a need to build an edge server system that is capable of bridging all the heterogeneous local protocols and interconnects; delivering high computing power for protocol transcoding, AI and real-time control of all the many different devices in the field; and offering the required bandwidth for billions of messages from and to the devices. Additionally, it has to be designed to withstand the harsh environmental conditions in the field, for example, offering resistance against high and low temperatures as well as shocks and vibrations, plus it should offer server-like remote management features for reliable operation and reduced maintenance efforts. As those systems also serve as a local IoT gateway/hub for exchange with the central Tencent Cloud and additionally need to enable fast





The edge server hardware platform is scalable in terms of processor performance and I/O interfaces within a single system design due to the modular approach of server-on-module designs. They are based on the COM Express Type 7 specification, released by the PICMG standardisation body. The hardware vendor is congatec.



The COM Express Type 7 computer-on-module conga-B7AC/B7XD from congatec used in the recent Shanghai Business Park installation offers a massive scalability from 12 W TDP Intel Atom C3000 to Intel Xeon D 16 core processors with up to 32 threads.

deployment of energy devices via QR or barcode scans on mobile devices, they must also provide high bandwidth connectivity to the central cloud.

Today, a one-click scan code helps system integrators to support fast power device deployments. With such a scan, they can quickly bind and parameterise the power device to the edge server and its cloud (aka fog). In addition, non-contact sensors are used for continuous installation and debugging in deployment mode. A virtual device library assists the user in device selection and evaluation. With all these valuable functions and computer-assisted workflows, the device installation and deployment cycle has been reduced from one day to one hour. The upper layer of the installation uses certificates or key authentication methods to ensure secure access to devices.

Since May 2018, the first field tests of the new energy edge server platform have been finalised and first real-world applications are now going to be deployed in Shanghai Business Park where the real-time collection of all types of data is executed for dynamic monitoring, energy analysis, cost accounting, performance evaluation and reporting functions such as publication, energy management optimisation and energy-saving promotions. The scope of services includes technical load and security issues as well the management of purchasing and sales contracts, including risk and energy efficiency management.

The future goals are even more impressive and driven by the massive, intelligent and fast interconnections: with the combined computing power of Tencent Cloud's global data centre and the powerful edge, such a distributed edge server layer can support billions of access points to energy equipment as well as the reliable transmission of trillions of messages and decisions. All this can be realised in real time thanks to the decentralised edge server logic to maximise the energy efficiency from households and microgrids to smart cities and virtual grids at lowest costs. It is estimated that approximately 1.26 million edge servers are required to build a nationwide edge server infrastructure for China, calculating that per 1000 inhabitants one single edge server is needed. So there are quite a few edge servers to deploy over the next years until that goal is reached, but at least the first cornerstone has already been laid with the recent installation.

For the adaptive hardware of the new class of edge devices, the edge server designers have chosen a flexible system design based on COM Express Type 7 modules. These modules offer server-grade performance and functionality on a standardised form factor plus

cooling solutions. The modules come as application-ready super components, including core function units like CPU, control hub, memory as well as USB, PCIe and Ethernet connectivity. COM Express Type 7 modules are the first modules to specify multiple 10 Gigabit Ethernet connects in this context. For fast connectivity they offer an increased count of up to 32 PCIe lanes to add, for example, fast NVMe storage as well as GPGPUs for AI based on deep neural networks. The application-specific design is executed via a carrier board that holds the application-specific connectors and peripherals. This makes it possible to leverage one board design across different performance classes by just exchanging the module. This strategy also brings benefits for future upgrades, as more performance can easily be integrated by simply swapping the module against a more powerful variant.

First systems are based on modules with Intel Xeon D15xx processors with up to 16 cores and 32 threads. These processors offer a high per core performance thanks to Intel AVX2 extensions increasing performance when the same operations are performed on multiple data objects — relevant for AI for example — as well as Intel TSX-NI, which is focused on multi-threaded performance scaling and helps to make parallel operations more efficient. All these features result in an impressive performance per watt with a high throughput and overall server-grade performance. Alternative configurations are based on the Intel Atom C3xxx processors. Featuring up to 16 cores, those processors are the ideal fit for all installations that have to handle smaller package sizes in parallel while consuming as little energy as 11 W TDP.

Both modules offer ECC RAM for high data integrity and support the extended temperature range from -40 to +85°C for good reliability even under extreme conditions. The hardware vendor is congatec, who — in cooperation with its Chinese VAR as well as Intel — is providing the entire hardware platform as a boxed system including all required tests and services.

"It is great to work with congatec on this energy edge server project which will enable brand-new services," said Zhang Zhidong, CTO of Tencent's energy IoT partner. "As they provide us with a local contact here in China, it is very easy and comfortable for us to synchronise our needs. And with congatec working at the forefront of the COM Express Type 7 standardisation, we couldn't have chosen a better supplier."

Congatec Australia Pty Ltd
www.congatec.com

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EXAIR's Gen4 Standard Ion Air Knife is said to eliminate static electricity 30% better at low inlet pressures, which saves compressed air. Production speeds, product quality and surface cleanliness can thus be improved. The product eliminates static on plastics, webs, sheet stock and other product surfaces where tearing, jamming or hazardous shocks are a problem.

Gen4 products 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. Design features include a metal-armoured high-voltage cable to protect against abrasion and cuts, integrated ground connection and electromagnetic shielding. A selectable voltage power supply has been designed to operate Gen4 products.

The Standard Air Knife minimises compressed air use by inducing surrounding airflow at a ratio of 30:1. The amplified airflow carries the ions to the target, making it possible to eliminate static charges in less than half a second. Air volume and velocity are infinitely controllable from a 'breeze' to a 'blast' to gently wipe or forcefully blow away debris.

The product line is available in 76 to 1219 mm lengths. The electrical ion source is shockless and there is no radioactive element. Applications include surface cleaning, neutralising plastics, bag opening, printing machinery, packaging operations and elimination of painful static electricity shocks.

Compressed Air Australia Pty Ltd

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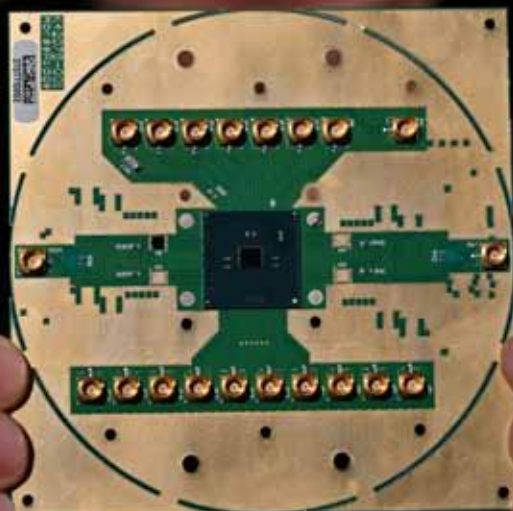


Image credit: Walden Kirsch/Intel Corporation.

CRYOGENIC CHIP

COULD ENABLE VIABLE QUANTUM COMPUTERS

Intel Labs has unveiled what is believed to be a first-of-its-kind cryogenic control chip — code-named ‘Horse Ridge’ — which should help speed up development of full-stack quantum computing systems.

Developed together with Intel’s research collaborators at QuTech, a partnership between the Delft University of Technology (TU Delft) and the Netherlands Organisation for Applied Scientific Research (TNO), Horse Ridge is expected to enable control of multiple quantum bits (qubits) and set a clear path towards scaling larger systems. It is fabricated in-house using Intel’s 22 nm FinFET technology, which will accelerate the company’s ability to design, test and optimise a commercially viable quantum computer.

To date, researchers have been focused on building small-scale quantum systems to demonstrate the potential of quantum devices. In these efforts, researchers have relied on existing electronic tools and high-performance computing rack-scale instruments to connect the quantum system inside the cryogenic refrigerator to the traditional computational devices regulating qubit performance and programming the system.

These devices are often custom-designed to control individual qubits, requiring hundreds of connective wires into and out of the refrigerator in order to control the quantum processor. Intel realised that this extensive control cabling for each qubit will hinder the ability to scale the quantum system to the hundreds or thousands of qubits required to demonstrate quantum practicality, not to mention the millions of qubits required for a commercially viable quantum solution.

With Horse Ridge, Intel simplifies the control electronics required to operate a quantum system, enabling the company to control multiple qubits. Replacing these bulky instruments with a highly integrated system-on-chip (SoC) should simplify system design and allow for sophisticated signal processing techniques to accelerate set-up time, improve qubit performance and enable the system to efficiently scale to larger qubit counts.

Horse Ridge is a highly integrated, mixed-signal SoC that brings the qubit controls into the quantum refrigerator — as close as possible to the qubits themselves. It effectively reduces the com-

plexity of quantum control engineering from hundreds of cables running into and out of a refrigerator to a single, unified package operating near the quantum device.

Designed to act as a radio frequency (RF) processor to control the qubits operating in the refrigerator, Horse Ridge is programmed with instructions that correspond to basic qubit operations. It translates those instructions into electromagnetic microwave pulses that can manipulate the state of the qubits.

“While there has been a lot of emphasis on the qubits themselves, the ability to control many qubits at the same time had been a challenge for the industry,” said Intel’s Director of Quantum Hardware, Jim Clarke.

“Intel recognised that quantum controls were an essential piece of the puzzle we needed to solve in order to develop a large-scale commercial quantum system. That’s why we are investing in quantum error correction and controls. With Horse Ridge, Intel has developed a scalable control system that will allow us to significantly speed up testing and realise the potential of quantum computing.”

Horse Ridge was designed to operate at cryogenic temperatures (approximately 4 K) — a particularly exciting feat as Intel progresses its research into silicon spin qubits, which have the potential to operate at slightly higher temperatures than current quantum systems require. Today, a quantum computer operates in the mK range — just a fraction of a degree above absolute zero — but silicon spin qubits have properties that could allow them to operate at 1 K or higher temperatures, which would dramatically reduce the challenges of refrigerating the quantum system.

As research progresses, Intel aims to have cryogenic controls and silicon spin qubits operate at the same temperature level. This will enable the company to leverage its expertise in advanced packaging and interconnect technologies to create a solution with the qubits and controls in one streamlined package.

Intel Australia Pty Ltd
www.intel.com.au



USB TYPE-C PORT PROTECTOR

Designers can easily migrate small electronic devices from legacy USB Micro-A or Micro-B interconnects to the latest Type-C style with the STMicroelectronics TCPP01-M12 port protector, which satisfies all protection requirements for USB-C connections.

The device is a microcontroller (MCU) companion chip that works with the 20 V/100 W USB Type-C power delivery controller integrated in ST's STM32G0 and STM32G4 MCUs. It is also able to protect 5 V-only connections managed by general-purpose MCUs such as STM32 and STM8 devices. In each case, only the TCPP01-M12 and MCU are required, permitting a space-efficient solution.

The product is designed to simplify the modernisation of industrial PCs, mobile POS terminals, medical devices, wearables, wall chargers, automotive infotainment equipment, gaming terminals, drones, audio/video systems, gateways, computers and peripherals. Features include defective power-adaptor protection to prevent equipment damage if a faulty power supply applies a wrong power profile. There is also short-circuit protection between VBUS pins and configuration channel (CC) lines, and IEC 61000-4-2 Level 4 + 8 kV ESD protection for VBUS and CC.

The product enters zero-power operation when no cable is connected, thereby extending battery life, and makes innovative use of the USB PD programmable power supply (PPS) to enable fast device charging. The IC also integrates driver circuitry for an external N-channel load switch to save bill-of-materials costs. Moreover, leveraging PPS support and the inherently low on-resistance of the N-channel switch, compared to the P-channel MOSFET typically used, minimises overall heat dissipation.

STMicroelectronics Pty Ltd
www.st.com

COMPUTING ACCELERATOR CARD

iEi's Mustang-MPCIe-MX2 computing accelerator mini-PCIe card features two Intel Movidius Myriad X vision processing units (VPUs). It provides a flexible AI inference solution for space-limited and embedded systems and is designed to execute two topologies simultaneously.

The flexible product supports Intel's OpenVINO toolkit for the optimisation of pre-trained deep-learning models such as Caffe, MXNT, ONNX and Tensorflow. The VPUs can run AI fast and are suitable for low power consumption applications such as surveillance, retail and transportation, as their power consumption is 7.5 W.

With the advantage of power efficiency and high performance to dedicate to DNN topologies, the card can be implemented in AI edge computing devices to reduce total power usage, providing longer duty time for rechargeable edge computing equipment.

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FIVE ARTIFICIAL INTELLIGENCE TRENDS FOR 2020

Stephane Marouani, Country Manager ANZ at Mathworks

Artificial intelligence is no longer a theoretical concept. As it moves into mainstream industry, system complexity increases while costs are driven down.

As AI starts to gather speed and practical uses become more apparent, here are five industry trends we are likely to see emerge throughout the coming year.

1 Workforce skills and data quality barriers start to abate

As AI becomes more prevalent in industry, more engineers and scientists — not just data scientists — will work on AI projects. They now have access to existing deep learning models and accessible research from the community, which allows a more significant advantage than starting from scratch. While AI models were once majority image based, most are also incorporating more sensor data, including time-series data, text and radar.

Engineers and scientists will greatly influence the success of a project because of their inherent knowledge of the data, which is an advantage over data scientists not as familiar with the domain area. With tools such as automated labelling, they can use their domain knowledge to rapidly curate large, high-quality datasets. The more availability of high-quality data, the higher the likelihood of accuracy in an AI model, and therefore the higher likelihood for success.

2 The rise of AI-driven systems increases design complexity

As AI is trained to work with more sensor types (IMUs, Lidar, Radar, etc), engineers are driving AI into a wide range of systems, including autonomous vehicles, aircraft engines, industrial plants and wind turbines. These are complex, multidomain systems where behaviour of the AI model has a substantial impact on the overall system performance. In this world, developing an AI model is not the finish line, it is merely a step along the way.

Designers are looking to model-based design tools for simulation, integration and continuous testing of these AI-driven systems. Simulation enables designers to understand how the AI interacts with the rest of the system. Integration allows designers to try design ideas within a complete system context. Continuous test-



ing allows designers to quickly find weaknesses in the AI training datasets or design flaws in other components. Model-based design represents an end-to-end workflow that tames the complexity of designing AI-driven systems.

3 AI becomes easier to deploy to low power, low cost embedded devices

AI has typically used 32-bit floating-point math as available in high-performance computing systems, including GPUs, clusters and data centres. This allowed for more accurate results and easier training of models, but it ruled out low-cost, low-power devices that use fixed-point math. Recent advances in software tools now support AI inference models with different levels of fixed-point math. This enables the deployment of AI on those low-power, low-cost devices and opens up a new frontier for engineers to incorporate AI in their designs. Examples include low-cost electronic control units (ECUs) in vehicles and other embedded industrial applications.

4 Reinforcement learning moves from gaming to real-world industrial applications

In 2020, reinforcement learning (RL) will go from playing games to enabling real-world industrial applications particularly for automated driving, autonomous systems, control design and robotics. We'll see successes where RL is used as a component to improve a larger system. Key enablers are easier tools for engineers to build and train RL policies, generate lots of simulation data for training, easy

integration of RL agents into system simulation tools and code generation for embedded hardware. An example is improving driver performance in an autonomous driving system. AI can enhance the controller in this system by adding an RL agent to improve and optimise performance — such as faster speed, minimal fuel consumption or response time. This can be incorporated in a full autonomous driving system model that includes a vehicle dynamics model, an environment model, camera sensor models and image processing algorithms.

5 Simulation lowers a primary barrier to successful AI adoption — lack of data quality

Data quality is a top barrier to successful adoption of AI — per analyst surveys. Simulation will help lower this barrier in 2020. We know training accurate AI models requires lots of data. While you often have lots of data for normal system operation, what you really need is data from anomalies or critical failure conditions. This is especially true for predictive maintenance applications, such as accurately predicting remaining useful life for a pump on an industrial site. Since creating failure data from physical equipment would be destructive and expensive, the best approach is to generate data from simulations representing failure behaviour and use the synthesised data to train an accurate AI model. Simulation will quickly become a key enabler for AI-driven systems.

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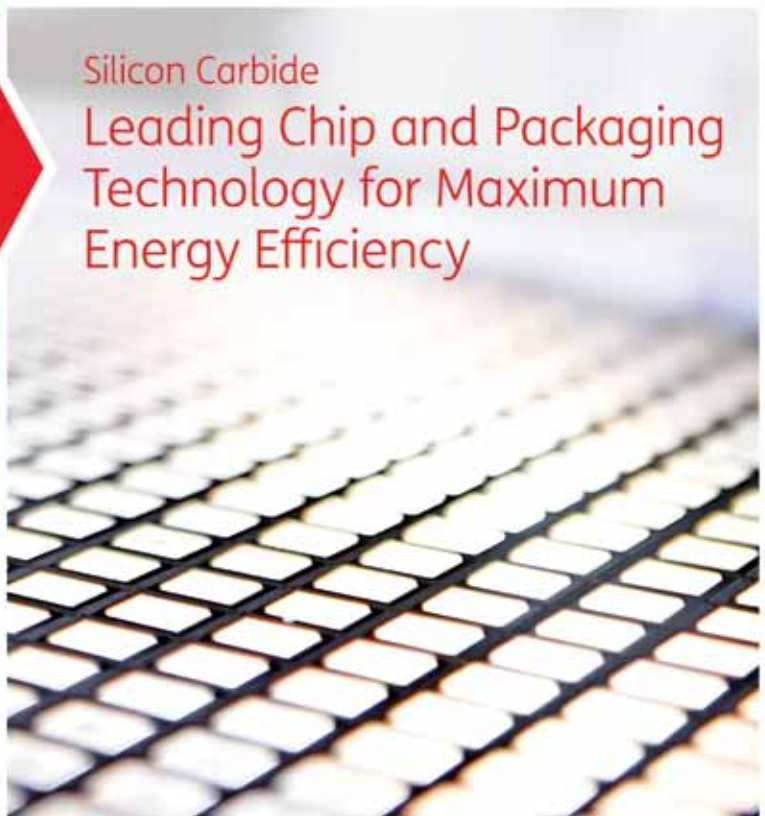


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AI TRAINING SYSTEM

iEi's GRAND-C422-20D is an AI training system that has maximum expansion ability to add in AI computing accelerator cards for AI model training or inference. Powered by an advanced 14 nm Intel Xeon W processor with an integrated Intel C422 PCH, and up to 256 GB DDR4 ECC RDIMM/LRDIMM RAM, the storage server delivers high performance for data transmission and applications.

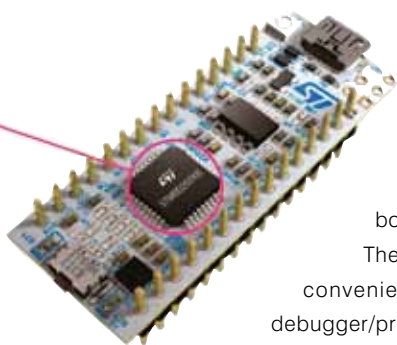
Storage spaces support up to 20 2.5"/3.5" SATA 6 Gbps drives, allowing for SATA hard drives and SSDs. Businesses can create the most cost-effective storage by implementing suitable drives based on their needs. The AI training system is dedicated to these tasks because it offers a wide range of slots for storage expansion, acceleration cards and video capture, and Thunderbolt or PoE add-on cards for unlimited data acquisition possibilities.

In order to develop a useful training model, existing and widely used deep learning training frameworks such as Caffe, Tensor-Flow or Apache MXNet are recommended. These facilitate the definition of the apt architecture and algorithms for a distinct AI application.

Other features include: six PCIe slots with up to four dual-width GPU cards; a water cooling system on the CPU; support for two U.2 SSDs; support for one M.2 SSD M-Key slot (NVMe PCIe 3.0 x4); support for a 10 GbE network; and IPMI remote management.

ICP Electronics Australia Pty Ltd

www.icp-australia.com.au



DEVELOPMENT BOARDS

STMicroelectronics is looking to making design starts using 8-bit STM8 microcontrollers (MCUs) faster and more accessible for creative minds of all types by introducing development boards in the easy-to-use Nucleo-32 form factor.

The compact boards are controlled and powered conveniently through a USB connection. An ST-LINK debugger/programmer is integrated, which saves using an external debug probe and allows simple drag-and-drop Flash programming. Arduino Nano pins simplify functional expansion using off-the-shelf shields and let users connect with open-source hardware communities. The boards are supported by major development toolchains including IAR Embedded Workbench for STM8 and Cosmic CXSTM8.

STM8 MCUs feature a high-performing 8-bit core, on-chip memory including up to 128 KB of Flash, and peripherals shared with the STM32 MCU family such as timers, analog peripherals, CAN2.0B and digital interfaces. The MCUs are suitable for creating smart sensors, actuators and other products within tight power and space constraints.

The first available STM8 Nucleo-32 board, the NUCLEO-8S207K8, contains a 32-pin STM8S207K8 MCU, which provides features including 12 high-current outputs and multiple capture-compare channels.

STMicroelectronics Pty Ltd

www.st.com

ISOLATED 10 W CONVERTERS

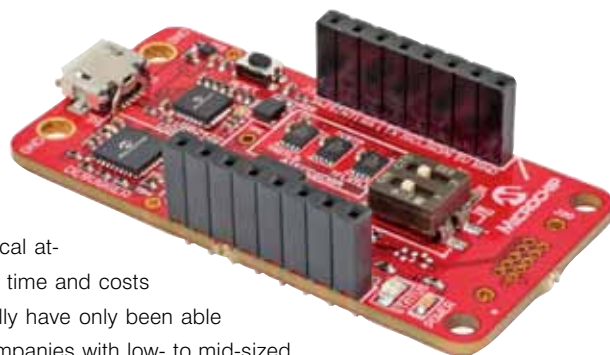
Traco Power's TEL 10WI series is a range of isolated 10 W converters that come in an ultracompact DIP-16 metal package. The low-power DC/DC converters are designed to provide maximum miniaturisation without sacrificing high efficiency, with power density of 3.83 W/cm³.

The series offers an ultrawide 4:1 input voltage range and features high efficiency of up to 86%, enabling an operation temperature of up to 70°C at full load and up to 88°C with 50% load. The converters have an internal input filter to comply with conducted emission EN 55032/EN 55022 class A and are suitable for space-critical and applications in instrumentation, IT and industrial electronics.

element14

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IoT SECURITY PLATFORM

Hardware-based security is the only way to protect secret keys from physical attacks and remote extraction, but extensive security expertise, development time and costs are required to configure and provision each device. Manufacturers typically have only been able to support configuring and provisioning for high-volume orders, leaving companies with low- to mid-sized deployments with low-performing options.

To address this need in the mass market, Microchip has introduced what is claimed to be the industry's first pre-provisioned solution that provides secure key storage for low-, mid- and high-volume device deployments using the ATECC608A secure element. Microchip's Trust Platform for its CryptoAuthentication family enables companies of all sizes to easily implement secure authentication.

The Trust Platform consists of a three-tier offering, providing out-of-the-box pre-provisioned, preconfigured or fully customisable secure elements, allowing developers to choose the platform best suited to their individual design. The first tier, Trust&GO, provides zero-touch pre-provisioned secure elements with a minimum orderable quantity (MOQ) as low as 10 units. The second tier in the program, TrustFLEX, offers the flexibility to use the customer's certificate authority of choice while still benefiting from preconfigured use cases. For those who would like to entirely customise their designs, the third tier in the program — TrustCUSTOM — provides customer-specific configuration capabilities and custom credential provisioning.

Microchip worked with Amazon Web Services (AWS) to enable a straightforward and simplified onboarding process into AWS IoT services for products designed with all variants of the Microchip Trust Platform.

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SELF-CLINCHING FASTENERS IN ELECTRONIC DESIGNS

In the early days, manufacturers used 56 M1.2 screws to hold a keyboard assembly in place, but made a switch to clinching micro pins. This substitution eliminated the time-consuming task of tapping 56 holes in each assembly and ultimately streamlined the assembly process. The pins are simply pressed into place, do not require any rotation for permanent installation and displace very little material during the process.

As this application example demonstrates, the process of considering (or reconsidering) methods to attach thin metal assemblies and/or components often can suggest different and, sometimes, more practical approaches. Self-clinching fasteners will allow for component removal and re-attachment whenever needed for access or service; will often dramatically reduce the amount of attachment hardware (such as loose washers, lock washers and nuts); and will usually require only a single mating piece to complete final component attachment. Fewer parts promote lighter designs, quicker assembly and lower production costs — and, when installed, self-clinching fasteners will not loosen or fall out and never have to be handled again.

The benefits of all self-clinching fasteners arise from their design, which features an annular recess for locking the fastener in place and an element to prevent fastener rotation in service. Regardless of type, self-clinching fasteners install permanently in thin ductile metal sheets by pressing them into place in a properly sized hole and applying sufficient squeezing force. This forces a serrated clinching ring, knurl, ribs or hex head into the panel surface, displacing sheet material into a specially designed annular recess in the shank or pilot of the fastener, known as an undercut. The metal forced into the undercut secures the fastener against axial movement, while a non-round displacer secures the fastener against rotation. No secondary operations are necessary.



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SELF-CLINCHING FASTENERS CAN BE INSTALLED MANUALLY IN SMALL QUANTITIES WITH A TOOL AS SIMPLE AS AN ARBOUR PRESS.

Dozens of types and thousands of variations of self-clinching fasteners (steel, stainless steel or aluminium) have been engineered over the years. Notable product families include threaded and through hole, spacers and standoffs, captive screw assemblies, cable tie mounts and hooks, and face-to-face panel mounting hardware, among others. Newly introduced 'micro' self-clinching fasteners have expanded application possibilities, especially in the consumer electronics marketplace, offering smaller thread sizes and thinner sheet capability than legacy product, and innovative fastener designs continue to be introduced to meet new and emerging application needs.

Case study #1

A laser-levelling device developed by a manufacturer incorporates a rotating laser beam. The laser is placed on a bracket that floats on springs, which ensures that the laser beam is always horizontal, performing as a gyro. But special weld nuts for mounting were causing several problems in the assembly of the gyro, including misplaced studs, studs placed in an angle other than 90° and weld spatter. All adversely affected the gyro's function. Design engineers turned to self-clinching studs to replace the weld nuts, which solved the problems (they were installed permanently exactly where specified) and contributed to a cleaner assembly process (without the spatter).

Self-clinching fasteners can be installed manually in small quantities with a tool as simple as an arbour press. For high-volume jobs, fasteners can be fed automatically using a dedicated installation press or to in-die equipment. In all applications the sheet material must always meet three basic requirements for success:

- Metal sheets into which the fastener will be installed must have adequate ductility to allow the displaced sheet material to cold flow into the undercut without fracturing.
- Metal sheets into which the fastener will be installed must be sufficiently softer (typically 20 points on Rockwell B Scale) than the fastener so that the fastener itself does not significantly deform during the installation process.
- Sheets must meet the minimum sheet thickness required by the particular fastener. With trends towards thinner sheets, new product families have been released for sheets as thin as 0.4 mm and designs for even thinner sheets are being developed.

As just one example, in creating right-angle designs (such as in chassis construction or attaching interior components in enclosures), traditional methods have included bent tabs and relief slots, brackets and hardware, and/or welding. Each, however, tends to raise performance and/or production concerns.

In electronic enclosures where EMI is an issue, the 'holes' created when bent tabs are used can impact negatively on desired shielding. Where tabs are welded, an extra production step is forced and attendant plating/finish problems can occur. Where right-angle brackets are used for mounting, a variety of additional necessary hardware includes attaching screws, washers, lock washers and nuts, which tend to hamper assembly time and increase parts inventory.

Clinch-type threaded and unthreaded fasteners suitable for the production of right-angle assemblies offer a solution by eliminating any need for tab cut-outs, brackets, welding, extra hardware or secondary tapping operations. The outcome: more predictable designs and tighter design control.

Case study #2

A manufacturer's two-piece enclosures benefited by specifying six aluminium unthreaded self-clinching fasteners and compatible thread forming screws to create right-angle attachment points.

The result: fastening hardware in each enclosure was reduced by half, per-unit assembly time decreased to 15 min instead of 1-1/2 h and two fabricating steps were eliminated. Punching and bending operations have become unnecessary.

A final note: designers can reinforce their decision-making in properly specifying a fastener for the application by enlisting a supplier's support and resident resources in the early stages of the design process. Even after a fastener is specified, new assembly challenges or changes in end-product design may occur and such a partnership can help keep the door open to invaluable experience and assistance.

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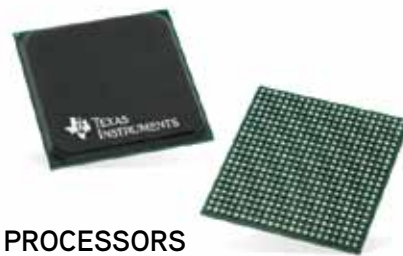
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ITECH's IT8600 series programmable combined AC/DC electronic load has a power rating of 1800, 3600 and 5400 W; a frequency range of 45–450 Hz; a voltage range of 15 V–260 Vrms and 50 V–420 Vrms; and a current range of 20, 40 and 60 Arms.

The product is able to measure Vrms, Vpk, Vdc, Irms, Idc, W, VA, VAR, CF, PF and FREQ. It also has an oscilloscope function supporting the display of voltage and current waveform on a 7" LCD screen.

The unit has three working modes for AC electronic load (CC/CR/CW) and four for DC electronic load (CV/CC/CR/CP). It features external 0–10 V analog control input, as well as a voltage and current analog monitoring function. It also includes RS232, GPIB, LAN and USB communication interfaces and an external USB flash disk interface.

Fuseco Power Solutions Pty Ltd
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PROCESSORS

Texas Instruments' (TI) Sitara AM574x processors incorporate dual-core Arm Cortex-A15 reduced instruction set computer (RISC) CPUs with Arm Neon extensions and two TI C66x floating-point DSP cores.

The processors include dual Programmable Real-time Unit for Industrial Communications subsystems (PRU-ICSS) that can be used for Industrial Ethernet protocols such as Profinet, EtherCAT and Ethernet/IP. The devices also combine programmable video processing with an integrated peripheral set, offer up to two embedded vision engines (EVEs) and include cryptographic acceleration.

The devices integrate a robust Image and Video Accelerator – High Definition (IVA-HD) subsystem with support for 4K at 15 fps, encode and decode support for H.264 CODEC, a 2D graphics accelerator and a dual-core 3D GPU. Other features include two-port Gigabit Ethernet, a general-purpose memory controller, enhanced direct memory access (EDMA) controller, sixteen 32-bit general-purpose timers and a 32-bit MPU watchdog timer.

The devices achieve high levels of processing and are designed to meet the intense processing needs of modern embedded applications, including industrial communications, human-machine interface (HMI) and automation and control.

Mouser Electronics
au.mouser.com



ALL-IN-ONE INTEGRATED POWER MODULE

The latest addition to RECOM's DC/DC converter portfolio is designed to be one of the smallest in its class of low-profile QFN-

packaged buck regulator power modules. The RPX-2.5 all-in-one integrated module (buck regulator, inductor and capacitor) features flip-chip technology which increases power density and improves thermal management.

In a tiny footprint measuring 4.5 x 4 x 2 mm, the RPX-2.5 provides an input range from 4.5 to 28 VDC, allowing 5, 12 or 24 V supply voltages to be used. The output voltage can be set with two resistors in the range from 1.2 up to 6 V. The maximum output current is 2.5 A and the output is fully protected against continuous short-circuits, output overcurrent or over-temperature faults.

It has an efficiency of up to 91% and is thermally optimised due to its flip-chip technology. An integrated shielded inductor in this miniature package makes it optimal for space-constrained applications.

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MACHINE LEARNING S/TEM

The Thermo Scientific Metrios AX is a scanning transmission electron microscope (S/TEM) that uses machine learning to automate high-quality data collection. Designed for the semiconductor industry, the product allows lab operators to quickly generate precise data, while minimising the need for operator training.

The device enables semiconductor labs to automatically acquire and measure critical dimensions

on semiconductor devices during development or in support of manufacturing. Incorporating machine learning into the instrument helps minimise the time needed to develop automated recipes, allowing more productive utilisation of the microscope.

Built on Thermo Fisher's ultrahigh-resolution Spectra platform, the Metrios AX incorporates advancements that make it easy to automate repetitive jobs, obtain sub-angstrom resolution images with high contrast and keep the microscope automatically aligned for peak performance. It was designed to improve failure analysis, process qualification and metrology by helping semiconductor labs easily create automated workflows that improve productivity.

Machine-learning technology is at the core of the Smart Automation included in the Metrios AX. This technology simplifies automation by coordinating all the necessary instructions to identify, align and image regions of interest in a sample. Smart Automation reduces the time required to create and maintain automated workflow scripts, or 'recipes', while efficiently handling process variability. The automation enables semiconductor labs to acquire data on sample jobs in less than 4 h. The product also features Smart Alignment software that automatically adjusts the column alignments, ensuring that the data collected meets stringent metrology accuracy specifications.

The product features high-sensitivity Panther S/TEM detector infrastructure and enhanced (SCORR) corrector technology, which together provide low-dose, high-contrast, damage-free imaging at sub-angstrom resolution.

Thermo Fisher Scientific
www.thermofisher.com.au

DUAL-BAND WIRELESS MCU MODULES

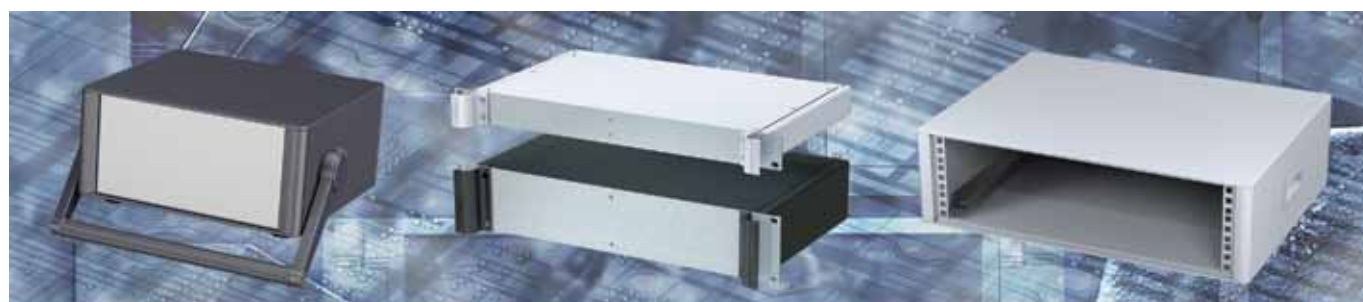
The CC3235MODx SimpleLink dual-band wireless microcontroller modules, from Texas Instruments (TI), integrate a high-performance application processor, network processor and crypto engine in a single chip with a rich set of peripherals. The CC, ISD/IC, ETSI/CE and MIC-certified CC3235MODx modules are suitable for a wide range of Internet of Things (IoT), building automation, security and healthcare applications.

The modules integrate a 40 MHz crystal, 32.768 kHz RTC clock, SPI serial flash, RF filters, diplexer and passive components, plus a network processor that runs all Wi-Fi and internet logical layers. The network processor subsystem completely offloads the host microcontroller and includes an 802.11a/b/g/n dual-band 2.4 and 5 GHz radio, baseband and MAC with a powerful hardware cryptography engine.

The devices feature capabilities that are intended to simplify the connectivity of IoT applications, including 802.11a/n 5 GHz support, coexistence capabilities for radios in the 2.4 GHz band (such as Bluetooth Low Energy), antenna selection, enhanced security with FIPS 140-2 Level 1 certification, up to 16 concurrent secure TCP/IP sockets and a certificate sign request (CSR).

The modules are available in two variants: the CC3235MODS and CC3235MODSF. The CC3235MODS incorporates an Arm Cortex-M4 microcontroller with 256 KB of application RAM, IoT networking security and device identity/keys. The CC3235MODSF builds on the CC3235MODS and adds a user-dedicated 1 MB of executable flash in addition to the 256 KB of RAM. Both variants offer microcontroller-level security features such as file system encryption, user IP (microcontroller image) encryption, secure boot and debug security.

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RUGGED TABLET

Winmate's M900P is a compact, 8" rugged tablet designed for mobile rugged use. It helps fulfil the needs of those who want portability and ease of carry as well as good application use.

The Windows 10-based device comes equipped with an Intel Pentium N4200 Apollo Lake processor and Intel Graphics for high processing performance, low power consumption and extended battery life. Its 1280 x 800 display features a projected capacitive touch screen with optical bonding and allows for outdoor viewability.

Built for operations in harsh industrial environments, the device is MIL-STD-810G certified. Its lightweight (900 g) yet rugged design features a wide operating temperature range (-20 to +60°C), an IP65 rated water- and dust-proof enclosure and 1.5 m drop tolerance.

Communication options such as GPS, Wi-Fi, Bluetooth 5.0 and optional 4G LTE enable records to be updated in real time, ensuring the most up-to-date information is always available. With user-configurable data capturing options such as built-in barcode or RFID readers, and an optional smart card reader module, the rugged tablet is crafted to suit any user-specific requirements in field service, warehousing or transportation applications.

For a transportation and in-vehicle based solution, the device comes with a built-in DB15 interface connector that will enable the device to be connected to Winmate's vehicle gateway, which is able to read vehicle data for more powerful information integration.

Backplane Systems Technology Pty Ltd
www.backplane.com.au



DC/AC INVERTERS

Nova Electric's rugged NGLM inverters are designed to provide many years of service in high shock, vibration, humidity and EMI environments in compliance to RTCA/ DO-160G and MIL-STD-704F.

The pure sine wave inverters accept standard inputs of 28, 48, 120 or 230 VDC nominal. They are offered in 3, 4.5 and 6 kVA output power, and output voltage is tightly regulated with less than 3% total harmonic distortion.

The devices are modular, with small footprints and flexible mounting configurations. The inverter chassis measures approx 45 x 33 x 20.30 cm and weighs a total of 15.42 kg. A mounting plate is integrated into the chassis.

Input connection is typically via bus bars with terminal blocks for output, though circular MS-type connectors are available optionally. The inverters use IGBT-based high-frequency switching technology to achieve high MTBF and low mean time to repair.

The series is suitable for airborne applications, military vehicle applications, ground support, mobile systems, UAVs and drones, tactical systems, naval applications and communications.

Metromatics Pty Ltd
www.metromatics.com.au

ABSOLUTE PRESSURE SENSOR

Würth Elektronik presents a compact MEMS-based (microelectromechanical systems) absolute pressure sensor: the WSEN-PADS.

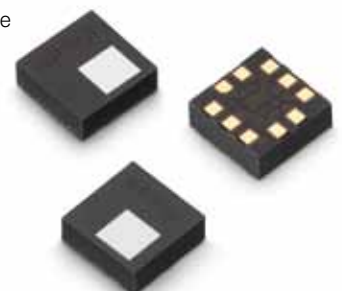
The 2 x 2 x 0.8 mm sized device measures pressure in the range between 26 and 126 kPa. Its output data rate can be selected between 1 and 200 Hz. The sensor contains an ASIC (application-specific integrated circuit) and a temperature sensor. This means the output values are already calibrated.

The absolute pressure sensor offers the possibility of preparing the measured data for various applications using activatable integrated algorithms in such a way that the programming workload for a connected controller is reduced. The measured data can be read out via a standard I²C interface. The I²C interface is extended by an additional interrupt pin whose function can be modified by the user.

An application example is the use of the pressure sensor as an altimeter. Due to its high resolution, the sensor provides information that enables the position of individual floors in buildings to be mapped. This supports an indoor navigation system.

The product is suitable for mobile devices on account of its slim design. Since the sensor can be operated at very low power consumption, it is also possible to supply it with batteries or even energy via energy harvesting. The piezoresistive sensor is specified for an industrial temperature range from -40 to +85°C.

Würth Electronics Australia Pty
www.we-online.com



BIMODAL SENSOR PROCESSES BOTH TOUCHLESS AND TACTILE STIMULI

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Through the clever use of magnetic fields, scientists from the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) and the Johannes Kepler University Linz have developed what is claimed to be the first electronic sensor that can simultaneously process both touchless and tactile stimuli. Prior attempts have so far failed to combine these functions on a single device due to overlapping signals of the various stimuli.

The skin is likely the most functionally versatile part of the body — not only is it able to differentiate between the most varied stimuli within seconds, it can also classify the intensity of signals over a broad range. Now, a research team led by HZDR's Dr Denys Makarov and Linz's Professor Martin Kaltenbrunner has managed to produce an electronic counterpart with similar characteristics.

Described in the journal *Nature Communications*, the new sensor could massively simplify the interplay between humans and machines, providing a seamless interactive platform for virtual and augmented reality scenarios. As noted by Dr Makarov, "Applications in virtual reality are becoming increasingly more complex. We therefore need devices which can process and discriminate multiple interaction modes."

Current systems work either by only registering physical touch or by tracking objects in a touchless manner. Both interaction pathways have now been combined in the sensor, which has been termed a 'magnetic microelectromechanical system' (m-MEMS) by the scientists.

"Our sensor processes the electrical signals of the touchless and the tactile interactions in different regions," said HZDR's Dr Jin Ge, first author on the study. "In this way, it can differentiate the stimuli's origin in real time and suppress disturbing influences from other sources."

On a thin polymer film, the scientists first fabricated a magnetic sensor, which relies on what is known as the giant magnetoresistance (GMR). This film in turn was sealed by a silicon-based polymer layer (polydimethylsiloxane) containing a round cavity designed to be precisely aligned with the sensor. Inside this void, the researchers integrated a flexible permanent magnet with pyramid-like tips protruding from its surface.

"The result is rather more reminiscent of cling film with optical embellishments," Dr Makarov said. "But this is precisely one of our sensor's strengths."

This is how the sensor remains so flexible: it fits all environments perfectly. Even under curved conditions, it works without losing its

functionality. The sensor can thus very easily be placed, for example, on the fingertip; indeed, it is in this manner that the scientists tested their development.

"On the leaf of a daisy we attached a permanent magnet, whose magnetic field points in the opposite direction of the magnet attached to our platform," Dr Ge said. As the finger approaches this external magnetic field, the electrical resistance of the GMR sensor drops. This occurs until the point when the finger actually touches the leaf. At this moment, it rises abruptly because the built-in permanent magnet is pressed closer to the GMR sensor and thus superimposes the external magnetic field.

"This is how our m-MEMS platform can register a clear shift from touchless to tactile interaction in seconds," Dr Ge said.

This allows the sensor to selectively control both physical and virtual objects, as one of the experiments conducted by the team demonstrates: on a glass plate with which they furnished a permanent magnet, the physicists projected virtual buttons that manipulate real conditions, such as the room temperature or brightness. Using a finger on which the 'electronic skin' had been applied, the scientists could first select the desired virtual function touchless through interaction with the permanent magnet. As soon as the finger touched the plate, the m-MEMS platform switched automatically to the tactile interaction mode. Light or heavy pressure could then be used, for example, to lower or increase the room temperature accordingly.

The researchers have thus cut down an activity that had previously required several interactions to merely one, opening up the potential for applications beyond virtual reality — the electronic skin could also be used, for example, in sterile environments. Surgeons could use the sensors to handle medical equipment without touching it during a procedure, which would reduce the danger of contamination.

"This may sound like a small step at first," Prof Kaltenbrunner said. "In the long term, however, a better interface between humans and machines can be built on this foundation."

Semiconductor company STMicroelectronics has been chosen by the Renault–Nissan–Mitsubishi Alliance to supply high-efficiency silicon-carbide (SiC) power electronics for onboard chargers (OBCs) in the Alliance's upcoming electric vehicles.

EVs need an OBC to handle charging from standard roadside charge points, when a dedicated home-charging system or super-charger is not available. The time to recharge is determined by the OBC power rating; the units in today's EVs have ratings between about 3 and 9 kW.

SiC, meanwhile, is a power-semiconductor technology that enables highly efficient power switches (MOSFETs) and rectifiers (diodes). It is a wide bandgap (WBG) semiconductor material that works at high frequencies, can withstand high operating temperatures and has smaller form factors than traditional

silicon-based materials, giving component designers a good deal of control over device characteristics. Compared to conventional silicon, WBG semiconductors can withstand higher applied voltages in relation to device size, which allows lightweight components to be rugged as well as energy-efficient.

Renault–Nissan–Mitsubishi plans to use SiC power technology to build more efficient and compact high-power OBCs that will further increase attractiveness of electric vehicles for the users

by cutting battery-charging time and enhancing driving range, while giving designers more freedom to style the vehicle and optimise packaging, weight distribution and vehicle drivability. As the alliance's chosen partner for advanced SiC technology, ST will provide design-in support to help maximise OBC performance, while also supplying associated components including standard silicon devices.

"As the pioneer and global leader in zero-emission electric vehicles, our objective remains to be the number one provider of mainstream mass-market and affordable EVs around the world," said Philippe Schulz, Alliance VP Design Electric & Hybrid Powertrain.

"The small size, light weight and high energy efficiency we can achieve using ST's SiC technology in our OBC, combined with the increased battery efficiency, will enable us to accelerate the adoption of electric vehicles by reducing charging times and extend the range of our EVs."

"SiC technology can help the world by reducing dependence on fossil fuels and increasing energy efficiency," added Marco Cassis, President, Sales, Marketing, Communications and Strategy Development, STMicroelectronics.

"Building on our long cooperation, we are now working with Renault–Nissan–Mitsubishi to realise the many advantages SiC can bring to EVs. Moreover, this commitment helps ensure success by increasing the economies of scale to deliver superior-performing SiC-based circuits and systems that are also cost-effective and affordable."

The OBCs with ST's SiC are scheduled to enter volume production in 2021.

STMicroelectronics Pty Ltd
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CABLE ASSEMBLIES

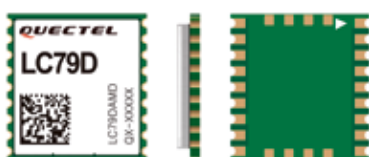
Harwin has broadened its portfolio of ready-made cable assemblies to include the Gecko Screw-Lok (Gecko-SL) 1.25 mm connector family, building on the options already available using Harwin's Datamate products. Available in both single- and double-ended arrangements, the cable assemblies fully comply with the established IPC-620 cable and wire harnessing industry standard. They can be specified for either cable-to-cable or cable-to-board implementations.

Each cable has a 26 AWG wire gauge PTFE construction, and comes in 150, 300 and 450 mm lengths. The assemblies are fully compatible with existing metal backshells, for both added mechanical robustness and strong EMC resilience. They are suitable for situations where there are multiple mating operations involved.

Due to the hexagon-slotted screw fixings and mate-before-lock mechanism, the rugged assemblies are straightforward to deploy, especially in space-constrained environments. They benefit from the inherent resilience that Gecko-SL connectors exhibit to high degrees of shock/vibration and extreme temperatures, as well as their relatively strong current carrying capacity (2 A per contact, despite the narrow pitch).

Users can choose from 6–50 pin arrays for their assemblies, meaning there are no lead times to factor in and end system production is not delayed. The necessary fixing hardware is provided, either directly or as part of the backshell kit. All supplied assemblies are 100% continuity checked, streamlining the system integration process.

Clarke & Severn Electronics
www.clarke.com.au



HIGH-PRECISION GNSS MODULE

The Quectel LC79D L1/L5 high-precision GNSS module is based on Broadcom's BCM47755 GNSS chip.

The product offers simultaneous support for L1 and L5 bands for GPS, Galileo and QZSS satellites, L1 band for GLONASS and BeiDou satellites, and L5 band for IRNSS. The multi-GNSS support, along with integrated LNA and SAW, allows the device to reach accuracies near 1 m and has good performance in deep urban canyons. The combination of standalone operation and low power make it suitable for anyone requiring a higher performing GNSS solution.

The product is useful for applications include IoT, tracking, precision agriculture, drones and anyone requiring high precision. In Host Mode, the device can also support dead reckoning focused on the e-bike, robotics and autonomous vehicle markets. It comes in an ultracompact, 10.1 x 9.7 mm package.

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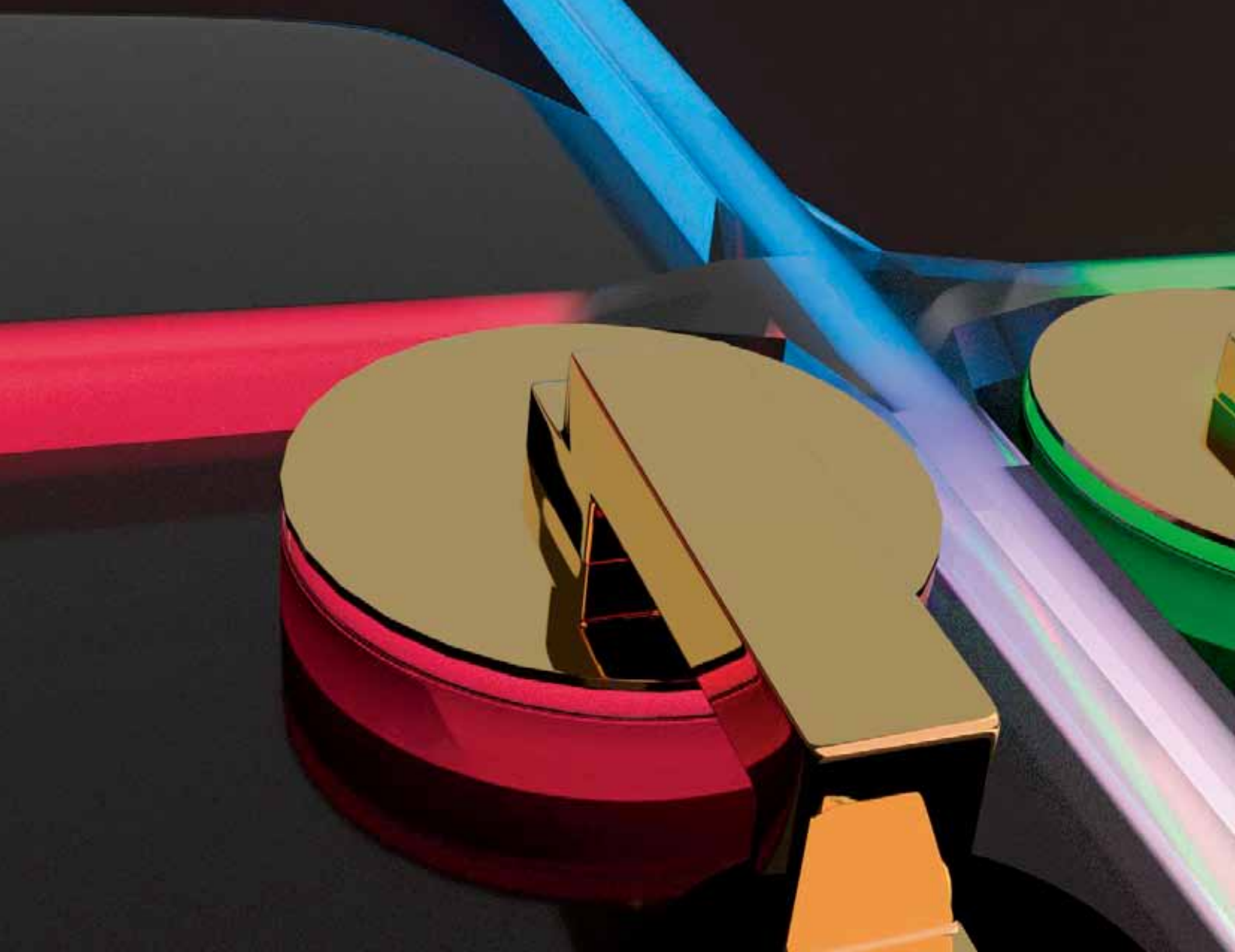
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OPTICAL SWITCH CAN REROUTE LIGHT IN COMPUTER CHIPS

Researchers at the US National Institute of Standards and Technology (NIST) and ETH Zurich have collaborated on an optical switch that routes light from one computer chip to another in just 20 billionths of a second — said to be faster than any other similar device.

Described in the journal *Science*, the compact switch is claimed to be the first to operate at voltages low enough to be integrated onto low-cost silicon chips, and redirects light with very low signal loss. Its record-breaking performance also marks a major new step towards building a computer that uses light instead of electricity to process information.

Relying on particles of light — photons — to transport data within a computer offers several advantages over electronic communications. Photons travel faster than electrons and don't waste energy by heating up the computer components. Managing that waste heat is a major barrier to improving computer performance. Light signals have been used for decades to transmit information

over great distances using optical fibres, but the fibres take up too much room to be used to carry data across a computer chip.

Now, the researchers have created a switch that exploits the wave nature of light. When two identical light waves meet, they can superpose such that the crest of one wave aligns or reinforces the crest of the other, creating a bright pattern known as constructive interference. The two waves may also be exactly out of step, so that the valley of one wave cancels the crest of the other, resulting in a dark pattern — destructive interference.

In the team's set-up, a light beam is confined to travel inside a miniature highway — a tube-shaped channel known as a waveguide. This linear highway is designed so that it has an off-ramp



BY CHANGING THE WIDTH OF THE GAP BETWEEN THE SILICON DISK AND THE GOLD MEMBRANE BY ONLY A FEW NANOMETRES, THE RESEARCHERS COULD DELAY OR ADVANCE THE PHASE OF THE HYBRID LIGHT WAVE

— some of the light can exit into a racetrack-shaped cavity, just a few nanometres away, etched into a silicon disk. If the light has just the right wavelength, it can whip around the racetrack many times before leaving the silicon cavity.

The switch has one other crucial component: a thin gold membrane suspended just a few tens of nanometres above the silicon disk. Some of the light traveling in the silicon racetrack leaks out and strikes the membrane, inducing groups of electrons on the membrane's surface to oscillate. These oscillations, known as plasmons, are a kind of hybrid between a light wave and an electron wave: the oscillating electrons resemble the incoming light wave in that they vibrate at the same frequency, but they have a much shorter wavelength. The shorter wavelength lets researchers manipulate the plasmons over nanoscale distances, much shorter than the length of the original light wave, before converting the oscillations back into light. This, in turn, allows the optical switch to remain extremely compact.

By changing the width of the gap between the silicon disk and the gold membrane by only a few nanometres, the researchers could delay or advance the phase of the hybrid light wave — the point in time when the wave reaches a crest or valley. Even minuscule variations in the width of the gap, which the team accomplished by electrostatically bending the gold membrane, dramatically altered the phase.

Depending on how much the team had advanced or delayed the phase of the wave, when it recombined with light still traveling in the tube-shaped highway, the two beams interfered either constructively or destructively. If the light beams match up to

interfere constructively, the light will continue in its original direction, travelling down the tube. But if the light beams interfere destructively, cancelling each other out, that pathway is blocked. Instead, the light must move in another direction, determined by the orientation of other waveguides, or routes, placed close to the blocked pathway. In this way, the light can be switched at will to any of hundreds of other computer chips.

The study authors say their work may come as a surprise to many in the scientific community because the results contradict long-held beliefs. Some researchers have thought that opto-electro-mechanical switches would not be practical because they would be bulky, operate too slowly and require voltages too high for the components of a computer chip to tolerate.

Scientists had also once thought that a plasmonic system would greatly attenuate light signals because photons would penetrate the interior of the gold membrane, where electrons would absorb much of the light energy — but the researchers have now proved that assumption wrong. The compactness of the device and a design that ensured that few photons would penetrate the membrane resulted in a loss of just 2.5% of the light signal, compared with 60% with previous switches. That puts the switch, although still a prototype, within reach of commercial applications.

For example, in driverless cars, the switch could rapidly redirect a single light beam that must continually scan all parts of the roadway to measure the distance to other automobiles and pedestrians. The device could also make it easier to use more powerful light-based circuits instead of electricity-based ones in neural networks. These are artificial intelligence systems that simulate how neurons in the human brain make decisions about such complex tasks as pattern recognition and risk management.

The new technology also uses very little energy to redirect light signals, which may help realise the dream of quantum computing. A quantum computer processes data stored in the subtle interrelations between specially prepared pairs of subatomic particles. However, these relationships are extremely fragile, requiring that a computer operate at ultralow temperatures and low power so that the particle pairs are disturbed as little as possible. Because the new optical switch requires little energy — unlike previous optical switches — it could become an integral part of a quantum computer.

The team is now working to make the device even smaller by shortening the distance between the silicon disk and the gold membrane. This would further reduce signal loss, making the technology even more appealing to industry.

SPIN WAVES

COULD STOP DEVICES FROM OVERHEATING

Modern computer memory encodes information by switching magnetic bits within devices. Now, a research team led by the National University of Singapore (NUS) has found a way of using 'spin waves' to switch magnetisation at room temperature for more energy-efficient spin memory and logic devices.

Traditional electronic chips suffer from substantial 'Joule heat', which occurs due to the flow of an electric current producing high temperatures and is caused by rapid motion and frequent collision among moving charges inside the devices. This not only causes a large amount of power dissipation, it also hinders the chip's processing speed and limits the number of chips that can be incorporated into appliances.

"We always encounter such problems and inconveniences when using our phones, computers and other electronic devices," said NUS Professor Yang Hyunsoo, leader of the new research. "We often find that these devices are becoming 'hot' and 'slow'; moreover, we need to charge them frequently and have to bring another portable charger sometimes."

Rather than adopting standard electron injection methods used in traditional electronics, Prof Yang's team creatively used spin waves to switch magnetisation. Spin waves are propagating disturbances in the ordering of magnetic materials; from the quasiparticle point of view, spin waves are known as 'magnons'.

The team built a bilayer system consisting of an antiferromagnetic magnon transport channel and a topological insulator spin source. They then demonstrated spin wave-driven magnetisation switching in the adjacent ferromagnetic layer with a high efficiency at room temperature.

The new switching scheme based on spin waves can avoid moving charges; therefore, much less Joule heat and power dissipation would be expected for devices. The advance of spin wave-based switching could thus open a new avenue for energy-efficient chips.

"The spin waves (magnons) can deliver spin information even in insulators without involving moving charges," said Dr Wang Yi, first author of the study. "This unique property potentially allows longer spin propagation but with lower dissipation compared to electron spins. Then we can control the magnetisation if we transfer the spin information from the magnons to the local magnetisation, which can be understood as 'magnon torques'."

Just as a linear force is a push or a pull, a torque can be thought of as a twist to an object. "Hence, this new way to manipulate the magnetisation can be used for future data memory and logic devices," Dr Wang said.

"Our work first shows that the magnon torque is sufficient to switch the magnetisation at room temperature," Prof Yang added. "Even the efficiency of the magnon torque is comparable with previously pursued electrical spin torque efficiency. We believe it can be substantially enhanced by engineering devices further, so that the magnon torque will become more energy efficient."

Dr Wang said, "We believe our report of the new magnon torque scheme for magnetisation switching is a game-changing idea in spintronics. It will invigorate not only a new research area in magnonics, but also practical devices operated by magnons."

Next, the research team will further engineer the efficiency of magnon torques and explore all magnon devices without involving electrical parts. In addition, the operation frequency of spin waves is in the terahertz range. Terahertz devices can transmit data at significantly higher speeds than currently possible.

"Therefore, magnon torque-based devices will allow the implementation of ultrahigh-speed applications in the future," Prof Yang said.



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www.wfmedia.com.au

Head Office

Unit 7, 6-8 Byfield Street, North Ryde
Locked Bag 2226, North Ryde BC NSW 1670
Ph: +61 2 9168 2500

Editor

Lauren Davis
wnie@wfmedia.com.au

Publishing Director/MD Geoff Hird

Art Director/Production Manager
Julie Wright

Art/Production

Veronica King, Colleen Sam

Circulation Dianna Alberry, Sue Lavery
circulation@wfmedia.com.au

Copy Control Mitchie Mullins
copy@wfmedia.com.au

Advertising Sales

Group Sales Manager

Nicola Fender-Fox - 0414 703 780
nfender-fox@wfmedia.com.au

Account Manager

Sandra Romanin - 0414 558 464
sromanin@wfmedia.com.au

Asia

Tim Thompson - 0421 623 958
tthompson@wfmedia.com.au



Contact the editor

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