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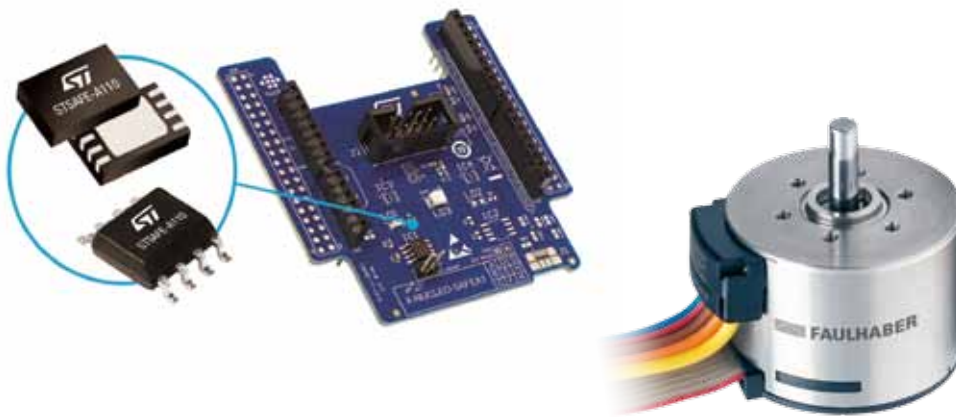
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# CONTENTS

- 4 Testing high-throughput satellites — from prototyping to in-orbit verification
- 15 How to optimise solder stencil aperture to increase connector options
- 20 Tandem solar cell efficiency closes in on 30%
- 22 7 Industry 4.0 trends for 2020
- 26 Teaching tomorrow's vehicles to 'hear'
- 30 Creating custom-coloured light with 2D semiconductors
- 34 Nano antennas enable data transfer
- 38 Diamond film boosts heat dissipation efficiency of GaN HEMTs
- 42 Flexible touchscreens could be printed like newspaper



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## COVER STORY



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Service Manager Jing is proud of the latest addition to her continually upgraded lab, which can calibrate the latest R&S equipment including high-end FSWP phase noise analysers, FSW spectrum analysers, ZNA vector network analysers, CISPR 16-1-1 compliant ESW EMI/EMC receivers, RTO and RTP multi-domain oscilloscopes, TV analysers and other portable equipment.

Jing said: "Customers are now able to save considerable cost and time by having their equipment calibrated in Australia instead of overseas. The quality of our equipment is constantly being put to the test and the team has a very good record of meeting customer requirements providing cost-effective solutions and precise, certified calibrations quicker than most expect."

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# TESTING HIGH-THROUGHPUT SATELLITES

## FROM PROTOTYPING TO IN-ORBIT VERIFICATION

*Dr Rajan Bedi\**

To deliver the next generation of satellite applications, operators are exploiting the onboard processing advantages of digital, wideband high-throughput payloads at higher frequencies. By moving to Ku, K, Ka, O and V-band, larger bandwidths are available to deliver services such as real-time, ultrahigh-definition Earth observation and low-latency internet.

**W**hen developing satellite electronics, testing occurs throughout all stages of spacecraft development: from characterising the performance of analog parts, digital logic, SpaceWire/SpaceFibre interfaces, RF circuits and antennas during the initial system architecture, to verifying the functionality of hardware demonstrators and validating proof-of-concepts at the prototyping (EM) phase. This is followed by measuring the performance of complete payload subsystems and then entire spacecraft validation in a representative environment using thermal-vacuum chambers during the qualification (EQM) stage. Prior to lift-off, final integration checks are typically performed at the launch site; and throughout operation, regular in-orbit checks of the transmission links are made to monitor and confirm quality of service (QoS).

The key challenge for today's manufacturers of high-throughput satellites is how to test

payloads processing GHz bandwidths using M-QAM, M-PSK or M-APSK RF carriers. The ADCs and DACs are directly sampling IF/RF carriers at GSPS speeds handling Gbps of data.

Starting at the receiver, phased-array antennas and digital beamforming techniques are increasingly being used by satellites of all sizes, orbits and frequencies to maximise the radiation pattern for reception and transmission. Determining the direction of arrival of incoming signals improves the received signal strength and reduces fading, interference and side-lobe levels, increasing the capacity of high-throughput payloads. Higher spatial diversity, better frequency re-use and more precise user positioning are also achieved.

Continuing with the high-throughput signal chain but moving to RF frequency conversion in the receiver and transmitter, a key challenge for satellite manufacturers is how to measure relative or absolute group delay (phase linearity) with unknown or unstable

local oscillators. Frequency and phase changes due to drift and noise limit the accuracy of current testing methods. Furthermore, increasing integration and miniaturisation has meant that OEMs no longer have access to the local oscillator or a common reference signal.

This article will focus on mixed-signal and payload testing. As the resolution and speed of broadband ADCs/DACs continue to increase, satellite manufacturers are struggling to verify if their mixed-signal subsystems can reliably meet the needs of operators. Traditional signal generators do not help as their harmonics, intermodulation distortion and phase-noise levels pollute measurements leaving many OEMs unsure if their ADC/DAC designs are compliant and/or whether their test equipment is fit for purpose.

For ADCs and DACs, the first tests are a series of single-tone measurements at different frequencies to understand in-band SNR, harmonic and spurious performance.





CW characterisation allows OEMs to simultaneously differentiate between device-level artefacts and system issues, eg, an ADC interleaving spur vs noise coupling from the routing of the sampling clock, power supply or poor grounding.

ADC/DAC sampling multiplies the input with the clock in the time domain, which is equivalent to convolving the signal spectrum with that of the clock. It is therefore paramount that satellite manufacturers understand the bandwidth and frequency content of both.

For single-tone testing, the SMW200A offers spacecraft OEMs good spectral purity with a specified single-sideband phase noise of -139 dBc (typical) at 1 GHz (20 kHz offset), and non-harmonic and harmonically related spurs of <-90 and <-55 dBc respectively. Its output power ranges from -120 to +18 dBm, sufficient to exercise the full scale of an ADC's analog front-end.

Once the single-tone performance of the mixed-signal hardware has been understood, its linearity and wideband operation can be characterised using more representative stimuli such as multi-tone or noise-power ratio carriers to provide a measure of intermodulation distortion.

Following CW, multi-tone and wideband measurements, the complete payload is then tested using representative stimuli such as modulated carriers to verify operational performance. The SMW200A can be used to generate any arbitrary waveform capable of synthesising 2 GHz of I/Q signal bandwidth up to 40 GHz.

For modulated carriers, the SMW200A offers a measured frequency response of <0.4 dB over the 2 GHz of bandwidth. There is an option of a second RF 2 GHz I/Q channel up to 20 GHz and for beamforming satellites, precise, stable, phase-coherent outputs are available to measure active

antenna systems. Proprietary waveform standards can also be generated.

Once a modulated carrier format is selected and input to the payload processor, eg, M-QAM, M-PSK or M-APSK, its performance needs to be measured. For digital RF communication, error vector magnitude (EVM) and bit-error rate (BER) are the major metrics used to measure the quality of transmission.

EVM is a measure of multi-level, multi-phase digital modulation quality and error performance used by satellite communication, quantifying the difference between the expected complex voltage of a demodulated symbol and the received value. EVM considers all of the potential phase and amplitude channel distortions as well as noise, providing a single, comprehensive measurement figure for determining quality.

BER is the number of errors divided by the total number of bits transmitted



measured during a given time interval and usually expressed as a percentage.

The FSW signal and spectrum analysers can directly measure the resulting EVM and BER modulation quality, as well as traditional metrics such as group delay, noise figure, spurious, NPR, ACLR, phase noise, compression and frequency response up to 500 GHz. Predefined satellite standards such as DVB-S2(X) are supported.

The FSW signal and spectrum analysers offer up to 5 GHz of analysis bandwidth for high-throughput satellites. The specified phase noise is -140 dBc at 1 GHz (1 kHz offset), with real-time bandwidth of 800 MHz, spurious free dynamic range (SFDR) of >100 dBc, a minimum displayed average noise level (DANL) of -169 dBm and a measurement uncertainty of <0.4 dB. DANL refers to the level of the instrument noise floor given a particular bandwidth and represents the best-case sensitivity of an analyser when measuring small signals. An input below this level cannot be detected.

Once a high-throughput payload has been tested and proven in ambient conditions, its operation must be characterised and qualified in a representative environment. Vacuum chambers replicate the thermal and atmospheric conditions of outer space; however, standard test equipment is not designed to work within TVAC, remaining outside and interfacing to the DUT inside the chamber using long cables. A key concern for manufacturers is that leads, adapters and switches in the set-up drift as the temperature changes within



ONCE THE PERFORMANCE OF THE PAYLOAD HARDWARE HAS BEEN SUCCESSFULLY VERIFIED AND QUALIFIED, TESTING OF THE FLIGHT-GRADE (FM) PRODUCTION ELECTRONICS CAN BE AUTOMATED TO ALLOW OEMS TO MEET TIME-TO-MARKET NEEDS

TVAC and regular calibration is necessary to ensure accurate measurements.

Previously, system error correction for network-analyser measurements used to be a tedious task as the calibration units in the set-up had to be continually connected and disconnected. This was a time-consuming and error-prone process. An inline calibration module is available to track up and downlink errors due to cabling and temperature changes from -30 to +80°C. The ZN-Z33 has low insertion loss, from 1.5 dB at 1 GHz to 5 dB at 40 GHz, and high directivity from 10 MHz to 40 GHz.

Once the performance of the payload hardware has been successfully verified and qualified, testing of the flight-grade (FM) production electronics can be automated to allow OEMs to meet time-to-market needs, while at the same time providing a fast and repeatable test solution. All of the equipment discussed can be controlled remotely using industry-standard interfaces such as GPIB IEEE 488.2, LAN, USB and RS-232, supporting many scripting languages including Matlab, Python and CVI. The Standard Commands for Programmable Instruments (SCPI) command for every operation can be displayed and a really useful feature is a SCPI macro recorder which captures the manual testing steps developed during the verification of the initial prototype and generates code for automated measurements during production. This pre-programmed sequence of computerised testing can also be replayed if components have to be de-risked for space during radiation testing at a cyclotron and throughout the qualification phase in TVAC.

After launch, signal and spectrum analysers can be used by operators for in-orbit

verification to measure the quality of downlink carriers from satellites, the received uplink or the regenerated signal inside the transponder by comparing with known references.

For post-launch verification of satellite links and ground stations, the key challenges are to ensure that carriers arrive with sufficient power to maintain QoS and that frequency components experience the same delay to preserve their relative phases. Atmospheric conditions affect a satellite's signal power received at a ground station which in turn impact EVM and BER, eg, fog, clouds and precipitation attenuate the downlink carrier and increase noise especially at higher communication frequencies such as Ku and Ka-band.

A concern for operators is unintentional or deliberate interference which degrades the QoS of a satellite link or, in the worst case, puts it out of operation. Ground stations can direct an uplink to the wrong satellite saturating a transponder. The cost to perform tests is also a major concern, ie, the time a channel is out of service for post-launch maintenance rather than generating revenue.

This article has described the challenges faced by satellite manufacturers and operators to test high-throughput payloads throughout all stages of spacecraft development.

*\*Dr Rajan Bedi is the CEO and founder of Spacechips, which provides ultrahigh-throughput, onboard processing and transponder products for telecommunication, Earth observation, satellite-based internet and M2M/IoT satellites. The company also offers design consultancy, technical marketing, business intelligence and training services. Email [info@spacechips.co.uk](mailto:info@spacechips.co.uk) for further information.*

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# STM32WL



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## WASTE HEAT COULD BE USED TO POWER ELECTRONICS

Researchers have developed an energy-harvesting device that can convert environmental waste heat (such as that lost from the human body) into electricity — an attractive prospect for powering small electronics. Their findings were published in *Scientific Reports*.

A thermocell is a device that converts environmental heat into electricity through the thermal charging effect. Although thermocells are inexpensive and efficient, so far only low output voltages — just tens of millivolts (mV) — have been achieved and these voltages also depend on temperature. Now, a research team led by the University of Tsukuba has developed a thermocell containing a material that exhibited a temperature-induced phase transition of its crystal structure. Just above room temperature, the atoms in this solid material rearranged to form a different crystal structure. This phase transition resulted in an increase in output voltage from zero to around 120 mV — an improvement over that of existing thermocells.

"The temperature-induced phase transition of our material caused its volume to increase," explained Professor Yutaka Moritomo, senior



author of the study. "This in turn raised the output voltage of the thermocell."

The researchers were able to finely tune the phase transition temperature of their material so that it lay just above room temperature. When a thermocell containing this material was heated above this temperature, the phase transition of the material was induced, which led to a substantial rise of the output voltage from zero at low temperature to around 120 mV at 50°C.

The thermocell containing the phase transition material also overcame the issue of a temperature-dependent output voltage. Because the increase of the output voltage of the thermocell induced by the thermal phase transition was much larger than the temperature-dependent fluctuations of output voltage, these fluctuations could be ignored. "Our results suggest that thermocell performance can be strongly boosted by including a material that exhibits a phase transition at a suitable temperature," Prof Moritomo said. "This concept is an attractive way to realise more efficient energy-harvesting devices."

## LITHIUM-SULFUR BATTERIES DEVELOPED DOWN UNDER

Australian researchers are on the brink of commercialising what is claimed to be the world's most efficient lithium-sulfur (Li-S) battery, which could outperform current market leaders by more than four times and power Australia well into the future.

Dr Mahdokht Shaibani from Monash University led an international research team that developed an ultrahigh-capacity Li-S battery which has better performance and less environmental impact than current lithium-ion products, with the capability to power a smartphone for five continuous days or enable an electric vehicle to drive more than 1000 km without needing to refuel. The team's study has been published in the journal *Science Advances*.

Using the same materials as in lithium-ion batteries, the researchers reconfigured the design of sulfur cathodes so they could accommodate higher stress loads without a drop in overall capacity or performance. Inspired by bridging architecture first recorded in processing detergent powders in the 1970s, the team engineered a method that created bonds between particles to accommodate stress and deliver stability for more than 200 cycles — unprecedented in such thick cathodes, according to the study authors — with Coulombic efficiency above 99%.

Monash Professor Mainak Majumder, a corresponding author on the study, said the development could transform the way phones, cars, computers and solar grids are manufactured.

"Successful fabrication and implementation of Li-S batteries in cars and grids will capture a more significant part of the estimated \$213 billion value chain of Australian lithium, and will revolutionise the Australian vehicle market and provide all Australians with a cleaner and more reliable energy market," Prof Majumder said. "Our research team has received more than \$2.5 million in funding

from government and international industry partners to trial this battery technology in cars and grids from this year."

Co-author Associate Professor Matthew Hill, also from Monash, said attractive performance, lower manufacturing costs, abundant supply of material, ease of processing and reduced environmental footprint make this new battery design attractive for future real-world applications.

"This approach not only favours high-performance metrics and long cycle life, but is also simple and extremely low-cost to manufacture, using water-based processes, and can lead to significant reductions in environmentally hazardous waste," Assoc Prof Hill said.

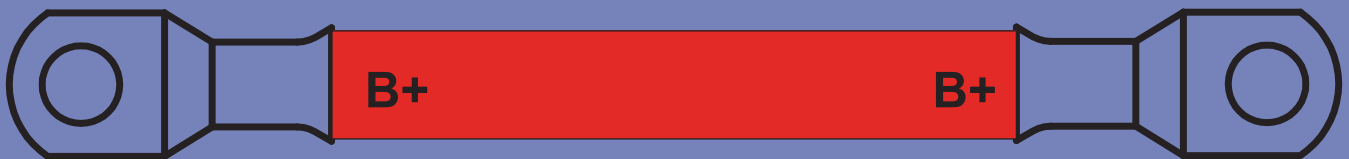
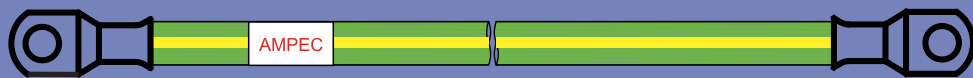
The researchers have an approved filed patent for their manufacturing process, and prototype cells have been successfully fabricated by their German R&D partners at the Fraunhofer Institute for Material and Beam Technology IWS. Some of the world's largest manufacturers of lithium batteries in China and Europe have already expressed interest in upscaling production, with further testing to take place in Australia in early 2020.



Image courtesy of Dr Mahdokht Shaibani

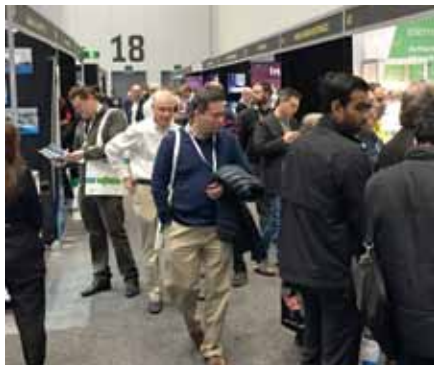


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## ELECTRONEX EXPO RETURNS TO SYDNEY IN 2020



Following the success of 2019's Electronex – The Electronics Design & Assembly Expo and Conference, held from 11–12 September at the Melbourne Convention and Exhibition Centre, the event returns to Rosehill Gardens in Sydney from 9–10 September 2020.

The move to the MCEC in Melbourne was described by organiser Australasian

Exhibition and Events (AEE) as an outstanding success, with more than a 12% increase in attendance and a record number of exhibitors participating in the 2019 event. In a further endorsement for the growth of the electronics sector and the success of the event, 53% of visitors had not attended Electronex previously and over 90% were engineers, managers or involved in production or purchasing. AEE said that “the move to MCEC was well received by both visitors and exhibitors, with several of our regular exhibitors commenting that it was the best Electronex show they had ever been involved in”.

Electronex was first held in 2010 and has grown to become the pre-eminent trade event for companies that utilise electronics in manufacturing, assembly or servicing. Reflecting the growth of high-tech niche manufacturing in Australia, at the recent

Melbourne expo 87% of visitors said that they had met new companies and 81% discovered new products and technology they were not aware of, reinforcing the important role of exhibitions in sourcing new technology and solutions in our rapidly changing marketplace.

The SMCBA Surface Mount Conference was also held concurrently with the expo and was well attended, with over 80 delegates participating in the two-day technical workshops. Free seminars were also held on the expo floor and covered a range of hot industry topics to complement the conference workshops.

The Sydney expo is now open for bookings and at least 60% of the space has already been booked. For information about exhibiting at Electronex 2020, contact AEE on 03 9676 2133 or email [info@auexhibitions.com.au](mailto:info@auexhibitions.com.au).

## TRANSISTOR TECHNOLOGY REACHES RECORD FREQUENCIES

Scientists at the Fraunhofer Institute for Applied Solid State Physics IAF have developed a novel type of transistor with extremely high cut-off frequencies: metal–oxide–semiconductor HEMTs (MOSHEMTs). The transistor is expected to enable even smaller and more powerful devices, having reached record frequencies of 640 GHz.

The high-frequency characteristics of high-electron-mobility transistors (HEMTs) have steadily improved, with the transistors becoming increasingly faster by downscaling the gate length to 20 nm. However, the thinner the barrier material of indium aluminium arsenide (InAlAs) becomes, the more electrons leak from the current carrying channel through the gate. These unwanted gate leakage currents have a negative impact on the efficiency and durability of the transistor, which renders further downscaling attempts impossible.

Silicon MOSFETs (metal–oxide–semiconductor field-effect transistors) are no stranger to this problem; however, they possess an oxide layer that can prevent unwanted leakage currents for longer than is the case with HEMTs. With this in mind, researchers combined the advantages of III–V semiconductors and Si MOSFETs and have replaced the Schottky barrier of a HEMT with an isolating oxide layer. The result is the metal–oxide–semiconductor HEMT.

“We have developed a new device which has the potential to exceed the efficiency of current HEMTs by far,” said Dr Arnulf Leuther, a researcher at Fraunhofer IAF. “The MOSHEMT allows us to downscale it even further, thus making it faster and more efficient.”

With the new transistor technology, Dr Leuther and his team have succeeded in achieving a record with a maximum oscillation frequency of 640 GHz. According to Dr Leuther, “This surpasses



the global state of the art for any MOSFET technology, including silicon MOSFETs.”

To overcome the gate leakage currents, the scientists had to use a material with a significantly higher barrier than the conventional Schottky barrier. They replaced the semiconductor barrier material with a combination of isolating layers consisting of aluminium oxide (Al<sub>2</sub>O<sub>3</sub>) and hafnium oxide (HfO<sub>2</sub>).

“This enables us to reduce the gate leakage current by a factor of more than 1000,” said Dr Axel Tessmann, a scientist at Fraunhofer IAF. “Our first MOSHEMTs show a very high development potential, while current field effect transistor technologies have already reached their limit.”

The extremely fast MOSHEMT is designed for the frequency range above 100 GHz and is therefore especially promising for novel communication, radar and sensor applications. In the future, high-power devices will ensure a faster data transmission between radio towers and enable imaging radar systems for autonomous driving as well as higher resolution and precision of sensor systems. And the researchers have already succeeded in realising an amplifier MMIC (monolithic microwave integrated circuit) based on indium gallium arsenide (InGaAs) MOSHEMTs for the frequency range between 200 and 300 GHz — said to be a world first.





## STRETCHABLE SOLAR CELLS RETAIN HIGH EFFICIENCY



Researchers from the King Abdullah University of Science and Technology (KAUST) have turned rigid silicon into solar cells that can be stretched by 95%, while retaining high solar energy capture efficiency of 19%. Their work, published in *Advanced Energy Materials*, shows that crystalline silicon solar panels could be just as effective when incorporated into stretchy wearable electronics or flexible robot skin as they are when used as rigid rooftop panels.

Although many solar materials are being investigated, silicon remains the photovoltaic industry's favourite. As explained by researcher Nazek El-Atab, "Monocrystalline silicon remains the material of choice in the PV industry due to its low cost, nontoxicity, excellent reliability, good efficiency and maturity of the manufacturing process."

One drawback of silicon, for certain applications, is its rigidity, unlike some thin film solar cells. However, these flexible cells either consist of low-cost, low-efficiency organic materials or more efficient but very expensive inorganic materials. Muhammad Mustafa Hussain and his team have now developed low-cost, high-efficiency, silicon-based stretchy solar cells.

The key was to take a commercially available rigid silicon panel and coat the back of the panel with a highly stretchable, inexpensive, biocompatible elastomer called ecoflex. The team then used a laser to cut the rigid cell into multiple silicon islands, which were held together by the elastomer backing. Each silicon island remained electrically connected to its neighbours via interdigitated back contacts that ran the length of the flexible solar cell.

The team initially made rectangle-shaped silicon islands that could be stretched to around 54%, according to Hussain. "Beyond this value, the strain of stretching led to diagonal cracks within the brittle silicon islands," he said. The team tried different designs to push the stretchability further before settling on triangles, which saw them achieve "world-record stretchability and efficiency", Hussain said.

The team now plans to incorporate the stretchy silicon solar material to power a multisensory artificial skin developed by Hussain's lab. Making solar panels that stretch with even greater flexibility is also a target.

"The demonstrated solar cells can be mainly stretched in one direction — parallel to the interdigitated back contacts grid," Hussain said. "We are working to improve the multidirectional stretching capability."

## Transfer Multisort Elektronik

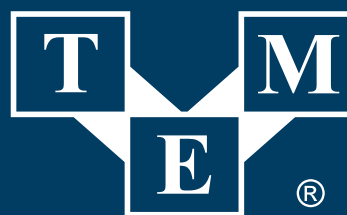
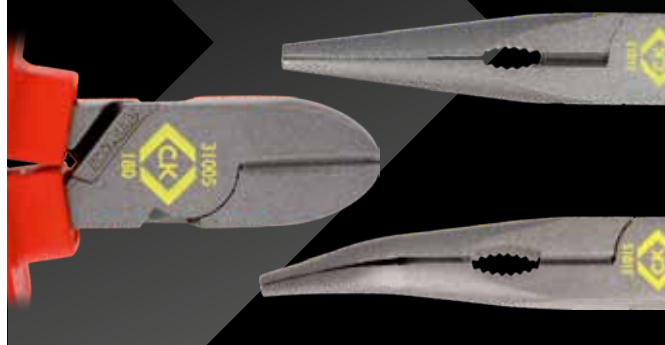
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## ROGOWSKI COILS

LEM's ART and ARU series are Class 0.5 Rogowski coils for electronic measurement of AC current with galvanic separation between the primary power circuit (power) and the secondary measurement circuit. The company's Perfect Loop Technology is designed to reduce position and proximity error compared to traditional coils.

The flexible current transformers are widely used for transformer condition monitoring, power metering, power quality analysis and fault detection. Their split core design provides easy installation for retrofit applications or installations with high load currents, multiple busbars or limited space.

Combined with the AI-PMUL multi-range integrator and signal conditioner module, the user can measure from 100 to 5000 A user selectable, adjust the input sensitivity from 22.5 to 120 mV/kA and even output true RMS process measurements including 0–5 V, 0–10 V, 0–20 mA and 4–20 mA. Traditional power meters outputs included are 0.333 and 0.166 V, with a soon-to-be-released dedicated 1 A integrator.

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## AI EMBEDDED SYSTEM

iEI's ITG-100AI fanless ultracompact AI embedded system comes with I/O interfaces for various applications and comes pre-installed with a Mustang-MPCIE-MX2 AI accelerator card, which includes two Intel Movidius Myriad X VPUs, to provide a flexible AI inference solution.

The palm-sized embedded system can run AI fast, and is suitable for low power consumption applications such as surveillance, retail and transportation. With the advantage of power efficiency and high performance to dedicate deep neural network (DNN) topologies, it can be implemented in an AI edge computing device to reduce total power usage, providing longer duty time for the rechargeable edge computing equipment.

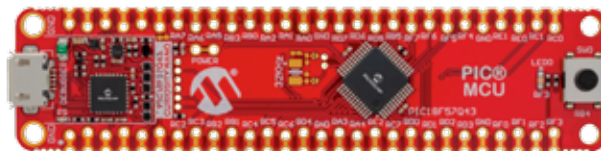
Key features include: Intel Atom x5-E3930 1.3 GHz (up to 1.8 GHz); 2x GbE LAN ports; 2x RS-232/422/485; and 1x M.2 A-key slot for Wi-Fi module.

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## MCU FAMILY

In microcontroller (MCU)-based system design, software is often the bottleneck for both time to market and system performance. By offloading many software tasks to hardware, Microchip's next-generation PIC18-Q43 family is designed to help developers bring higher performing solutions to market faster.



The family's combination of peripherals offers users versatility and simplicity when creating custom hardware-based functions with easy-to-use development tools. Configurable peripherals are smartly interconnected to allow near zero latency sharing of data, logic inputs or analog signals without additional code for improved system response. The family is suitable for a variety of real-time control and connected applications, including home appliances, security systems, motor and industrial control, lighting and Internet of Things (IoT).

Core Independent Peripherals (CIPs) are peripherals that have been designed with additional capabilities to handle a variety of tasks without the need for intervention from the central processing unit (CPU). With CIPs like timers, simplified pulse width modulation (PWM) output, configurable logic cells (CLCs), analog to digital converter with computation (ADCC), multiple serial communications and more, the family is designed to make it easy for developers to customise their specific design configuration.

The CLC provides programmable logic that operates outside the speed limitations of software execution, providing users with the ability to tailor such things as waveform generation, timing measurements and more. CLCs can be the 'glue' logic to connect on-chip peripherals for hardware customisation with ease. Its core-independent communication interfaces, including UART, SPI and I<sup>2</sup>C, offer flexible, easy-to-use building blocks for developers looking to create a customised device, while the addition of multiple DMA channels and interrupt management accelerate real-time control with simplified software loops.



With Microchip's comprehensive development tool suite, users can quickly and easily generate application code and customise combinations of CIPs in a graphical user interface (GUI) environment. The family operates up to 5 V, which increases noise immunity and enables users to interface to a wide range of sensors.

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## INTEGRATED ENCODER FOR FLAT MOTORS

FAULHABER's BXT motor family, comprising brushless DC motors with especially short design, has been expanded with the diameter-complaint IEF3-4096 magnetic encoder. With just 6.2 mm of additional length, the motor/encoder units remain short. In addition, the encoder is fully integrated in the robust motor housing.

With a flat design, the IEF3-4096 offers three channels with index function and a high resolution of up to 4096 lines per revolution. Furthermore, a variant with a line driver is available.

The encoder can be combined with the 2214...BXT H, 3216...BXT H and 4221...BXT H housed BXT motors — a useful combination for precise positioning with high torque in constrained spaces. Typical applications are found in robotics, medical technology, laboratory automation and industrial automation.

The encoder is connected with a ribbon cable; suitable connectors are available.

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## ZVS BUCK-BOOST REGULATOR

Vicor has released its PI3740 ZVS buck-boost regulator with an extended operating temperature range of -55 to +115°C and optional tin-lead BGA packaging for MIL-COTS applications. The product is a high-density and high-efficiency buck boost regulator with an 8–60 V input voltage range and supports output voltages from 10–50 V.

The device offers up to 140 W in a 10 x 14 mm SiP package and higher power delivery can be achieved with additional devices in parallel. The ZVS switching topology also enables efficiency as high as 96%.

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### MIXED-SIGNAL OSCILLOSCOPE

Keysight's MSOX40224 mixed-signal oscilloscope is designed to offer next-generation performance, a 12" touch screen and an intuitive interface to provide results quickly. It is available to rent from TechRentals.

The unit gives users a high probability of capturing random and infrequent events and signal behaviour with its update rate of one million waveforms per second. It is designed to elevate users' debugging experience with MegaZoom IV smart memory technology, which is said to display more waveforms as well as to find the most difficult problems in the design.

The mixed-signal oscilloscope further enables waveform analysis by integrating seven instruments in one: oscilloscope channels, logic channels, digital voltmeter (DVM), dual-channel WaveGen function/arbitrary waveform generator, frequency response analyser (Bode plots), 8-digit hardware counter and serial protocol analyser including USB.

**TechRentals**

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### RACKMOUNT ENCLOSURES WITH SMOOTH TOP

METCASE has launched a version of its COMBIMET 19" rack cases with a wraparound top, designed to offer good aesthetics and easier access to components. Applications for the aluminium enclosure include networking, communications, industrial computers, sound and studio, laboratory instruments and industrial control.

The updated design combines the versatility of COMBIMET with the aesthetics of METCASE's VERSAMET 19" rack cases, with the U-shaped top reducing the number of case parts and removes the need for visible top screws. Other features include ergonomic front handles and earth connection points on all panels.

The solid top COMBIMET 19" is supplied unvented, fully assembled and in a choice of two colours: light grey and black. It is currently available in one height (1U) and two depths: 265 and 365 mm. Custom sizes can also be specified.

Accessories include a PCB mounting kit, PCB/panel fixing screws (M3), 19" mounting kits and mounting plates. Customisation services include bespoke sizes, custom front/rear panels, CNC machining, fixings and inserts, painting and finishing, and digital printing of legends and logos.



Other standard versions of COMBIMET include the original design (vented/unvented top and base; removable top, base and rear panels) in standard sizes 1U to 6U, a super-deep (610 mm) case for server racks (1U to 6U) and an open-top case (2U, 3U).

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## HOW TO OPTIMISE SOLDER STENCIL APERTURE TO INCREASE CONNECTOR OPTIONS

David Decker\*

Designers of high-density electronics systems can now match 0.15 mm co-planarity connectors with 0.10 mm-thick solder stencils through careful aperture design.

As electronic systems increase in component density, designers will typically look to match fine 0.10 mm-thick solder paste stencils on the PC board to equally fine connectors with a co-planarity not in excess of 0.10 mm. However, a connector co-planarity value of 0.15 mm is not uncommon and it gets increasingly difficult to achieve 0.10 mm as the number of connector pins increases and with

formed-pin, right-angle connectors. This has restricted designers' connector options and either forced the use of multiple connectors when a single connector would have been preferred, or the use of stepped stencils. Both options add cost and complexity to the system design and production.

However, a study by Samtec and Phoenix Contact has shown that by optimising the solder stencil aperture, designers can use the more widely available and less expensive 0.15 mm co-planarity connectors with the finer 0.10 mm stencils, while still meeting IPC-J-STD-001 Class 2 criteria for a 100% yield.

This article will discuss the relationship between stencils and connector co-planarity and the trade-offs and restrictions designers face. It will then describe the study, its results and

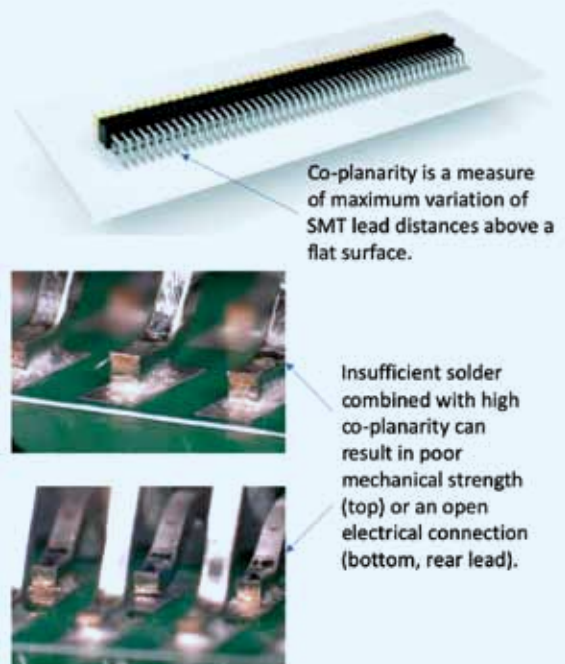
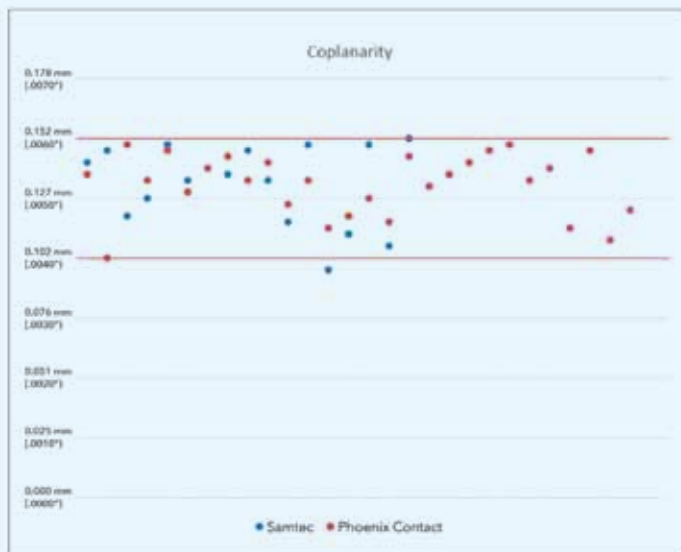


Figure 1a and 1b: Co-planarity measures maximum lead height variation above a flat surface and it is critical to keep that variation to a minimum for SMT device leads to avoid problem joints (lower right). Image source: Samtec.



**GOOD CO-PLANARITY IS CRITICAL FOR GOOD SOLDER JOINTS: IF A PIN OR LEAD IS SITTING TOO HIGH, IT MAY NOT MAKE SUFFICIENT CONTACT WITH THE SOLDER PASTE**

the impact of those results with respect to design optimisation for cost, space, performance and reliability.

## The stencil and connector co-planarity relationship

It's not too difficult to precisely place a fine brick of solder paste using precisely machined stencils. However, it gets increasingly difficult to match the connector to that finely stencilled solder as the number of connector pins increases and where connector pins need to be formed and shaped, such as for right-angle connections. The main issue is the co-planarity of the connector pins.

Roughly speaking, the term 'co-planarity' refers to the maximum distance between the highest and the lowest lead, or pin, when the connector is sitting on a flat surface. It is typically measured using optical gauging equipment (Figure 1a).

Good co-planarity is critical for good solder joints: if a pin or lead is sitting too high, it may not make sufficient contact with the solder paste, resulting in a mechanically weak joint or a completely open electrical connection. Most specifications call for a co-planarity of between 0.10 and 0.15 mm.

With the right process and tools, it's possible to consistently build connectors for most applications with co-planarity of 0.15 mm. However, a co-planarity of 0.10 mm is more difficult to achieve as pin counts increase and especially with advanced

shaping and forming of the connector pins to specific angles, such as dual row, right angle. Maintaining this lower co-planarity can increase connector costs.

With large boards now comprising in excess of 3000 components and smaller, more integrated electronic devices forcing tighter space constraints (and as a result finer pitch components), designers are more frequently considering the use of 0.10 mm-thick stencils. If the stencil is made any thicker, there is a higher risk of solder bridging between leads or pads. However, they are having difficulty finding connectors that meet the 0.10 mm co-planarity specification, with sufficient pin counts and suitable form factors.

Designers do have options, however. They can use a stepped stencil approach, with a thinner stencil for the fine pitch components and a larger stencil for the connector. This solves the problem, but at a higher stencil cost that may not fit applications where there isn't sufficient space between components on either side of the step. The general rule of thumb requires a distance between stepped apertures of 36x the step thickness.

Another option is to use multiple connectors. Fewer pins make it easier for a connector to meet tighter co-planarity specifications. However, more connectors also add cost, as well as layout complexity and reliability issues. In addition, while a connector may meet 0.10 mm co-planarity requirements, a 0.10 mm stencil results in less solder volume, leading to a potentially weaker mechanical joint.

## How to optimise the stencil aperture

To see if these trade-offs can be minimised, Samtec and Phoenix Contact studied the effects of modifying the apertures of the stencil for three connector series. They used a 0.15 mm stencil with 1:1 aperture so the deposited solder was the same size



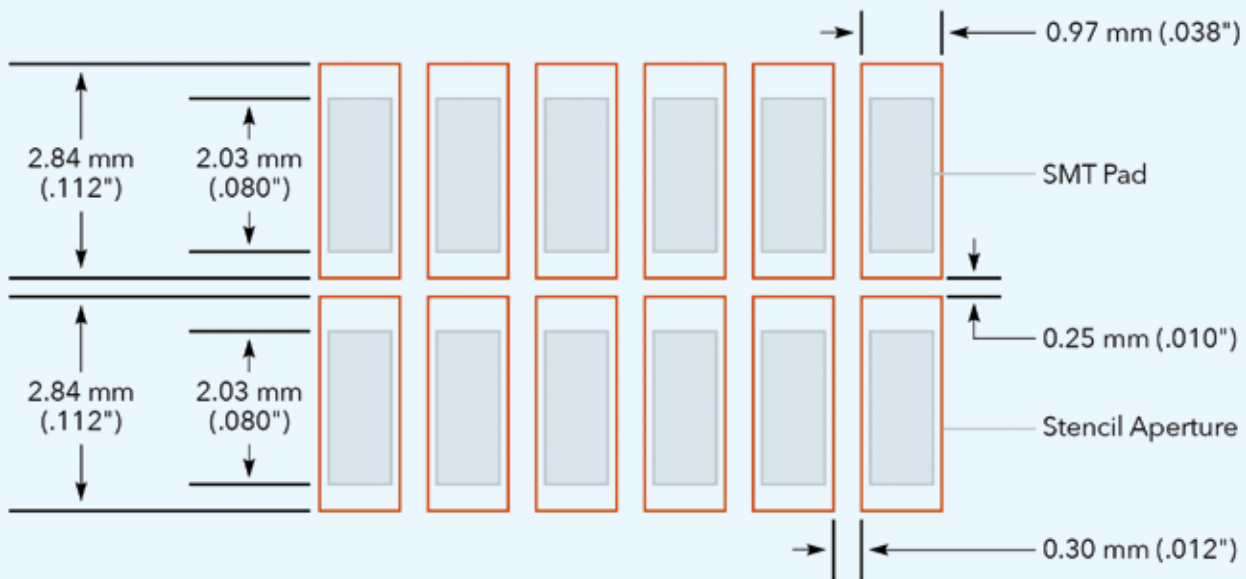


Figure 2: The orange outline shows the optimal aperture dimensions for the FTSH connector. Image source: Samtec.

and shape as the copper pad. They then added two variations of 0.10 mm stencils with enlarged apertures. Connectors were then built and selected for the study based on co-planarity values between 0.10 and 0.15 mm.

The study involved adjusting the aperture size beyond the size of the pad (overprinting) to increase the volume of solder and create a better connection, but not so much that it would cause bridging or leave solder balls on the board surface. To achieve this, the study relied on the tendency of solder to coalesce on the heated pad once it has reached its liquidus temperature during reflow. Still, the right size aperture must be determined for each connector type (Figure 2).

For instance, the optimal aperture to ensure a good solder joint between the sample FTSH connector, with a co-planarity of 0.152 mm, and the 0.10 mm stencil, is 2.84 x 0.97 mm. This results in a high-quality joint that meets IPC-J-STD-001 Class 2 criteria for a 100% yield (Figure 3).

Based on these results, it's clear that designers working with 0.10 mm stencils should give connectors with maximum

co-planarity values of 0.15 mm a second look. If the optimum stencil aperture has been determined to allow the combination, this can open up a whole range of off-the-shelf connector options and avoid restrictive or expensive alternatives. If the optimum aperture is not available online or has not yet been determined, it's important to contact the connector manufacturer early in the design process to either determine the optimum aperture or find a more suitable solution for any given application.

The key is to engage early. The further down the road a design has gone, the more limited the options.

## Conclusion

Knowing the trade-offs yet hearing customers' calls for ever finer stencils and tighter co-planarity, the research and development team at both Samtec and Phoenix Contact came together and found a way to optimise the stencil aperture such that connectors with 0.15 mm co-planarity can be used with 0.10 mm stencils. This result is the best of all worlds: fine 0.10 stencils, more connector options, low cost, low complexity and mechanically strong joints that meet IPC-J-STD-001 Class 2 criteria.



Figure 3: A sample FTSH connector with a co-planarity of 0.152 mm soldered using a 0.10 mm-thick stencil with optimised apertures shows a high-quality joint for both the inner (left) and outer (right) rows. Image source: Samtec.

*\*David Decker earned a Masters of Engineering degree in Mechanical Engineering from the University of Louisville's Speed Scientific School in 1993 and acquired his Professional Engineering licence in 1998. After beginning his career as an injection mould tooling engineer with Lexmark and then General Electric Appliances, David moved on to Samtec where he has worked for 22 years holding positions in new product design, custom product design and as Director of the Interconnect Processing Group for the last 15 years. David is also a Lieutenant in the Reserve Division of the Clark County Sheriff's Office, where he has served for nine years.*

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The laser comes in Osram's robust TO90 package. Compared to the first TO56 generation that included three pins, the TO90 package contains only two pins for contact. Due to the simpler cooling, the generated heat can be easily dissipated from the component. In addition, the integration of the laser into the final lighting solution is less complicated.

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## DATA SENSING GATEWAY

Powered by an Intel Atom E3815 processor and featuring three configurable COM, two LAN (one PoE), eight programmable GPIO, one HDMI and one USB 3.0, the UNO-420 is designed for connecting legacy equipment to new mesh networks. Suitable for harsh industrial environments as well as limited space applications, it has a compact form factor and supports a wide operating temperature range of -20 to 60°C.

Enabling remote infrastructure management, the device supports Wi-Fi, 3G, 4G/LTE and NB-IoT wireless modules that facilitate long-distance data transmissions, over-the-air updates and real-time communication. The UNO-420 is also embedded with a Trusted Platform Module 2.0 that provides security for cloud-based data operations. Unlike standard gateways, the product adopts a PoE-In design that allows the terminal to be powered via a LAN port; this should reduce wiring and minimise maintenance costs.

Featuring Advantech's WISE-PaaS/EdgeLink protocol-conversion software, the UNO-420 supports more than 200 communication protocols, enabling data collection from legacy devices. It allows user-defined data acquisition periods for each input interface, reducing the volume of data transmitted and stored on the cloud. This, combined with the software's plug-and-play functionality, is designed to reduce programming, streamlining application development and deployment.

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## SECURE ELEMENT

Introducing features to secure data exchanges in increasingly aggressive contexts, the STMicroelectronics STSAFE-A110 secure element is designed to protect consumer and industrial connected devices in the Internet of Things (IoT), preventing the counterfeiting of genuine products by strictly assuring their authenticity.

The product offers state-of-the-art certified protection and access to secure loading of cloud credentials to provide mass registration of IoT devices and ensure only authorised devices can access online services. This critical secured personalisation can be performed at a secure ST factory at no extra cost for yearly quantities in excess of 5000 units, simplifying and protecting the manipulation of secret data during IoT devices manufacturing.

The device features an embedded secure operating system and is based on hardware that is certified to Common Criteria Evaluation Assurance Level 5+ (EAL5+). Each unit comes with a unique identification and X.509 certificates that aid secure device connection.

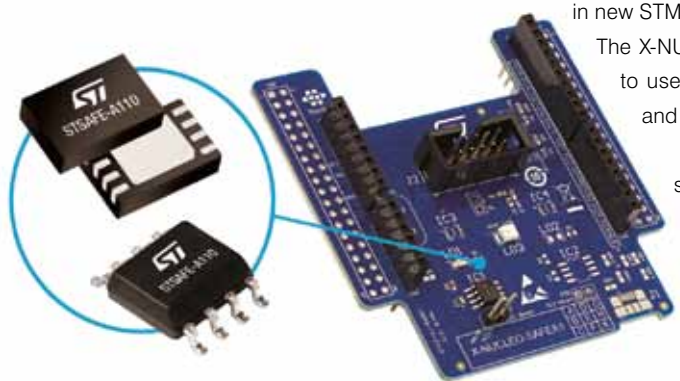
The secure element is integrated with the STM32Cube development ecosystem to be quickly incorporated in new STM32 designs requiring an authentication and secure-connection capability.

The X-NUCLEO-SAFEA1 expansion board jump-starts development and is ready to use with any STM32 Nucleo development board and free X-CUBE-SAFEA1 and X-CUBE-SBSFU software packages.

Typical applications include brand protection for components like consumables, accessories or power-tool batteries, and the authentication of cloud-connected IoT devices such as vending machines, farm implements or environmental sensors.

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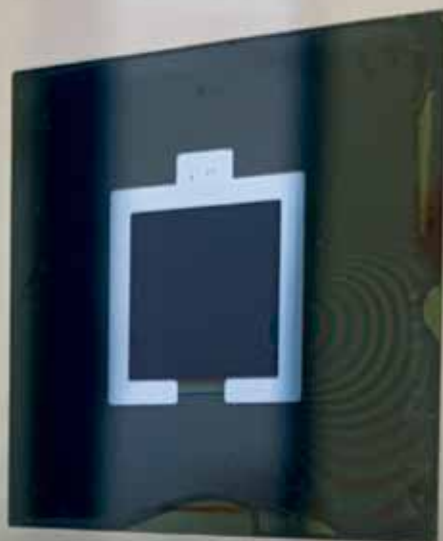
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# TANDEM SOLAR CELL

EFFICIENCY CLOSES IN ON 30%



*The tandem solar cell was realised on a typical laboratory scale of 1 cm<sup>2</sup>. However, scaling up is possible. Image ©Eike Köhnen/HZB.*

German and Lithuanian researchers have developed a solar cell, made of the semiconductors perovskite and silicon, that converts 29.15% of the incident light into electrical energy — believed to be a world record. The material used to produce the solar cell, which self-assembles to form a molecular-thick electrode layer, presents a facile way of realising highly efficient tandem solar cells.

While silicon converts mostly the red portions of sunlight into electricity, perovskite compounds primarily utilise the blue portions of the spectrum. A tandem solar cell made of stacked silicon and perovskite thus achieves significantly higher efficiency than each individual cell on its own.

Helmholtz-Zentrum Berlin's (HZB) Professor Bernd Stannowski and Professor Steve Albrecht have already jointly set records for monolithic tandem solar cells on several occasions. At the end of 2018, they presented a tandem solar cell made of silicon with a metal-halide perovskite that achieved an efficiency of 25.5%. The next record was set by Oxford Photovoltaics, with a value of 28%, but now HZB looks to have reclaimed the record.

"We developed a special electrode contact layer for this cell in collaboration with the group of Professor Vytautas Getautis (Kaunas University of Technology — KTU), and also improved intermediate layers," said Eike Köhnen and Amran Al-Ashouri, doctoral students in Prof Albrecht's group.

The new electrode contact layer permitted improvement of the perovskite compound's composition in the HZB laboratory. This compound is now more stable when illuminated in the tandem solar cell and improves the balance of electrical currents contributed by the top and bottom cells. The silicon bottom cell comes from Prof Stannowski's group and features a special silicon-oxide top layer for optically coupling the top and bottom cells.

KTU's monolayers can also be considered a perfect hole-transporting material, as they are cheap, formed by a scalable technique and form very good contact with perovskite material. The self-assembled monolayers (SAMs) are as thin as 1–2 nm, covering the entire surface; the molecules are deposited on the surface by dipping it into a diluted solution. The molecules are based on carbazole head groups with phosphonic acid anchoring groups and can form SAMs on various oxides.

"Perovskite-based single-junction and tandem solar cells are the future of solar energy, as they are cheaper and potentially much more efficient," said Prof Getautis from KTU. "The limits of efficiency of currently commercially used silicon-based solar elements are saturating. Moreover, existing production capacities of silicon solar cells can be used."

By integrating a SAM-based perovskite solar cell into a tandem architecture, a cell that converts 29.15% of the incident light into electrical energy was produced. This value has been officially certified by the photovoltaic calibration laboratory (Callab) of the Fraunhofer Institute for Solar Energy Systems ISE and now appears in the charts of the US National Renewable Energy Lab (NREL), which has been tracking the rising efficiency levels for nearly all types of solar cell since 1976. Perovskite compounds have only been included in the charts since 2013 — and the efficiency of this class of material has increased more than in any other material since then.

All processes used to realise the 1 cm<sup>2</sup> solar cell are also suitable in principle for large surface areas, with initial tests having shown how vacuum deposition could assist in scale-up. And while 1 g of silicon would produce only a couple of square centimetres of the solar element using traditional technologies, 1 g of the material synthesised at KTU is enough to cover up to 1000 m<sup>2</sup> of the surface. In addition, the self-assembling organic material is significantly cheaper than the alternatives used in photovoltaic elements currently.

The KTU material, called 2PACz and MeO-2PACz, will soon appear in the market, meaning it can be further researched in laboratories around the world and eventually find its way into industry. Meanwhile, the HZB team will continue in its efforts to break the 30% efficiency barrier, which they believe is well within reach. The realistic practical efficiency limit for tandem cells made of silicon and perovskite is about 35%.





## HANDHELD ENCLOSURES

Hammond Electronics has launched its 1552 family of handheld enclosures. Initially available in six sizes, the IP54-rated UL94-V0 flame-retardant ABS enclosure features an ergonomic design that fits comfortably into the hand, enabling it to be used for long periods in applications such as a machine controller or an electric hoist control.

The end panels are removable for easy modification; for use with flying cables, an alternative end panel with an integral rubberised cord protector

and a strain relief bracket is available. An optional wall-mounted holder allows the unit to be stored in a convenient location when not in use. The product can also be used as a desktop enclosure.

All the launch sizes are 50 mm wide and either 22 or 30 mm high, with both heights available in lengths of 70, 110 and 150 mm. All sizes are available in black and grey with a satin texture. A recess for a membrane keyboard or a display is moulded in the top face and PCB standoffs are moulded in the base section. The top is secured to the base with four self-tapping colour-coded screws; snap closures are fitted to the centre of the longer units to prevent bowing.

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### Contact Information

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# 7 INDUSTRY 4.0 TRENDS

## FOR 2020



Industry 4.0 is making manufacturing more productive and profitable than ever before. Jos Martin, Senior Engineering Manager at mathematical computing software provider MathWorks, reveals seven major trends he expects to see in 2020 to help professionals foresee the technologies that will define the next decade — and where the factory of the future is headed.

**T**here will of course be challenges along the way, such as meeting increasing demand for personalised and customised goods, reducing waste and handling resources more responsibly, but with creativity and ingenuity, these can be tackled, and the benefits can be realised. So, what is on the horizon?

### 1. Standardised protocols for seamless interoperability of connected machines

It will be important to ensure interconnectivity, with machines and modules being dynamically rearranged in the factory. Standardised protocols like OPC UA TSN will play a key role in ensuring that equipment from different vendors interoperates seamlessly. Cumbersome cabling and cable runs will disappear and be replaced with wireless protocols like 5G and its successors. But machines will not only be connected with each other, but also to cloud systems where elastic calculation power is available for running powerful algorithms on business and engineering data.

### 2. Reinforcement learning goes next level

Artificial intelligence (AI) programs trained with reinforcement learning (RL) are beating human players in board games like Go and chess, but they're doing so much more for Industry 4.0. RL is helping engineers implement controllers and decision-making algorithms for complex systems such as robots and autonomous systems, automated driving, 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. RL could power breakthroughs in more autonomous, even driverless, operation of mobile plant equipment within an industrial setting.

### 3. Collaborative robots work hand in hand with humans

The automation industry has been discussing the vision of 'sample size one' for some time — how production lines can produce one of a kind, without running into long changeover times or other inefficiencies. With Industry 4.0, this vision must eventually come true to meet the requirement of full individualisation in production. To meet this, machines cannot be set up in a fixed, inflexible manner on the shop floor, where they are commissioned, parameterised and tuned for one specific product that is produced over and over again for months or even years. Tomorrow's production lines must be flexible — built from multiple mechatronic modules that can easily be rearranged, with more and more robots or 'cobots' (collaborative robots working hand in hand with human workers), and AI that parameterises and tunes the machines according to the next — individualised — item that is manufactured on the line.

### 4. Simulation makes virtual commissioning a reality

As software complexity and the number of possible combinations of modularised software components grows, performing comprehensive tests on the physical machine gets harder and more time-consuming, and will eventually become impossible. Given this, it will be vitally important to perform virtual commissioning of the software to





verify the absence of errors and to validate if requirements are met, based on simulation models, before the physical production line is even in place. Innovation leaders like Krones, a leading manufacturer of bottle filling lines worldwide, are already using multi-domain simulation models for virtual commissioning today.

### 5. Predictive maintenance and AI evolve with edge computing

As edge computing devices and industrial controllers develop, they are offering a rapidly growing calculation power. In conjunction with the use of cloud systems, they are paving the way for a new dimension of production system software functionality. AI algorithms will dynamically optimise the throughput of the entire production line, while minimising the consumption of energy and other resources. This will help teams and their organisations not only minimise waste, and deliver on corporate social responsibility policies, but also crucially save money. Predictive maintenance will evolve and consider data not only from one machine or site, but across multiple factories and across equipment from different vendors. Depending on the requirements, the algorithms will be deployed on non-real-time platforms, as well as on real-time systems like PLCs, as Beckhoff recently demonstrated at Hanover Messe in Germany.

### 6. Higher quality data removes some hurdles for AI deployment

We know training accurate AI models requires lots of data, and analyst surveys do name data quality as a top barrier to successful adoption of AI. In 2020, simulation will help lower this barrier.

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.

### 7. Not only data scientists will rule the roost

Out of all the trends, the biggest will be on the human beings working in the factory of the future. By capitalising on technology and tools, more engineers and scientists, not just data scientists, will work on AI. The factory of the future requires engineers who can build models, dealing with large datasets and handling the respective development tools in order to address the above trends. Therefore, companies building and operating industrial equipment need to change their job postings and hire skilled engineers with a completely different profile to be ready for a future in which Industry 4.0 is merely the beginning.

From collaborative robots working hand in hand with humans to simulation making virtual commissioning a reality, there are a whole host of trends we will see in 2020 define the factory of the future. Adapting to these changes won't be easy, but with teamwork and the right tools it is achievable.

MathWorks Australia  
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## LoRA SYSTEM-ON-CHIP

Powering the search for sustainability through smart infrastructure and logistics, smart industry and smart living, STMicroelectronics has released the STM32WLE5 LoRa system-on-chip (SoC) for connecting smart devices to the Internet of Things (IoT) using long-distance wireless connections.

The SoC lets product developers create devices such as remote environmental sensors, meters, trackers and process controllers that help efficiently manage energy and resources. It combines ST's skills in ultralow-power STM32 microcontroller design with a LoRa-compliant radio in one single-die and easy-to-use device.

In addition to the embedded LoRa modulation, the product is also capable of (G)FSK, (G)MSK and BPSK modulation, thus allowing various alternative protocols. Moreover, high RF performance with low power consumption is designed to ensure ongoing wireless connectivity and extend the runtime of battery-powered devices.

By leveraging the STM32 MCU architecture, developers can easily introduce wireless connectivity in existing embedded designs by porting to the STM32WLE5. ST's LoRaWAN software for wireless network communications has passed all regional certifications for use worldwide.

The product is available in a 5 x 5 mm UFBGA73 package. It is fully integrated into the STM32 ecosystem, including STM32Cube software support, as well as a LoRaWAN stack certified for all regions and available in source-code format.



**STMicroelectronics Pty Ltd**  
[www.st.com](http://www.st.com)



## POWER SUPPLY FOR STATIC ELIMINATORS

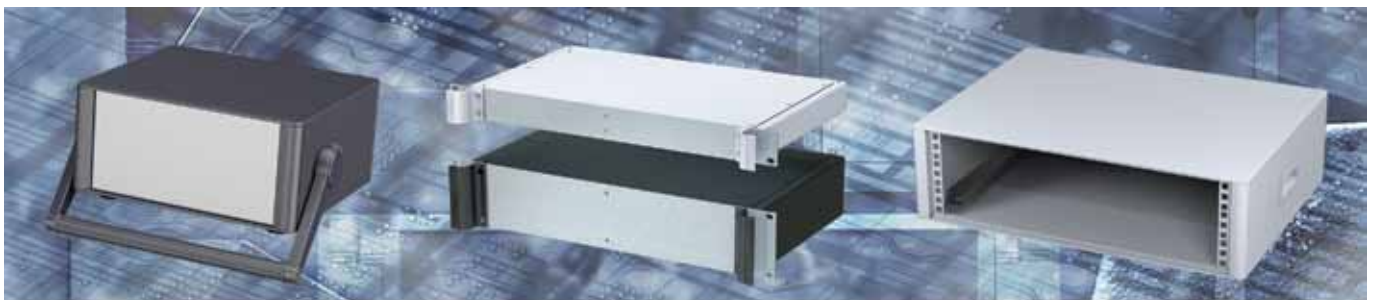
EXAIR's Gen4 Two Outlet Selectable Voltage Power Supply allows users to choose input voltages of 115 or 230 VAC. Two 5 kV stainless steel output connectors can energise two static eliminators. Applications using up to two Gen4 Super Ion Air Knives, Ion Air Guns, Ion Air Cannons, Ionizing Bars or any other EXAIR Gen4 Static Eliminator product can be connected to one power supply.

The two outlet power supplies are UL component recognised as well as CE and RoHS compliant. They also feature an electromagnetically shielded modular power supply cable, which eases routing and connections.

The power supply is housed in a durable metal enclosure (140 x 102 x 26 mm) that is suitable for rugged, industrial environments. An integrated fuse on the primary protects against voltage spikes. The lighted power switch indicates operation and is field replaceable.

Gen4 Static Eliminators have a bayonet-style connector that can be inserted into the power supply where the electrical connection is made deep inside to prevent a shock hazard. Static eliminator products for the power supply are all shockless and have armoured high-voltage cables, which resist abrasion and cuts.

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# COMTEST LABORATORIES PTY LTD AND TÜV SÜD: A NEW PARTNERSHIP

Recently Comtest Laboratories Pty Ltd, based in South Melbourne, Australia, and TÜV SÜD China signed an agreement strengthening cooperation within the fields of testing, inspection & products certification. The TÜV SÜD & Comtest Laboratories collaboration streamlines these processes.

German giant TÜV SÜD, with its collection of more than 1000 laboratories worldwide, offers Australian, New Zealand and international clients a seamless customer experience, no matter which country or region the products are intended for.

Expanding your product sales overseas can be time-consuming and legally confusing. In each region of the world, compliance standards constantly change, certification can be a lengthy and costly process unless you know the correct path to follow.

For South Melbourne firm Comtest Laboratories, the partnership means any client can have their product tested or assessed to Australian standards or be tested by one of TÜV SÜD's laboratories for almost any standard in the world.

Services that can be accessed include, but are not limited to: testing, inspection, auditing and certification for electrical and electronics, telecommunications, hardline and soft-line products.

Comtest Laboratories is an accredited NATA laboratory. The National Association of Testing Authorities (NATA) provides accreditations to laboratories that meet high standards of testing, which allow greater confidence that products have been tested accurately.

## Getting your product tested



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## TEACHING TOMORROW'S VEHICLES TO 'HEAR'

Modern cars already feature a range of sophisticated systems, but the self-driving cars of the future will also have auditory capabilities.

**T**oday's cars are equipped with a host of advanced driver-assistance systems designed to reduce the burden behind the wheel, with features such as automatic parking and blind-spot monitoring employing cameras, radar and lidar to detect obstacles in the immediate vicinity of the vehicle. In other words, they provide vehicles with a rudimentary sense of sight.

In the future, systems that can capture and identify external noises are set to play a key role — along with smart radar and camera sensors — in putting self-driving cars on the road. Researchers at the Fraunhofer Institute for Digital Media Technology IDMT are now developing AI-based systems that can recognise individual acoustic events such as sirens. These will give vehicles auditory capability — that is, it will endow them with a sense of hearing.

"Despite the huge potential of such applications, no autonomous vehicle has yet been equipped with a system capable of perceiving external noises," said Danilo Hollosi, Head of the Acoustic Event Recognition group at Fraunhofer IDMT. "Such systems would be able to immediately recognise the siren of an approaching emergency vehicle, for example, so that the autonomous vehicle would then know to move over to one side of the highway and form an access lane for the rescue services."

There are numerous other scenarios in which an acoustic early-warning system can play a vital role — when an autonomous vehicle is turning into a pedestrian area or residential road where children are playing, for example, or for recognising defects or dangerous situations such as a nail in a tyre. In addition, such systems could also be used to monitor the condition of the vehicle or even double as an emergency telephone equipped with voice-recognition technology.

### Noise analysis with AI-based algorithms

Developing a vehicle with auditory capability poses a number of challenges. Here, however, Fraunhofer IDMT can call on specific project experience in the field of automotive engineering as well as a wealth of interdisciplinary expertise. Key areas of investigation include signal capture on the basis of optimal sensor positioning as well as signal preprocessing, signal enhancement and the suppression of background noise.

The system is first trained to recognise the acoustic signature of each relevant sound event. This is done by machine-learning methods that use acoustic libraries compiled by Fraunhofer IDMT. In addition, Fraunhofer IDMT has written its own beamforming algorithms. These enable the system to dynamically locate moving sound sources such as the siren on an approaching emergency vehicle. The result is an intelligent sensor platform that is able to recognise specific sounds.

*A modified roof fin for testing acoustic sensors for the capture of external noise.  
Image ©Fraunhofer IDMT/Hannes Kalter.*







## ACOUSTIC SENSORS

Fraunhofer has also written its own AI-based algorithms. These are used to distinguish the specific noise that the system is designed to identify from other background noises.

"We use machine learning," Hollosi explained. "And to train the algorithms, we use a whole range of archived noises." Fraunhofer and partners from industry have already created initial prototypes, which should be reaching market maturity by the middle of the coming decade.

The acoustic sensor system comprises microphones, a control unit and software. The microphones, installed in a protective casing, are mounted on the outside of the vehicle, where they capture airborne noise. Sensors transmit these audio data to a special control unit that then converts them into the relevant metadata. In many other areas of use — such as security applications, the care industry and consumer products — the raw audio data are directly converted to metadata by smart sensors.

Modified versions of this computer-based process for identifying acoustic events can be used in other sectors and markets. Such applications include quality control in industrial manufacturing. In this case, smart battery-powered acoustic sensors are used to process audio signals from plant and machinery. This information is sent wirelessly to a processor. On this basis, it is possible to determine the condition of the production plant and pre-empt any imminent damage. Other applications include automatic voice-recognition systems to enable hands-free documentation by technicians conducting, for example, turbine maintenance.

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### THREE-PHASE AC CURRENT METER

Monnit has introduced the ALTA Industrial Wireless Three Phase AC Current Meter (500 Amp), which measures the RMS current of an alternating current AC system by using three current transformers that wrap around the wires of a three-phase power system.

The wireless sensor reports minimum RMS current, maximum RMS current, average RMS current and duty cycle for each phase, plus the combined amp hours of all three phases. The iMonnit system is capable of generating watt-hour or kilowatt-hour readings based on user-specified RMS voltage. This makes it suitable for applications such as current monitoring, current usage, amperage monitoring, amp hour meter, watt-hour meter and kilowatt-hour meter.

To measure the current, clip the CT around a single wire of a powered system. Once the sensor has powered on and is connected to the gateway it will begin taking measurements. These measurements are based on the averaging interval (5 s default). The sensor reports data to iMonnit.

The current transducer measures current without making physical contact with the wire itself. This combined with the hinged clamping feature of the CT means no rewiring is needed. In a scenario where the user may have to open the outer sheath of multipair wire in order to access a single wire, there would be no need to open the jacket around any inner wires.

**Metromatics Pty Ltd**

[www.metromatics.com.au](http://www.metromatics.com.au)



### DESIGN SOFTWARE FOR VISION SYSTEMS

MathWorks has announced that with the availability of Release 2019b of the MATLAB and Simulink product families, Vision HDL Toolbox includes native multipixel streaming support to process high-frame-rate (HFR) and high-resolution videos on FPGAs. Video, image processing and FPGA design engineers can speed the exploration and simulation of behaviour and implementation trade-offs when processing 4k or 8k video and videos with resolutions of 240 fps or higher.

Engineers designing FPGAs for real-time processing of high-resolution and HFR video in applications such as industrial inspection, medical imaging and intelligence, surveillance and reconnaissance (ISR) are challenged to meet throughput, resource usage and power consumption targets. The toolbox offers blocks that can process four or eight pixels in parallel, with the underlying hardware implementation automatically updated to support simulation and code generation with the specified parallelism.

This capability helps hardware engineers collaborate with image and video processing engineers to explore and simulate vision processing hardware behaviour at a high level of abstraction. By adding HDL Coder to this design workflow, engineers can generate synthesisable, optimised target-independent VHDL or Verilog code directly from their verified high-level models.

The product provides pixel-streaming algorithms for the design and implementation of vision systems on FPGA, ASIC and SoC devices. It provides a design framework that supports a diverse set of interface types, frame sizes and frame rates. The video and image processing algorithms in the toolbox model hardware implementations include latency, control signals and line buffers. The algorithms are designed to generate readable, synthesisable code in VHDL and Verilog (with HDL Coder). The generated HDL code is FPGA-proven for frame sizes up to 8k resolution and for HFR video.

**MathWorks Australia**  
[au.mathworks.com](http://au.mathworks.com)

### WIRELESS SENSOR KIT

The TI LaunchPad SensorTag kit offers integrated environmental and motion sensors, multiband wireless connectivity and easy-to-use software to help users prototype their next connected application. The fully enclosed and battery-operated kit is useful for quickly evaluating a

complete sensor network and stress testing the various protocol stacks available in TI's SimpleLink MCU platform.

The kit allows users to: implement a wide array of environmental sensors in a network; create flexible sensor networks featuring 100+ nodes; design with multiple connectivity options (Bluetooth, Sub-1 GHz, Thread, Zigbee and more) enabled by the SimpleLink

CC1352R wireless MCU; and build custom nodes by adding sensors, displays and more through the TI BoosterPack ecosystem.

**Texas Instruments Australia Ltd**

[www.ti.com](http://www.ti.com)







## MULTIMONITOR GRAPHICS CARDS

The Matrox D-Series of next-generation, multidisplay graphics cards have been designed to power video walls in commercial and critical 24/7 environments. The single-slot graphics cards drive up to four 4Kp60 displays and can be easily combined to output up to 16 x 4K monitors for high-density video walls in control rooms, enterprises, industries, government, military, pro AV, digital signage, security and more.

Leveraging a custom-built NVIDIA Quadro embedded GPU, the series delivers smooth video playback and graphics performance on up to four high-resolution HDMI or DisplayPort displays. OEMs, system integrators and AV installers can also combine up to four cards via board-to-board framelock cables, to drive up to 16 synchronised 4K displays. In addition, the series offers HDCP support for playback of protected audio and video content, as well as Microsoft DirectX 12, OpenGL 4.5 and OpenCL 1.2 support to run the latest professional applications.

The series works seamlessly with Matrox's complete video wall portfolio. It can be paired with Matrox Mura IPX capture and IP encode/decode cards for multichannel 4K and Full HD capture, streaming and recording support, and/or combined with Matrox QuadHead2Go multimonitor controllers to power up to 64 1920x1080p60 displays from one system.

The series includes the robust Matrox PowerDesk desktop management software. Users can select from a variety of tools — including stretched or independent desktops, clone mode, pivot, bezel management, edge overlap and more — to easily configure and customise multidisplay set-ups. Additionally, the feature-rich Matrox MuraControl video wall management software provides users with an intuitive platform to manage video wall sources and layouts either locally or remotely, and in real time.

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# CREATING CUSTOM- COLOURED LIGHT

## WITH 2D SEMICONDUCTORS

Swiss and UK researchers have discovered structures based on two-dimensional materials that emit tailor-made light in any colour you could wish for.

Finding new semiconductor materials that emit light is essential for developing a wide range of electronic devices. But making artificial structures that emit light tailored to our specific needs is an even more attractive proposition. However, light emission in a semiconductor only occurs when certain conditions are met.

Researchers from the University of Geneva (UNIGE), in collaboration with The University of Manchester, have now discovered an entire class of 2D materials that are the thickness of one or a few atoms. When combined together, these atomically thin crystals are capable of forming structures that emit customisable light in the desired colour. Their research has been published in the journal *Nature Materials*.

Semiconductor materials capable of emitting light are used in sectors as diverse as telecommunications, light-emitting devices (LEDs) and medical diagnostics. Light emission occurs when an electron jumps inside the semiconductor from a higher energy level to a lower level. It is the difference in energy that determines the colour of the emitted light. For light to be produced, the velocity of the electron before and after the jump must be exactly the same, a condition that depends on the specific semiconducting material considered. Only some semiconductors can be used for light emission: for example, silicon — used to make computers — cannot be employed for manufacturing LEDs.

"We asked ourselves whether two-dimensional materials could be used to make structures that emit light with the desired colour," said Professor Alberto Morpurgo from UNIGE.

2D materials are perfect crystals which, like graphene, are one or a few atoms thick. Thanks to recent technical advances, different 2D materials can be stacked on top of each other to form artificial structures that behave like semiconductors. The advantage of these 'artificial semiconductors' is that the energy levels can be controlled by selecting the chemical composition and thickness of the materials that make up the structure.

"Artificial semiconductors of this kind were made for the first time only two or three years ago," said Nicolas Ubrig, a researcher in the team led by Prof Morpurgo. "When the two-dimensional materials have exactly the same structure and their crystals are perfectly aligned, this type of artificial semiconductor can emit light. But it's very rare."

These conditions are so strict that they leave little freedom to control the light emitted. As explained by Prof Morpurgo, "Our objective was to manage to combine different two-dimensional materials to emit light while being free from all constraints."

The physicists thought that, if they could find a class of materials where the velocity of the electrons before and after the change in energy level was zero, it would be an ideal scenario which would always meet the conditions for light emission, regardless of the details of the crystal lattices and their relative orientation. A large number of known 2D semiconductors have a zero-electron velocity in the relevant energy levels. Thanks to this diversity of compounds, many different materials can be combined, and each combination is a new artificial semiconductor emitting light of a specific colour.

"Once we had the idea, it was easy to find the materials to use to implement it," said Professor Vladimir Fal'ko from The University of Manchester. Materials that were used in the research included various transition metal dichalcogenides (such as  $\text{MoS}_2$ ,  $\text{MoSe}_2$  and  $\text{WS}_2$ ) and  $\text{InSe}$ ; other possible materials have been identified and will be useful for widening the range of colours of the light emitted by these new artificial semiconductors.

"The great advantage of these 2D materials, thanks to the fact that there are no more preconditions for the emission of light, is that they provide new strategies for manipulating the light as we see fit, with the energy and colour that we want to have," Ubrig said. This means it is possible to devise future applications on an industrial level, since the emitted light is robust and there is no longer any need to worry about the alignment of atoms.



## UNINTERRUPTIBLE POWER SUPPLY

The Delta Amplon RT 1–20 kVA UPS range is a power solution for mission-critical ICT environments. It offers operations- and energy-saving features such as a high output power factor of 0.9, said to provide more real power to critical loads.

It also features an operation temperature tolerance up to 50°C; up to 94% AC-AC efficiency and 97% efficiency in ECO mode; and intelligent battery management to sustain battery life and performance.

According to the company, this model has a much smaller footprint than other models, which can save up to 67% of space, and has good local communications through a rotatable LCD display.

The UPS range also offers optional Li-ion battery technology allowing hot-swappable battery strings, replaceable from the front of the rack and enabling continuous operation. This feature addresses critical issues such as maintenance costs, space, manageability and total cost of ownership.

**Delta Electronics Industrial Automation**  
[www.deltaww.com/ia](http://www.deltaww.com/ia)



## MAGNETIC SINGLE-TURN ABSOLUTE ENCODER

The AES-4096 L magnetic single-turn absolute encoder supplies a unique angular value within a motor revolution for each shaft position, with a resolution of 4096 steps. The position is available immediately after power on. It is equipped with a line driver to eliminate interference during signal transmission. This permits the motor/encoder unit to be positioned up to 5 m away from the controller.

The encoder can be combined with brushless DC-motors of the B, BX4, BP4 and BXT series. It transfers the signals using the BiSS-C protocol via an SSI interface. The BiSS protocol is designed for industrial applications in which high transmission speed, flexibility and minimum implementation effort are required.

The AES-4096 L encoder can be used for both speed and motion control. In addition, sine commutation of the motor is possible, providing efficient operation with minimal torque ripple. Digital Hall sensors for commutation of the motors are generally no longer needed.

The encoder is connected with a flat ribbon cable; suitable connectors are optionally available.

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# NEXT GENERATION SMART SERIES PICK & PLACE MACHINE

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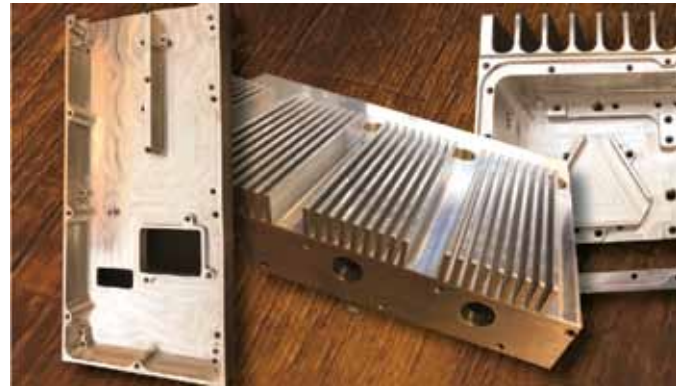
## DIGITAL SIGNAGE PLAYER

Advantech's fanless DS-082 4K digital signage player is powered by AMD Ryzen V1000/R1000 processors and integrated with AMD VEGA graphics. It simultaneously drives multiple UHD (4K)/FHD (1080 P) displays via HDMI, delivering seamless content flows across digital menu boards, self-ordering systems, retail applications, queuing systems and multimedia kiosks.

To simplify digital signage network management, the DS-082 is integrated with both WISE-PaaS/SignageCMS multimedia content management software and WISE-PaaS/DeviceOn remote device management software. WISE-PaaS/SignageCMS allows users to easily edit content layout, schedule and dispatch programs. An up-to-date scheduling function is also available to allow real-time information and advertising campaign management. WISE-PaaS/DeviceOn software is designed to monitor signage devices in real time, make maintenance easier and reduce the need for on-site support. Moreover, WISE-PaaS/DeviceOn provides a McAfee whitelist security function to ensure on-screen content is secured while Acronis tools recover essential data and create backups.

Suitable for space-limited applications with an ultraslim profile of 19 mm, the digital signage player facilitates easy installation behind the displays. For secure installation, the device features a bracket that supports wall mount, VESA and DIN-rail mounting for various application requirements.

**Advantech Australia Pty Ltd**  
[www.advantech.net.au](http://www.advantech.net.au)



## BRUSHLESS DC FLAT MOTORS

maxon's brushless DC flat motors are now available in combinations with planetary gearboxes, encoders and vented rotors for increased torque. The 90 mm-diameter ventilated motors offer power level increases from 160 to 600 W within the same diameter.

Two length options of 27.4 and 39.9 mm are selectable with two air cooling options. Four winding options are available for DC voltages varying from 12 to 60 VDC. Continuous torque capability is up to 1610 mNm from the motor alone; when combined with planetary, worm and helical gearhead options, repeated peak torque levels of 650 Nm have been achieved.

High ratios and 25600 qc integrated internal encoders make the motors useful for rotary joint applications such as robotics and industrial machinery actuators. The company can also manufacture custom versions with specific cable looms and rear shafts for mounting loads on both sides of the motor. The combination of the flat motors with high-stiffness, low-profile, zero-backlash and trochoidal-style gearheads also makes the complete drive suitable for wheel drive applications such as autonomous ground vehicles and warehouse logistic machinery.

**maxon motor Australia Pty Ltd**  
[www.maxonmotor.com.au](http://www.maxonmotor.com.au)



## PYROELECTRIC PROXIMITY SENSOR

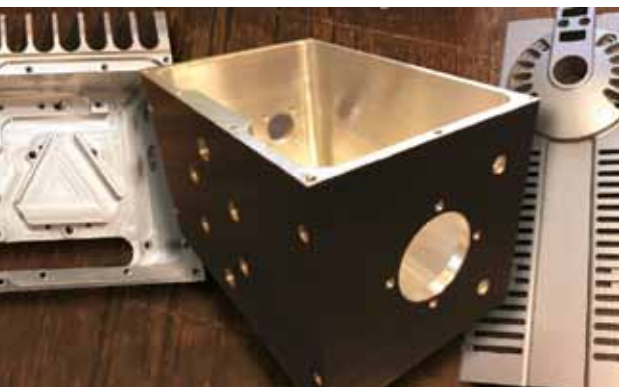
The PIR Click board, from Mikroe, is a pyroelectric sensor supporting human presence detection. The product is equipped with an onboard PL-N823-01 pyroelectric proximity infrared (PIR) sensor from KEMET Electronics, which enables human detection through glass or resin. The high-performance sensor is suitable for a range of consumer electronics and Internet of Things applications, such as office automation, contactless switching, lighting, air conditioners and more.

The device generates voltage when exposed to infrared radiation from human bodies. The low-power sensor is passively triggered by moving subjects, enabling it to deliver energy-saving performance in applications relying on human presence detection. The product includes a white plastic Fresnel lens that filters visible light, allowing the sensor to detect the infrared signature emitted by humans. The onboard PIR sensor features KEMET's piezoelectric ceramic material and element structure, said to result in greater freedom of design for products using resin or glass.

The product is part of the Mikroe Click board ecosystem, a modular design that enables developers to connect any Click board to a standardised mikroBUS socket with no hardware configuration required. The versatile mikroBUS standard socket contains all necessary pins to connect Mikroe's complete range of Click boards, including wireless communication modules, sensor modules and other accessories.

**Mouser Electronics**  
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## CNC MACHINING SERVICE

M&S CNC Machining can produce a vast array of high-quality enclosures, isolators and mounts for the electronics, data transfer and telecommunications fields.

Material used is normally aluminium plated due to its good heat transfer qualities, with the grade selected based on part complexity and customer outcome. Solid parts with integral heat sinks and PCB mounting surfaces can be machined to suit an application or multiple part designs produced to customer demand.

Surface finishes are offered in basic clear ROHS corrosion protection or a variety of coloured powder coatings, as well as colour combinations using an anodising process. Colours are typically utilised for branding, cosmetic value or product identification of a certain area or feature and can be masked to produce a two-tone effect for the purpose.

Another variation of custom machining in this area is the production of special purpose machine facias, usually with some type of 3D design aspect on the visible front, with electronics hardware mounted on the rear.

Windows for LEDs, switches, etc. can be machined to customer specification with cosmetic model updates easily accommodated. M&S CNC can also engrave or laser mark company logos, part/ID numbers or sequentially mark for traceability.

**M&S CNC Machining Pty Ltd**  
[www.mandscnc.com.au/](http://www.mandscnc.com.au/)

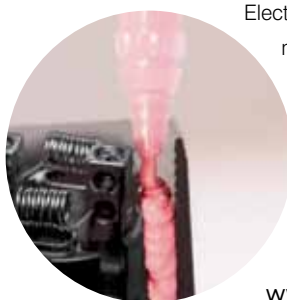
## THERMAL GAP FILLERS

Electrolube's latest thermal gap fillers provide an effective heat transfer solution for many different applications. The GF300 and GF400 thermal interface materials are two-part, liquid silicone-based fillers that provide thermal performance of 3 W/mK (GF300) and 4 W/mK (GF400). Both products reduce the risk of air pockets forming by effectively filling the entire heatsink, making them suitable for applications where the gap is non-uniform such as between multiple components and a collective heatsink/case.

Using a simple 1:1 mix ratio in either 50 or 400 mL cartridges, for hand or machine application, the fillers are applied in a soft flexible 'putty' that can be easily moulded around different shaped housings with low stress on components. Following application, the gap fillers can be cured at room temperature or accelerated with heat. They provide a wide operating temperature range between -50 and +200°C and have low viscosity to enable easy dispensing. After curing, the products form a low modulus elastomer, preventing the pump-out phenomenon of the thermal interface layer from the bond line and ensuring minimal degradation of heat dissipation. Both gap fillers are UL approved with the UL94 V-0 flame retardancy rating and RoHS compliant.

Thermal gap fillers are typically used in touch screen and mobile applications, but the GF300 and GF400 are versatile enough for more diverse applications. Areas of use include consumer electronics, printed circuit board assembly, housing electronic components discretely, telecoms applications such as data centre servers and fibre-optic equipment, lighting and LEDs applications, power electronics, and ECUs and HEV/ NEV batteries in automotive electronics. More recently,

Electrolube has seen demand surge for engine and transmission control modules, memory modules for PCs and laptops, power conversion equipment for applications such as chargers, power grid, solar panels and wind turbines, semiconductors, microprocessors/graphic processors, and MOFSET arrays with common heat sinks, such as field effect transistors.



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# NANO ANTENNAS

## ENABLE DATA TRANSFER

Physicists from the University of Würzburg have successfully converted electrical signals into photons and radiated them in specific directions using a low-footprint optical antenna that is only 800 nm in size. Their work, claimed to be a world first, has been published in the journal *Nature Communications*.

**D**irectional antennas convert electrical signals to radio waves and emit them in a particular direction, allowing increased performance and reduced interference. This principle, which is useful in radio wave technology, could also be interesting for miniaturised light sources. After all, almost all internet-based communication utilises optical light communication. Directional antennas for light could be used to exchange data between different processor cores with little loss and at the speed of light. To enable antennas to operate with the very short wavelengths of visible light, such directional antennas have to be shrunk to nanometre scale.

The Würzburg physicists have now described for the first time how to generate directed infrared light using an electrically driven Yagi-Uda antenna made of gold, developed by the nano-optics working group of Professor Bert Hecht. But what does a Yagi-Uda antenna for light look like?

"Basically, it works in the same way as its big brothers for radio waves," said Dr René Kullock, a member of the nano-optics team. An AC voltage is applied that causes electrons in the metal to

vibrate and the antennas radiate electromagnetic waves as a result.

"In the case of a Yagi-Uda antenna, however, this does not occur evenly in all directions but through the selective superposition of the radiated waves using special elements, the so-called reflectors and directors," Dr Kullock said. "This results in constructive interference in one direction and destructive interference in all other directions." Accordingly, such an antenna would only be able to receive light coming from the same direction when operated as a receiver.

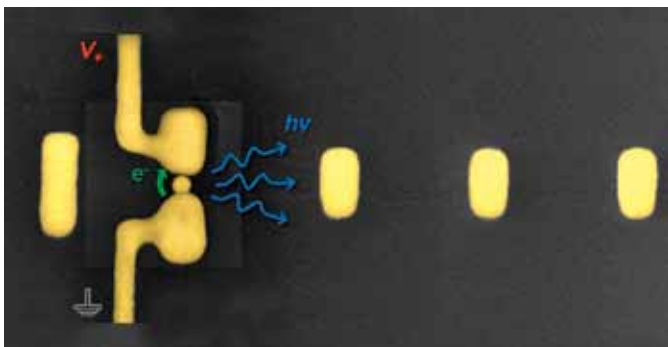
Some time ago, the Würzburg physicists were able to demonstrate that the principle of an electrically driven light antenna works. But in order to make a relatively complex Yagi-Uda antenna, they had to come up with some new ideas. In the end, they succeeded thanks to a sophisticated production technique.

"We bombarded gold with gallium ions, which enabled us to cut out the antenna shape with all reflectors and directors as well as the necessary connecting wires from high-purity gold crystals with great precision," Prof Hecht said.

Next, the physicists positioned a gold nanoparticle in the active element so that it touches one wire of the active element while keeping a distance of only 1 nm to the other wire. Dr Kullock said, "This gap is so narrow that electrons can cross it when voltage is applied using a process known as quantum tunnelling." This charge motion generates vibrations with optical frequencies in the antenna, which are emitted in a specific direction thanks to the special arrangement of the reflectors and directors.

The Würzburg researchers are fascinated by the unusual property of their novel antenna that radiates light in a particular direction although it is very small. As in their larger counterparts, the radio wave antennas, the directional accuracy of light emission of the new optical antenna is determined by the number of antenna elements.

"This has allowed us to build the world's smallest electrically powered light source to date which is capable of emitting light in a specific direction," Prof Hecht said, though much work still needs to be done before the new invention is ready to be used in practice.



The electrically powered Yagi-Uda antenna was built at the University of Würzburg's Department of Physics. Image credit: Department of Physics.



## HORIZONTAL MALE CONNECTORS

Harwin has extended its Gecko-SL (Screw-Lok) product range to include horizontal male connectors. The range is particularly suitable for engineers, offering a compact, lightweight alternative to conventional Micro-D connectors.

Specifying the male throughboard connector at 90° to the PCB offers additional layout flexibility to maximise space above the board. Connectors can now be located at a PCB edge, routing a mated cable sideways outside the PCB stack. A key application to benefit from this connection style is CubeSats, where many designs involve a series of PCBs in a dense stack, with all cabling routed into the space outside the stack. Similar tight space restrictions occur in avionics (particularly UAV design), larger satellites, military (such as radar and portable communication equipment), robotics and motorsport.

The horizontal connectors can also be used with female PCB connectors to give a motherboard/daughterboard arrangement, useful for replacement modular PCBs or larger equipment systems.

The horizontal format connectors are fitted with stainless steel Screw-Loks, designed to be mate-before-lock for ease of use — simply push the connectors fully together before engaging the screws. Engineers can choose the standard Screw-Lok with board-mount (with the engaging screw on the female connector) or the reverse-fix (with the engaging screw on the male connector). Pin counts match the rest of the Gecko-SL series, from six to 50 contacts.

The connectors have an operating temperature range from -65 to +150°C, exhibit strong vibration (20G at 2 kHz for 6 h) and shock (up to 100G) resilience, and show low outgassing, satisfying both NASA and ESA specifications. Current rating is set at 2.8 A max single contact, or 2 A per contact if all are loaded.

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### MULTICIRCUIT SMART POWER METER

ICP DAS's PM-4324A-100P multicircuit smart power meter monitors up to eight three-phase circuits or 24 single-phase circuits, or any combination of single- or three-phase circuits.

The product can measure up to 24 currents via external current transformers (CTs). This flexibility makes it suitable for multitenant facilities such as residential projects, office buildings and shopping malls. The compact instrument is designed to easily fit into existing panelboards or be flush mounted nearby, thus eliminating the need for retrofit projects or for allocating extra space for the device.

The product has two separate main circuit inputs that can be used in different power systems.

Other features include: true RMS power measurements; energy analysis for 3P4W, 3P3W, 1P3W, 1P2W; current measurements up to 400 A with different CT ratio; voltage measurements up to 500 V; easy install with split core CT; W accuracy better than 0.5% (PF=1); support for RS-485, Ethernet or CAN bus interface; support for two power relay output (Form A); and total harmonic distortion (THD).

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### PHOTOCOUPLEDERS FOR INDUSTRIAL EQUIPMENT

Renesas Electronics has announced five 8.2 mm creepage photocouplers, claimed to be the world's smallest isolation devices for industrial automation equipment and solar inverters.

With a package width of 2.5 mm, the RV1S92xxA and RV1S22xxA photocopplers are said to reduce PCB mounting area by 35% compared to competitive couplers. They help designers shrink equipment size, increase robot axes and improve factory floor productivity. They also meet the needs of the zero-energy house that requires smaller solar equipment for more installations in limited space. They are suitable for DC to AC power inverters, AC servo motors, programmable logic controllers (PLCs), robotic arms, solar inverters, and battery storage and charging systems.

The RV1S9260A 15 Mbps communications coupler and RV1S9213A intelligent power module (IPM) driver use tiny LSS05 packages with a 0.65 mm pin pitch, half the pitch of conventional packages. With a package height of 2.1 mm, the photocouplers can be directly mounted on the backside of a PCB, freeing up space for topside-mounted components. Three times infrared reflow soldering



provides flexibility. The RV1S92xxA photocopplers' electric isolation and high CMR noise rejection (50 kV/ $\mu$ s) protect low-voltage microcontrollers and I/O devices from high-voltage circuits when transferring high-speed signals.

The RV1S2281A and RV1S2211A are DC input and low DC input, transistor output photocopplers, and the RV1S2285A is an AC input, transistor output coupler. The RV1S22xxA devices also provide 8.2 mm creepage distance, 2.5 mm package width and 2.1 mm package height. They come in LSSOP packages with a 1.30 mm pin pitch.

All five photocopplers deliver 5000 Vrms reinforced isolation and high temperature operation to withstand harsh operating environments. They support 200 and 400 V systems with reinforced insulation to meet industrial safety standards. They adhere to the strict UL61800-5-1 standard for motor drive equipment and the UL61010-2-201 standard for control devices such as PLCs.

**Renesas Electronics**

[www.renesas.com](http://www.renesas.com)





# AUTOMATIC IDENTIFICATION WITH ELATEC RFID READERS

Devices using RFID technology for identification are widely used in warehouse logistics, shipping and management. A large number of available solutions and a frequent need to integrate them into a single, coherent system can be problematic and time-consuming.

**S**olutions offered by **Elatec** allow you to reduce costs and time that are necessary to integrate new solutions into the existing systems.

## Auto ID solutions with Elatec RFID readers

The rapidly growing market of RFID and wireless communication systems poses new challenges to hardware manufacturers and solution integrators who offer Auto ID products. Regardless of the area of application, the key element is the choice of the right RFID technology for proximity identification. It is of crucial importance, as many different RFID standards operate in parallel. In this way, often used RFID technologies differ in standard from the newly introduced solution. An example of such a problem can be an office building, where RFID technology is used to control access of employees. At some point, there is a need for systemically integrated access of employees to printers equipped with RFID readers installed in the building. Let us assume that the readers used in printers work in a different standard from that used for access control. This situation forces the employees to use two cards — one allowing access to the workplace and the other for identification purposes in the printer. Universal Elatec RFID readers and modules eliminate this inconvenience by offering support for the vast majority of currently used RFID technologies. This applies to both low-frequency (LF) 125/134.2 kHz and high-frequency (HF) 13.56 MHz communications.

## Smartphone instead of contactless card

In addition to support for most RFID technologies, the latest **Elatec** TWN4 MultiTech 2 BLE proximity reader supports **NFC** and **Bluetooth Low Energy (BLE)** technology. As a result, RFID cards can be omitted in the identification process and smartphones can be used instead. The reader supports the most popular models, such as iPhone devices and smartphones

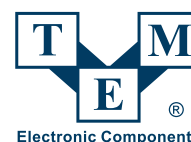
with Android and Windows operating systems. Following the example of an office building, the use of **Elatec** readers makes it possible to avoid identification problems for employees who have forgotten to take their card from home.

## Quick setup

Another great advantage of TWN4 MultiTech RFID is that its functionalities can be automated with scripts that are run directly in the reader. In addition, the script can be changed to allow the reader to use a different **RFID** standard. Modification can be done via wireless interface using a **TWN4** configuration card. This is a great convenience for maintenance employees and technicians who don't want to waste their time disassembling integrated devices and it makes it possible for them to reconfigure such devices quickly and non-invasively.

## RFID technology recognition

In the case of switching from one solution to another, such as in the example presented above, recognition of the previously used RFID technology is essential in order to propose a new, optimal solution. As a standard, an **RFID** card used in the existing application would have to be sent to the supplier or integrator. This lengthy procedure is no longer required with **Elatec** RFID analysis tools such as **TechTracer Lite**. It can recognize the RFID technology used in the existing solution on the spot. This saves both the solution provider and the customer time, costs and the risk of mistakes.



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# DIAMOND FILM

## BOOSTS HEAT DISSIPATION EFFICIENCY OF GaN HEMTs

Fujitsu and Fujitsu Laboratories have successfully developed what they claim is the world's first technology for growing a diamond film with highly efficient heat dissipation on the surface of gallium nitride high electron mobility transistors (GaN HEMTs), which are used in power amplifiers for technologies like weather radars and communications equipment.

The design is said to reduce the amount of heat generated by the devices during operations by 40%, leading to simplification of the cooling system and making it possible to miniaturise radar systems that rely on GaN HEMTs. This improvement to the design should make it significantly easier to install larger numbers of the devices for applications including improved weather forecasting and 5G communications.

In recent years, GaN HEMTs have been widely used as transistors for high-frequency amplifiers in weather radar and wireless communications. In the future, achieving breakthroughs in areas like the highly accurate observation of localised torrential downpours and the creation of a stable millimetre-wave high-speed communication environment for 5G communications will make it necessary to increase





the number of radars and base stations deployed in the world by a considerable degree.

Limitations inherent to existing designs continue to prevent an increase in the number of installations, however. The transistors used in radar systems have higher output power due to the need to operate at longer distances, which increases the amount of heat they generate. Cooling equipment is required because of the performance degradation caused by overheating. This remains expensive, and the large size of the entire system, including the cooling apparatus, limits the installation location, making simplification and miniaturisation of the cooling equipment an important challenge for designers.

One possible way to reduce the size and complexity of the cooling system is to increase heat dissipation efficiency by covering not only the back surface of the GaN HEMT but also the front surface with a diamond film. This diamond film, which possesses excellent heat dissipation properties, would effectively lower the internal temperature

of the GaN HEMT. In order to achieve this effect, however, a diamond crystal with a large grain size is required to pass heat efficiently so that heat does not accumulate inside the diamond. A high temperature of about 900°C is usually required to grow such a diamond film, which unfortunately destroys the GaN HEMT underlying the diamond growth.

When a diamond film is grown at low temperature (~650°C) at which the GaN HEMT is not destroyed, the resulting reduction in thermal energy given to the methane gas used to create the diamond means that the growth of the diamond is incomplete. Using the low-temperature method, it is only possible to grow microscopic diamond particles (or nanodiamonds) of several hundred nanometres or less. Furthermore, each particle becomes an aggregate of crystals facing different directions, which inhibits efficient heat transfer between particles (Figure 1).

### The new technology

To address this challenge, Fujitsu has developed a technology for growing a highly heat-spreading diamond film at low temperatures (about 650°C) where transistors are not destroyed, and succeeded in demonstrating the operation of a GaN HEMT with a highly heat-spreading diamond film on its surface.

To grow the diamond film with this method, nanodiamond particles with a diameter of several nanometres are placed on the entire surface of the device. The nanodiamond particles are then exposed to methane gas with high thermal energy to convert the carbon contained in the methane gas into diamond, which can then be incorporated into the particles. Carbon, with its high energy, is selectively incorporated into diamonds that point in a particular direction, allowing diamonds that point in the same direction to bond together and grow.

Focusing on the fact that the thermal energy given to methane varies depending on the pressure and the concentration of methane gas during diamond growth, Fujitsu discovered that nanodiamond particles oriented in a specific direction can be selectively enlarged at low temperatures. This makes it possible to convert a nanodiamond into a micrometre-sized diamond 1000 times larger (Figure 2). As a result, heat can easily pass through the diamond and the GaN HEMT can dissipate heat efficiently.

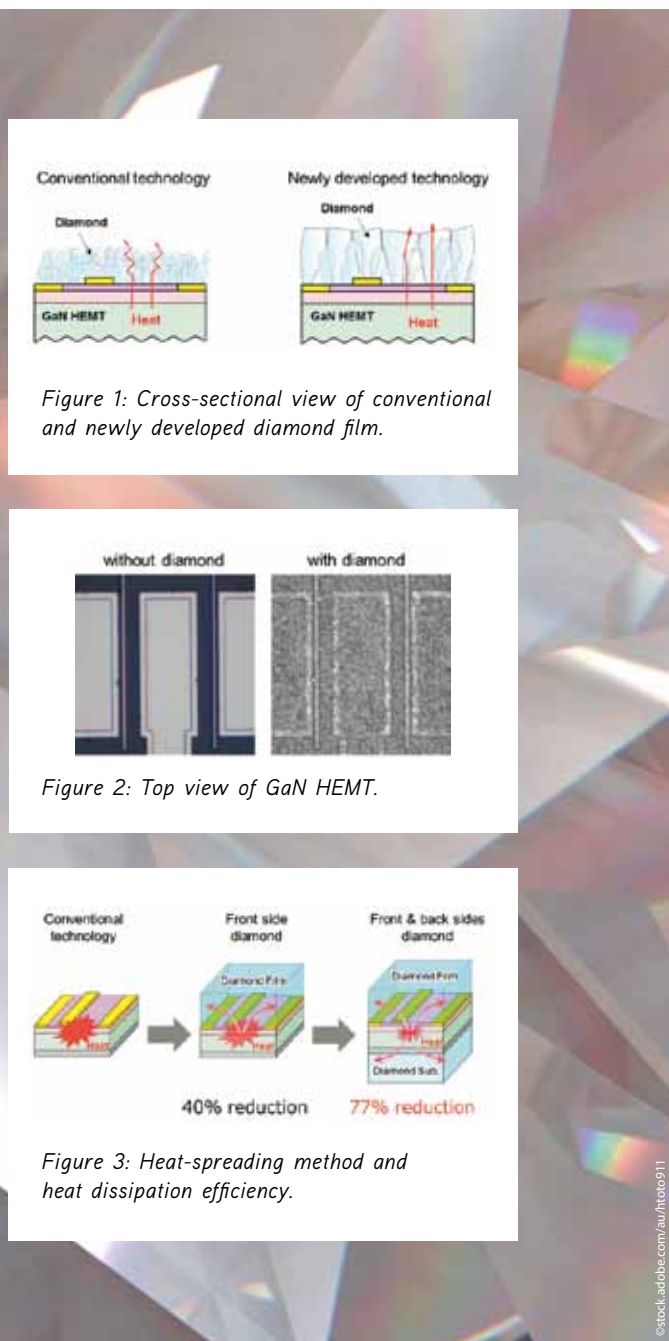
### Outcome

By using the newly developed technology, the amount of heat generated during GaN HEMT operation is reduced by approximately 40% compared to without diamond film, and the temperature can be lowered by 100°C or more. Furthermore, by combining the heat dissipation from the back side of the GaN HEMTs with single-crystal diamond developed by Fujitsu and silicon carbide bonding technology at room temperature, the front and back sides of the GaN HEMTs can be covered with a diamond film, which is expected to reduce heat generation by approximately 77% (Figure 3).

This enables the use of small cooling devices for high-performance radar systems that previously required large cooling devices, thereby saving space and making it easier to install the large number of units demanded for advanced weather forecasting and communications technologies.

Details of the high-heat-dissipation GaN HEMT amplifiers were presented at the 2019 MRS Fall Meeting & Exhibit, held in Boston in early December. Going forward, Fujitsu aims to commercialise the technology in fiscal 2022 for use in weather radar systems and next-generation wireless communication systems.

Fujitsu Australia  
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## POWER AMPLIFIER

Engineered for defence and aerospace applications, the 100 W QPA3069 power amplifier from Qorvo provides high power density and power-added efficiency for 2.7–3.5 GHz radiofrequency (RF) based designs. Fabricated with Qorvo's 0.25  $\mu\text{m}$  gallium nitride-on-silicon carbide (GaN-on-SiC) production process, the high-power, S-band amplifier is designed to simplify system integration and offers high performance in a 7 x 7 x 0.85 mm package.

The power amplifier features greater than 58 dBm of saturated output power and over 25 dB of large-signal gain. The device's power-added efficiency (PAE) is rated at 53%, and the RF output power where the device starts to draw positive gate current (PSAT) is measured at 50 dBm. The amplifier features input return loss as low as 13 dB and output return loss as low as 7 dB. To simplify system integration, the product also features two RF ports that are fully matched to 50  $\Omega$ , each integrated with DC blocking capacitors.

The device has an operating temperature of -40 to 85°C and a power dissipation of 117 W at the top of the temperature range. The lead-free, RoHS-compliant amplifier is suitable for S-band radar applications.

**Mouser Electronics**

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## AUTOMATIC DIRECTION FINDING ANTENNA

The ADFA 2 is Narda Safety Test Solutions' second automatic direction finding antenna, with a frequency range that has been increased by more than three times. When connected to Narda's powerful real-time receiver, the SignalShark, the device can precisely localise signals between 10 MHz and 8 GHz.

The product delivers stable measurement results in seconds — it is insensitive to reflections. Its wide frequency range means that direction finding at low and high frequencies is covered equally. Compact and universal, it combines a broad spectrum with the minimum outlay of equipment. This makes the device suitable for mobile network providers and regulatory authorities, as well as for military applications.

For applications on the move, the unit is easily attached to a car roof with the aid of its magnetic base; a single cable links it to the SignalShark. It delivers precise results even without the vehicle correction tables that are usually required. While still on the move, the measurement technician can superimpose a heatmap on a stored map on the SignalShark display as well as view the found direction. The localisation software in the device automatically indicates where the interference source is most likely to be located.

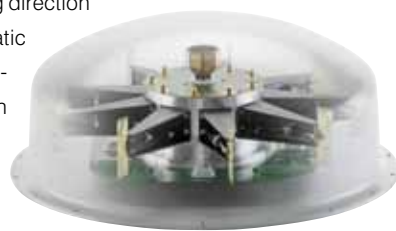
An array of nine antenna elements (dipoles) are arranged on a flat plane with a central omnidirectional reference antenna, which allows the measurement technician to observe the signal spectrum during direction finding. The principle of automatic direction finding using single-channel receivers is based on the phase difference between the antenna elements. The nine dipoles are measured against the central reference antenna

— the greater the distances between them, and thus the detected phase difference, the more reliable the bearings.

As a result of the extended frequency range at both ends of the scale, there is a lower plane for the range from 10 to 200 MHz and an upper one for the range from 2.7 to 8 GHz. These additional planes mean the device weighs 6.5 kg, with a diameter of 480 mm.

**Narda Safety Test Solutions GmbH**

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# SENSOR APPLICATIONS FOR DRIVING EFFICIENCY IN ELECTRONICS PRODUCTION

The manufacturing volume for electronics parts such as printed circuit boards (PCB) is steadily rising to keep up with economic demand. The industry has introduced parts miniaturisation and high-speed production systems to be able to reach production quotas. Advanced sensor technology is used to ensure reliable measurement, monitoring and inspection at every stage of the manufacturing process. This is to ensure the highest quality for the manufactured products.

The sensor requirements for such applications should be compact, easy to integrate into existing machinery and able to measure at high speed. An example of such technology is a non-contact laser triangulation sensor for measuring distance, displacement, position and thickness. The laser triangulation sensor has a compact design and is capable of adapting to rapidly changing surfaces while retaining its superior measurement accuracy. Some example applications of laser triangulation sensors in electronics manufacturing are outlined here.

## Monitoring the presence and position of components in PCBs

Laser triangulation sensors have been previously used in a fully automated system to monitor the position of components in a PCB. Generally, the components in a PCB are miniature and cannot be easily detected with conventional measuring equipment. The blue laser triangulation sensors have a shorter wavelength and can measure at a higher resolution, which is suitable for this application. They also have a high measuring rate to enable short cycle testing in the production environment.

## Print head positioning in laser printers

The exact distance from the print head to the object is crucial to ensure high quality of the final products in production processes. Laser triangulation sensors are compact and can be easily mounted on the print head for accurate distance detection. Conjunctively, the sensors can also measure the depth of the scribe line in the PCB to ensure that the printed components are separated.

## Distance measurement in adhesive dispensers

Laser sensors have also been previously used on the glue dispensing machine. The sensors are mounted on the dispensing head to ensure that the adhesive dispenser is always at the correct working distance to the object. The advantage of using laser sensors for this application is the sensors' capability to

adapt quickly to a changing surface, ie, when the products move in the production line. They can continuously provide accurate distance measurement with high reliability.

Similarly, the laser triangulation sensors can also be used to detect the height of the paste bead during automated applications of heat conducting paste in electronics such as in LED light production. The dosage is determined by the height of the paste bead. It is crucial to achieve the correct dosage, as overloading of paste impairs its thermal resistance and too little paste may overheat the parts.

## Other sensors requirements

A non-contact confocal displacement sensor can be used to measure the thickness of the protective coating on the PCB. The protective coatings are essential to protect the board from environmentally degrading compounds such as moisture. The confocal displacement sensors are suitable for this application due to their capability to achieve high-precision measurement on multi-layered objects and on thin layers, which is a limitation for laser sensors. Confocal sensors can also be used to measure the assembly gap on display glass on smartphones after the assembly process.

Bestech Australia partners with Micro-Epsilon, a world-leading company in high-precision sensors and instrumentation, to provide high-quality sensors and support for test and measurement applications in Australia and New Zealand. In addition to laser triangulation sensors, we also offer a wide variety of high-precision non-contact sensors to cover almost all measurement requirements in the electronics industry, from chip production to complex assembly monitoring.

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# FLEXIBLE TOUCHSCREENS

## COULD BE PRINTED LIKE NEWSPAPER

Australian researchers have developed an ultrathin and ultraflexible electronic material, able to be printed and rolled out like newspaper, for the touchscreens of the future. The work was led by RMIT University and has been published in the journal *Nature Electronics*.

**A**s explained by lead researcher Dr Torben Daeneke, most mobile phone touchscreens are made of a transparent material — indium tin oxide (ITO) — that is very conductive but also very brittle.

"We've taken an old material and transformed it from the inside to create a new version that's supremely thin and flexible," said Dr Daeneke, an Australian Research Council DECRA Fellow at RMIT.

"You can bend it, you can twist it, and you could make it far more cheaply and efficiently than the slow and expensive way that we currently manufacture touchscreens.

"Turning it two-dimensional also makes it more transparent, so it lets through more light.

"This means a mobile phone with a touchscreen made of our material would use less power, extending the battery life by roughly 10%."

To create the new type of atomically thin ITO, researchers from RMIT, UNSW, Monash University and the ARC Centre of Excellence in Future Low-Energy Electronics Technologies (FLEET) used a thin film common in mobile phone touchscreens and shrank it from 3D to 2D, using a liquid metal printing approach.

An indium-tin alloy is heated to 200°C, where it becomes liquid, and then rolled over a surface to print off nanosheet sheets of indium tin oxide. These 2D nanosheets have the same chemical make-up as standard ITO but a different crystal structure, giving them new mechanical and optical properties.

The touch-responsive technology is 100 times thinner than existing touchscreen materials and so pliable it can be rolled up into a tube. It is readily compatible with existing electronic technologies and, because of its incredible flexibility, could potentially be manufactured through roll-to-roll (R2R) processing just like a newspaper.

It also absorbs just 0.7% of light, compared with the 5–10% of standard conductive glass. To make it more electronically conductive, just add more layers.

"There's no other way of making this fully flexible, conductive and transparent material aside from our new liquid metal method," Dr Daeneke said.

"It was impossible up to now — people just assumed that it couldn't be done."

The product is also easier to create than the transparent thin film material used in standard touchscreens, which is manufactured in a slow, energy-intensive and expensive batch process conducted in a vacuum chamber. Dr Daeneke noted, "The beauty is that our approach doesn't require expensive or specialised equipment — it could even be done in a home kitchen."

The research team has now used the new material to create a working touchscreen as a proof of concept, and has applied for a patent for the technology. The material could also be used in many other optoelectronic applications, such as LEDs and touch displays, as well as potentially in future solar cells and smart windows.

"We've shown it's possible to create printable, cheaper electronics using ingredients you could buy from a hardware store, printing onto plastics to make touchscreens of the future," Dr Daeneke said.

"We're excited to be at the stage now where we can explore commercial collaboration opportunities and work with the relevant industries to bring this technology to market."



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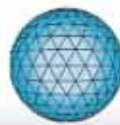


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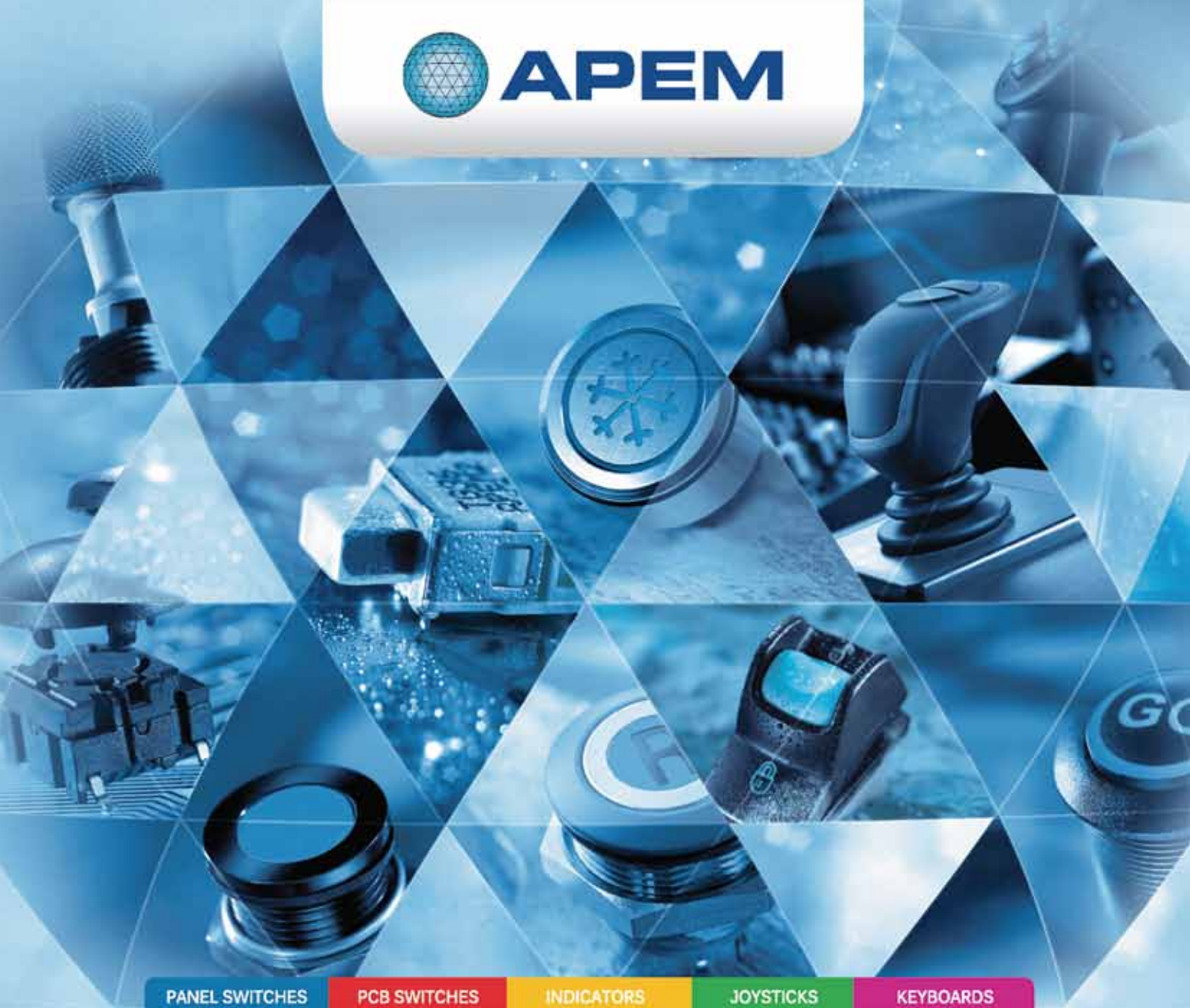


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