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Backplane Systems Technology announces the POC-500 Series of embedded controllers offering performances said to be unprecedented in this form factor. Featuring the AMD Ryzen embedded V1605B/V1807B 4-core/8-thread processor, it delivers up to three times the CPU performance of previous POC Series.

GPU performance-wise, it delivers 3.6 TFOPS in FP16, which is rare in a compact form factor. It incorporates an M.2 2280 NVMe SSD (PCIe Gen3 x2) to support twice the disk read/write speed of typical 2.5" SSDs. It is available in two AMD Ryzen CPU variants: the V1807B (45 W) for high computing power demand and the V1605B (15 W) for low power consumption, rugged fanless operation.

The series includes the POC-551VTC, a fanless in-vehicle PC offering high performance in a small form factor. The rugged design meets an operating temperature of -40 to +70°C, EN50155 railway and E-Mark certifications, making it suitable for applications where shock and vibration are considerations.

The POC-551VTC offers four 802.at PoE+ ports to supply 25 W power to devices such as IP cameras. It supports M.2 and three mPCIe expansion slots, CAN bus for in-vehicle communication and isolated DIO for sensor/actual control. The built-in ignition control and wide-range DC input provides a solution for vehicle applications.

The series offers both a DIN-rail and wall-mount mechanical design and front-accessible I/Os. The PC measures 63 x 176 x 116 mm, yet features 4x PoE+, 4x USB 3.0 and 4x COM ports with a screw-lock mechanism to ensure cables are secured. The industrial computers emphasise CGU/GPU performance, a considered I/O design and a rugged housing to meet the demands of industrial, process control and in-vehicle applications.

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CREATING A ROOM- TEMPERATURE QUBIT COMPONENT

Lauren Davis

Materials technology company Archer Exploration has announced the latest milestone in its mission to create a qubit processor that can operate at room temperature — potentially a game changer for the emerging quantum computing industry.

Archer CEO Dr Mohammad Choucair explained that the processing power of classic devices, such as laptops and phones, is starting to reach its limits. The secret to greater processing power lies in quantum computing, which has the potential to solve problems that classical computers find extremely difficult or impossible. But according to Dr Choucair, the biggest problem in quantum computing bottles down to the materials that are currently available — the majority of quantum computers are only able to operate at subzero temperatures, and while other devices use light or special materials which overcome the temperature challenge,

these are difficult to integrate into modern electronics.

“At the moment, all the materials that are out there, your quantum processor either works at a really low temperature, -273°C , or if it works at room temperature, it’s very difficult to integrate,” he said. “That means, generally speaking, all your quantum computers are housed in big ivory towers that you cannot access. And if you want access, you probably have to access it through the cloud. It’s not on board your device. Very limited in use, very early stages. There is no widespread ownership.”

Things changed back in 2012 when Dr Choucair, then employed by the University

of Sydney, invented a conducting carbon material that was shown to have the potential to process quantum information at room temperature, thus overcoming both the limitations of subzero operating temperatures and electronic device integration for qubits. Since joining Archer as CEO around two years ago, he has helmed the company’s efforts to develop a core device (chip) made of this material, as part of the company’s ^{12}CQ project. The quantum chip forms the basis of IP that has been exclusively licensed from the University of Sydney.

Construction commenced on the chip prototypes in June this year, with work taking place at the Research and Prototype

Image courtesy Archer Exploration Limited (ASX:AXE).

Foundry Core Research Facility at the Sydney Nanoscience Hub, the University of Sydney. Development was led by Archer's Quantum Technology Manager, Dr Martin Fuechsle — an internationally recognised figure in pioneering quantum device fabrication, and the inventor of the world's first single-atom transistor. It was his job to assemble the atom-scale materials componentry while overcoming technical challenges in controlling, reducing or eliminating the technical risks associated with realising the 16 claims in the company's patent application.

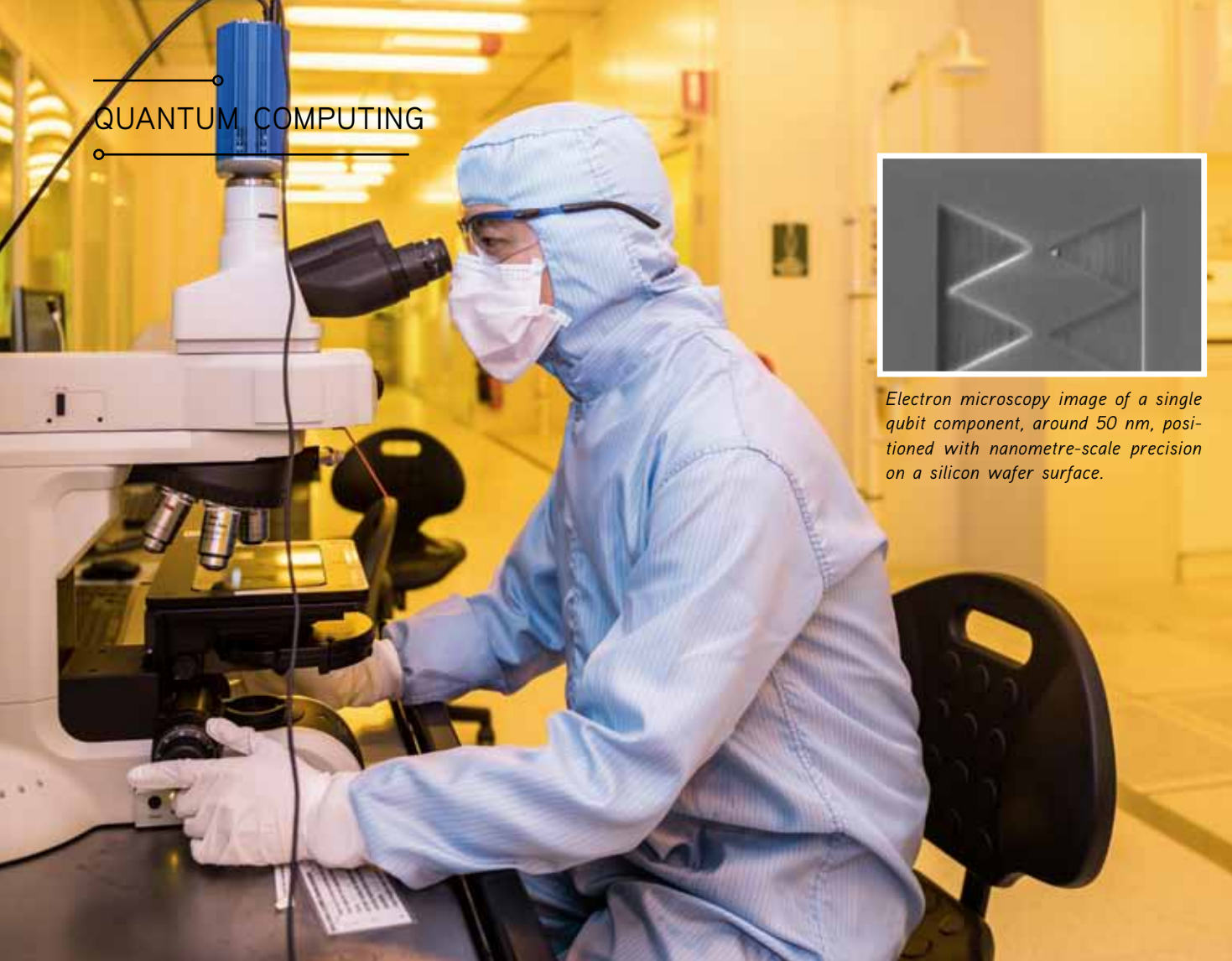
Access to the Research and Prototype Foundry's facilities within the \$150 million Sydney Nanoscience Hub was, in no uncertain terms, vital to the chip's development. Funded under the National Collaborative Research Infrastructure Strategy (NCRIS), the Hub is part of the Australian National Fabrication Facility (ANFF), which seeks to

provide micro and nano fabrication facilities to Australian researchers both academic and industry based — including big industry customers such as Microsoft, who have their own spaces within the facility. For a company like Archer, this means ongoing access to multimillion-dollar instruments that are ideal for small-scale device development — such as electron-beam lithography tools — without the need to purchase such instruments.

"We're transferring patterns at these scales of a few nanometres up to a few hundred microns," said Nadia Court, Facility and Program Manager at the Research and Prototype Foundry. "And what's unique in this space is the fact that we can go right from prototyping ... right through to proof-of-concept, scalable processes. So that would be going right through to pilot-scale production.

"People are using these facilities to change designs on the fly, try and see whether or not they can get things working, and there's a very fast turnaround. So that actually really does tend to de-risk the value proposition for people who are investing in commercialisation of technologies in this space. So that's one of the reasons why these types of facilities are so good."

When it came to assembling the first component of Archer's chip, a single qubit component was isolated and precisely positioned on a silicon wafer. The process was performed with nanometre-scale accuracy on a silicon substrate (though the process was not limited to silicon), at room temperature, and was found to be repeatable and reproducible. This process will allow Archer to quickly build and test quantum information processing devices incorporating a number of qubits, individual qubits or a



Electron microscopy image of a single qubit component, around 50 nm, positioned with nanometre-scale precision on a silicon wafer surface.

Images courtesy Archer Exploration Limited (ASX:AXE).

combination of both, which is necessary to the company's aim of building a chip for a practical quantum computer.

In August, Archer announced that assembly of its first qubit component, around 50 nm in size, was complete. Dr Choucair said this was a remarkable achievement, noting, "The qubits are only a few tens of nanometres in size and this means we need to have a high level of accuracy in physically positioning our qubits to successfully build a working device. It is incredibly difficult to apply such a high of degree precision in controlling qubit location; however, we have unambiguously achieved this."

Although too small to view with the naked eye, the qubit base material is now proudly stored by Archer in a vial of liquid, as a testament to its structural stability. As explained by Dr Choucair, "When you think about what are the prerequisites of doing quantum computing at room temperature, you need to have something called an electron spin lifetime of more than 100 ns. We have the only conducting material that's able to show a spin lifetime of 175 ns.

"You can move it, you can put it in a liquid, you can dry it up, put it back in the device, in the chip, and it will still work. You can heat it up to 1000°C, you can cool it down, you can take it down to liquid helium,

you can take it out, you can breathe on it, you can spit on it, you can do whatever you like, and it still works."

Further improvements and optimisation to the process are likely to reduce the time required to build a working chip prototype, according to the company. But while other organisations may seek to use such a chip as the basis of a purely quantum computer, Archer's end goal is more of a hybrid device.

"We don't envision having a quantum-only device — we've always envisioned having a quantum chip sitting side by side, integrated into current and modern electronics," Dr Choucair said. "And that's actually a very big deal for us to even be able to say that. Not many institutes or organisations even have the possibility of saying that.

"On every single device on the planet potentially you could integrate a quantum chip and have it used under practical conditions. So we don't need low temperatures, we don't need well-defined crystals, we don't need atomic manipulation, photonics, use of metals — all this stuff. That's how big of a paradigm shift this material represents.

"What kind of opportunities will that allow? Take two examples: I want to send money overseas, and I want to send a WhatsApp message. If you did have a quantum chip in there, then you could start

running software and algorithms that can do this a lot more securely and a lot more efficiently. So that's something that other people would look at as a potential offering for that end use."

Archer now seeks to continue development of the ¹²CQ qubit processor chip by completing the next stages of component assembly towards a proof-of-concept prototype chip. The company later intends to commercialise chip products through licensing and direct sales by seeking to establish commercial partnerships with highly resourced and skilled organisations, which could allow for product scale, IP transfer and distribution channels.

"We've met a key milestone in de-risking and progressing the chip technology development, while demonstrating a key success factor the quantum computing community commonly uses to qualify the most promising early-stage, long-term potential solutions to practical quantum computing," Dr Choucair said.

"In the next 12 months we want to continue building our chip, and we want to progress our technology readiness level ... which means putting the components together, testing them, assembling a device, and also start validating the technology's commercial readiness."



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Image ©Nick Pitsas

CSIRO AND PIOTREK PARTNER ON SOLID-STATE BATTERIES

Australia's national science agency, CSIRO, has formed an agreement with Japanese specialist chemical manufacturer Piotrek that will see Australian-developed battery technologies commercialised globally within the next five years.

The two organisations have partnered to develop the next generation of solid polymer electrolytes (SPEs) for lithium batteries, utilising CSIRO's proprietary RAFT (reversible addition-fragmentation chain transfer) polymer technology and Piotrek's ion-conducting polymers (ICP). These battery technologies will be suitable for portable electronic devices, drones and automotive vehicles — and should address a critical safety need with lithium batteries by helping prevent battery fires.

"This partnership will help Piotrek make our batteries safer and more efficient, and with our industry reach we will get our advanced batteries to the market faster," said Piotrek General Manager Ihei Sada.

"Together we will develop the world's safest, longer life solid-state high-energy battery."

Solid-state batteries are a class of lithium batteries that typically use a lithium metal anode — the highest specific energy of all battery anodes — resulting in batteries with twice as much energy as today's lithium battery technologies. Additionally, there are no volatile or flammable liquids inside a solid-state battery that can catch fire at low temperatures if the cell is damaged.

CSIRO Battery Research Leader Dr Adam Best said that with several companies already active in this field, there are proposals to have solid-state battery-enabled devices in the market by 2025, if not sooner.

"Our RAFT technology allows us to tune our SPEs' properties to expand their versatility for different types of batteries and fuel cells, and will also significantly reduce the cost of device assembly and manufacture," Dr Best said.

CSIRO's Dr John Chiefari, co-inventor and co-developer of the RAFT polymer technology, said the collaboration with Piotrek will bring together battery technologies from both organisations to fast-track the development of an SPE for use in high energy (4.5–5 V) lithium batteries for electric vehicles and drones.

"This development will underpin the growth of high-energy batteries for the electric vehicle market," he said.

CSIRO is also working with Piotrek to automate electrolyte processes using robots, and to license a new electrolyte recipe.

A NEW CANDIDATE FOR N-TYPE SEMICONDUCTORS

Japanese scientists have produced a novel organic substance that can potentially be adapted to form an n-type semiconductor, with wide-ranging applications in the field of electronics.

Semiconductors can be made of either organic (carbon-based) or inorganic materials, though organic semiconductors have some clear advantages over inorganic semiconductors. As noted by Professor Makoto Tadokoro of the Tokyo University of Science, "Organic semiconductor devices, unlike hard inorganic semiconductor devices, are very soft and are useful for creating adhesive portable devices that can easily fit on a person."

However, despite the advantages of organic semiconductors, there are very few known stable molecules that bear the physical properties of n-type semiconductors, compared to inorganic n-type semiconductors. N-heteroheptacenequinone is a well-known potential candidate for n-type semiconductor materials, but it is unstable in air and UV-visible light, and insoluble in organic solvents. Now, Prof Tadokoro and colleagues have identified a novel substance, derived from N-heteroheptacenequinone, that overcomes these drawbacks.

To obtain the substance, N-heteroheptacenequinone was made to undergo a four-step process of chemical reactions involving repetitive refluxing, evaporation, recrystallisation and heating. The final product achieved was C₆OAHCQ — a red solid with a crystalline near-planar structure involving two tetraazaphthalene 'backbones' and one benzoquinone backbone. It has eight electron-deficient imino-N atoms and two carbonyl moieties.

To confirm its electrochemical properties, C₆OAHCQ was made to undergo a series of tests including a UV-visible absorption spectroscopy in the solution state, cyclic voltammetry and theoretical calculation of electrostatic potential. It was also compared with a tetraazapentacenequinone analog, with the results published in the journal *Organic and Biomolecular Chemistry*.

The tests revealed that the electron-deficient imino-N atoms and two carbonyl moieties in C₆OAHCQ provide it with an electron-accepting behaviour. In fact, the number of electrons accepted by C₆OAHCQ is more than that by fullerene C₆₀, which suggests improved conductivity. Cyclic voltammetry showed that C₆OAHCQ exhibited reversible four-step, four-electron reduction waves, which indicated that C₆OAHCQ is stable and has good electrostatic potential; the UV-visible spectroscopy also showed its stability in UV-visible light.

C₆OAHCQ also showed electrochromic properties, which enable its potential application in many specialised areas such as the development of smart windows, electrochromic mirrors and electrochromic display devices. C₆OAHCQ was also found to have excellent solubility in common organic solvents. It was overall found to be advantageous and had improved properties compared to the tetraazapentacenequinone analog.



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SPEEDING UP COMPUTATION WITH NANOPHOTONICS

Japanese researchers have developed a new type of processor known as PAXEL — a device that can potentially bypass Moore's law and increase the speed and efficiency of computing. Described in the journal *APL Photonics*, PAXEL is placed at the front end of a digital computer and optimised to perform specific functions but with less power consumption than is needed for fully electronic devices.

Metal-oxide semiconductor field-effect transistors are the basis for most integrated electronic circuits, but they are limited by Moore's law, which says the number of microprocessor chips on a single electronic circuit will double every two years. There is an inherent limit to this, though, based

on the way the size of the microprocessor chips relates to the quantum mechanical nature of electrons.

It is possible to partially overcome the Moore's law problem by using parallel processing, in which multiple processors carry out simultaneous computations; however, this approach does not work for every application. So the researchers decided to use light for the data transport step in integrated circuits, since photons are not subject to Moore's law. Instead of integrated electronic circuits, much new development now involves photonic integrated circuits (PICs); the PAXEL accelerator uses power-efficient nanophotonics, which are very small PICs.

Nanophotonics, such as those used in PAXEL, operate at the speed of light and can carry out computations in an analog fashion, with data mapped onto light intensity levels. Multiplications or additions are then performed by varying light intensity. The investigators considered different PAXEL architectures for a variety of uses, including artificial neural networks, reservoir computing, pass-gate logic, decision-making and compressed sensing.

One particularly interesting application of PAXEL is in so-called fog computing. This is like cloud computing but uses computational resources (servers) near the 'ground' where the originating event occurs. A compact PAXEL attached to a tablet or other handheld device could detect signals and transmit the information through a 5G wireless link to nearby fog computing resources for data analysis.

Applications of the technology are expected in a wide array of areas, including medical and veterinary point-of-care testing, diagnostics, drug and food testing, and biodefence.

SANDWICH-STRUCTURED ELECTRODE ENHANCES LITHIUM-SULFUR BATTERIES

Chinese researchers have found a way to improve lithium-sulfur battery performance, creating a sandwich-structured electrode using a novel material that traps polysulfides and increases the reaction kinetics. Their work has been published in the journal *APL Materials*.

Lithium-ion batteries aren't keeping up with energy demands from higher power electronic devices, electric vehicles and smart electric grids. To develop higher capacity batteries, researchers have looked to lithium-sulfur batteries because of sulfur's high theoretical capacity and energy density. But there are still several problems to solve before lithium-sulfur batteries can be put into practical applications, such as sulfur's intrinsically low electrical conductivity and the rapid capacity decay caused by polysulfides escaping from the cathode.

The biggest problem is the shuttling effect that occurs during cycling. This effect causes the diffusion of polysulfides from the cathode, creating capacity loss. It also consumes a lot of fresh lithium and electrolytes, and reduces battery performance.

To solve the shuttling problem and improve lithium-sulfur battery performance, researchers from the Beijing Institute of Technology looked to the metal-organic framework (MOF) known as ZIF-67, constructed from metal ions or metal clusters and organic ligands, which holds great promise in gas storage and separation, catalysis and energy storage. MOF-derived materials are

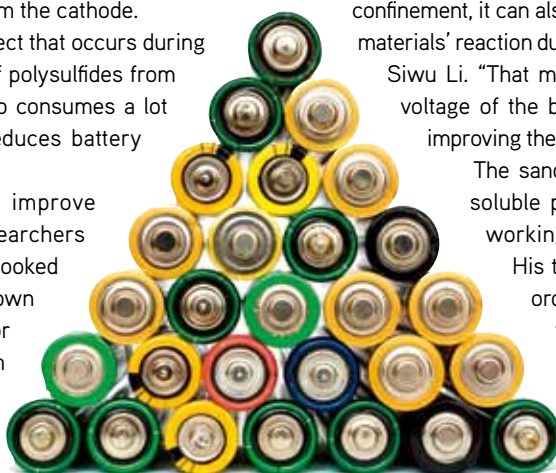
also attractive in energy storage due to their robust structure, porous surface and high conductivity.

The researchers created a sandwich-structured electrode with sulfur immobilised in between two layers of a ZIF-67-derived material, PZ67 — this was found to improve the practical energy density of the lithium-sulfur battery to three to five times higher than that of lithium-ion batteries. The PZ67 is composed of polar materials, and the porous carbon showed a synergistic effect in the chemical interaction, served as a physical barrier, offered a high conductivity to prohibit the polysulfide shuttling effect and enhanced the batteries' cycling performance.

"The porous PZ67 can not only absorb the polysulfides to form a confinement, it can also improve the kinetics of the actual active materials' reaction during the battery cycling," said study author Siwu Li. "That means it may also improve the discharge voltage of the battery, and that is a big contribution to improving the energy density of the batteries."

The sandwich-structured electrode that confines soluble polysulfides could be useful for anyone working to confine soluble materials, Li said.

His team now plans to continue their work in order to scale up the process of fabricating the hybrid electrode using a hot pressing procedure. They also plan to address instabilities on the anode side of lithium-sulfur batteries, possibly by adding a protective layer.



ALUMINIUM PROFILE ENCLOSURES

OKW Gehäusesysteme's SYNERGY and SMART-TERMINAL aluminium enclosures feature good stability, heat dissipation and a high-quality appearance due to the combination of anodised aluminium profiles and attractive plastic parts. The elegant aluminium profiles offer flexibility, and can be manufactured individually in length according to user requirements.

The SMART-TERMINAL housing series consists of two profiles (C-base profile and bottom profile) made of glass bead-blasted and anodised aluminium. The two open sides can be closed with design seals in green or grey as well as with covers made of high-quality ASA+PC-FR. Matching end plates made of aluminium are also available, eg, for use in embedded systems. In addition to individual length dimensioning, it is also possible to produce the design seals and covers in other colours as creative visual features.

The aluminium profiles have horizontal guides and screw channels for mounting PCBs in the interior. The flat surfaces simplify the subsequent machining and installation of interfaces, display/touch solutions, etc. The covers offer a recessed area to protect the cables and plugs. For ergonomic operation and a favourable reading angle of 12°, the accessory range includes a case canting kit. The enclosures are supplied with round cord seals and sealing rings to achieve IP54 protection.

The SYNERGY enclosure series offers a high-quality appearance in the basic shapes of square, rectangular, circular and oval. The construction consists of an aluminium profile (glass bead-blasted and anodised) as well as a top and bottom part in black made of ASA+PC-FR with good UV resistance and high flame resistance. The bottom part has an opening with a screw-down cover — practical for installing a battery compartment or for access to the interior. The recessed surface in the top part is suitable for decor foils or membrane keyboards. The enclosure offers plenty of space for the electronics, has no inclined surfaces and is easy to assemble.

Both aluminium profile enclosures can be further modified according to user requirements. Options include mechanical processing, a user-specific profile length, lettering/printing/laser etching, painting, assembly processes or the production of plastic parts in special colours.

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DEVELOPING AND TESTING USB TYPE-C AND USB PD PRODUCTS IN A CONTROLLED ENVIRONMENT

Rich Miron, Applications Engineer, Digi-Key Electronics

The latest USB connector/cable, power delivery (PD) and protocol specifications (USB Type-C, USB PD 3.0 and USB 3.2, respectively) make the connectors easier to use and boost USB's data throughput and power delivery capabilities. However, for designers eager to exploit the new specifications, they are finding that implementation has many challenges. In particular, the higher voltage and current support can lead to damage to incompatible peripherals and overheating of cables, connectors and ports.

What developers unfamiliar with USB Type-C and USB PD need is a way to experiment with the new technologies in a controlled environment with an appropriate software interface. USB silicon vendors have responded by introducing evaluation kits (EKs) with software and boards which include power supplies, USB connections to a PC and the latest generation of USB chips. These EKs allow developers to gain experience with configuring USB Type-C and USB PD using a proven design with a user-friendly interface. The EKs can also be used as a reference design for the developers' prototypes.

This article will outline the key attributes of the latest USB Type-C specifications and describe some of the complexities of implementation. It will then introduce kits from ON Semiconductor,



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USB TYPE-C IS BASED ON A COMPACT, REVERSIBLE PLUG CONNECTOR THAT IS EASIER FOR CONSUMERS AND BETTER SUITS THE FORM FACTOR OF MODERN CONSUMER ELECTRONICS.

- Higher throughput: USB 3.2 (introduced in 2017 and now absorbing all prior USB 3.x specifications) offers data rates of up to 20 Gbps.
- Higher power: USB PD 3.0 offers up to 100 W (5 A x 20 V) for rapid charging of tablets and portable computers.

The USB Type-C connector is mandatory for USB 3.2 Gen 2x2, and future versions of the standard will only be compatible with it (and not the Type-A and Type-B connectors). The specification incorporates a 24-pin connector that provides four +5 V ground pairs, two differential pairs for the USB 2.0 data bus, four pairs for the SuperSpeed data bus, two 'sideband use' pins, $V_{\text{CONN}} +5 \text{ V}$ power for active cables, and channel configuration (CC) pins for cable orientation detection and management of connections. Note that the pins used in a specific application vary depending on the communication protocol employed and power delivery requirements (Figure 1).

A 'fully featured' USB Type-C connector and cable can support the fastest USB data rates. For example, with USB Type-C, a designer could opt for USB 3.2 Gen 1 (SuperSpeed 5 Gbps), USB 3.2 Gen 2 (SuperSpeed 10 Gbps) or USB 3.2 Gen 2x2 (SuperSpeed 20 Gbps) protocols. Note that 'not fully featured' USB Type-C connector and cable combinations exist which are unable to support features of the latest specification. The rest of this article will consider designs which employ fully featured USB Type-C hardware only.

USB Type-C also allows the designer to take advantage of the highest USB PD voltages and currents available under the USB PD 2.0/3.0 power protocols. From USB PD 2.0, the specification defines four voltage levels at 5, 9, 15 and 20 V. Also, instead of six fixed levels of the original USB PD standard, the power supplies may support any maximum source output power from 0.5 to 100 W. Sources supplying more than 15 W offer voltages of 5 and 9 V, those supplying more than 27 W offer 5, 9 and 15 V, and those supplying more than 45 W offer 5, 9, 15 and 20 V. These various combinations of voltage and current are called 'Power Profiles'.

While the flexible power levels have many advantages, they do add complexity as well as some interesting design challenges due to the higher voltages and currents supported by the technology. For example, USB PD requires an additional component — a port controller — to negotiate and implement USB PD power profiles. Designers used to USB Type-A design will not be immediately familiar with these differences, which increases the risk of non-optimal or possibly damaging design decisions.

For example, a USB Type-C system with USB PD can connect to a USB Type-A port through an A-to-C cable; the USB Type-A

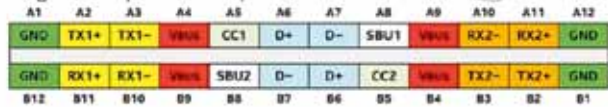
STMicroelectronics and Texas Instruments and show how these can be used to safely explore the capabilities of the new USB technologies. The integrated components upon which the evaluation kit and boards are based can then be designed into new products to take advantage of greater performance while saving space and reducing component count.

Why upgrade to the latest USB specifications?

The key reasons for updating a product to the latest USB specifications are:

- Greater convenience: USB Type-C is based on a compact, reversible plug connector that is easier for consumers and better suits the form factor of modern consumer electronics.

Looking into the product receptacle:



Looking into the cable or product plug:

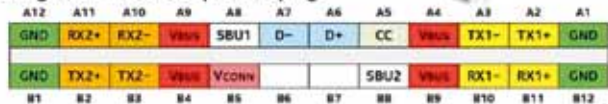


Figure 1: The USB Type-C 24 pin connector is reversible with the CC pins used for cable orientation detection and management of connections. Image source: Texas Instruments.

port V_{BUS} is held at about 5 V, but the USB Type-C port with USB PD can supply up to 20 V at 5 A. The port with the higher V_{BUS} voltage drives current into the other port, and many USB Type-A port power switches do not have reverse current protection so they can be damaged by the higher voltage.

Managing USB Type-C complexity

The versatility offered by USB Type-C and USB PD is realised through configurable cables, ports and power settings. USB Type-C connectors electronically detect and configure connections using the CC. USB Type-C ports can be host-only, device-only (functioning in traditional USB host and device roles) or dual-role ports (DRP); the host being the downward facing port (DFP) and the device the upward facing port (UFP).

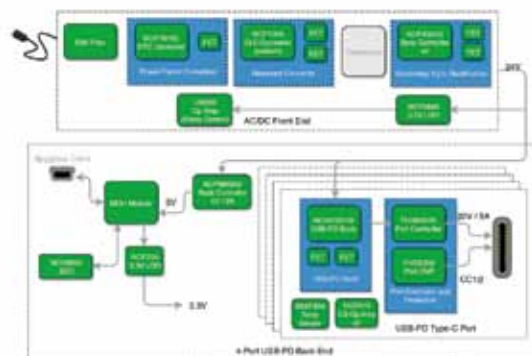


Figure 2: ON Semiconductor's USB Type-C EK features a 200 W AC/DC front end and a four-port USB PD output. Image source: ON Semiconductor.

Other advantages of USB Type-C include:

- Reconfigurability of dual-role ports. For example, a portable computer may function as a UFP when being charged by a monitor or a DFP when powering a mini-fan.
- The ability to electronically determine if V_{BUS} is using USB Type-C standard power or USB PD, configuring V_{CONN} if needed.
- Support of optional alternate and accessory modes.

Port controllers work with PD controllers to negotiate power requirements and direction so that, for example, a device with a modest battery like a smartphone doesn't try to power a device with high power requirements like a portable computer. Port controllers often include an embedded microcontroller, which eliminates the need for an external device to supervise power transactions.

To help manage complexity and ensure a successful design, USB chip suppliers have introduced evaluation kits which allow the designer to experiment with optimised and protected circuitry to evaluate configurations of USB Type-C and USB PD to best suit the application. An example is ON Semiconductor's STR-USBC-4PORT-200W-EVK, a USB Type-C four-port, 200 W EK. This kit allows a developer to explore the capabilities of USB PD 3.0 at voltage outputs of 5, 9, 15 and 20 V and currents of up to 5 A, for a maximum per port output power of 100 W. Due to limitations of the power supply, the EK is restricted to a total maximum output power of 200 W across its four ports.

The STR-USBC-4PORT-200W-EVK comprises a USB PD port controller, a high-voltage protection switch and a step-down (buck) power supply controller. It comes equipped with an AC/DC power supply running from a 90 to 265 V input. Overcurrent and thermal protection are built in. The EK comes with ON Semiconductor's Strata software which includes configuration tools to test power profiles, experiment with various fault and foldback features, and monitor system telemetry while supplying connected devices with variable charging loads (Figure 2).

The port controller on the EK is ON Semiconductor's FUSB307B, which is designed to implement a USB Type-C port controller (TCPC) with USB PD capabilities. The chip complies with the USB PD interface specification as a TCPC with a standardised interface for a USB Type-C Port Manager (TCPM) and incorporates USB Type-C detection circuitry enabling manual attach/detach detection. The chip's time-critical PD functionality is handled autonomously, avoiding the need to use a system microcontroller or TCPM.

For its part, STMicroelectronics offers the STEVAL-ISC004V1 USB PD EK. The EK is a ready-to-use USB PD source, based on the company's STUSB4710A USB PD controller, that demonstrates



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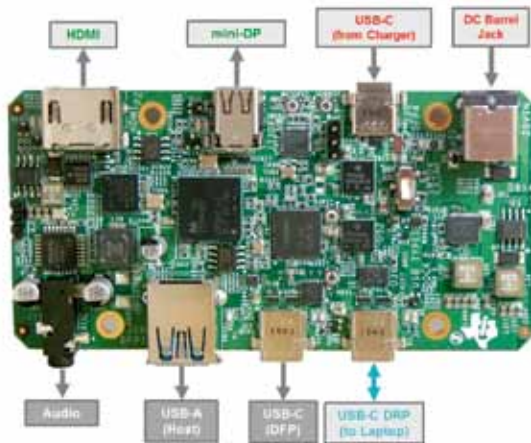


Figure 3: TI's USB-CTM-MINIDK-EVM USB Type-C interface EK is a reference solution for a USB Type-C dock including USB data, USB PD, audio and video. Image source: Texas Instruments.

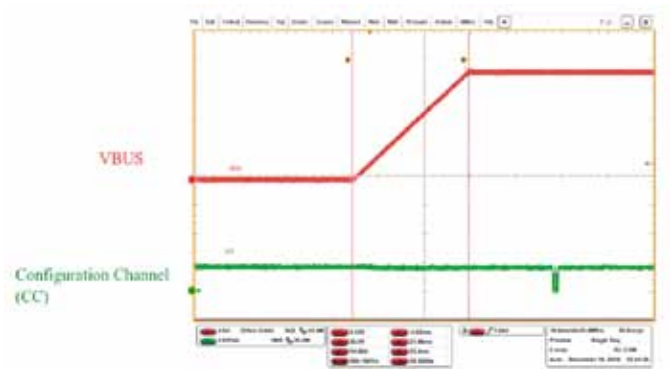


Figure 4: ON Semiconductor's USB Type-C EK can be connected to an oscilloscope for detailed analysis of the chip's operating characteristics. Image source: ON Semiconductor.

how to convert a fixed-voltage DC power input into a USB PD variable voltage output. The USB PD Controller communicates over USB Type-C CC to negotiate a given amount of power to an attached device and can handle any connections to a DFP or UFP without microcontroller support.

Texas Instruments (TI) also offers a USB Type-C docking station interface EK, the USB-CTM-MINIDK-EVM (Figure 3). The EK is a reference solution for a USB Type-C dock, including USB PD, audio, USB data, power and video. The EK supports both source and sink power capabilities over the primary USB Type-C PD port. When powered by an external USB Type-C charger, the dock can source 5 V at 3 A or 12 to 20 V at 5 A.

The EK incorporates:

- **TUSB8041:** A four-port USB 3.0 hub controller which can provide up to SuperSpeed USB via both DFPs and UFPs.
- **TUSB321:** A TCPC for determining port attach and detach, cable orientation and role detection. The chip can be configured as a DFP, UFP or DRP.
- **TPS65982:** A USB Type-C controller for USB PD negotiation and power path enabling.

The ON Semiconductor, TI and STMicroelectronics EKs guide an engineer through the process of setting up and configuring a USB Type-C design with USB PD.

Development on the ON Semiconductor EK is conducted through the company's Strata Developer Studio. To start, developers need to apply an AC voltage to the EK, connect it to the PC via the USB Mini-B cable, log in and allow the PC to detect the EK and download the relevant content.

The developer can make some basic settings to the system including the maximum system power (from 30 to 200 W), a setting which ensures the total PD 'contracts' from the four ports don't exceed the total power from the AC supply and an 'assured power' setting whereby port 1 always has an allocated amount of power and the other ports share the remaining power between them. There is also a fault protection setting that determines the temperature threshold at which a fault condition should be indicated.

The developer can then experiment with individual port settings including:

- **Max port power:** Once this is set, no contract will be offered that exceeds the limit.
- **Current limit:** From 0 to 6 A.
- **Cable compensation:** To reduce voltage drop at the sink device when sourcing higher currents.

- **Advertised profiles:** Once a device is plugged in, a list of profiles that were offered to the sink device will be displayed.

The developer can then access a browser which details total input voltage and power to the USB ports, and information on the performance of each port including profile (volts), PD contract (watts), output voltage and power, temperature and efficiency. The EK can connect to an oscilloscope to show more detailed performance information such as V_{BUS} transitions (Figure 4).

The STMicroelectronics EK works in a similar manner to the ON Semiconductor EK. Once connected to a DC source of 22 V (min) and a peripheral device with a USB Type-C connector, the EK's onboard USB PD controller's settings can be read from non-volatile memory via an I²C interface to a PC. The PC interface then allows the developer to reconfigure up to five PD voltage and current outputs, peak currents, and undervoltage and overvoltage lock outs. Once these profiles are set up on the PC they can be programmed into the USB PD controller's memory and used to power the connected peripheral device.

TI's EK needs to work in conjunction with the company's USB Type-C enabler board. The enabler board is connected to a PC with a USB Type-A to USB Type-B cable and a DisplayPort cable; the EK is then connected to the USB Type-C enabler board with a USB Type-C cable. The developer can then experiment with the configuration of the USB 3.0 hub, TCPC and USB Type-C controller directly from the PC.

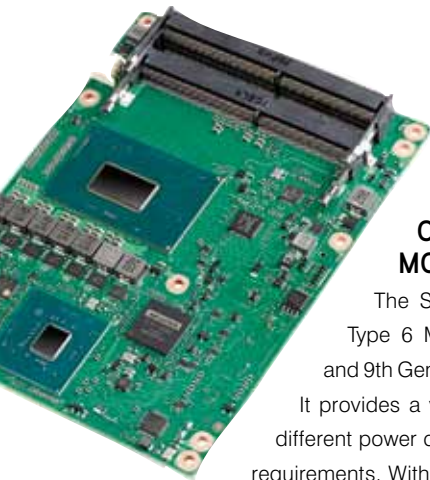
Conclusion

USB Type-C and USB PD bring consumer convenience, higher throughput and enhanced power delivery for either powering — or charging the batteries of — connected peripheral devices. But the technologies also bring increased complexity, making implementation a challenge for developers familiar only with USB Type-A systems.

As shown, developers unfamiliar with USB Type-C and USB PD can now take advantage of evaluation kits from key USB silicon providers that allow experimentation with the technologies in a controlled manner via friendly user interfaces. The EKs can also be used as a reference design for the developer's prototypes.

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COMPUTER-ON-MODULE

The SOM-5899 is a COM Express Type 6 Module designed with an 8th and 9th Gen Intel Core H-series processor.

It provides a variety of scalable options for different power consumption and performance requirements. With its full spectrum SKUs and 2- to 6-core processors offering 25 to 45 W thermal design power, users can easily find the target SKU to fulfil system design specifications.

Featuring a dual-channel 96 GB ECC and non-ECC DDR4 memory design, the SOM-5899 is designed to increase memory capacity and bandwidth to enhance data transmission ability. Furthermore, it provides multiple high-speed I/O: three ports with independent 4K displays, four ports with USB3.1 Gen 2 (10 Gbps) and four ports with SATA Gen3.

The device supports three independent displays, which includes various interfaces: VGA, LVDS for legacy applications and three DDI ports that are configurable as HDMI/DVI/DisplayPort, for enriched visual and image focus. With its multiple I/O design, it is suitable for a variety of applications across fields such as medical, servers, gaming and more.

Advantech Australia Pty Ltd
www.advantech.net.au



MODULAR PANEL PC

iEi's PPC-F-Q370 series AI-ready modular panel PC is powered by an 8th Generation LGA1151 Intel Core i7/i5/i3 and Pentium processor. It can be used as an inference computing system for AI applications.

The panel PC has a modular design to achieve high flexibility by assembling the FLEX series system with the LCD touchscreen module. Active cooling is utilised to effectively transfer heat from the chassis and maintain system performance.

The series includes four low-profile PCIe slots for various expansions; two of them are PCIe 3.0 x8 slots for adding GPU cards or image processing cards for high-performance artificial intelligence computing. Four 2.5" SATA SSD bays with RAID function are protected in a lockable cover to ensure security of data and disks.

The system is also equipped with two M.2 M-key (2280) slots to support PCIe SSD and NVMe, providing a variety of storage interfaces from which users can choose.

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

DISTORTION-CANCELLING, HIGH-VOLTAGE LED DRIVER

Featuring a novel distortion-cancelling input-current shaping (ICS) circuit, the HVLED007 AC/DC LED driver from STMicroelectronics is designed to enable energy-saving solid-state luminaires to comply with increasingly stringent lighting regulations.

The device implements a peak current mode PFC control optimised for isolated high-power-factor quasi-resonant flyback converters. The ICS ensures an effectively sinusoidal input waveform with low total harmonic distortion (THD) over the full load and input-voltage range; THD is below 5% at full load. With near-unity power-factor capability and maximum energy efficiency over 90%, the product is designed to meet designers' needs for a single control IC to address multiple medium- and high-power LED-lighting applications up to 80 W.

The unit completes ST's HVLED family of digital ICs for driving LEDs directly from the rectified mains. With their advanced integration and features that support economical primary-side regulation, HVLED drivers are designed to enable compact circuit size while enhancing system reliability and lighting performance.

The electrical parameters of the HVLED007 are specified down to -40°C, allowing use in outdoor lighting including street lighting as well as indoor applications. The totem-pole output stage can source and sink 600 and 800 mA respectively, enabling use in EN61000-3-2 compliant switched-mode power supplies up to 100 W in addition to lighting applications. Protection features including short-circuit, overload and overvoltage protection are built in.

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

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

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

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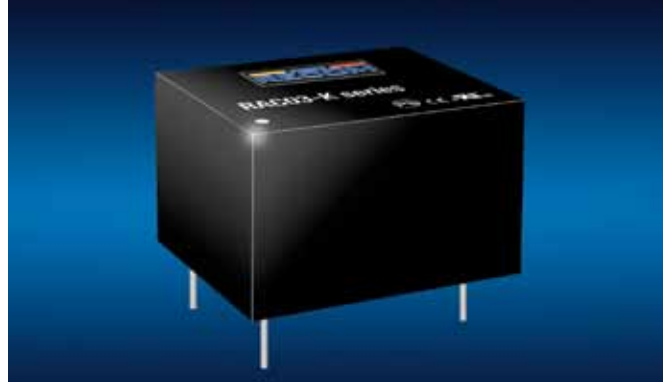
Anritsu has introduced a new option for its Bluetooth Test Set MT8852B to support the latest Bluetooth Core v5.1 (BT 5.1) specification for evaluating key positioning services. With the BLE AoA/AoD Option, the MT8852B can conduct efficient RF-signal angle of arrival (AoA) and angle of departure (AoD) measurements, designed to help speed time to market and lower test costs during development, validation and manufacturing of Bluetooth Low Energy (BLE) 5.1 devices and equipment.

BLE AoA/AoD is said to offer high position accuracy that creates a better user experience and allows for applications such as accurate inventory tracking and indoor navigation systems. With the new option installed on the MT8852B, engineers can ensure that emerging products and services comply with the latest specification, according to Anritsu.

The MT8852B supports the test procedures specified by the Bluetooth Special Interest Group (SIG) RF Test Specifications for performing the various Basic Rate (BR), Enhanced Data Rate (EDR), BLE, Bluetooth Audio and other measurements required by developers, manufacturers and vendors of Bluetooth chipsets, modules, devices and systems. The MT8852B test set comes with PC application software for development work, as well as displaying test packets graphically. The application software also performs automatic pass/fail evaluation for test limits to simplify fault troubleshooting at the development and prototyping stages.

A patented Adaptive Frequency Hopping (AFH) test function for 2.4 GHz band WLAN equipment allows the MT8852B to conduct coexistence tests. The test set also supports CombiTests for configuring automated turnkey solutions for testing in high-volume production environments.

Anritsu Pty Ltd
www.anritsu.com



AC/DC CONVERTER

The RAC03-K AC/DC converter, from RECOM, was designed to be the smallest 3 W solution on the market. It is a versatile converter that can be used in a wide range of applications due to complete certifications for ITE and household standards.

In a compact 28 x 23 mm footprint, the modules deliver an output power of 3 W from -40 to +60°C and 2 W up to 80°C. Despite such high power density and its small footprint, the series is a total solution supporting Ecodesign Lot 6 standby mode operation for worldwide applications in automation, Industry 4.0, IoT, households and home automation.

The power modules are versatile, with an input voltage range from 85 to 264 VAC and international safety certifications for industrial, domestic, ITE and household applications. They are also easy to use, with a reinforced class II installation rating and a wide margin to class B emissions compliance without external components.

RECOM Power GmbH
www.recom-power.com



PLASTIC ENCLOSURE FAMILY

Hammond Electronics has announced its 1557 family. Initially available in four plan sizes, each in two heights, it is available in polycarbonate, sealed to IP68, and ABS, designed to meet IP66. The sizes are 80 x 80 x 45 and 60 mm and 120 x 120, 160 x 160 and 200 x 200 in

heights of 45 and 70 mm. All versions are available in black and grey.

Rounded corners and top face provide a modern, smooth style, and environmental sealing allows the enclosures to protect the housed equipment against dust and water entry in dirty and damp environments. The device can be used as a free-standing enclosure when fitted with the supplied feet, or it can be wall mounted with either four visible fixings or two hidden ones.

PCB standoffs are provided in both the lid and base. The enclosure is assembled with corrosion-resistant M4 stainless steel machine screws, which are threaded into integral stainless steel bushings for repetitive assembly and disassembly. The IP68 polycarbonate versions are UV stabilised for outdoor use with a UL94-5VA rating, while the IP66 ABS versions have a flammability rating of UL94-HB for indoor use.

Hammond Electronics Pty Ltd
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SUPERCAPACITOR MODULE FOR RUGGED APPLICATIONS

The XLR-51 supercapacitor module, from Eaton, extends the XLR module family to 51.3 V and 188 F. It is suitable for rugged applications in harsh environments, such as transportation, marine, grid storage and material handling.

The supercapacitor module is designed to provide efficient energy storage for high power, high charge/discharge and peak power shaving applications and to improve power quality for voltage spikes and brownouts for backup power applications. Each module includes an integrated cell voltage management circuitry, an overvoltage alarm and a temperature output.

UN-ECE Reg 10 and Reg 100 certifications have been achieved on the 48 and 51 V XLR modules. The scope of these standards governs provisions for wheeled vehicle electromagnetic compatibility for Reg 10 and specific environmental requirements for integration into electric power trains (ie, electric vehicles) for Reg 100.

The XLR supercapacitor module is a self-contained energy storage device comprising 18 individual XL60 supercapacitor cells. It is RoHS compliant and requires no external battery management system (BMS) due to Eaton's cell balancing technology. With up to a 20-year lifespan, the module is said to increase the life of primary transportation energy storage systems by reducing the need for replacement parts and batteries.

Eaton Industries Pty Ltd

www.eaton.com



PCI EXPRESS POWER OVER ETHERNET CARD

ICP Australia introduces iEI's GPOE Series (GPOE-2P and GPOE-4P) PCI Express Power over Ethernet card.

With PoE technology, users can easily connect various PoE PD supported IP cameras to the control system through the standard CAT-5/ CAT-6 cable (up to 100 m) to transfer both electrical power and data at the same time. In this application, users can lower the difficulty of routing to avoid the risk of power adapter failure and easily build the system to act as PSE, allowing the entire production process to be monitored and controlled from A to Z.

An access control system can be easily developed by connecting PoE-capable devices like a door controller, locking system and RFID reader. Combining power supply and data transmission in a single cable can save both cost and time on system installation, according to the company. It is also easy to integrate an IP-based system into the existing IP infrastructure.

The GPOE Series can be easily added to in-vehicle control systems and connect to various devices like surveillance cameras, bus payment terminals or in-bus digital signage systems. Both data and electrical power can run on standard CAT-5/CAT-6 cable to lower the difficulty of routing and avoid the risk of power adapter failure.

Key features include: PCI Express x1 compliant; 802.3at/af compliant (GPOE-4P), 802.3at compliant (GPOE-2P); supports IEEE 802.3at for PoE with 30 W per port (GPOE-2P); support for total 60 W under full load (GPOE-4P); supports link aggregation/jumbo frames (9 KB); supports 12–24 VDC input power.

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ETHERNET TESTER

The Viavi SmartClass 4800 Ethernet Tester is a modern tool for ensuring data and voice services achieve expected key performance indicators. It examines electrical (10/100/1000M) and optical (100M, 1GE) Ethernet links. It is available to rent from TechRentals.

The product offers fast examinations with automated enhanced RFC 2544 and SAMComplete testing per ITU-Y.Y.1564. It also features an integrated burst testing approach per MEF 34 and RFC 6430 TrueSpeed TCP throughput testing.

It is suitable for applications including performance assessment of Carrier Ethernet services, activation and maintenance of metro Ethernet networks, deployment of active Ethernet (point-to-point) access services, switched networks, traffic generation and QoS verification.

The device is optimised for field use with its multitouch screen, scripted workflows and clear results. It supports efficient practices with repeatable procedures and methods.

TechRentals

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RIGHT-ANGLE GEAR DRIVE

The STG gearbox from Dunkermotoren, featuring Spirotec gearing, is an angular gearbox developed for the long service life of BG motors. Further features of the Spirotec gearbox are a high transmittable torque, high robustness and low-noise operation.

Spirotec gearing is a special type of Spiroid gearing in which the gearing parts are designed as a pairing of a helical pinion and a spiral-toothed ring gear. The cylindrical pinion allows free axial positioning, which is the basis for the simplified assembly of the gear parts. In addition, the Spirotec gearing is said to achieve a higher degree of efficiency than other worm gear units.

With a maximum service life of 22,000 h, the unit — combined with the BG65 brushless motor — is designed to be suitable for most high-tech machine drive applications in today's market.

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'SPOOFING'

AND HOW TO ENSURE GPS SECURITY

Maria Simsky, Technical Writer at Septentrio

As technological advances make GPS/GNSS devices more affordable, our lives are becoming increasingly dependent on precise positioning and timing. Industries such as survey, construction and logistics rely on precise positioning for automation, efficiency and safety.

GNSS time provides the pulsating heartbeat for the backbone of our industry by synchronising telecom networks, banks and the power grid. A single day of GNSS outage is estimated to cost \$1 billion in the US alone. GNSS is a reliable system, and to keep it as such professional GNSS receivers need to be wary of all possible vulnerabilities that could be exploited. Using GNSS receivers which are robust against jamming and spoofing is key for secure PNT (positioning, navigation and time).

What is GPS/GNSS spoofing?

Radio interference can overpower weak GNSS signals, causing satellite signal loss and potentially loss of positioning. Spoofing is an intelligent form of interference that makes the receiver believe it is at a false location. During a spoofing attack a radio transmitter located nearby sends fake GPS signals into the target receiver. For example, a cheap SDR (software-defined radio) can make a smartphone believe it's on Mount Everest!

Why GPS spoofing?

Imagine a combat situation. Clearly, the side that uses GPS/GNSS technology would have an advantage over the side that does not. But what if one side could manipulate GPS receivers of their adversary?



This could mean taking over control of autonomous vehicles and robotic devices that rely on GPS positioning. For example, in October 2018, Russia accused the US of spoofing a drone and redirecting it to attack a Russian air base in Syria.

In the last three years over 600 incidents of spoofing have been recorded in the seas near the Russian border. These ships appeared to be 'transported' to nearby airports. This type of spoofing might have been introduced as a defence mechanism to ground spy drones. Most semi-professional drones on the market have a built-in geofencing mechanism that lands them automatically if they come close to airports or other restricted areas.

Some of the most enthusiastic spoofers are Pokémon GO fans who use cheap SDRs to spoof their GPS position and catch elusive Pokémon without having to leave their room.

Types of spoofing

Spoofers overpower relatively weak GNSS signals with radio signals carrying false positioning information. There are two ways of spoofing:

1. Rebroadcasting GNSS signals recorded at another place or time (so-called meaconing).
2. Generating and transmitting modified satellite signals.

Spoof-proof: how to protect your receiver against spoofing

In order to combat spoofing, GNSS receivers need to detect spoofed signals out of a mix of authentic and spoofed signals. Once a satellite signal is flagged as spoofed, it can be excluded from positioning calculation.

There are various levels of spoofing protection that a receiver can offer. Let's compare it to a house intrusion detection system. You can have a simple entry alarm system or a more complex movement detection system. For added security you might install video image recognition, breaking-glass sound detection or a combination of the above.

Like a house with an open door, an unprotected GNSS receiver is vulnerable to even the simplest forms of spoofing. Secured receivers, on the other hand, can detect spoofing by looking for signal anomalies, or by using signals designed to prevent spoofing such as Galileo OS-NMA and E6 or the GPS military code.

Advanced interference mitigation technologies, such as the Septentrio AIM+, use signal-processing algorithms to flag spoofing by detecting various anomalies in the signal. For example, a spoofed signal is usually more powerful than an authentic GNSS signal.

AIM+ won't even be fooled by an advanced GNSS signal generator: Spirent GSS9000. With realistic power levels and with actual navigation data within the signal, AIM+ can identify it as a 'non-authentic' signal.

Other advanced anti-spoofing techniques, such as using a dual-polarised antenna, are being researched today.

Satellite navigation data authentication

Various countries invest in spoofing resilience by building security directly into their GNSS satellites. With OS-NMA (Open Service Navigation Message Authentication), Galileo is the first satellite system to introduce an anti-spoofing service directly on a civil GNSS signal.

OS-NMA is a free service on the Galileo E1 frequency. It enables authentication of the navigation data on Galileo and even GPS satellites. Such navigation data carries information about satellite location and if altered will result in wrong receiver positioning computation. While currently in development, OS-NMA is planned to become publicly available in the near future. Also, GPS is experimenting with satellite based anti-spoofing for civil users with their recent Chimera authentication system.

Recently, within the scope of the FANTASTIC project led by GSA, OS-NMA anti-spoofing protection was implemented on a Septentrio receiver.

The strongest shield: signal-level GNSS authentication

The Galileo system will be offering Commercial Authentication Service (CAS) on the E6 signal with the highest level of security for safety-critical applications such as autonomous vehicles. The signal-level encryption will be based on similar techniques as the military GPS signals. Only the receivers who have the secret key are able to track such encrypted signals. The secret key is also needed to generate the signal, making it impossible to fake. CAS authentication techniques are currently being prototyped at Septentrio in collaboration with the European Space Agency.

Spoof-resilient GNSS means reliable precise positioning and timing, and peace of mind for everyone touched by this indispensable technology.

Septentrio
<https://www.septentrio.com/en>





OPTICAL TIME-DOMAIN REFLECTOMETER

The Fluke DSX-8000QOI contains the DSX-8000 copper analyser, CertiFiber Pro OLTS quad wavelength, OptiFiber Pro OTDR quad wavelength, and a USB fibre inspection probe. It is available to rent from TechRentals.

The DSX-8000 copper analyser enables testing and certification of twisted-pair cabling for up to 40 Gigabit Ethernet deployments and will handle any cabling system such as Cat 5e, 6, 6A, 8 or Class FA and I/II. It is said to make tasks easier to manage and to achieve system acceptance faster.

The CertiFiber Pro Optical Loss Test Set offers efficient fibre-optics certification. Featuring a simple user interface, the CertiFiber Pro eliminates errors and speeds up troubleshooting. It performs Tier 1 (basic) fibre certification in 3 s and complies with all applicable cabling standards, which call out the encircled flux launch condition requirements for optical sources.

The OptiFiber Pro OTDR offers SmartLoop technology that tests two fibres in a single test, eliminating the need to travel to the far end of the connection to perform tests. It performs Tier 2 (extended) fibre certification and displays a graphical EventMap for easy trace interpretation.

The Fibre Inspection probe allows users to inspect and certify fibre-optic connector end-faces in one second.

TechRentals

www.techrentals.com.au

DIGITAL SMART ACCELEROMETER NETWORK

The CAN-MD (Controller Area Network – Machinery Diagnostics) accelerometer, from Dytran Instruments, is a bus-based, digital smart accelerometer network with configurable firmware for machinery health monitoring and diagnostics.

The sensor offers the ability to collect vibration data, process spectral data and calculate condition indicators (CIs) within the sensor itself without the need of an external data processor used with traditional analog IEPE type accelerometers. A CI is the result, or the processed data, that is provided as an output onto the CAN bus. CIs are sent over the CAN bus v2.0b interface using a Sage/Dytran developed network protocol.

The product offers a variety of benefits for test cell operators to help monitor the health of key assets. These include digital solutions that offer simpler wiring schemas by reducing cable runs to one primary bus cable, as opposed to the multitude of individual cable runs required by analog systems.

Data reduction from CAN-MD edge computing is said to minimise the need for high-speed network connections or large data repositories for IIoT integration. Powerful user-configurable acquisitions and data processing algorithms performed in the sensors remove the need for traditional data acquisition hardware.

Widespread adoption of CAN bus allows the sensors to interface with COTS CAN data logger, gateways, test cell hardware and digital bridge devices using the detailed interfaced control documents available for CAN-MD and expand the sensor channel count on existing data acquisition hardware equipped with a CAN bus — up to 32 sensors are available on a single CAN channel.

Metromatics Pty Ltd

www.metromatics.com.au



LARGE INTERNAL MIX ATOMIZING NOZZLES

EXAIR's 1/2" No Drip Internal Mix Atomizing Spray Nozzles work in the same way the company's standard atomising nozzles do, but have the added benefit of positively stopping liquid flow when compressed air is shut off. The devices mix liquid and air inside the nozzle and produce fine atomisation of liquids up to 300 cP. No additional air line is required to control the No Drip feature.

When spraying any type of liquid, post-spray liquid flow can cause big problems. Unwanted drips can ruin product function on sealing or mating surfaces and ruin the appearance of painted or coated finishes. In addition, excess liquid flow wastes precious resources such as coatings, chemicals or water. No Drip nozzles are suitable where no post-spray drip is permissible. When the compressed air supply is shut off the nozzle positively seals off the flow of liquid, eliminating the possibility of drips.

The spray nozzles are available in four patterns: narrow angle round, wide angle round, flat fan and 360° hollow circular pattern. They are for pressure-fed applications that don't require independent air and liquid control. They are fully adjustable to minimise air and liquid consumption and have interchangeable liquid and air caps. Flow ranges from 0.5 to 1147 L/h. They are CE compliant and conflict mineral free.

Compressed Air Australia Pty Ltd

www.caasafety.com.au



ENCLOSURE RANGE

The SMART-CONTROL by OKW Gehäusesysteme is an enclosure for easy installation in standard room corners. In addition, the enclosure range can be used on the desk at an ergonomically inclined angle.

The plastic enclosures are available in two sizes: the smaller version S with 142 x 81 x 46 mm and the version M with 173 x 101 x 59 mm. They are available in the flame-resistant material

ASA+PC-FR (UL 94 V-0) with high UV protection, in off-white. The enclosures can be finished by means of mechanical processing, printing/lettering, EMC aluminium coating and assembly processes in accordance with user specifications.

The range of wall and tabletop enclosures was designed in two parts, with one top part and one bottom part each. The upper parts can be ordered in two different versions — as convex curved parts or with recessed operating areas for membrane keypads. There are fastening pillars in the top part as well as in the bottom part for mounting parts and PCBs. Protection class up to IP55 is possible with the help of an optional seal. The individual parts are screwed together on the rear of the enclosure using Torx stainless steel screws. A desktop stand set (accessory) ensures desktop positioning and an ergonomic reading angle of 45° when the enclosure is set up horizontally.

Assembly is simple and quick through snap-in installation with an adapter which is screwed directly to the enclosure. The same universal adapter is also used to mount the enclosure on the wall or in 90° inside corners. The wall suspension element is also included in the range of accessories.

Applications range from security and monitoring technology, environmental technology, IoT/IIoT, gateways, measurement and control technology to medical and laboratory technology.

ROLEC OKW Australia New Zealand P/L

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The MPLAB ecosystem now provides comprehensive product support and powerful debug tools that can increase your confidence in your design. Key features in MPLAB X Integrated Development Environment (IDE) include I/O View to display and modify pin states on the fly and Data Visualizer to stream real-time data and provide terminal windows all within a single tool. MPLAB X IDE also offers automatic hardware detection to provide register definitions and links to product data sheets and applicable software libraries to make your development even easier.

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YOUR FUTURE WORKPLACE WILL BE AS SMART AS YOU ARE

Watch any modern spy movie and chances are there's a scene where the hero infiltrates an ultramodern office tower, manipulating biometric security scanners before hacking a terminal in a server room, which triggers an alarm and program to evacuate all the air from the room. Yes, your heart is racing just thinking about it.

The reality is, these buildings exist, but thankfully their automated systems are far more benevolent than anything a Hollywood scriptwriter could come up with. Say hello to the smart building and future workplace.

While the word 'smart' is thrown around with wild abandon these days, an easier way to think of it is as a 'connected and automated' building; one in which everyday functions — such as security, lighting and air-conditioning control — are handled through a central gateway integrating multiple systems that

monitor a collection of networked sensors that can trigger automated actions based on the data they obtain. For example, if the building detects a meeting room is vacant, it will shut off or lower the lighting, and the heating or cooling.

"It's no longer just words and hype," said Mark Blum, Co-Founder and CEO of Cognian Technologies. "In the IT space, computers in buildings have been connected for quite some time. But in the building operational space, it's now really starting to happen."



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"Primarily, though, this has been happening in buildings at the top end of town; that's where a lot of the innovation is happening. What we're doing at Cognian is, we want to democratise the industry so it's not just large buildings that are smart; it's all buildings."

To that end, the team at Cognian have developed Synchronesh Wireless; a wireless IP 'backbone', built on Schneider Electric's open, IoT-enabled EcoStruxure platform, that connects all building services into a central control system.

"What we're doing is figuring out ways to use mandatory infrastructure that can then offer more smart features and productive workplaces," said Gavin McClelland, Digital Buildings National Offer Manager with Schneider Electric. "We can aggregate the data from connected machines or sensors and offer various Advisor packages that are applications which offer insights and enhanced management from the cloud, so a tenant or facility manager can control the building from anywhere you have phone or internet access."

"What we are seeing are self-learning buildings. They are fitted out with devices that are producing data that is analysed by software applications which then deliver automated outcomes to give occupants or owners a better experience and make the buildings more efficient in their day-to-day running."

"We now have cheap-to-install wireless monitors that can collect data down at the individual workstation level rather than up at the more

ambiguous 'whole floor' level. This enables applications to then provide three services — occupancy analytics, wellbeing analytics and geolocation way finding. This information is now available to parts of the organisation that normally haven't accessed or been offered data — that is, HR teams or workforce planning or even workplace designers."

"People and the workforce infrastructure are the biggest cost for many businesses and workplaces. For example, the cost of each workstation per year in a Class A building can range across \$10–25K. So if you have more workstations than you need, it's not an efficient spend. For the first time organisations can gain data on workstation use — how often, what days, what time of the day, and movements around the station. Plus the CO₂ levels, temperature and humidity at the workstation, which are important wellbeing factors."

When early designs for Synchronesh attracted government eyes, a federal government accelerator grant for \$1 million followed. It has since grown into an easily implemented and scalable system, appearing in smart buildings around the world.

"It has to be simple," said Blum. "Simple to install, simple to configure, no troubles in maintenance; those factors are designed into both the way we handle wireless connections, to the way we configure and set it up. We make it very, very easy."

"There are wireless technologies out there that can service a small area, but really what you want is something that is ubiquitous and just works. Synchronesh is designed to scale up to entire floors and entire buildings."

Far from offering mere functional features, a smart building also has the ability to not just enhance employee wellbeing, but also reduce its carbon footprint. International Energy Agency research shows that the combined buildings and buildings construction sectors are responsible for 36% of global final energy consumption and nearly 40% of total direct and indirect CO₂ emissions. Digitalisation of buildings is a critical element to overcoming this significant issue for owners and the community.

This was a pivotal concept when Schneider Electric technology played a large role in the design of The Edge, in Amsterdam. Dubbed the 'smartest building in the world', The Edge is a net zero-energy building — it generates more solar power than it uses — and features functions to enhance employee wellbeing. The building can recognise your car when you drive up and direct you to a parking spot, and then set your preferred room temperature and lighting as you enter the meeting room it has booked for you.

"Human beings weren't designed to live indoors," said Blum, "but we spend most of our waking hours in these buildings. Our bodies are attuned to natural light rhythms, but we're subjected to non-natural lighting."

"By tracking movement and producing heat maps of where people are, you make sure that you're only cooling, heating and ventilating where people are, not where it's empty; and adjusting lighting to make the built environment match our circadian rhythms — the better we feel, the better our mood. Wellness, energy and utilities for the people within, it happens through connectedness."

"Our vision is to make every building a smart building," said Blum. "It's not just about the top, shiny glass, grade-A buildings; it's about every building. It's about creating an IoT, scalable system that will grow in the future."

Thankfully, building designers are now combining simple use OT (operational technology) with IT to create a smart system that connects and exists between the two. That said, we're still in the very early days of this growth, which some would say is the most opportune time to design and create the workplace of the future.

"If you're a tenant, a building owner or a developer, you need to be really careful about the fitout you're doing," said McClelland. "You need to ensure it's not going to get ripped out and replaced in a couple of years. If you're smart you can futureproof your asset for many years to come; through your IP backbone, down to the types of sensors you install now."

For the team at Cognian, the growth of Synchronesh throughout the world will improve workplaces to nurture happier, healthier and more productive employees.

At Schneider Electric, McClelland said the smart building team is focusing on educating developers, architects, system integrators and contractors on what out-of-the-box technology is on offer today, so their mindset is focused on developing Australia's and New Zealand's next generation of smart workplaces.

For more information on Schneider Electric's smart building solutions, visit se.com/au/buildings.

Schneider Electric
se.com/au/buildings

Schneider
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Custom interconnect solution provides space savings

Although the term 'PCB' tends to elicit the image of a solid, green, rectangular circuit board covered in traces, today's advanced electronics frequently employ PCBs with cut-outs in a variety of shapes and sizes to enable reduced-size end devices. The geometric mismatch between irregularly shaped PCBs and standard rectangular connectors, and especially those with lead-frame contacts, can make it extremely difficult to impossible to make efficient use of limited PCB real estate and achieve the high component density.

Connectors are widely available in a multitude of shapes and sizes, but the unique size, weight and performance demands of many new, next-generation electronics require customised solutions to meet those specifications both on budget and on time, and especially when the solution must also meet stringent standards.

As a case in point, a customer had a request for a small, lightweight and low-profile surface-mount connector that would maximise real estate on a uniquely shaped PCB and meet the rigorous performance and long-term reliability demands of a mission-critical application. They also requested keying and polarisation capabilities to facilitate blind mating, minimal tooling and set-up costs, and a quick turnaround time. Their request was brought to Advanced Interconnects, a leading designer and manufacturer of innovative, technologically advanced interconnect solutions.

To fulfil the request, design engineers at Advanced Interconnects literally thought outside of the box, bypassing traditional rectangular configurations in favour of a semicircular configuration capable of utilising the perimeter

of the PCB, providing both the ruggedness and flexibility required, and achieving a low, 6 mm stack height. Board-to-board connectors that utilise screw-machined terminals with multi-finger contacts are ideal for meeting the high-reliability demands and design requirements. And these designs are typically custom-made using high-temperature moulded, FR-4 or polyimide film insulators with application-specific features such as shrouds, standoffs or special plating.

To achieve the necessary reliability and overall size reductions, the team employed a 1 mm-pitch ball grid array socket adapter contact system with a solder ball PCB interface. This contact system's screw-machined terminals have multi-finger contacts that are said to provide superior reliability and performance over stamped-and-formed pins and can accommodate a variety of low-voltage differential signalling (LVDS) requirements for power, signal and ground options.

The proprietary solder ball terminal design provides a strong solder joint with enhanced elasticity, effectively compensates for minor co-planarity issues between boards, and is said to take up less space than typical lead-frame technology (eg, lead-to-trace or PCB pad).

The team then employed customisable FR-4 insulators, which eliminate tooling costs since they don't require a mould and allow for multiple design revisions and fast prototypes during the development phase, along with fine-pitch BGA socket adapter terminals, which are available in pitches down to 0.5 mm.

Once the design was complete, the engineers used precise CNC machinery to create rough samples for electrical and mechanical testing, achieving a fast, custom request to ready-to-test prototype span of less than five days. Created from FR-4 on an in-house driller/router machine, the prototype connector incorporated 1 mm-pitch solder ball terminals on both the male header and the mating female socket and alignment pins for a fully keyed and polarised solution that could facilitate blind mating. Vertical integration and existing screw-machined terminal designs eliminated the need for expensive tooling and set-up costs, such as stamping dies, which made the custom solution a quick and affordable way to satisfy a range of application requirements.

By leveraging in-house engineering expertise, field-proven interconnect technology and precision machinery, the following six key specifications for the custom 70-position SMT Perimeter Connector application were being satisfied: mission-critical reliability; maximised real estate on a rounded PCB; keying and polarisation capabilities; lightweight, low-profile form factor; minimal tooling and set-up costs; and quick turnaround time.



Ampec Technologies Pty Ltd
www.ampec.com.au

MIXED-LAYOUT CONNECTORS

Harwin has introduced Gecko-MT connectors — mixed-layout versions of its Gecko-SL series. By complementing the data contacts with two or four power contacts (in power/data configurations of either 1+8+1 or 2+8+2), the products are designed to enable space and weight reductions in electronic hardware. This means they address modern system designs where major constraints can be placed on these parameters. The respective power and data current ratings are 10 and 2.8 A max per contact.

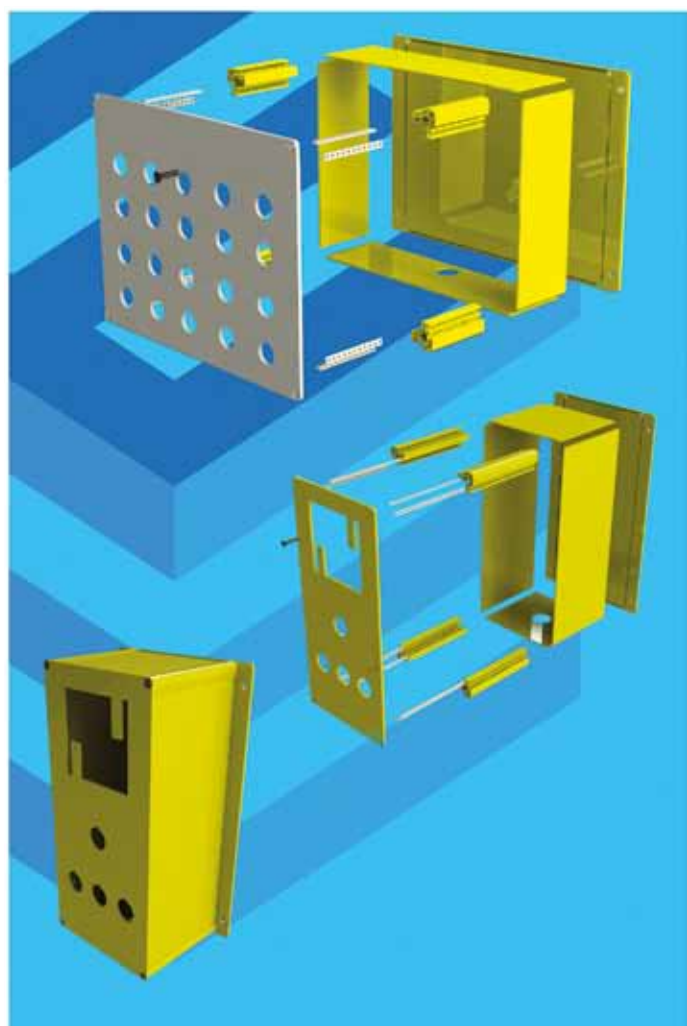
The initial release comprises female and male cable connectors, plus female vertical and male right-angle PCB connector options. These components are fitted with sturdy, stainless steel screw-lock fixings (in both conventional and reversed formats), to ensure ongoing interconnect integrity in challenging application environments. They have 20G vibration and 100G shock resilience and their operational temperature range spans from -65 to 150°C. Low outgassing properties are also exhibited.

By encompassing both data and power in a single compact and lightweight solution, the connectors are optimised for avionics, defence, space and motorsport. Among the key target applications are robotics, unmanned aerial vehicles (UAVs), battery management and satellites.

The connectors should enable engineers to streamline their designs, improve size and weight profiles and reduce bill-of-materials costs by using a smaller component than comparable Micro-D connectors. By combining power and signal in one robust mating pair, Harwin says savings can be made in both weight and space, without any compromise in performance or longevity.

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HIGHLY SENSITIVE DIODE CONVERTS MICROWAVES TO ELECTRICITY

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The Japan Science and Technology Agency (JST), Fujitsu and the Tokyo Metropolitan University have developed a highly sensitive rectifying element in the form of a nanowire backward diode, which can convert low-power microwaves into electricity. The technology is expected to play a role in harvesting energy from radio waves in the environment, in which electricity is generated from ambient radio waves such as those emitted from mobile phone base stations.

In preparation for the commencement of the true IoT era, energy-harvesting technologies, which transform the minute sources of energy in the surrounding environment into electricity, have come under the spotlight as means for creating sensor networks that function without batteries. One such example re-uses as electricity the low-power radio waves (microwaves), ubiquitous in open space, that are emitted from mobile phone base stations, for use in communications. Equipment used in generating electricity from ambient radio waves consists of a radio wave power generating element, which includes an antenna for collecting radio waves and a rectifying element (diode) that rectifies the radio waves.

The responsiveness (sensitivity) of a diode to microwaves largely depends on the steepness of rectification characteristics and on diode size (capacity). Generally, Schottky barrier diodes, which utilise the rectification occurring at the junction formed between a metal and a semiconductor, are used as the diodes for power conversion. Due to rectification characteristics becoming slow at extremely low voltages and the size of elements being larger than several micrometres (μm), however, sensitivity to low-power microwaves weaker than microwatts (μW) was insufficient, and it was difficult to convert ambient radio waves into electricity. This led to a demand for diodes with increased sensitivity.

The researchers carried out development to create a diode with higher sensitivity. Specifically, they shrank the capacity of and miniaturised a backward diode that is capable of steep rectification operations with zero bias, as rectification occurs by joining two different types of semiconductors and current flows with a different principle (tunnel effect) than conventional Schottky barrier diodes.

Conventional backward diodes were formed by processing the thin film of a layered compound semiconductor into a disk shape via etching. Nonetheless, because the materials are prone to damage under processing, it was difficult to finely process diodes to a submicron size and operate them.

By adjusting the ratio (composition) of the constituent elements of the connected semiconductor materials and, at a minute level,

the density of the added impurities, the researchers succeeded in growing crystals in nanocrystals with a diameter of 150 nm comprising n-type indium arsenide (n-InAs) and p-type gallium arsenide antimonide (p-GaAsSb) for a tunnel junction structure necessary for the characteristics of the backward diode. Moreover, in the process for implanting insulating material around the nanowire and the process for forming electrode film with metal on both ends of the wire, a new technology was used for mounting that does not damage the nanowire. As a result, they were able to form a submicron-sized diode, which was difficult to do with conventional miniaturisation process technology for compound semiconductors, and thereby succeeded in developing a nanowire backward diode with over 10 times the sensitivity of conventional Schottky barrier diodes — said to be a world first.

In testing the new technology in the microwave frequency of 2.4 GHz, which is currently used in the 4G LTE and Wi-Fi communication line standards for mobile phones, the sensitivity was 700 kV/W — roughly 11 times that of the conventional Schottky barrier diode (with a sensitivity of 60 kV/W). Therefore, the technology can efficiently convert 100 nW-class low-power radio waves into electricity, enabling the conversion of microwaves emitted into the environment from mobile phone base stations in an area that is over 10 times greater than was previously possible (corresponding to 10% of the area in which mobile phone communications are possible). This has led to expectations that it can be used as a source of power for sensors.

In the future, it is expected that the newly developed nanowire backward diode will be applied in using plentiful ambient radio wave energy in 5G communications, serving as a stable power source of sensors and contributing to battery-free sensors used to monitor infrastructure such as constructions and buildings. Going forward, the research group will further increase the sensitivity of the diode, optimise the diode-integrated antenna and add power control for voltage consistency, aiming to realise a technology that can generate power anywhere using ambient radio waves.

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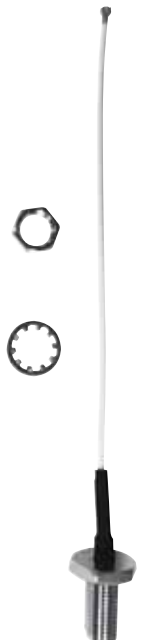
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OPEN HARDWARE COMPUTER

BeagleBone AI, created by the BeagleBoard.org Foundation, is a powerful open hardware computer that makes it easy to explore how artificial intelligence (AI)

can be used in a variety of applications, such as automation in industrial, commercial and home designs.

The device is built on a Texas Instruments Sitara AM5729 processor with dual-core Arm Cortex-A15 subsystem, and includes two TI C66x DSPs and four embedded vision engine (EVE) cores with TI Deep Learning (TIDL) support. Bolstering the board's graphics and display capabilities are an IVA-HD subsystem with support for 4K at 15 fps, a 2D graphics accelerator and a dual-core 3D GPU.

The product includes 1 GB of RAM and 16 GB of onboard eMMC flash, two dual-core programmable real-time units (PRU) and a pre-installed Debian Linux distribution. The board offers Gigabit Ethernet, 802.11ac Wi-Fi, Bluetooth 4.2 connectivity options, and mechanical and header compatibility with the open source BeagleBone Black. The board also includes connectors for micro-HDMI, USB Type-C for power and SuperSpeed dual-role controller, and USB 2.0 host.

Mouser Electronics
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The clips can be used for the low-resistance connection of the cable shield with the grounding point — such as a circuit board, metal plane or casing — thus improving the cable's EMC properties.

Würth Electronics Australia Pty
www.we-online.com

POWER-FACTOR CONTROLLER

Combining the flexibility of digital power with the responsiveness of analog algorithms, STMicroelectronics' STNRGPF12 dual-channel interleaved boost-PFC controller is easily configured and optimised using the company's eDesignSuite software.

Suited to applications over 600 W, the product is designed to enhance efficiency in equipment as diverse as industrial motor controls, charging stations, uninterruptible power supplies, 4G and 5G base stations, welding machines, telecom switches, home appliances and data-centre power supplies.

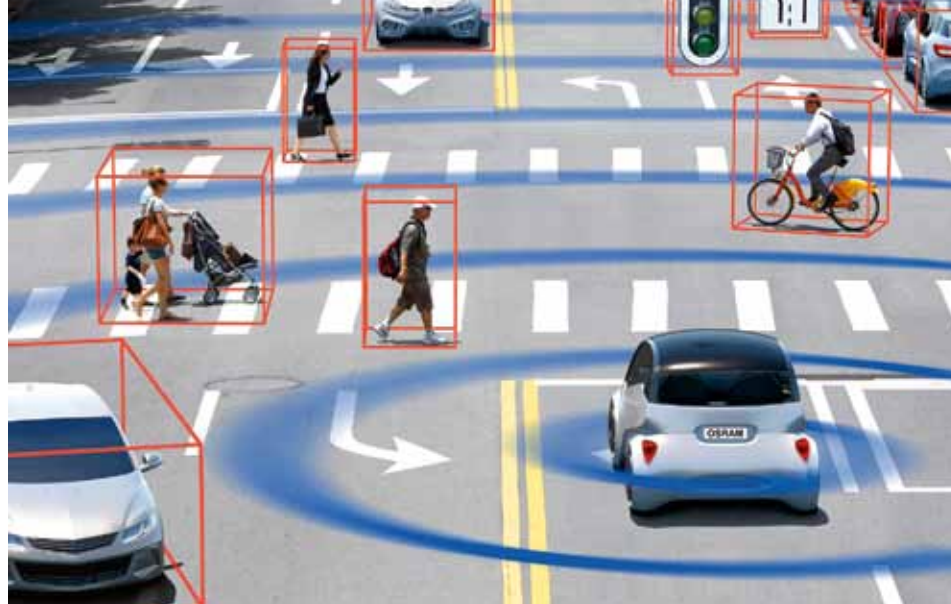
The device operates in continuous-conduction mode (CCM) at fixed frequency with average-current-mode control. The inner current loop utilises a hardware analog proportional-integral (PI) compensator, while the outer voltage loop is performed by a digital PI controller with fast dynamic response. This enables the product to manage cascaded control of the voltage and current loops to regulate the output voltage by acting on the total average inductor current.

Rich feature integration includes digital inrush-current limiting, which leverages silicon controlled rectifiers (SCR) in the high-side switching circuitry to facilitate soft-start management and enhance system robustness. The unit also supports load feed-forward, current balancing, phase shedding and fan control. An integrated UART allows access to non-volatile memory for user configuration of PFC parameters to meet specific application needs and permits monitoring of parameters in the field.

Users can unleash the potential of the product by taking advantage of ST's extensive ecosystem, which includes the STEVAL-IPFC12V1 dual-channel 2 kW interleaved PFC reference design, as well as the configuration software, to jumpstart their designs.

STMicroelectronics
Pty Ltd
www.st.com





LIDAR LASERS FOR AUTONOMOUS VEHICLES

Osram has released two AEC-Q102 qualified four- and single-channel pulse lasers for LiDAR (light detection and ranging) applications — the SPL S4L90A_3 A01 and SPL S1L90A_3 A01 — offering efficiency of up to 33%.

A central aspect in terms of safety in autonomous vehicles is the range of the infrared light source; a powerful laser is required to be able to look as far ahead as possible. Both products showcase an output power of 125 W at 40 A per channel. Due to low thermal resistance of 30 K/W for the single-channel-version (SPL S1L90A_3 A01) and 17 K/W for the four-channel device (SPL S4L90A_3 A01), heat is easily dissipated from the component, even at high currents.

The four-channel version features a chip with four emission areas that deliver an optical power at 480 W. The laser enables a long detection range at a size of 3.35 x 2.45 x 0.65 mm, making it only slightly larger than the single-channel version (2 x 2.3 x 0.65 mm).

Due to the SMT lasers' high power and extended duty cycle range of up to 0.2%, users can expect to reach a long detection range with good resolution. Additionally, eye-safe system designs can be achieved with the high-power 905 nm products. The package design also enables short pulse widths of around 2 ns.

Osram Australia Pty Ltd
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Motherboard assembled for medical wearable devices

Medical devices call for extreme reliability and accuracy due to their special application requirements, and medical care has been one of PCBCart's leading business scopes since the assembly service provider was established in 2005.

Recently, PCBCart completed a PCBA project for a patch insulin pump system developed by MicroTech Medical, which specialises in development, manufacturing, sales and maintenance of Category II and III medical equipment. MicroTech Medical later expressed great satisfaction with the performance of the assembled PCBs.

The assembled PCB in this project was a motherboard that was required to initialise the patch insulin pump, display the user's data concerning blood glucose, calculate bolus and basal increments, and

instruct the user to inject the proper amount of insulin at the right time. To implement the above functions, double-sided SMT assembly was called for on a 1 mm-thick bare PCB, using ENIG as a surface finish.

To minimise product, the project adopted a large number of BGAs, QFNs and LCCs, such as TPS65217DRSL (0.4 mm pitch QFN), TLV320AIC3106IZQE (0.5 mm pitch BGA), MT29F2G08ABAEAH4-IT:E (0.8 mm pitch BGA), AM3354BZCZ100 (0.8 mm pitch BGA), BG connectors, etc. The smallest package size is 0201.

To be fully compatible with the project's requirements, engineering staff at the PCBCart plant carried out professional operating procedures to conform to quality standards. SMT assembly at the PCBCart plant goes through solder paste printing, SPI, placement, reflow soldering, AOI, etc, after which inspections or tests are conducted in order to confirm product quality.

"We feel great satisfaction towards PCBCart for its high-level PCBA capability and high reliability," said Zhao, Purchasing Manager at MicroTech Medical. "The manufacturing procedure is totally traceable in the whole process and we don't need to worry about lead time. We've decided to build long-term cooperation with PCBCart on this project and we're also expecting more."

"We are quite satisfied with the quality of assembled PCBs provided by PCBCart," added Wang, Quality Manager at MicroTech Medical. "All the boards pass input and output tests and drop tests. We're very happy to see that."

PCBCart
www.pcbcarts.com



HIGH-PERFORMANCE REFLOW SOLDERING

The Neoden IN6 reflow oven was carefully designed with proper heating elements and next-generation sensors that ensure consistent and even heating throughout the entire length of the process chamber. There is also a built-in filtration system for the solder smoke, eliminating the issue of air contamination.

The product requires no external ventilation system, as all safety features are included in the unit. This gives the device flexibility in where it can be placed and used in a manufacturing setting, since there is no need to worry about adequate ventilation.

The product has a responsive touch-screen control unit capable of meticulous programming options. Its manufacturing profile is customisable and the machine can have up to 16 different profiles saved at any given time, which cuts down on the time required to change over to a different profile. Errors that can be made during reprogramming are said to be effectively eliminated once the profiles have been set properly.

The six heating zones located on the top and bottom of the reflow oven ensure stable and uniform heating for all the PCB components. The temperature can be easily viewed through the display located on the side of the oven and can be stabilised within $\pm 0.2^{\circ}\text{C}$.

The full hot-air convection system offers a complete soldering performance, no matter the project. The conveyor speed ranges from 15 to 60 cm/min.

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MULTIFUNCTION, WATERPROOF, DURABLE KEYPADS

Using touch to trigger functions is an everyday occurrence; however, Setolic's strain gauge technology makes it possible to apply touch functionality to almost any material, including rigid metals such as stainless steel and aluminium, glass, plastic, ceramics and wood. This allows a product to have keys printed directly onto its housing; when the user touches the keys, a slight deformation occurs in the material.

The strain gauge sensor network recognises even sensitive mechanical deformations to determine the location, pressure and duration of the press, then activate the key. The details of the pressure and duration of the press are also transferred, enabling multiple functions to be programmed from the same key.

The sensors for each key are mounted on a PCB, which in turn is mounted behind the housing material, resulting in a keypad that is completely sealed and has no moving parts. Offering IP69K ratings, the keypad is waterproof, durable and seamless. Additional functions such as LED illumination and haptic feedback can be included.

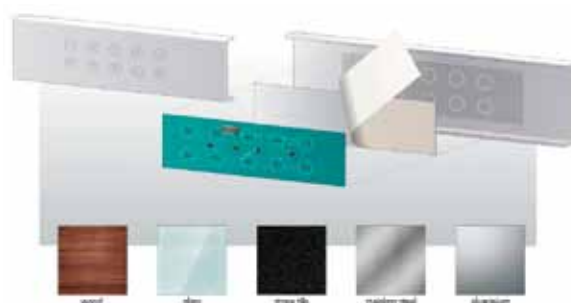
As the keys are operating a force sensor, measurements can be taken on the force applied to a given key. This means that a light touch can be differentiated from a firm, hard key press. The different press type can then be used to operate different functions, such as a volume control.

The keypads can incorporate visual feedback using LEDs and audio feedback. Additionally, the keypads can provide tactile feedback using an integrated vibration motor, which gives a different feel depending on the front surface material.

Typical applications include medical, transport and industrial equipment; household goods; products requiring special aesthetic design; and products that must be robust.

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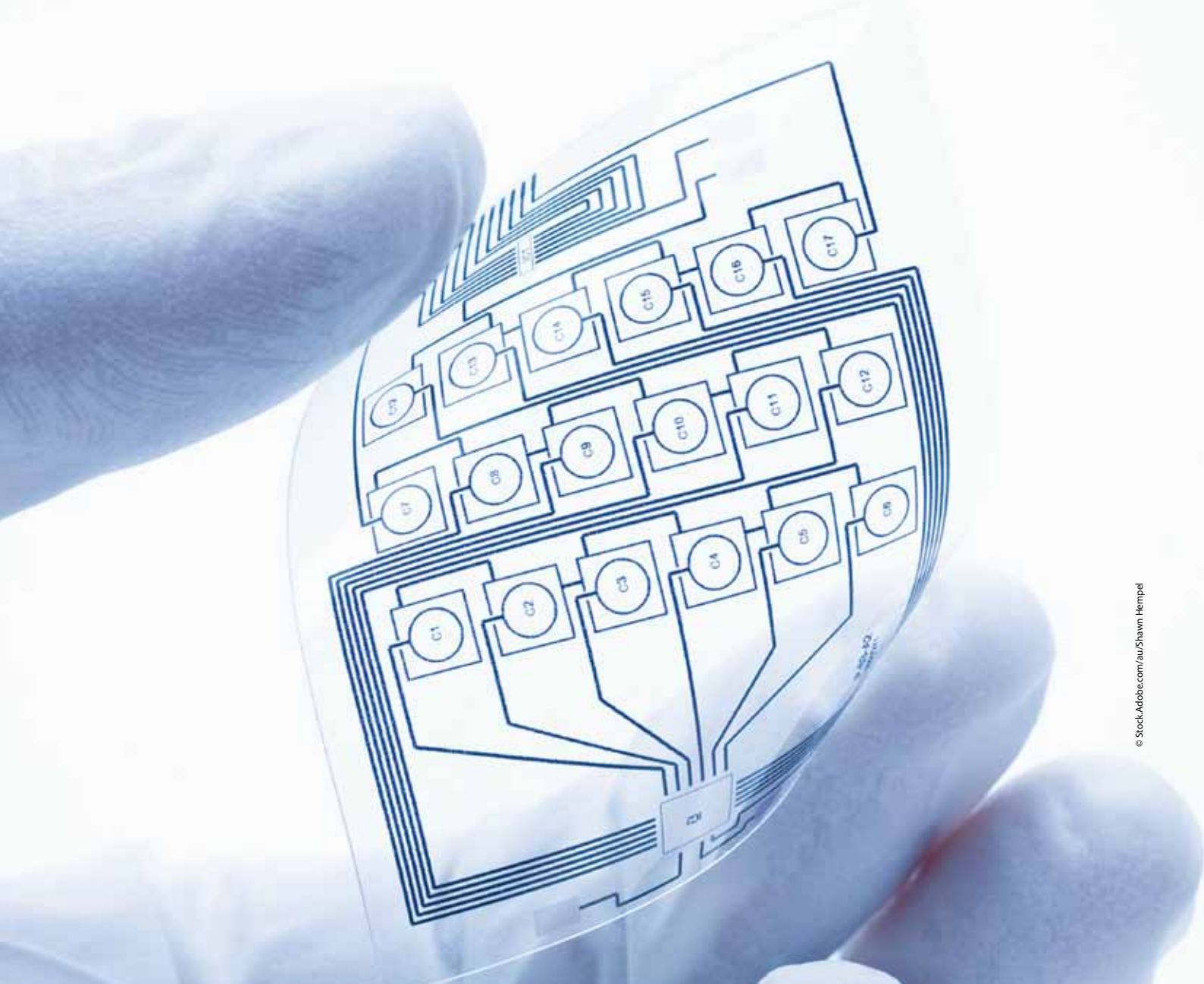
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PRINTED ELECTRONICS: THE DEFINING TRENDS IN 2019

Raghu Das, CEO

The printed electronics industry has been quietly refocusing over the last few years, with players seeking specific opportunities where the technology adds strong value for the application.

This has been as niche as utilising inkjet printing as a small part of the process of producing etched circuit boards, replacing five process steps with one, and reducing material consumption and the time to change circuit designs to creating new industries based on platforms such as in-mould electronics where there is clear added value over incumbent processes.

Of course fundamental research is still ongoing across many fronts, but the order of the day is identifying specific needs and opportunities. In this article we explore some of the key trends in printed electronics in 2019.

Data is taken from the new IDTechEx report 'Printed, Organic and Flexible Electronics 2020–2030', which provides a complete and detailed assessment of the entire industry, which IDTechEx

has now covered for almost 20 years. This looks at the big picture, not just printed devices but also those which may be flexible or based on functional organic materials.

Five key trends in 2019

1. In-mould electronics gains momentum

In-mould electronics (IME) is a subset of structural electronics — ultimately 3D electronics with benefits including fewer components to integrate, faster turnaround times, ease of design and light weighting. It is also cost-competitive. The 2019 market for IME is \$5.6 million — barely a market — but one which IDTechEx expects to grow to over \$1 billion in 2029. With strong engagement from automotive and whitegoods appliance makers to use IME for human machine interfaces, adoption is mostly hindered by scale-up and reliability testing proof which is rapidly being worked through.

2. 5G and electric vehicles create new markets for conductive inks

The increasing interest and inevitable move to 5G poses new material opportunities, in particular for electromagnetic (EMI) shielding due to the higher frequencies employed by 5G. IC plating can be slow, relatively expensive and difficult to get good coverage on all sides of the IC package. This is being targeted by those in conductive inks.

The adoption of electric vehicles means the greater use of power semiconductors. Here heat dissipation and management is an issue, and therefore printable thermal interface materials represent a large emerging opportunity — and not just for power semiconductors in vehicles but also in other applications such as high-power LEDs.

3. Component providers move downstream in search of niches

Printed or flexible components with new capabilities do not always replace existing components on a like for like basis, unless there is a problem with the existing component. Often they enable new things to be done thanks to their new attributes. In this case the supplier of such a novel component is not just inventing the component but also often needs to get involved in inventing the product and demonstrating the market demand. Numerous companies have therefore moved downstream, from creating electronic skin patches using flexible printed batteries to warehouse management systems using printed flexible organic photodetector strips.



PRINTED OR FLEXIBLE COMPONENTS WITH NEW CAPABILITIES DO NOT ALWAYS REPLACE EXISTING COMPONENTS ON A LIKE FOR LIKE BASIS, UNLESS THERE IS A PROBLEM WITH THE EXISTING COMPONENT.

4. Health care, health care, health care

The ability to implement flexible and stretchable electronics is being increasingly utilised by the healthcare and related wellness industry. Consumer electronics companies are pivoting their wearable technology devices to being more focused on health care. The market for medical wearables over the coming five years will grow faster than the overall wearable technology market.

Companies are exploiting new form factors of electronics — such as stretchable sensors — to create increased user comfort while providing ongoing actionable data. Significant developments in gas sensors, enabled by materials such as graphene and carbon nanotubes, can maximise the benefit of utilising the many biomarkers in breath, which is also an unobtrusive detection method versus alternatives.

5. Fixing hybrid electronics

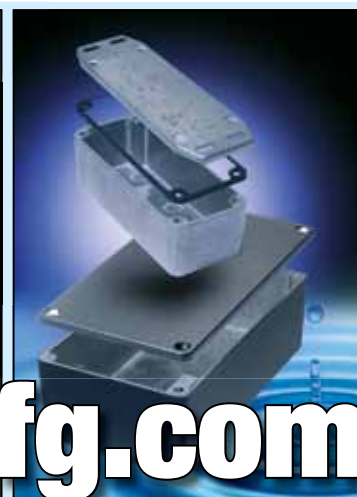
Hybrid electronics — the mixture of conventional components and flexible or printed electronics components where needed — can bring the best of both worlds. However, there are several bottlenecks, which have mostly been treated as afterthoughts but are now holding back volume use. Examples include the need for conductive adhesives to attach components that can be cured at low temperature to utilise low-temperature substrates and having high-speed automated equipment to handle the many different shapes and formats of components and assemble these.

These issues are still works in progress, but so far 2019 has seen some of these hurdles being broken down, which will open up more use cases.

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BATTERY MONITOR IC

With the MAX17853 battery monitor IC from Maxim Integrated Products, designers can achieve ASIL-D compliance for automotive applications using a single chip for a safe battery management system. Targeting mid-to-large cell count configurations for automotive applications, such as battery packs for electric and hybrid vehicles, the product's flexible architecture (Flexpack) allows users to rapidly make changes to their module configurations to quickly respond to market demands, without spinning and qualifying additional boards.

Achieving safety compliance in automotive applications can require adding redundant components to the system. The MAX17853 is claimed to be the only ASIL-D-compliant IC for mid-to-large cell count configurations, enabling users to create a system that meets a high level of safety for voltage, temperature and communication. Also contributing to higher safety is the device's battery cell balancing system, which automatically balances each cell by time and voltage to minimise risk of overcharging. Users can achieve all this without adding extra components such as redundant comparators to help achieve smaller form factors.

In addition, the device is said to reduce system BOM cost by up to 35% compared to competitive solutions, enabling the user to achieve lower overall cost for their BMS solution. The IC also supports multiple channel configurations (8–14 cells) with one board, enabling users to reduce design time by up to 50% through reduced validation and qualification time.

Avnet Electronics Marketing

www.em.avnetasia.com



MULTIPROCESSOR SYSTEM-ON-CHIPS

Xilinx Zynq UltraScale+ multi-processor system-on-chips (MPSOCs) combine a high-performance Arm-based multicore, multiprocessing system with ASIC-class programmable logic. The de-

vices deliver high scalability and can offload critical applications, such as graphics and video pipelining, to dedicated processing blocks. They also include a full complement of integrated peripherals and connectivity cores suitable for next-generation applications such as 5G wireless, automotive ADAS and Industrial Internet of Things (IIoT).

The MPSOCs comprise three distinct variants (CG, EG and EV), each of which includes two or four Arm Cortex-A53 cores and two Arm Cortex-R5 real-time processing units. The dual-core CG devices are optimal for industrial motor control and sensor fusion.

Both the EG series and EV series devices feature four Cortex-A53 cores, as well as an Arm Mali-400 graphics processing unit. The EV series also includes a video codec unit that supports H.265 High Efficiency Video Coding (HEVC) and H.264 Advanced Video Coding (AVC) standards, making them suitable for multimedia, ADAS and surveillance applications.

Mouser Electronics

au.mouser.com



DATA CARTRIDGE

The LTO Ultrium8 Data Cartridge (LTO-8), from FUJIFILM, allows for the backup and archive of large-capacity data. It utilises the company's barium ferrite (BaFe) magnetic particles, which offer useful magnetic properties, good recording/retrieval performance and long-term durability.

With LTO-8, Fujifilm has further developed its NANOCUBIC technology to produce even smaller BaFe magnetic particles than those used in LTO-7. The magnetic particles are separated by highly controlled dispersion process and the tape surface roughness is controlled, achieving smooth surface of magnetic layer with enhanced NANO coating technology.

In this way, Fujifilm has increased the storage capacity up to 30 TB (12 TB for non-compressed data) — twice the capacity of the LTO-7 — and high-speed data transfer reaching 750 MBps (360 MBps for non-compressed data). Furthermore, appropriate material design has allowed for high tracking performance and durability for the magnetic heads in the tape drives, resulting in stability and high performance.

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CABINET COOLER SYSTEMS

EXAIR's Hazardous Location Cabinet Cooler Systems have achieved the UL classified designation for Div1 environments. They have been tested by UL and passed the stringent requirements for use on classified purged and pressurised electrical enclosures within Class I Div 1, Groups A, B, C and D; Class II Div 1, Groups E, F and G; and Class III environments. The cooling capacity of up to 5600 Btu/h is suitable for electrical enclosures with problematic overheating. The coolers are CE compliant and available for NEMA 4 and 4X enclosures.

HazLoc Cabinet Coolers convert an ordinary supply of compressed air to -7°C without refrigerants or CFCs. The cold air is circulated through the enclosure to eliminate high-temperature malfunction. They mount in a standard electrical knockout while keeping the NEMA 4 or 4X (IP66) rating of the enclosure. The cabinet cooler systems include an auto drain filter separator to ensure no moisture passes to the inside of the electrical enclosure. An optional thermostat control minimises compressed air use and keeps the enclosure at $\pm 1^{\circ}\text{C}$ of the setting.

EXAIR's full line of cabinet cooler systems is available for NEMA 12, 4 and 4X enclosures from 275 to 5600 Btu/h. They are UL listed, conform to the CE general safety directive for machinery and have no moving parts to wear out.

Applications include cooling control panels, PLCs, microprocessors, fractional Hp variable frequency drives and robotics.

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CREATING CONDUCTIVE YARN FOR FUNCTIONAL FABRIC

Researchers from Drexel University have developed a way to coat cellulose yarn with flakes of a conductive, two-dimensional material, to imbue it with the conductivity and durability it needs to be knitted into functional fabrics. Their work has been published in the journal *Advanced Functional Materials*.

Most attempts to turn textiles into wearable technology use stiff metallic fibres that alter the texture and physical behaviour of the fabric. Other attempts to make conductive textiles using silver nanoparticles, graphene and other carbon materials raise environmental concerns and come up short on performance requirements. Furthermore, the coating methods that are successfully able to apply enough material to a textile substrate to make it highly conductive also tend to make the yarns and fabrics too brittle to withstand normal wear and tear.

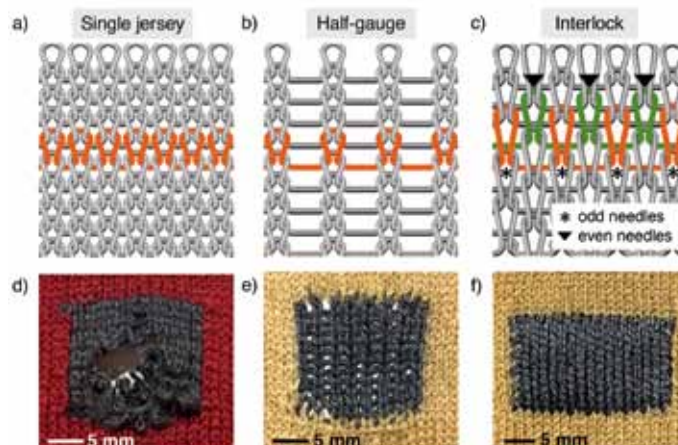
"Some of the biggest challenges in our field are developing innovative functional yarns at scale that are robust enough to be integrated into the textile manufacturing process and withstand washing," said Professor Genevieve Dion, Director of Drexel's Center for Functional Fabrics.

"We believe that demonstrating the manufacturability of any new conductive yarn during experimental stages is crucial. High

electrical conductivity and electrochemical performance are important, but so are conductive yarns that can be produced by a simple and scalable process with suitable mechanical properties for textile integration. All must be taken into consideration for the successful development of the next-generation devices that can be worn like everyday garments."

Prof Dion, a pioneer in the field of wearable technology, teamed up with Professor Yuri Gogotsi, a leading researcher in the area of two-dimensional conductive materials, to approach the challenge of making a conductive yarn that would hold up to knitting, wearing and washing. Prof Gogotsi's group was part of the Drexel team that discovered highly conductive two-dimensional materials known as MXenes in 2011, and have been exploring their properties and applications for them ever since. His group has since shown that it can synthesise MXenes that mix with water to create inks and spray coatings without any additives or surfactants — a revelation that made them a natural candidate for making conductive yarn that could be used in functional fabrics.

"Researchers have explored adding graphene and carbon nanotube coatings to yarn; our group has also looked at a number of carbon coatings in the past," Prof Gogotsi said. "But achieving the level of conductivity that we demonstrate with MXenes has not been possible until now. It is approaching the conductivity of silver nanowire-coated yarns, but the use of silver in the textile industry is severely limited due to its dissolution and harmful effect on the



environment. Moreover, MXenes could be used to add electrical energy storage capability, sensing, electromagnetic interference shielding and many other useful properties to textiles.”

In its basic form, titanium carbide MXene looks like a black powder. But it is actually composed of flakes that are just a few atoms thick, which can be produced at various sizes. Larger flakes mean more surface area and greater conductivity, so the team found that it was possible to boost the performance of the yarn by infiltrating the individual fibres with smaller flakes and then coating the yarn itself with a layer of larger-flake MXene.

The team created the conductive yarns from three common, cellulose-based yarns: cotton, bamboo and linen. They applied the MXene material via dip-coating, which is a standard dyeing method, before testing them by knitting full fabrics on an industrial knitting machine. Each type of yarn was knitted into three different fabric swatches using three different stitch patterns — single jersey, half-gauge and interlock — to ensure that they are durable enough to hold up in any textile from a tight-knit jumper to a loose-knit scarf.

“The ability to knit MXene-coated cellulose-based yarns with different stitch patterns allowed us to control the fabric properties, such as porosity and thickness for various applications,” the researchers wrote.

To put the new threads to the test in a technological application, the team knitted some touch-sensitive textiles. Not only did the MXene-based conductive yarns hold up against the wear and

tear of the industrial knitting machines, but the fabrics produced survived a battery of tests to prove its durability. Tugging, twisting, bending and washing did not diminish the touch-sensing abilities of the yarn, the team reported — even after dozens of trips through the spin cycle.

The researchers suggest that the ultimate advantage of using MXene-coated conductive yarns to produce these special textiles is that all of the functionality can be seamlessly integrated into the textiles. So instead of having to add an external battery to power the wearable device, or wirelessly connect it to your smartphone, these energy storage devices and antennas would be made of fabric as well — an integration that, though literally seamed, is a much smoother way to incorporate the technology.

“Electrically conducting yarns are quintessential for wearable applications because they can be engineered to perform specific functions in a wide array of technologies,” the team wrote.

Using conductive yarns also means that a wider variety of technological customisation and innovations are possible via the knitting process. For example, the study authors suggested, “the performance of the knitted pressure sensor can be further improved in the future by changing the yarn type, stitch pattern, active material loading and the dielectric layer to result in higher capacitance changes”.

Prof Dion’s team at the Center for Functional Fabrics is already putting this development to the test in a number of projects, including a collaboration with textile manufacturer Apex Mills — a leading producer of material for car seats and interiors. Prof Gogotsi suggests the next step for this work will be tuning the coating process to add just the right amount of conductive MXene material to the yarn for specific uses.

“With this MXene yarn, so many applications are possible,” Prof Gogotsi said. “You can think about making car seats with it so the car knows the size and weight of the passenger to optimise safety settings. Textile pressure sensors could be in sports apparel to monitor performance, or woven into carpets to help connected houses discern how many people are home. Your imagination is the limit.”

SENSORS

Image © Astrid Eckert/TUM.

Thanks to the synthetic skin developed by Professor Gordon Cheng and his team, robot H-1 is able to feel the touch of a human.

ARTIFICIAL SKIN IMPROVES SENSORY ABILITY OF ROBOTS

Sensitive synthetic skin enables robots to sense their own bodies and surroundings — a crucial capability if they are to be in close contact with people.

With this in mind, researchers at the Technical University of Munich (TUM) have combined artificial skin with control algorithms, creating what is claimed to be the first autonomous humanoid robot with full-body artificial skin. As documented in the journal *Proceedings of the IEEE*, the skin cells were originally developed around 10 years ago, but their potential was only recently fully realised upon their integration into a sophisticated system.

The artificial skin developed by Professor Gordon Cheng and his team consists of hexagonal cells about 2.5 cm in diameter. Each is equipped with a microprocessor and sensors to detect contact, acceleration, proximity and temperature. Such artificial skin enables robots to perceive their surroundings in much greater detail and with more sensitivity. This not only helps them to move safely, it also makes them safer when operating near people and gives them the ability to anticipate and actively avoid accidents.

The biggest obstacle in developing robot skin is computing capacity. Human skin has around 5 million receptors, and efforts to implement continuous processing of data from sensors in artificial skin soon run up against limits. Previous systems were quickly overloaded with data from just a few hundred sensors.

To overcome this problem, Prof Cheng and his team do not monitor the skin cells continuously, but rather with an event-based system that reduces the processing effort by up to 90%. The trick is that the individual cells transmit information from their sensors only when values are changed. This is similar to the way the human nervous system works. For example, we feel a hat when we first put it on, but we quickly get used to the sensation. There is no need to notice the hat again until the wind blows it off our head. This enables our nervous system to concentrate on new impressions that require a physical response.

With the event-based approach, Prof Cheng and his team have now succeeded in applying artificial skin to a human-size autonomous robot not dependent on any external computation. The H-1 robot is equipped with 1260 cells (with more than 13,000 sensors) on its upper body, arms, legs and even the soles of its feet. This gives it a new 'bodily sensation' — for example, with its sensitive feet, H-1 is able to respond to uneven floor surfaces and even balance on one leg.

With its special skin, the H-1 can even give a person a hug safely. That is less trivial than it sounds, as robots can exert forces that would seriously injure a human being. During a hug, two bodies are touching in many different places. The robot must use this complex information to calculate the right movements and exert the correct contact pressures.

"In areas such as nursing care, robots must be designed for very close contact with people," Prof Cheng said.

The robot skin system is also highly robust and versatile. Because the skin consists of cells, and not a single piece of material, it remains functional even if some cells stop working.

"Our system is designed to work trouble-free and quickly with all kinds of robots," Prof Cheng said. "Now we're working to create smaller skin cells with the potential to be produced in larger numbers."



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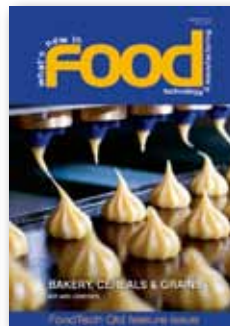
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