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Hardware-based trust provides key to

IoT security



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Dear readers,

Not a single week passes-by without the announcement of record-breaking OLED output efficiencies with cheap and scalable manufacturability or deeper photonics integration for on-chip optical interconnects.

Improving battery chemistries or cell design in order to reach higher energy densities is another of the recurrent topics that regularly feed our electromobility pages.

Our News & Technology pages are a testimony of the exciting changes driven by the electronics industry. Other features you'll find covered in your October edition of **eeNews Europe** include Digital Signal Processing, Microwave & RF Circuits, and Test & Measurement.

Month after month, year after year, discover how technology matures and moves from the lab to the industrialization stage.

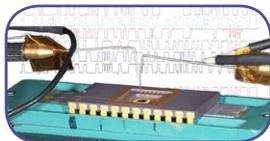
Enjoy the October edition of **eeNews Europe** and don't hesitate to get in touch and tell us your stories, from starting up a company to developing your first prototypes, achieving your first product design-in, sharing your insight on this fast-paced industry or to contribute your expertise on some of the topics we'll be covering along the year.

Julien Happich
Editor in Chief



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Specialty foundry Tower gains momentum

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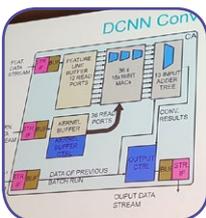


30 - 35: DIGITAL SIGNAL PROCESSING

ST preps second neural network IC

STMicroelectronics is designing a second iteration of the neural networking technology that the company reported on at the International Solid-State Circuits Conference (ISSCC) in February 2017.

This is set to be a product distinct from what is described as a demonstrator IC, and it is a technology that CEO Carlo Bozotti is enthusiastic about.



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With narrowband the path to IoT is wider

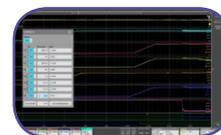
NB-IoT could enable sub-\$5 devices with ten-year plus battery life, could cope with devices being situated in remote rural or basement locations, and could support as many as 50,000 devices from a single cell tower. But even that's not the full story behind the interest in NB-IoT.



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Power sequencing verification made easier with an 8-channel oscilloscope

Using a 4-channel oscilloscope to verify power rail timing in an embedded system can be time-consuming. This article shows some examples using an 8-channel scope.



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This month, Gas Sensing Solutions Ltd (GSS) is giving away 10 of its MiniIR CO₂ sensor evaluation kits, worth £200 each, for *eeNews Europe's* readers to put to the test.



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Stepping up security in chip design: Texplained

By Julien Happich

Headquartered in Valbonne, South of France, start-up Texplained is on a mission to render chip-level reverse engineering a dead-end for IC counterfeiters. Although today's Common Criteria Certification schemes for secure chips consider laboratory-grade invasive attacks as a negligible threat, Texplained's CEO Clarisse Ginet is here to prove otherwise.

"It used to be the case, maybe 15 years ago, that invasive attacks (chemically and physically removing layers to read through a chip's architecture) were too technical and too costly to be a threat, but this is no longer the case today", argues Ginet, "Just imagine, we are a small startup and yet we were able to fund our own lab and break into most commercial chips available today."

There is a plethora of countermeasures aimed at non-invasive attacks such as Differential Power Analysis (DPA) side channel attacks for which Rambus provide noise-reduction and obfuscation IP. But the reality, argues Ginet, is that today's serious counterfeiters want it all, the chip's internals together with its embedded code, and they opt for invasive attacks most of the time since they get a 100% target hit.

"Nowadays, due to numerous countermeasures, non-invasive attacks or semi-invasive attacks have become quite difficult and bring little value to hackers", notes the CEO, "you don't really know what you are looking for and where to look, so you have to accidentally kill a lot of chips by inadvertently triggering security mechanisms."

"But once a chip has been opened up and analysed thoroughly, it is easier to guide non-invasive attacks to extract its code or to communicate with it through its standard or custom protocol. If you look at the multibillion dollar opportunities in counterfeiting payTV smart cards or producing off-branded printer cartridges and other computer peripherals, these are markets that have been broken through invasive attacks, because they offer a 100% yield."

And if most counterfeiters target consumer products shipping in the hundreds of millions, state-sponsored counterfeiters could target military-grade ICs, reverse-engineer them and replicate them with backdoors before infiltrating them into the supply chain. According to the Ginet, today's secure chips are so vulnerable that not including invasive attacks into Common Criteria Certification schemes is akin to a denial of reality.

Of course, there are chips that resist better than others, some are actively shielded with intricate metal layers, others feature PUFs (Physically Unclonable Functions), but in the end, none of these chips will resist a complete strip-out giving away all their secrets.

"It may take a few attempts, but once you've completely mapped a chip's internals, you can always find ways to bypass a shield before inducing a code leak" Ginet told *eeNews Europe*.

Yet, she says Texplained has patented a unique hardware IP solution that thwarts all attempts at leaking out the embedded

code, even when the chip has been fully analysed and understood. That means you could still duplicate a physical chip, but without ever having access to its code, it would just be dead silicon.

"Instead of adding costly shielding metal layers or trying to obfuscate a chip design, which can always be reverse-engineered anyway, we only introduce a few standard cells within the circuit to detect any attempt at extracting the code", explained Ginet.

The NVM Defender module as Texplained calls it (for the protection of Non-Volatile Memory) consists of "sensing cells" carefully placed in the critical path of the data after the instruction register.

Ginet didn't want to tell much more, though she admitted

there was some form of initial calibration run that would establish what a normal software execution flow would be like, so that any significant difference sensed by the hardware cells along that critical path would trigger a Defense Module (integrated on a custom basis depending on the chip's architecture) able to kill the chip or stop all executions.

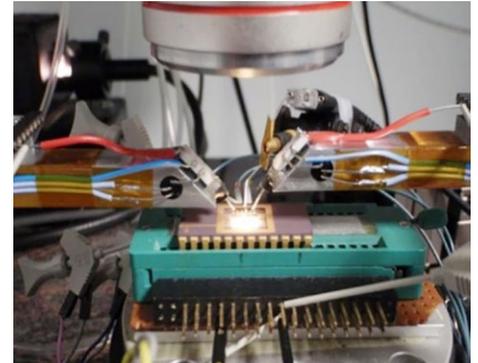
Because both the detection and the defense module are 100% designed in hardware with anti-bypass features and based on standard cells fully integrated in the digital core of the chip, they operate "on-the-fly" and intrinsically detect any deviation from a normal execution flow. They make the chip self-aware at the hardware level, rather than relying on a potentially compromised software check. The extra cells along the data path offer constant passive monitoring with no impact on power consumption.

"Our IP is minimally invasive, ranging from a few extra standard cells to maybe one hundred cells maximum depending on the chip's architecture" said Ginet, "in terms of footprint, this is practically negligible compared to the tens of thousands of standard cells you find in a typical smart card chip and certainly less costly and more effective than implementing complete metal shields or PUFs which can require up to 25 000 logic gates solution".

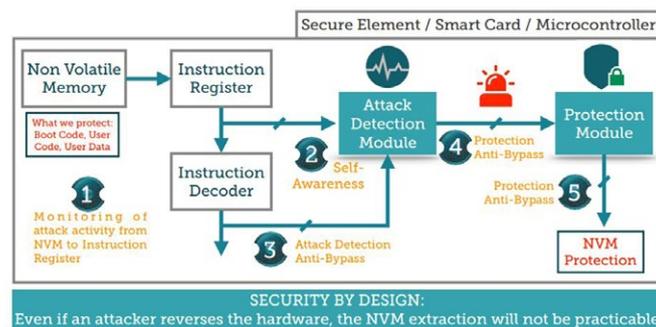
The new IP, claims Ginet, renders invasive attacks useless because you can't bypass the countermeasures, hence over with counterfeiting, cloning or code emulation on other chips.

Licensing its NVM Defender IP, Texplained charges an upfront fee plus royalties per chips produced.

Deliverables include the architecture of the countermeasure, the design specification of the detection module and support from Texplained to adapt the countermeasure to the chip's architecture for a seamless integration.



An advanced probing setup.



Texplained's NVM Defender as a bloc diagram.



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FPGA startup wins funds from Xilinx, Samsung

By Peter Clarke

Efinix Inc. (Santa Clara, Calif.), an FPGA startup founded in 2012 by a couple of veteran engineers, has raised \$9.5 million in a funding round led by FPGA vendor Xilinx Inc.

This brings the amount raised by the company to \$16 million and the money will be used to bring its first products to market. They use what the company calls 'Quantum' programmable technology, a technology the company claims gives it a 4x improvement in power-performance-area (PPA) over traditional programmable architectures. This is achievable by way of circuit-level architecture implemented on the same SRAM memory cells and baseline process technologies that rival FPGA vendors use.

The technology behind "Quantum" is the use of a universal circuit that can be used as either a routing block or for logic, according to Sammy Cheung, CEO and co-founder of Efinix.

Cheung said that traditional FPGAs use dedicated silicon blocks for routing and others for look up tables (LUTs). In contrast Efinix has block that can be configured for routing or logic depending on the circuit being implemented which allows for superior optimization and for a stripping out of complexity that is found in traditional FPGAs.

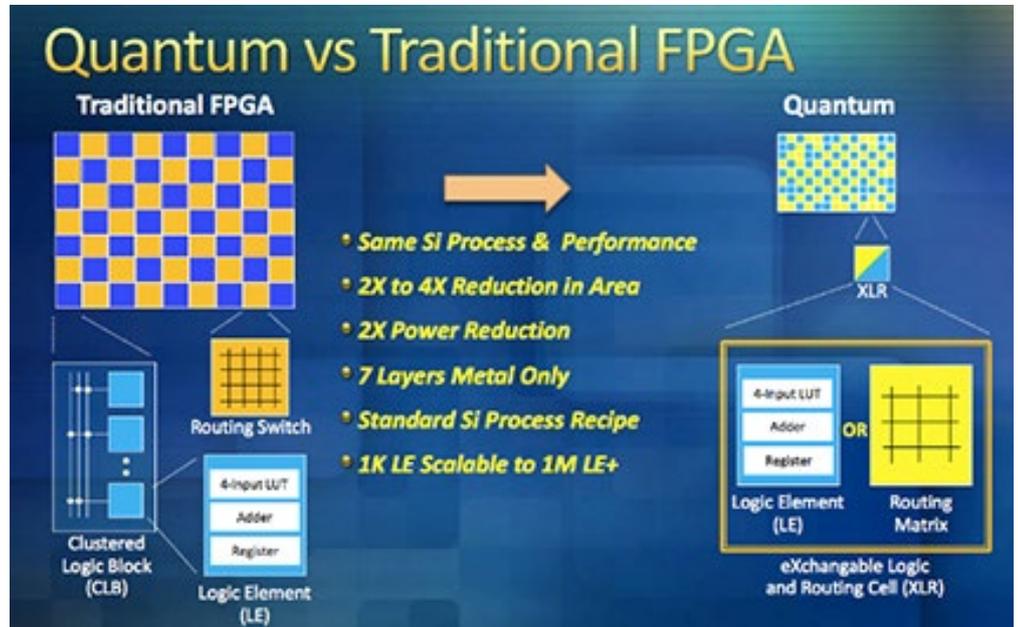
That reduction in complexity provides Efinix with its 4x advantage Cheung told *eeNews Europe*.

The investment round was led by Xilinx and Hong King X Technology Fund (HKX). Others in the round included Samsung Ventures Investment, Hong Kong Inno Capital and Brizan Investments.

"High-volume applications and markets are prime targets for our Quantum-accelerated products," said Cheung, in a statement. "Combining our Quantum programmable technology and Efinity Integrated Design Environment, we will be launching a number of joint development projects and a new line of silicon product platforms in the coming months thanks to the funding announced today."

The Efinix hardware will initially range from 4K LUTs to 150K LUTs, Cheung said. The company reckons its technology is good for use in mobile products and machine learning applications and it will come to market as both stand-alone ICs and as FPGA fabric licensed for use within SoCs, Cheung said.

Efinix has been working with foundries Semiconductor Manufacturing International Corp. (SMIC) and Taiwan Semiconductor Manufacturing Co. Ltd. and has silicon designs in 40nm



and 28nm CMOS process technology. Cheung said the potential area advantage provided by Quantum allows the use of more mature and lower cost process nodes but he added that the company would also be pushing down below 28nm to 10nm "very soon."

"Efinix's solution can address a wide variety of applications that are typically not served by today's FPGAs," said Salil Raje, senior vice president of software and IP products group at Xilinx. "We are excited to be an investor and look forward to working with them."

A spokesperson for Samsung Ventures said: "We envision many applications that feature Quantum technology embedded inside ASICs, ASSPs, or FPGAs."

"Our priority is to do our own branded products but we want to develop a business model with more focus on customer- and application-specific circuits," Cheung said.

Cheung said that he and his co-founder Tony Ngai, CTO, had formed the company setting out to build a flexible, more efficient FPGA architecture. Conventional FPGA architectures are limited by having to engineer routing blocks for worst-case routing, are not suitable for integration in

ASICs and ASSPs because they require special silicon process recipe tweaks.

By moving to a universal block that can be either logic or routing, we gain an advantage of fine-grained flexibility and optimization, good wide bus performance and flexible pipelining for PPA trade-offs, Cheung said.

"We will get revenue this year from some customers who have prepaid but we are looking to ramp product sales in 2018, Cheung said.



Sammy Cheung, CEO of Efinix Inc.

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Hardware-based trust provides key to IoT security

Mark Patrick, Mouser Electronics



As the internet of things (IoT) develops, the issue of security is taking centre stage. The connectivity and protocol standardisation that the IoT entails increases the threat to devices and, through them, the service-networks to which they provide access. A number of threats have already become apparent, such as the hacking of motor vehicles through their internet-connected infotainment systems and a variety of attacks on industrial as well as home devices and even toys.

In many cases the hacks were comparatively basic because of weak precautions taken by the manufacturers. Devices are often shipped with a standard and easy-to-guess password. The apps used to program IoT devices often contain information about their internal data structures, providing hackers with useful ammunition.

By focusing on IoT endpoints and devices, hackers can enable a number of attack types, from simple observation for gaining information useful for a larger infrastructural attack to direct manipulation of the device or the network. What is needed is an architecture for IoT devices that builds upon a true root of trust.

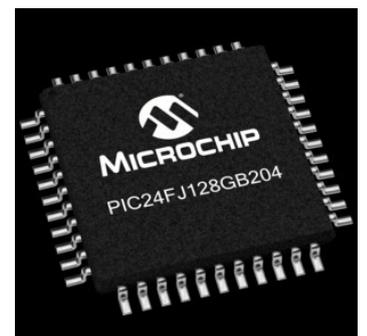
A root of trust provides a means to set up secure communication with only certified users and applications, reducing the ability of hackers to send messages to a device that may compromise its security. The root of trust also provides a means for the network itself to authenticate the device to prevent hackers from using their own

hardware break into systems by impersonating approved devices.

The keys and certificates used by secure protocols need to be stored in memory. But this needs to be a memory area that is separate from that used for application data. To be trusted, those keys and certificates need not only be valid but be protected from inspection by secure circuits in the hardware that prevent readout by any unauthorised user. Cryptographic processors complete the implementation by providing direct support for the protocols needed to securely authenticate and communicate with the device without risking the exposure of the full secret keys and certificates to other software running within the device.

Although there has been widespread criticism of the poor security of early IoT products, infrastructures based on the root-of-trust concept already exist and are in mass production. One example is that of the digital mobile phone, designed to support the GSM and later 3GPP standards, that has incorporated strong security as a key part of its makeup.

For it to be able to access the cellular wireless network, every phone must include a subscriber





identity module (SIM) that provides the means for operators to authenticate and communicate with the handset or device. A similar hardware construct is the Trusted Processor Module (TPM) originally developed for personal computers and now used in embedded products such as point-of-sale (POS) terminals. At the heart of these modules is the public key infrastructure (PKI) architecture. It is an architecture that provides number of facilities to support the various security needs of IoT devices and has begun to appear not just in devices developed for phones and PCs but leaner embedded systems.

PKI revolves around the concept of asymmetric cryptography, in which documents and other software objects are signed and checked using a combination of private and public keys. The mathematics of PKI relies on the inability to easily derive a private key from an associated public key. The public key may be disseminated freely. The private key needs to be protected. Within an embedded device, a securely made cryptoprocessor with protected memory provides the ideal substrate. One example is the PIC24FJ128GB204 with 128KB of onchip RAM and hardware cryptographic support. It is a member of the PIC24F GB2 family of microcontrollers made by Microchip Technology.

A key facility of a hardware trust module processor is to ensure that when the device boots it is running only authorised code and that an unknown outsider has not compromised it. This is known as secure boot. When the device starts up and reads the code from onboard read-only memory (ROM) it checks that each major segment has been signed by an authorised supplier. The supplier uses a private key to sign the code block. This signing process creates a one-way hash of the code itself combined with the private key. The hardware trust component examines the hash to check it for authenticity. Any changes to the codebase need to be signed using an appropriate key that the trust module checks before installation or update continues.

If the device encounters a block of code that is incorrectly signed, it will typically block the loading of the affected software and may move into a recovery state that attempts to obtain authorised code from the original supplier – possibly reverting to factory code stored in ROM – and send an alert if, it is able, to a server.

Although it is possible to implement some forms of secure boot without a hardware trust module, it is hard to ensure that the boot process will halt correctly if the hacker has penetrated far enough into the firmware. The processor in the hardware trust module can enforce security by performing decryption of key parts of the firmware on behalf of the host processor only if the hash is correct and to refuse decryption service to any software component that does not have a correct hash or key. With the ability to protect onchip keys and prevent them being changed or read out by an attacker, Microsemi's range of flash-based FPGAs, such as the SmartFusion 2, can be used to support secure-boot and other security functions.

Once the device has booted correctly, it can authenticate itself to the network using PKI mechanisms. Typically, the device will set up secure communications using a protocol such as Transport Layer Security (TLS), an adjunct to the commonly used HyperText Transfer Protocol (HTTP). Digitally signed certificates stored within the hardware trust module provide remote servers with the confidence that they are communicating with a known resource. The actual certificate is stored within the trust module so that only publicly accessible data is supplied over the network and the device's own internal bus to prevent hackers from being able to make use of eavesdropping techniques.

Without a hardware trust module, the hacker may be able to use a logic analyser or other instrument to probe the memory of the device and obtain the secret keys and certificates that can then be used to spoof the network servers.

Conversely, the IoT device needs to be sure that it is taking commands only from other devices or servers that it can trust. By having the hardware trust module check the certificates of those other devices against keys stored in protected memory the device can ensure it is communicating only with authorised systems.

As service profiles will change over time, the use of PKI exchanges allows certificates to be added or deleted. This ensures not only that services can be enhanced over time but other systems that are no longer part of the network or which are known to be compromised can be taken off the trusted list.

By taking advantage of the experience and technological infrastructure that has been developed for mobile telephony and computing, IoT manufacturers can gain a head start in providing a secure base for their products. The availability of devices such as members of Microchip's PIC24 GB2 family and the flash-based FPGAs from Microsemi provides IoT manufacturers with easy access to those technologies, giving them a solid foundation for the secure IoT.

You can learn more about the security aspect of IoT by accessing Mouser's comprehensive IoT resource at: mouser.com/applications/internet-of-things

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Specialty foundry Tower gains momentum

By Peter Clarke

Specialty foundry Tower Semiconductor Ltd. (Migdal Haemek, Israel), which trades as TowerJazz, continues to prosper under the stewardship of CEO Russell Ellwanger. *eeNews Europe* asked him about next technologies and manufacturing locations.

Revenue in the first half of 2017 was a record \$675 million, up 16 percent on the first half of 2016 and being driven by strong demand with additional manufacturing capacity coming on-stream in the United States and Japan. Gross and operating profit for the first half of 2017 were a record of \$176 million and \$110 million, respectively, increased as compared to \$134 million and \$71 million, respectively, in the first half of 2016.

So *eeNews Europe* asked Ellwanger for an update on Tower's progress; a follow up to an interview we conducted a couple of years ago.

All good so far considering Tower had annual sales of about \$100 million with a loss of twice that size in 2005, the year that Ellwanger was appointed, and reached \$1.25 billion in 2016. "Yes we've had 10 or 11 years of growth. The growth percentage has been high but we were coming from a low base," said Ellwanger. In fact, Tower's compound annual growth rate is above 25 percent and the period covers a number weak years for the semiconductor sector as a whole.

But has that been allowed because the competition from mainstream foundries against the specialists has diminished in recent years?

It was the case that larger pure-play foundries had a plan to redeploy their older wafer fabs to making More-than-Moore processes as they were bringing up new wafer fabs to do leading-edge digital IC manufacturing.

But perhaps the demands of developing those very expensive, deep nanometer processes kept those big foundries occupied and gave smaller foundries, such as Tower, a chance to grow.

"There are several foundries that do deep digital following Moore's Law and TSMC is at the leading edge. They also have a very good analog offering," commented Ellwanger. But Ellwanger also points out that the number of More-than-Moore manufacturing process offerings is extremely broad and that Tower rarely sees TSMC as a competitor in the market.

"We deal in three major technology sectors," said Ellwanger. "Power discretes and PMICs [power management ICs] are about 30 percent of revenue. RF components for front-ends, power amplifiers, low-noise amplifiers and RF infrastructure are about 30 percent, and then there's sensors. That is CMOS image sensors but specialised such as industrial vision, studio cameras, medical and x-ray using stitched dies. We also have some magnetics sensors and MEMS activities and that's growing," he added.

"Overall when you are enjoying greater than 20 percent organic growth you are doing ok," he said. "We rarely compete with TSMC. Within the area we choose to compete it is a level

playing field whereas below 10nm requires a tremendous amount of capital. For us 0.18-micron BCD is state of the art. This means we don't need so much capital. Our differentiation can be maintained through the calibre of people we employ."

Ellwanger added: "That organic growth is at above the rate of the foundry market is the best health indicator and that you are in the right markets."

Although many people speak of IoT it is a highly fragmented area of opportunity. One of the more

concrete examples is the electrification and electronification of the automobile to create a communicating vehicle. Is that something that is driving Tower's growth?

"Well it is very difficult for us to know what percentage of our power discretes goes into automotive. For PMICs I have a good feel, especially for lithium-ion batteries and we are gaining customers. RF for automotive is again a good growth segment for us. Denso used us for a 24GHz automotive radar. Lidar with cameras and MEMS is also promising. We don't have volume production at present but solid-state lidar is definitely in demand. It is a focus and a direction for the company," Ellwanger said.

"Automotive sensors are a tremendous opportunity with the need for sensor fusion across areas radar based on SiGe, lidar and CMOS image sensors." In 2016 about 20 percent of Tower's revenue was due to the automotive sector.

But the semiconductor and electronic industries are fast-moving environments. What technologies does Tower need to be bringing in?



TowerJazz's CEO Russell Ellwanger

“It is very important to have technology leadership. It is necessary but not sufficient to achieve success. That technology leadership must be within growth market and aligned with customers in multiple generations of their roadmaps,” said Ellwanger.

There are some instances where customers have brought processes to Tower and provided long-term contracts and asked Tower to take over manufacturing but increasingly Tower has to engage in leading-edge research and then go out and seek customers, Ellwanger said. But he added that it is definitely not a case of build it and they will come. “You find a partner or multiple partners to develop engineering based on that research.”

Seeking more detailed response *eeNews Europe* asked Ellwanger if Tower is moving into compound semiconductors, such as gallium nitride, to complement its position in silicon-germanium?

Ellwanger is cagey. His first point is that the silicon-germanium process is good for just about all RF applications and is cost efficient. “SiGe at 65nm is probably more than sufficient for most frequencies and has the advantage for allowing integrated chips.”

“There are different materials we are looking at and maybe they’ll work out and maybe they won’t. For compound semiconductors outside our served market then acquisition or partnership may be the way to go. There are things we are evaluating,” Ellwanger said.

But Ellwanger said that in terms of year-on-year market growth sensors is probably the biggest opportunity with a 25 to 30 percent CAGR.

The acquisition model can provide both technology and a customer, Ellwanger said. Otherwise it can be three years of technology development followed by three years of looking for a customer.

Ellwanger gives the example of discrete power where Tower took over base power production flows from Vishay, Fairchild and International Rectifier (now Infineon) and then provided incremental improvements specific to those customers. The alternative example is the PMIC design flow where Tower now works with three of the top 6 or 7 PMIC providers. Tower does this with a PMIC platform that it developed and that multiple fabless customers wanted to access. And in the RF area Tower works with manufacturing companies but who are effectively fabless in the area where Tower serves them.

So what about technology introductions in the power domain where silicon-carbide and gallium nitride are much talked about? “GaN is something we believe is needed. Right now GaN for power is a very small part of the market but at some point it will take off. We have been asked about it,” he said without saying more.

MEMS is an area where Tower is active. It is also an area where there are multiple manufacturing approaches to a fragmented set of applications. It has been argued for many years that MEMS market development has been hampered by its reputation for requiring a dedicated manufacturing process for

almost every product. Is this a suitable case for Tower to get more involved?

“We have Cavendish Kinetics as a customer with their tuneable antenna RF switch. We do make inertial sensors and speakers. But we are very selective. It has to be good performance, with a very good upside in terms of market and not too interfering with the running of a high-volume wafer fab,” said Ellwanger. He points out that the product-specific nature of most MEMS processes and the small size of MEMS makes wafer counts low and repeatedly resetting equipment to run a few wafers can be disruptive to running other processes in a large fab. “You really need a dedicated MEMS line. You would like to have that; a small line; a pilot line. Then you could transfer [a process] later to the high-volume line.”

Tower could spend its own money speculatively building such a pilot line. But Tower usually prefers to spend money alongside that of a customer who will take output.

“We have an annex at Newport Beach wafer fab built with FLIR Systems. We are willing to do a lot with key customers,” said Ellwanger. Tower makes MEMS at both Migdal Haemek and Newport Beach. However, he said there is nothing to report at present.

Along with additional processes comes the need for additional production. At present Tower seems well placed with 150mm and 200mm wafer fabs in Israel and 200mm wafer fabs in Newport Beach, California and San Antonio, Texas. By way of the TowerJazz Panasonic Semiconductor Company (TPSCO) in which Tower is the 51 percent shareholder it has control of three more fabs; 200mm fabs in Arai and Tonami Japan and a 300mm wafer fab in Ouzo, Japan.

And then there is the recently confirmed news that Tower is in partnership with Tacoma, Chinese investors and Chinese regional authorities to build a 200mm wafer fab in Nanjing, China. Tower has received an initial payment of \$18 million and according to reports there is a longer-term plan for a 300mm wafer fab in the same industrial park.

Meanwhile a project in India that Tower was involved with over several years appears to have fallen apart. So does this mean that India is now out of the running as a semiconductor manufacturing location for Tower and other chips companies?

Ellwanger said: “We were strongly involved in India for the building of a 300mm wafer fab. The government slowed it to a three-phase process and with that slow-down the project came to a point where the original lead partner could no longer meet the financial commitment.”

He continued: “The main learning isn’t about India. It was about not having a binding MOU [memorandum of understanding]. In the case of China there was a binding MOU signed in July 2016 and we have now received initial money this year.”

“There can be slowness in any country with legislators and bureaucrats but is India off the table? Absolutely not. At some point, there will be a semiconductor industry in India. Prime Minister Modi is an amazing person. We always have irons in the fire and India is a big value proposition for us,” said Ellwanger.

Grown on silicon: QD-based micro-ring GaAs lasers operate from 0.6mA

By Julien Happich

Led by professor John E. Bowers from the Optoelectronics Research Group of the University of California, an international team of researchers has not only succeeded in designing electrically-pumped quantum dot micro-ring lasers directly grown on silicon, the researchers also claim the sub-milliamp lasing threshold (0.6mA) and the device footprint are orders of magnitude smaller than those of previously reported lasers epitaxially grown on silicon.

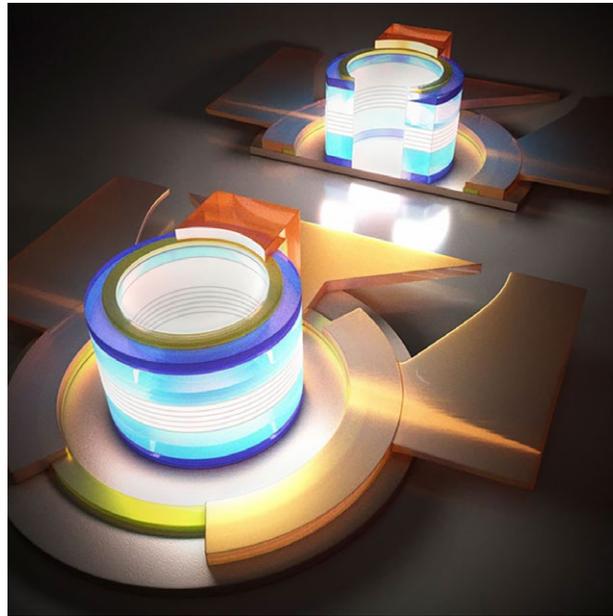
Emitting at 1.3 μm , the micro laser was tested under continuous-wave lasing at up to 100°C, making it very promising for integration into compact optical communication systems.

Their paper “1.3 μm submilliamp threshold quantum dot micro-lasers on Si” published in the *Optica* journal reveals a novel GaAs-on-Si heterogeneous growth strategy which confines dislocations and growth defects and allows for direct growth on silicon with no germanium buffer layer or substrate miscut.

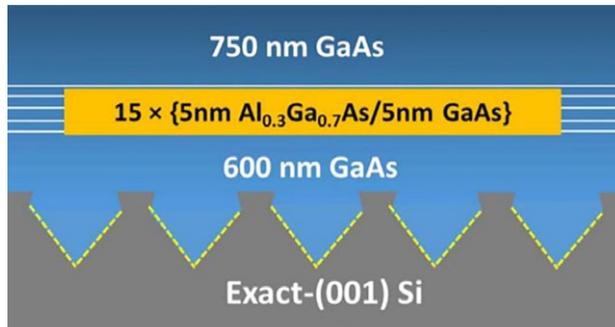
This was combined with a quantum dot (QD)-based active medium, known to effectively alleviate the negative influence of dislocations and surface recombination arising from lattice-mismatched growth and device fabrication.

First, the researchers etched V-grooves along the [100] direction on a (001) silicon substrate, which they filled with an array of GaAs in-plane nanowires grown directly inside the silicon V-grooves by selective-area metal-organic chemical vapor deposition.

Then further GaAs was grown including 15 periods of $\text{Al}_{0.3}\text{Ga}_{0.7}\text{As}/\text{GaAs}$ (5/5nm) superlattice for annihilating the threading dislocations. Eventually the GaAs nanowires were coalesced into a 1.5 μm -thick continuous and smooth surface,



Artist's rendering of the electrically pumped quantum dot micro-ring lasers. Courtesy of Department of Electronic and Computer Engineering, HKUST.



Schematic of the GaAs-on-Si template.

on top of which a $\text{GaAs}/\text{Al}_x\text{Ga}_{1-x}\text{As}$ graded-index separate-confinement laser heterostructure was grown in a molecular beam epitaxy system. This included seven InAs/InGaAs quantum dot-in-a-well layers incorporated in the laser active region, with a quantum dot density approaching $6 \times 10^{10} \text{ cm}^{-2}$.

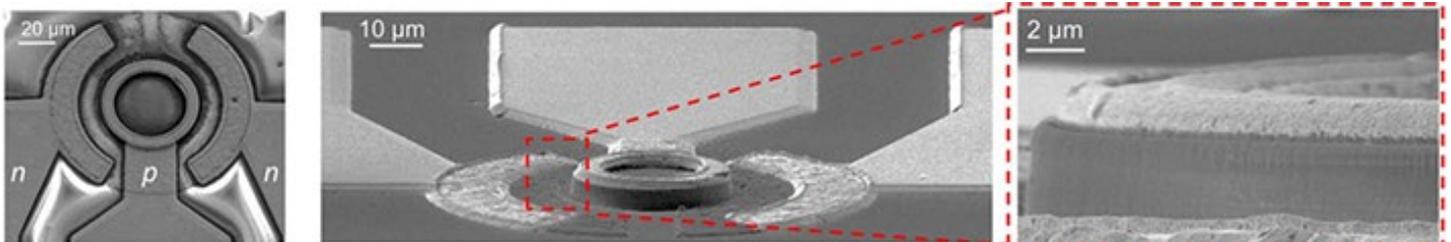
The paper reports that the 4.1% lattice mismatch between GaAs and silicon was mostly accommodated by the formation of a few nanometer-thick stacking faults in the V-grooved structure, enabling the fabrication of a defect-free GaAs laser with performances comparable to devices built on a native GaAs substrate.

Out of that stack, the researchers patterned the ring structures of various whispering gallery mode (WGM) lasers with radii ranging from 5 to 50 μm and ring widths ranging from 2 to 7 μm wide. The paper notes that a 4 μm -tall mesa allowed a strong lateral optical confinement supporting excellent cavity modes and enabling very low-threshold lasing. The scaled-down 10 μm wide device (with a 5 μm radius) gave the lowest lasing threshold, down to 0.6mA.

The researchers see their direct III-V/Si epitaxy fabrication method as a promising alternative to wafer-bonding techniques currently used to integrate light sources on silicon.

This could pave the way to denser photonic integration while maintaining low power operation.

On their roadmap, the authors plan to integrate in-plane coupling waveguides for the efficient extraction/coupling of the lasing light while trying to further improve the overall performance of their devices beyond that of heterogeneously bonded light sources. The researchers have secured several patents and make their technology available for licensing.



Top view (left) and cross-sectional view (middle) SEM images. (right) A 90° tilted zoomed-in SEM image of the mesa.

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German car industry turns towards electromobility

By Christoph Hammerschmidt

At the International Motor Show (IAA) in Frankfurt, the German automotive industry demonstrates that it has learned from the diesel scandal: all major manufacturers overbid each other with announcements of electric vehicles. However, it remains to be seen to which extend these announcements will be turned into real vehicle and at which speed.

The main malefactor in the diesel affair was probably Volkswagen. With an electric offensive, the company now presents itself as environmentally aware. Volkswagen CEO Matthias Müller announced a campaign for the industrialization of electric mobility. The company intends to spend real money on this: more than 20 billion euros in Volkswagen's "Roadmap E" for the development of new vehicles and production processes as well as for installation of the charging infrastructure. In this context, the company plans to develop two new purely electric vehicle platforms. Of all the approximately 300 different models of the Volkswagen Group (including subsidiaries Audi, Skoda, Seat and Porsche), there will be an electrified variant available by 2030 at the latest. Already by 2025, 50 pure electric models should be available. In addition, Volkswagen plans to invest 50 billion euros in the construction of a Gigafactory to produce batteries. The production capacity should be more than 150 GWh per year.

BMW plans to launch 25 electrified vehicle models by 2025, twelve of them with a purely electric drive. To this end, the company plans to change its existing model strategy: instead of bundling all its electrical models in the "i" product family, even the existing conventional mainstream models will be equipped with an



electric drive. At the same time, the Bavarian carmaker wants to hold on to its i brand as well. At the exhibition, BMW showcases the study of a four-door Gran Coupe with a purely electric drive.

The "iVision Dynamics" is intended to appeal to customers who value sportiness and luxury: the car should accelerate to 100 km/h in four seconds and be faster than 200 km/h in the top; its batteries are designed to allow a range of more than 600 km (370 miles). With this feature set, experts are already talking of the vehicle as BMW's "Tesla Killer".

Daimler plans to offer an electrified variant for its entire vehicle range, a total of more than 50 Mercedes Benz models. This is to be achieved even faster than the competitors, by 2022 the company says. Daimler CEO Dieter Zetsche is one step further than his competitors: the Smart brand, known for its two and four-door subcompact cars, is to be completely converted to electric drive over the next two years, at least in Europe and North America. Thus, according to Zetsche, Smart would be the first brand with a combustion engine, which would completely switch to electric drive. At the IAA the company showed how the future of the smart could look like: the concept car smart vision EQ fortwo runs electrically and fully automatically – i.e. level 5 of the autonomy scale and without steering wheel or brake pedal.

And the fuel cell drive? In the run-up to the fair, Daimler had already given an indication that the introduction of a vehicle would be expected soon. At the fair, the company has now made public plans for the GLC F-Cell to launch a hydrogen-powered small-series electric model later this year.

Daimler invests \$1 billion in US electromobility

By Christoph Hammerschmidt

Daimler has announced a battery production facility in the USA to supply its future EQ models with batteries.

It is the world's 5th battery factory of the Mercedes-Benz brand. In addition, the company plans to manufacture its battery-powered EQ SUVs at its US plant in Tuscaloosa.

In total, Mercedes-Benz will invest a billion US dollars in the expansion of its industrial activities in the United States. The move is expected to create over 600 new jobs. A large part of the investment is to be channelled into the implementation of the electrification of its model spectrum. The remainder will be used to expand the logistics activities at the same site.

By 2022, Mercedes-Benz Cars has announced to electrify its entire portfolio and offer customers at least one electrified alternative in each segment - from the Smart subcompact to large SUVs. In total, the company plans to develop more than 50 electrified vehicle variants. At the same time, Mercedes-Benz will continue to support the development of plug-in hybrids and the introduction of 48-volt systems. The first EQ series model, the EQC, will be rolled off the production line at the Mercedes-Benz plant in Bremen (Germany) from 2019; production of the EQ models in Tuscaloosa is scheduled to start at the beginning of the next decade.

The new battery factory near the existing Tuscaloosa plant will become part of Mercedes-Benz Cars' global battery pro-

duction network. This plant will complement Daimler's worldwide battery production network with two factories in Kamenz, Saxony, and additional sites in Stuttgart-Untertürkheim, Beijing and now Tuscaloosa. With this concept, the battery production network can react flexibly to market demand. The individual locations supply local vehicle production and are ready for export, if necessary. Construction work on the new factory in Alabama covering an area of over 90,000 square meters is expected to begin in 2018, with production scheduled to begin at the beginning of the next decade.

As part of the electrification of the powertrain, Daimler is developing the EQ brand with a vehicle family and an ecosystem that includes not only the vehicle as such but also a comprehensive suite of electric mobility products. This ranges from intelligent services to energy storage systems for private and commercial customers, charging technologies and sustainable recycling.

On the road to zero-emission driving, Daimler is pursuing a three-pronged drive strategy to achieve environmental compatibility across all vehicle classes (incl. commercial vehicles, vans) - with an intelligent mix of combustion engines and part electrification using 48-volt technology, EQ Power Plug in hybrids and electric vehicles powered by battery or fuel cells.

Battery-electric truck enters series production

By Christoph Hammerschmidt

Daimler Trucks has handed over its first fully electric truck from serial production in New York. Initially, the vehicle will be produced in a small series; mass production is scheduled to begin in 2019.

After several years of testing with customers in Germany and Portugal, Daimler partner Mitsubishi Fuso Trucks and Bus Corporation (MFTBC) has started production of its light truck. The FUSO eCanter is completely electrically powered and is designed for inner-city delivery traffic. Accordingly, the first customer with UPS is a company that will use the vehicle to supply customers from the logistics center. The customer's deployment scenario corresponds to the performance profile of the FUSO eCanter: during the day, the truck covers relatively short inner-city routes with many intermediate stops; it can be loaded overnight at the operator's branch office.

One battery charge is enough for a journey of about 100km (62 miles) with a payload of about 3.5 tons. The vehicle's electric powertrain consists of six high-voltage lithium-ion batteries with 420 V each and a total output of 13.8 kWh. The operating costs are said to be lower than those of a conventional diesel version: A saving of up to 1000 euros is to be achieved on a distance of 10,000km (which corresponds to a mileage of about four months).



The Fuso eCanter is the result of a development initiated by MFTBC: in 2010, Fuso presented its first prototype; in May 2017, the Japanese partner announced its first commercial customer in the Japanese market. Among the assets that Daimler

has contributed are the Mercedes-Benz Energy GmbH for local energy storage solutions. Daimler also announced an investment in StoreDot, an Israeli startup company known as a pioneer in the development of nanotechnology materials. These materials enable ultra-fast battery charging. The eCanter is produced by MFTBC in Tramagal, Portugal. It is planned to produce 500 pieces for selected customers.

Incidentally, there is a company that is somewhat further afield – a company that would actually be predestined as a potential customer for such vehicles: Deutsche Post DHL, Germany's largest logistics company. Due to a lack of suitable offers on the market, the company began to build its own small electric truck a few years ago. This vehicle, the StreetScooter, proved to be a great success: Originally, the small truck was only designed for its captive market; in view of the demand from other companies, Deutsche Post initially launched a small series. Together with Ford, the company has meanwhile developed the much larger StreetScooter Work XL, which will be built in a quantity of around 2500 units by 2018.

Nikola Motors, Bosch jointly develop electric powertrain for heavy truck

By Christoph Hammerschmidt

With the Nikola Two, the first electric long-distance truck is taking shape. US manufacturer Nikola Motors now revealed what the powertrain will look like. Supplier of the hardware and software is Bosch.

When it comes to electromobility, the public usually only has passenger cars in mind. Experts however agree that the commercial vehicle sector is particularly suitable for electrification. This applies in particular to those market segments where electric trucks operate on short distances and have a well-planned daily schedule; examples for such application scenarios are short-haul distribution, supermarket deliveries or parcel delivery. Some movement in the market can already be observed here. For example, Mitsubishi FUSO recently started series production of its Canter light truck, while Deutsche Post DHL, as a market outsider, operates a production facility for electric delivery vehicles. A year ago, Daimler also unveiled a short-distance electric-powered truck that could go into series production at relatively short notice.

On the other hand, radio silence prevails to a large extent in long-distance trucks. With one exception: last year, the US company Nikola Motors presented the prototype of a really large fuel cell-powered semi-tractor. Now this project is taking on a more concrete form. Nikola Motors intends to launch

its 1000-hp truck on the market by 2021. At 2700 Nm (2000 ft lbs), the engine will have a torque that is twice as high as that of conventional diesel trucks. The planned range is also impressive – the Nikola Two model, which is what we are talking about here, is supposed to be able to drive 1280 to approximately 1900 kilometres (800 to 1200 miles) with one hydrogen charge.



Instead of hanging for hours on a charging station, as is necessary for battery-powered vehicles, its hydrogen tank should be refilled within 15 minutes.

The power train of the giant is supplied by Bosch. It is a scalable and modular "e-axle" that combines motor, drive electronics and transmission in one compact unit. This recently introduced e-axle will play a central role in Bosch's electrification strategy – it scales from

small passenger cars to small commercial vehicles. However, the Nikola semi-tractor is not exactly a small truck.

The company therefore plans to install two such drives. At the same time, Bosch will continue to develop hardware and software for the requirements of such heavy-duty long-distance trucks, as announced by the two companies. Here, Bosch's electro-mechanical engineering for commercial vehicles and SMG (separator motor-generator) technology are used. In addition, Nikola and Bosch are cooperating in the development of fuel cells.

Dyson invests £2bn in electric car and battery development

By Nick Flaherty

Vacuum cleaner maker Dyson is investing over £2bn (£2.5bn) to develop a new generation of battery technology in its own electric car.

The company already has a team of 400 engineers working on the car design which is planned for launch in 2020 based around its digital motor technology. Dyson plans to double the size of the development team at Malmesbury in the UK over the next two years.

The secretive company has not said whether this is the launch of a concept vehicle or a production model. A production model would be tested on the roads in 2019 and so the car design and the battery technology would have to be at the advanced prototype stage already. How and where the batteries would be manufactured is also not disclosed and would be a major issue for the production of the vehicle.

Half the investment will go on new battery technology says founder and chief engineer Sir James Dyson in a letter to staff. The Dyson company bought US solid state battery developer Sahkti in 2015, although in April this year was reported to have changed direction on the battery development.

“If we are to continue to create new and disruptive technology, we must develop more advanced core technologies,” he said. “We have invested nearly \$310m into the research and development of the Dyson digital motor, a technology that now powers our most successful machines. We will do the same with batteries. Sahkti has developed a breakthrough in battery technology and together we will make this technology a reality.”



The UK government has provided £16m (\$20m) for the project.

“With tech players such as Dyson now entering the electric car market, it is clear that the competition in the sector is reaching new heights and is ripe for disruption,” said Taavi Madiberk, CEO of European ultracapacitor maker Skeleton Technologies. “Dyson’s move into this market is set to further ignite an already

dynamic sector, resulting in wider adoption and interest in EV and alternatively fuelled vehicles.”

This follows Daimler’s announcement of a \$1bn investment in battery technology for electric cars. This was challenged by Elon Musk, CEO of electric car maker Tesla, as too low, and Daimler confirmed it plans to invest \$10bn in its electric car programme.

Several European companies are building major plants for making batteries. BMZ in Germany, Samsung SDI in Hungary and Northvolt in Sweden are all building huge ‘gigafactories’ to support car production, and TerraE has also launched a foundry system for battery production.

This will put more pressure on the power grid, says Madiberk at Skeleton. “Government, industry bodies and innovators in the sector must work together to support energy storage technologies that complement the grid, such as ultracapacitor and battery technology. Only by having a stable and reliable energy infrastructure will the country be able to benefit from the exciting electric vehicle technologies that industry innovators such as Dyson will bring.”

Lightweight chassis changes battery pack design for electric vehicles

By Nick Flaherty

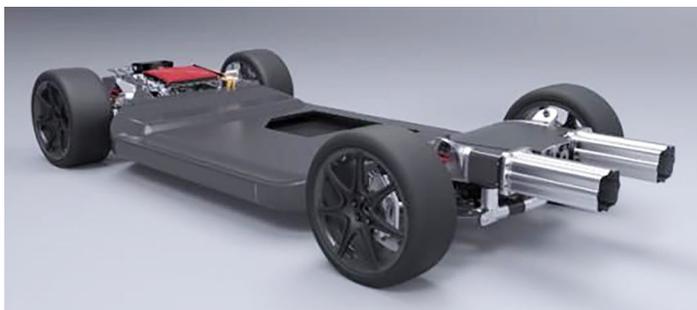
A new concept design for an integrated lightweight chassis by Williams Advanced Engineering in the UK could significantly change the way battery packs are designed for electric vehicles.

The FW-EVX concept design includes several innovations in battery pack design, cooling systems and lightweight structures, which have been integrated into a single, scalable platform. Forming high-strength 3D structures from 2D materials has created an exoskeleton for a battery module that also contributes to the structural performance of the battery which will change the way EV battery packs are designed.

“This represents a new direction for Williams’ advanced engineering business, as its own R&D team has developed the proprietary innovations and has submitted patents for a number of the inventions,” said Craig Wilson, managing director of Williams Advanced Engineering.

The platform has been developed in-house in collaboration with motor maker YASA, drivetrain maker Xtrac and motor con-

troller maker Sevcon. YASA’s e-motors provided the engineers with additional flexibility to increase vehicle range, load carrying capacity or performance when compared to alternative motors. The very short axial length of the motors solve the problem



of restricted space in hybrid and range-extended vehicle designs. Its proprietary Yokeless And Segmented Armature (YASA) motor topology is suited to high-volume automated assembly through advanced magnetic and structural materials, and the motors are built at a high-volume factory in Oxford, UK.

“Vehicle efficiency has always been core to Williams – whether it be in Formula One or with Williams Advanced Engineering’s customer projects,” said Paul McNamara, technical director of Williams Advanced Engineering. “These technologies, and our thinking around how to create a tightly integrated, light-weight chassis and powertrain package, have the potential to greatly increase the competitiveness of the next generation of electric vehicles.”



Infineon's fully integrated dimming solutions

CDM10V and CDM10VD – most flexible dimming interface ICs for 0–10 V

Infineon's CDM10V and CDM10VD are the industry's first single-chip lighting interface ICs. They are capable of transforming an analog 0–10 V input into a PWM or dimming input signal, required by a lighting controller IC. CDM10V and CDM10VD devices are dedicated for commercial and industrial LED lighting applications.

The compact and highly integrated devices allow designers to replace up to 25 discrete components, used in conventional 0–10 V dimming schemes, with a single device. Supplied in an ultra-miniature 6-pin SOT package, the CDM10V and CDM10VD perfectly match small PCBs with high component densities.

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- › Embedded digital signal processing which maintains minimum variations from device to device
- › PWM input
- › One-time configurable device: CDM10V and pre-configured devices with various feature sets

Key benefits

- › Single-device solution leading to low BOM and PCB savings
- › Dimming ICs in small SOT-23 package for high power density designs
- › Granular portfolio for highest flexibility and easy design-in
- › Wide input V_{CC} range 11–25 V, extended range down to 6 V for CDM10V
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The hunger's back says SEMI's Manocha

By Peter Clarke

Ajit Manocha, CEO of industry organization SEMI, reckons the hunger and excitement he experienced in the chip industry 37 years ago, is back.

Back then he was starting out as a research scientist at Bell Labs and the hunger and spirit of adventure was for all things semiconductor. Now there is a renewed hunger and MEMS and sensors are part of it, and this also part of an opportunity for Europe, said Manocha, the former CEO of Globalfoundries who took over as head of SEMI early in 2017.

Manocha came to the co-located European MEMS and Sensors and European Imaging and Sensors summits in Grenoble, France, organized by SEMI, to introduce the keynote speakers and support the events in their first year under SEMI's auspices.

In an interview with *eeNews Europe* Manocha pointed out that when he was starting out, double-digit percentage growth for the semiconductor industry was common. But more recently the accepted wisdom has been that semiconductors are mature and that the industry was consigned to low growth.

"Well this year growth is greater than 20 percent for the chip industry and IC equipment and materials are breaking all growth records since 2000. It is down to the new

applications in IoT, automotive, 5G, medical technology, and a lot of focus on AR/VR and machine learning," he said.

Notwithstanding that elevated average selling prices for memory ICs are a key part of this year's boom, it is true that when there is money around, hunger and excitement are a natural consequence.

Manocha said that when SEMI started out connection, collaboration and innovation were the mantra with the organization supporting these by way of setting standards, encouraging collaboration for conferences and collecting market data as well as working on health and safety issues. And SEMI is ready to do the same in the area of MEMS and sensors Manocha said.

When asked if recent political events and a world moving towards more regionalism and even protectionism created problems for SEMI, Manocha responded: "We work globally with governments in an advocacy role on the four Ts: trade, tax, technology and talent. For example SEMI is pushing for free trade and to lower corporate tax in the US where it is one of the highest rates." Manocha added that governments needed to spend money to fuel R&D and also to encourage the talent pool.

Although SEMI runs programs to support high-school students thinking of taking up science and technology courses, Manocha said the problem of students wanting to take business-, law-, and other vocationally-oriented degrees rather than

science was not only present in the western hemisphere but also in the eastern.

And since the birth of social media most computer science students are more interested in Google and Facebook as career choices than in hard science.

"We don't have enough talent in Taiwan and China's growth has been hurt by a lack of talent, which is one reason why China recruits from Taiwan," Manocha, said. "Industrial leaders and governments need to work together to level the playing field for students," Manocha said.



"SEMI wants to see the industry grow across the globe; in every region. We stay away from the political parties but the policies are important for growth."

However, Europe is struggling to remain significant in the semiconductor sector. To try and bolster its position it has recently started to roll out the Important Project of Common European Interest (IPCEI). This is a European Union policy instrument that facilitates state support for manufacturing, without breaching European competition laws – and by extension, arguably, World Trade Organization rules.

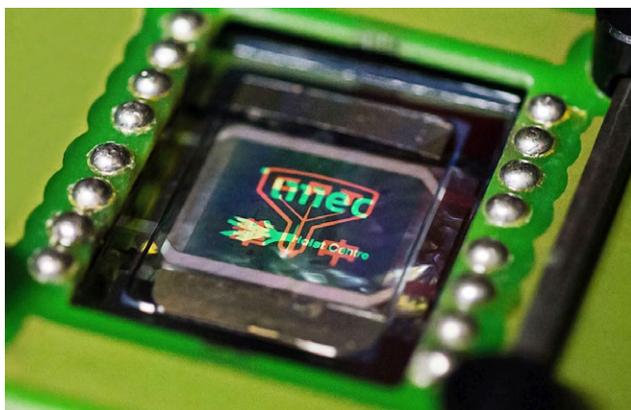
However, the extent of project still appears to be uncertain as it seems to be in an early consensus-forming stage. It is thought to be worth about €2 billion (about \$2.4 billion) and is intended to encourage corporate spending of about four or five times that amount. Contrast that with South Korea where about 50 manufacturing companies recently came together to say they would spend nearly \$50 billion on electronics manufacturing over the next seven years.

Surely Europe simply could not afford such spending? "Why not?" responded Manocha. "Innovation is critical and manufacturing is critical." Manocha left unsaid that ambition is also critical. "ASML is a great example for Europe," he concluded citing the market leader in semiconductor manufacturing equipment, which is based in the Netherlands.

Photolithography-patterned OLEDs could break 10kppi barrier, says imec

By Julien Happich

At the annual International Smart Display and Touch Panel Exhibition, Touch Taiwan, in Taipei, Taiwan, Chunghwa Picture Tubes Ltd. (CPT) together with IMEC and Holst Centre exhibited a 1400x1400 pixels (1.96 megapixel) OLED microdisplay with orange and green sub-pixel pitches of 10µm (giving a 20µm pixel pitch) and providing a colour pixel resolution of 1250 ppi.



The 1400x1400 pixels OLED microdisplay with orange and green sub-pixel pitches of 10µm.

Circumventing the resolution bottleneck of fine metal masking (FMM) or inkjet printing (IJP) technologies, the international team of researchers used a “FMM-free” technique leveraging photolithography on an i-line (365nm UV) chemically amplified photoresist system in a process flow dedicated to OLED stacks.

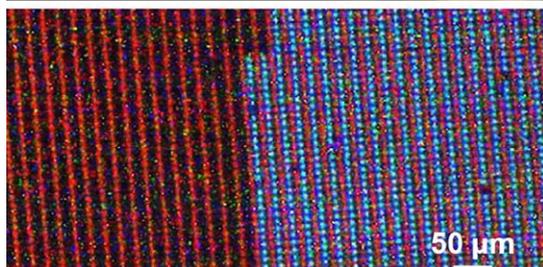
The unit on display exhibits uniform electroluminescence and each colour can be lit separately since all pixels are addressed individually. Preliminary lifetime investigation shows the colours can operate up to a few hundred hours at more than 50% of the original brightness, after patterning.

In an invited paper titled “Photolithography as Enabler of AMOLED Displays Beyond 1000 ppi” presented last May at SID 2017, IMEC and Holst Center in cooperation with Fujifilm had revealed their path to very high resolution OLED displays. In their paper, the researchers detailed how they had explored the feasibility of realizing resolution above 1000 ppi in functional OLED arrays, starting with a 1900x600 pixels passive display with 10µm red and blue subpixel pitches, resulting in a 2500ppi monochrome resolution and 1250 ppi in bi-colour arrays.

This had been done by patterning small molecule OLED stacks (phosphorescent red and fluorescent blue) on top of a metal bottom contact wrapped by an inorganic pixel definition layer (PDL), then capping the pixels with a semi-transparent top contact and glass encapsulation.

As part of their study, the researchers also realized OLED arrays with a 3µm pixel pitch (2µm pixel / 1µm spacing), yielding a monochrome resolution of 8466ppi and showing that their technique could possibly cross the 10,000ppi barrier once optimized. Photolithography, the researchers explain, allows for very high aperture ratios by minimizing the unused area between emitting elements.

Reversely, it could be used to create semi-transparent displays by selectively removing the OLED stack, hence limiting the area of the non-transparent OLED stack to the necessary minimum.



Electroluminescence image of a patterned 1250ppi, two-color passive display (top) and the optical microscope electroluminescence detail (bottom) of the pixels.

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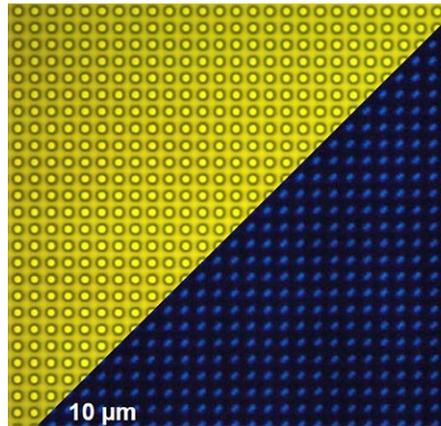
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On their roadmap, the authors envisaged the integration of organic photodetector subpixels to enable the display with adaptive luminance calibration or gesture recognition.

“Our goal is to identify and explore technology bottlenecks in the extremely competitive and fast-paced display industry. With research activities spanning from material and device science, through design, fabrication and integration all the way to tech transfer, we make use of our semiconductor and thin-film background,” stated Paul Heremans, program director of thin-film electronics at Holst Centre/imec.

“The collaboration with CPT enables us to improve the manufacturability readiness level of the OLED photolithography patterning method. This will enable production of ultra-high resolution OLED displays for next-generation user interfaces” Heremans added.

“The collaboration with CPT enables us to improve the manufacturability readiness level of the OLED photolithography



Optical microscope picture of the photoresist after development (top left) and photoluminescence image after photoresist strip (bottom right). Pixel size is $2\mu\text{m}$ and pixel spacing is $1\mu\text{m}$ (equivalent to a 8466ppi resolution monochrome).

patterning method. This will enable production of ultra-high resolution OLED displays for next-generation user interfaces” Heremans added.

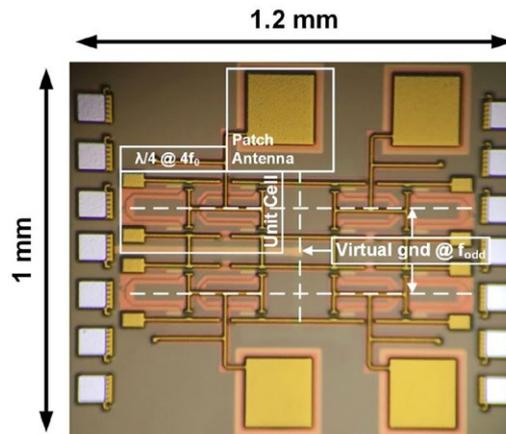
BiCMOS chip delivers 370GHz beam steering for next gen communications

By Julien Happich

Researchers from the University of California, Davis have designed a novel SiGe chip operating at tunable frequencies from 318GHz up to 370GHz, with a bandwidth of 52GHz. What’s more, the chip’s radio beam can be steered to precise locations, which could make it useful to transmit data at Gbit/s rates.

Presenting their results at the 2017 IEEE International Solid-State Circuits Conference in a paper titled “A 318-to-370GHz Standing-Wave 2D Phased Array in $0.13\mu\text{m}$ BiCMOS”, the researchers disclosed the symmetrical architecture of a millimetre-sized chip able to operate broadband frequency tuning (52GHz) independently of beam steering over an angle of 128° in the E plane and a maximum beam steering angle of 53° in the H plane.

Built using a $0.13\mu\text{m}$ SiGe BiCMOS process, the 2×2 array structure consists of four λ -size standing-wave (SW) oscillator unit cells, each made of two half-cell SW oscillators facing



Die micrograph.

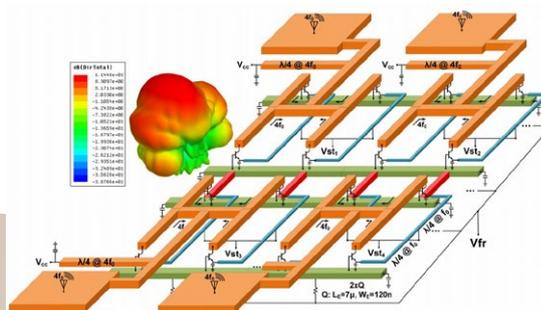
each other and coupled together through transmission lines in the collectors and $\lambda/4$ lines at the emitters of transistors (see figure 1).

The two half-cells operate out of phase resulting in a virtual ground along the line of symmetry and cancellation of fundamental frequency and other odd harmonics while combing the desired 4th harmonic, the paper reports.

The capacitively degenerated transistor provides a narrow-band negative transconductance that compensates for losses in the circuit and sustains the oscillation in a specific mode.

The transistors also act as nonlinear devices to generate the desired 4th harmonics, fed to an onchip patch antenna for radiation.

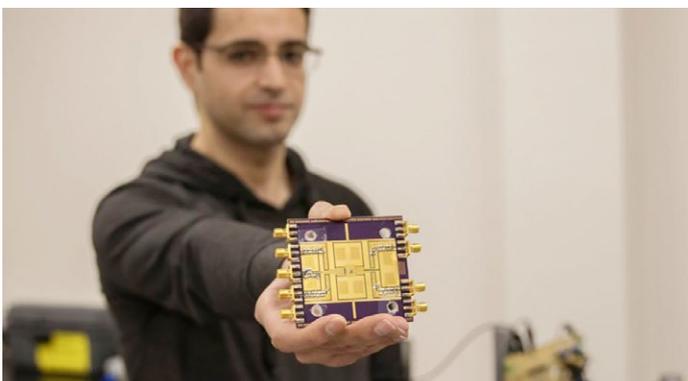
For their experiment, the chip was simply mounted on a FR4 PCB with



Structure of the 2×2 standing-wave (SW) phased array with on-chip patch antennas.

the supply, bias, and control voltages all provided through simple bond wires. At 344GHz, the maximum radiated power reported was -6.8dBm with a minimum phase noise of -93.1dBc/Hz . The chip consumed a total of 310-to-640mW across the band from a 1.5V supply.

Joint authors Omeed Momeni and Hossein Jalili concluded their paper by claiming their chip achieved the largest tuning range among fully integrated THz radiators, phased arrays, and oscillators, with the highest operation frequency and the widest beam steering range among fully integrated THz 2D phased arrays. In future work, the authors plans to integrate the chip into imaging and communication systems.



Graduate student Hossein Jalili displays the millimeter-wave/terahertz phased array chip that he and Assistant Professor Omeed Momeni prototyped in the UC Davis Millimeter-Wave Research Center in the College of Engineering. Maria Ines Perez-Vargas/UC Davis.

AlN nanowall-based UV LEDs boast 60% internal quantum efficiency

By Julien Happich

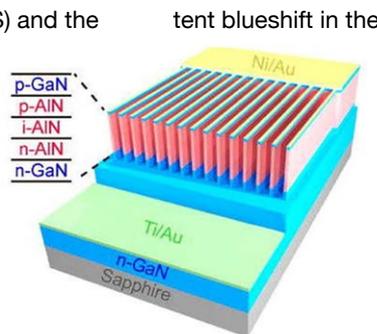
Researchers from the University of Michigan (US) and the McGill University (Canada) have demonstrated large area AlN nanowall light emitting diodes emitting at 214nm with an internal quantum efficiency as high as 60%.

The AlN nanowall LED stacks were built on top of GaN nanowall structures which were first created on an n-type GaN template on a sapphire substrate using e-beam lithography and dry etching techniques.

Grown through molecular beam epitaxy (MBE), the AlN nanowall LEDs then consisted of Si-doped AlN, non-doped AlN, and Mg-doped AlN segments, with each layer being approximately 40nm thick. A 3nm p-GaN layer was deposited on the top surface to serve as p-contact with Ti/Au n-metal.

Prior to growing the AlN nanowall LEDs, a 300nm thick SiO_x layer was first deposited on the GaN nanowall structures for surface passivation and electrical isolation, then p-Metal Ni/Au contacts were deposited through selectively etched areas.

The paper "Molecular beam epitaxial growth and characterization of AlN nanowall deep UV light emitting diodes" published in the Applied Physics Letters details various experiments with wall widths varying from 100nm to 1µm, noting a consistent blueshift in the emission wavelengths which the researchers explain by the reduced tensile strain distribution.



An AlN nanowall LED heterostructure grown on a GaN template on a sapphire substrate.

In their paper, the researchers report devices with nanowalls as long as 120µm, exhibiting excellent current-voltage characteristics, including a turn-on voltage of 7V and current densities of over 170A/cm² at 12V (when fabricated with a wall width of 410nm).

"Compared to conventional nanowires, nanowall structures exhibit well controlled geometry and are ideally suited for the fabrication of large area devices. Moreover, TM polarized light emission can be efficiently extracted from the lateral surface of nanowall structures" they write.

Another observation the researchers made was that AlN nanowall LEDs of narrower widths showed much higher injection current density. They attributed this to the reduced defect distribution and a more efficient Mg-dopant incorporation in AlN nanowall arrays with narrower widths. These nanowall structures could become an interesting building block for achieving high performance deep UV optoelectronic devices.

Sumitomo Metal Corporation (NSSMC), has prototyped OLEDs using a paper-thin translucent stainless steel foil as a substrate.

Flexible OLEDs switch color on demand

By Julien Happich

The Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology FEP has developed flexible adjustable-color OLEDs.

The OLEDs can be bent, designed transparent and with segmentations to fit a nearly unlimited range of shapes for new design opportunities. This work is a follow up of Fraunhofer FEP's 2015 breakthrough, when it first unveiled adjustable-color OLEDs on rigid substrates.

It took the German researchers another two years of development to integrate these adjustable-color OLEDs on flexible substrates. The OLED modules are able to switch their light emission between two different color temperatures, for example a yellow-blue bi-color emission system can be switched between a pure yellow, a pure blue but also to a white light by activating both colours simultaneously.

The color adjustability from one single lighting component increases design options when using OLEDs on curved surfaces in vehicle interiors such as roofs and curved fixtures.

Fraunhofer has also broadened the range of substrates its flexible OLEDs can be fabricated on, including metal and plastic films as well as ultra-thin glass.

As a separate development, Fraunhofer FEP, in cooperation with the Nippon Steel & Sumikin Materials Co., Ltd. (NSMAT) and Nippon Steel &

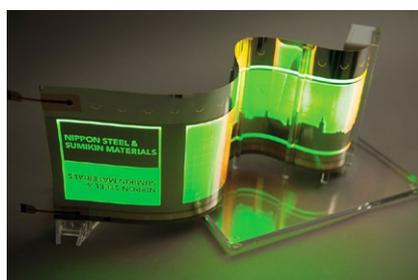


Sumitomo Metal Corporation (NSSMC), has prototyped OLEDs using a paper-thin translucent stainless steel foil as a substrate.

For several years now, stainless steel foil has been used in thin-film photovoltaics and batteries, and the substrate has been proven as a viable substrate for flexible electronic components. Compared to more conventional substrate materials such as glass or plastic web, stainless steel offers a better thermal conductivity. Thanks to a roll-to-roll compatible planarization layer developed by NSSMC, the good thermal conductivity of stainless steel makes it suitable to achieve homogenous large-area OLED lighting surfaces supporting current densities over 10 mA/cm². What's more, stainless steel provides excellent barrier properties against environmental influences, effectively protecting OLEDs from water vapour and oxygen.

Jun Nakatsuka, Manager of Business Development at NS-

MAT estimates that within three years from now, OLEDs designed on a stainless steel substrate could make their way into cars, as turn indicator and back-up lights, as cladding for fascia, and as advertising displays. The collaboration with NSMAT and NSSMC helped Fraunhofer FEP work out quality standards necessary for the future OLED fabrication, including the surface properties of the substrate. The OLED on stainless steel will be exhibited during aimcal 2017 in Tampa/USA.



Gold nanomesh enables ultra-breathable skin electronics

By Julien Happich

While numerous electronic skins have been reported in literature, all aimed at creating highly flexible wearable electronics, most of them rely on thin but impermeable substrates such as biocompatible silicone or parylene films. When designed for health monitoring applications and in direct contact with the patient's skin, electronic patches that lack breathability can soon become uncomfortable to wear, creating a risk of skin inflammation if worn several days in a row.

Trying to solve this issue, a team of Japanese researchers led by Prof. Takao Someya from the University of Tokyo have managed to remove the substrate altogether, creating a highly stretchable and breathable gold nanomesh to support or connect various sensing functions directly on the patient's skin, without adverse effects.

Published in *Nature* under the title "Inflammation-free, gas-permeable, lightweight, stretchable on-skin electronics with nanomeshes", their paper reports touch, temperature and pressure sensors directly implemented onto the skin and able to withstand hundreds of flexing and stretching cycles.

Key to breathability is the nanomesh structure. First, the researchers made nanofibres (300 to 500nm in diameter) by electrospinning a polyvinyl alcohol (PVA) solution. Those fibres were then intertwined to form a mesh-like sheet, electrodeposited with a 70 to 100nm-thick layer of gold on top. When applied to the skin and sprayed with water, the nanomesh's PVA nanofibres easily get dissolved and a highly conductive gold nanomesh remains,

adhering to the skin and conforming to its most minute details (including ridges and creases).

The dissolved PVA nanofibres act as a super-thin adhesion layer, only tens of nanometres thick and the nanomesh conductor is so conformable and stretchable that the wearer does not even feel it. What's more, the porous overlapping

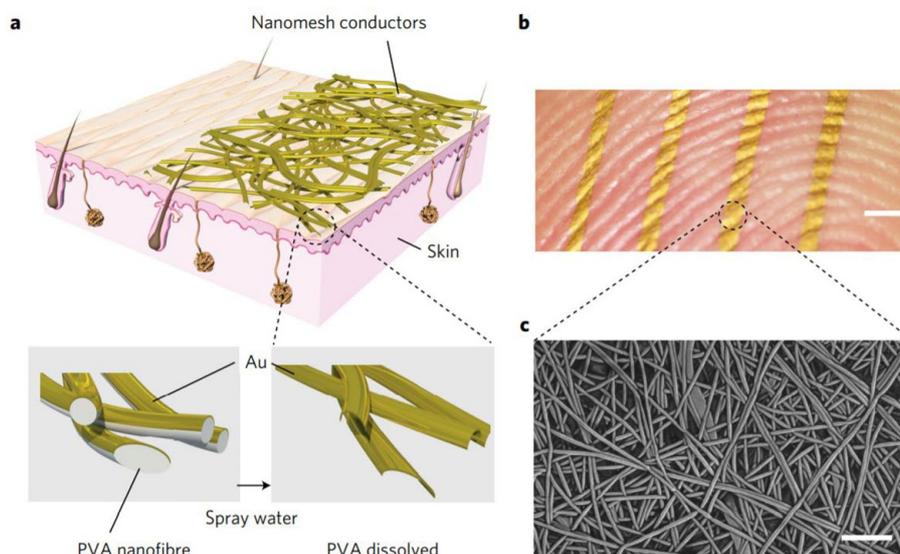
spaghetti-like structure of the nanomesh conductor exhibits excellent water vapour permeability, facilitating skin breathing. The resistivity of the gold nanomesh was estimated to $5.3 \times 10^{-7} \Omega \text{ m}$, conductance changed sharply under elongation, but gradually recovered to its initial value during shrinking, which could be harnessed to form a stretchable sensor.

In an experiment, the researchers created a touch sensor consisting of a simple nanomesh conductor array applied to a fingertip. The resistance between

the nanomesh conductor strips decreases when a conductive object creates a shortcut. Such electrode arrays were also used to create a thermal and a pressure sensor, by applying a strip of positive temperature coefficient (PTC) polymer and pressure-sensitive rubber across them, respectively.

In another implementation, the nanomesh conductors were used as on-skin electrophysiology electrodes for electromyography (EMG) recording and yielded good signals comparable to today's gel electrodes.

The researchers also tested a gold nanomesh skin patch for one week to prove the breathability and the very low risk of skin-inflammation, recording electromyograms with minimal discomfort to the user.



a) The nanomesh conductors applied on skin and the application process through PVA removal. b) The highly conformable nanomesh conductor across the ridges of a fingertip - scale bar is 1mm. c) A SEM image of the nanomesh conductor - scale bar is $5 \mu\text{m}$.



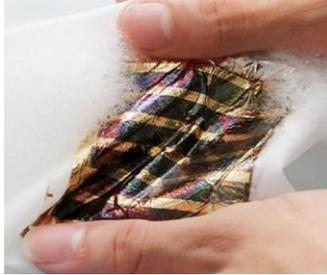
Gold nanomesh strips running across a finger conduct current from a flexible battery to a LED.

Stretchable waterproof organic solar cells for wearables and IoT designs

By Nick Flaherty

Researchers in Japan have developed an organic photovoltaic cell that is stretchable and waterproof so that it can be integrated into fabrics for wearable applications and other applications in the Internet of Things.

The team at the RIKEN Center for Emergent Matter Science (CEMS) and the University of Tokyo used a material called PNTz4T on a 1µm thick parylene film. The cell was then placed onto an acrylic-based elastomer and the top side of the device was coated with an identical elastomer to prevent water and air from leaking into the cell. The cell has an efficiency of 7.9% and produces a current of 7.86mW/cm² at 0.57 volts, based on a simulated sunlight of 100 mW/cm².



The elastomer protects the cell so that the efficiency decreased by just 5% after two hours in water, with a similar small fall (to 80%) after being folded in half (52% mechanical compression) for 20 cycles with 100 minutes of water exposure.

“We were very gratified to find that our device has great environmental stability while simultaneously having a good efficiency and mechanical robustness,” said Kenjiro Fukuda of the RIKEN Center for Emergent Matter Science.

“We very much hope that these washable, lightweight and stretchable organic photovoltaics will open a new avenue for use as a long-term power source system for wearable sensors and other devices.”

Flexible organic ultra-capacitor targets pacemakers and medical implants

By Nick Flaherty

Researchers at Queen’s University Belfast have designed a flexible and organic alternative to rigid batteries that power medical implants.

Dr Geetha Srinivasan and her team at Queen’s University Ionic Liquid Laboratories (QUILL) Research Centre in Belfast have developed a flexible supercapacitor with a longer cycle life, which could power body sensors.

The flexible device is made up of non-flammable electrolytes and organic polymer composites, which are safe to the human body. It can also be easily decomposed without incurring the major costs associated with recycling or disposing of metal based batteries. It handles 15000 cycles with nearly 100% efficiency

and a specific capacitance of roughly 5 mF/g, which is sufficient to activate biosensors.

The biopolymers are less likely to be rejected by the body, and the ultra-capacitor could be made from readily available natural feedstock, rather than expensive metals or semiconductors.

The organic storage device could also provide solutions in wearable electronics and portable electronic devices, making these more flexible.

“There is also opportunity to fabricate task-specific supercapacitors. This means that their properties can be tuned and also manufactured using environmentally friendly methods, which is important if they are to be produced on a large scale, for example in powering portable personal electronic devices,” said Dr Srinivasan.



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Algorithms process sensor data like the human brain

By Christoph Hammerschmidt

Can algorithms simulate the functioning of the brain? Most observers agree that the human brain is much more complex than can be represented by a computer. A group of researchers from the University of Ulm (Germany) is still trying to find out. The goal: the development of neuromorphic algorithms that capture, understand and transfer audio-visual sensor data to robotic systems.

NinjaTurtle has ink-blue ears, and with his dark camera eyes mounted on the side of the rounded body, the little robot looks rather cute. The machine helps neuroinformatics and cognitive scientists from Ulm test special algorithms based on human perception and cognition. The researchers hope that this will make processing of visual and auditory sensor data more robust, faster and more efficient.

“Still, the human brain is one of the most effective data processing systems in existence. Natural nervous systems are highly effective and superior to many technical systems, especially in the evaluation of sensory impressions,” explains professor Heiko Neumann. The deputy head of the Ulm Universities’ Institute of Neuroinformatics is one of the successful applicants, like his colleague Marc Ernst, head of the Department of Applied Cognitive Psychology. With their VAMORPH project, the scientists want to transfer neurobiological functions of the brain to robotic and information technology systems. The focus is on the development of so-called neuro-morphic algorithms, whose structure and mode of operation are oriented to the human brain and its elementary components, the neurons. Starting point is the question of how visual and auditory sensor streams can be processed, fused and used for technical purposes, for example for spatial orientation and navigation.

“Human perception is not clocked as in technical systems, but works on an event-based basis. Relevant is what changes over a certain period of time. From the enormous stream of information we are confronted with, the brain selects only those who are “relevant to survival” and make sense in the respective situation,” explains Ernst, a cognitive psychologist. This does not happen like with a conventional camera, where the spatial environment is captured by single images. The biological hearing process is just as complex and no less “data-economical”.

To hear and process auditory impressions, the brain combines sensory signals with expectations from different contexts of experience and calculates the information into a multi-sensory overall impression. “The integration of these sensory data streams is a masterpiece of the brain. Once we have understood exactly how this works, we can try to transfer these functionalities to technical systems for sensor data processing,” the Ulm researchers summarize their scientific mission.

To generate the neuromorphic algorithms, the scientists have developed biologically plausible learning methods that can be used to filter out the relevant information from all sensory data. Now, the researchers want to find out how practical and efficient the algorithms based on human models are. To this end, these algorithms are implemented on the robot platform and

tested on simple orientation tasks. The small ninja bot now has the task of visiting and collecting certain visual and acoustic “landmarks” without being distracted or distracted by background noise and visual obstructions.

In order to implement the algorithms, particular computer architectures are used. With this so-called “brain-inspired hardware”, the processor and memory are not separated, as is the case with conventional computers. Rather, they work together like neurons and their synaptic connections in the brain. This allows the data to be processed much faster and more efficiently. Thanks to cooperation partners, the group has access to scientific equipment that is probably unique for universities. For example, IBM Research Almaden (USA) provides neuro-morphic chip architectures in the field of brain-inspired computing. In addition, the scientists can

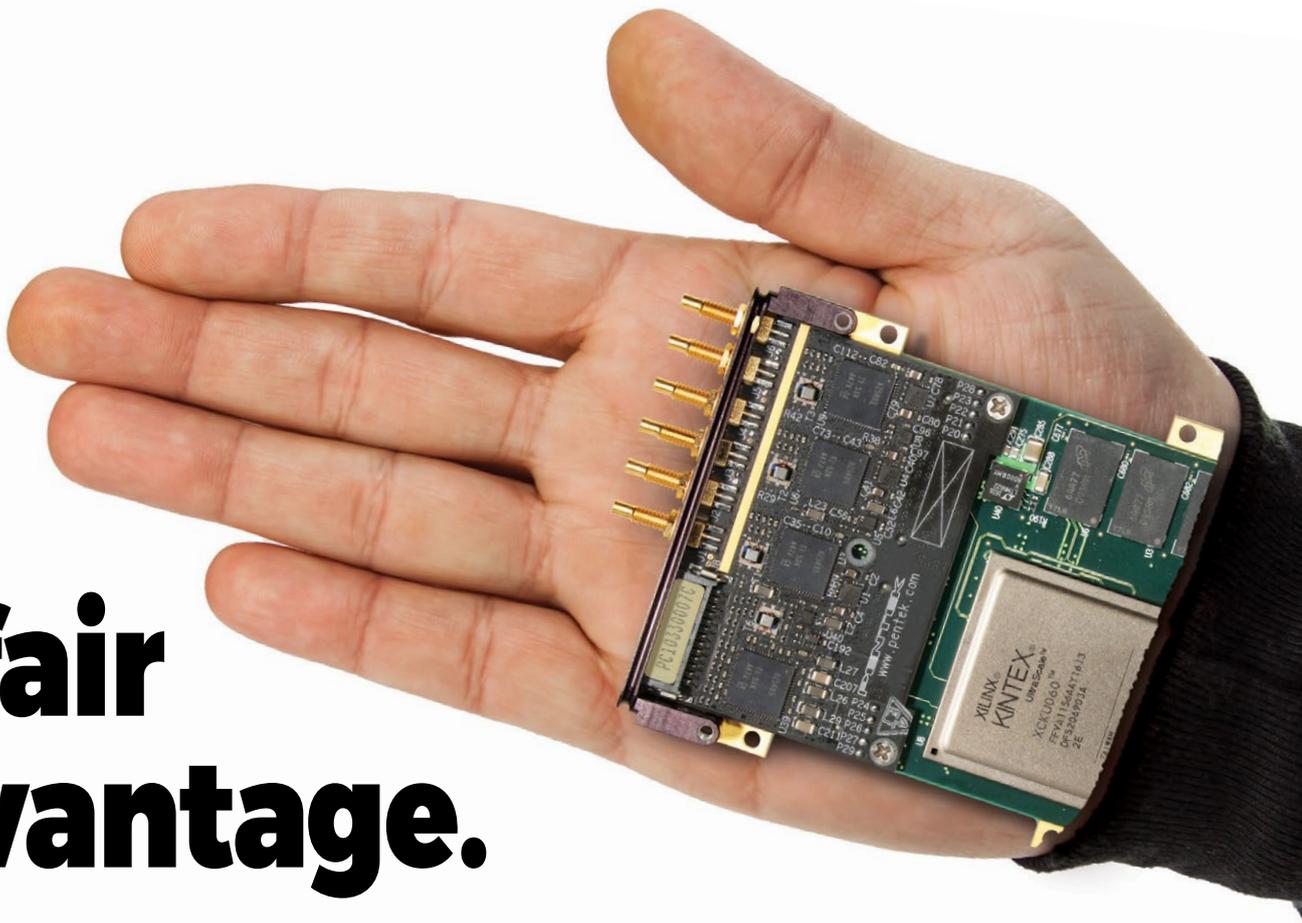
access a hardware platform from the EU-funded Human Brain Project and, through company IniLabs, to special neuro-morphic sensors.

If all goes well, NinjaTurtle will soon be able to move without being disturbed by noise, even under difficult visibility conditions, and will only consume a fraction of the computing capacity and storage space required by conventional computer architectures.

The project is part of the Neurorobotics programme of the Baden-Württemberg Foundation and is funded with 500,000 euros.



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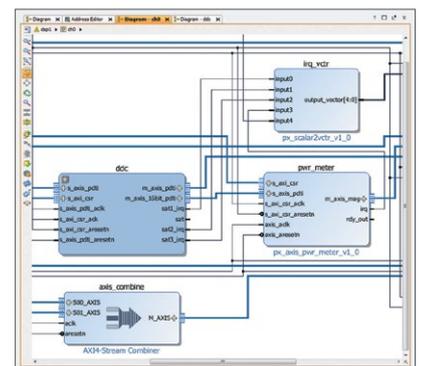
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Imagination, MIPS to be sold to China-, California-connected VCs

By Peter Clarke

Processor intellectual property licensor Imagination Technologies Group plc (Kings Langley, England) has agreed to sell off its MIPS processor business to Tallwood Venture Capital (Palo Alto, Calif.) and then to sell the remainder of itself to Canyon Bridge Capital Partners LLC (Palo, Alto, Calif.), a venture capital firm that is managing funds provided by China.

The sale of the MIPS processor business has been agreed for \$65 million in cash and is expected to close in October. The sale of what remains of Imagination to Canyon Bridge is dependent on the MIPS sale and has been agreed at £550 million in cash (about \$740 million) and could come into effect in November.

Tallwood VC is a stalwart of the California venture capital scene with a focus on semiconductor companies. Canyon Bridge Capital Partners is a much newer company that was recently prohibited from acquiring FPGA company Lattice Semiconductor Corp. by US President Donald Trump because of its Chinese connections.

Imagination's board of directors has agreed to Imagination to CBF Investment Ltd., a newly-formed company owned by Canyon Bridge Fund I LP (CBFI), which is a venture capital fund managed by Canyon Bridge Partners LLC.

Although Canyon Bridge is a new company with almost no track record, it has approximately \$1.5 billion of funds under management and Ray Bingham, a former CEO of EDA company Cadence Design Systems as an executive. The funds are being provided by initial anchor partner Yitai Capital Ltd., a Chinese state-owned enterprise, according to details provided by Imagination and Canyon Bridge.

Canyon Bridge's strategy is to provide equity capital to help strong companies to accelerate growth in new markets and particularly in China, according to the Canyon Bridge website.

In the announcement of the deal it is said Canyon Bridge intends to invest in PowerVR and Enigma R&D in the UK to allow



Imagination to advance its technical position in processor IP architecture and to help it to penetrate new application sectors and geographic markets. PowerVR is Imagination's line of graphics and neural network processors and Enigma is a line of communications IP. Canyon Bridge would also look to Imagination to develop artificial intelligence technology for such markets as augmented and virtual reality and machine autonomy, the



Andrew Heath, CEO of Imagination Technologies Group plc

document said. How much Canyon Bridge might be prepared to invest beyond the purchase price for Imagination was not discussed in the document.

The price that Canyon Bridge has agreed to pay for Imagination, 182 pence per share, represents a premium of 41.6 per cent over the Imagination share price of 128.5 pence per share recorded at the close of the London Stock Exchange Friday September 22.

Although Imagination has been a successful vendor of graphics processor units (GPUs), particularly in to smartphone SoCs, it has struggled financially and in the past relied on leading customers, particularly Apple Inc., to bail it out. Imagination put itself up for sale in June 2017 after it had revealed that Apple had said it would discontinue its licensing relationship with Imagination and stop

paying royalties.

Before the final disposal of Imagination goes ahead the company plans to sell its MIPS business, including all intellectual property and patents to Tallwood MIPS Inc., a subsidiary company of Tallwood Venture Capital. The price, on a cash and debt-free basis, will be \$40 million payable on completion with a further \$25 million due six months after completion.

"This transaction, which is separate to the offer for Imagination by Canyon Bridge, will ensure MIPS remains an independent licensing business," said Imagination CEO, Andrew Heath, in a statement issued after the close of the London Stock Exchange on Sept. 22.

In the same statement Bingham of Canyon Bridge, said: "With our backing and investment, Imagination can continue to invest in developing its technology, attract and hire the best engineers, and acquire and service customers globally."

Bingham continued: "We are investing in UK talent and expertise in order to accelerate the expansion of Imagination, particularly into Asia, where its technology platform will lead the continued globalization of British-developed innovation."

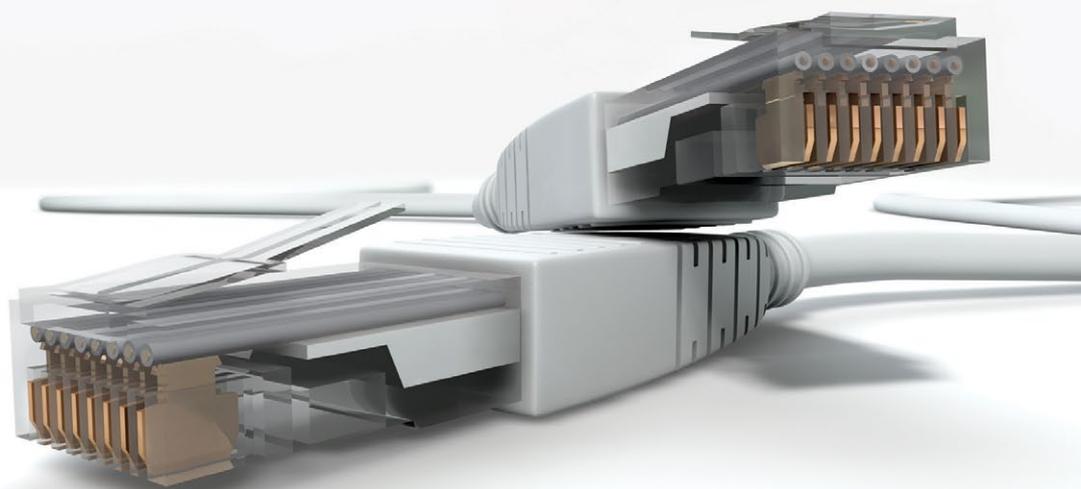
On the sale of Imagination Heath commented: "Imagination has made excellent progress both operationally and financially over the last 18 months until Apple's unsubstantiated assertions and the subsequent dispute forced us to change course. The acquisition will ensure that Imagination – with its strong growth prospects – remains an independent IP licensing business, based in the UK, but operating around the world."



Ray Bingham, partner at Canyon Bridge Capital Partners LLC.



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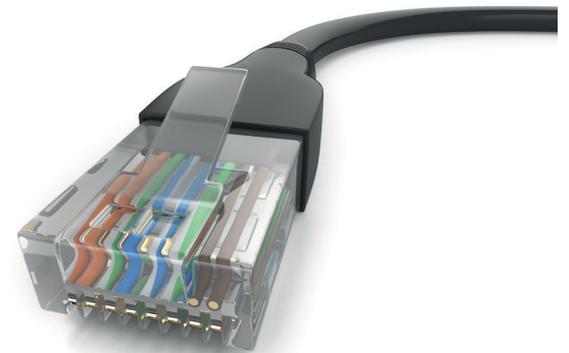
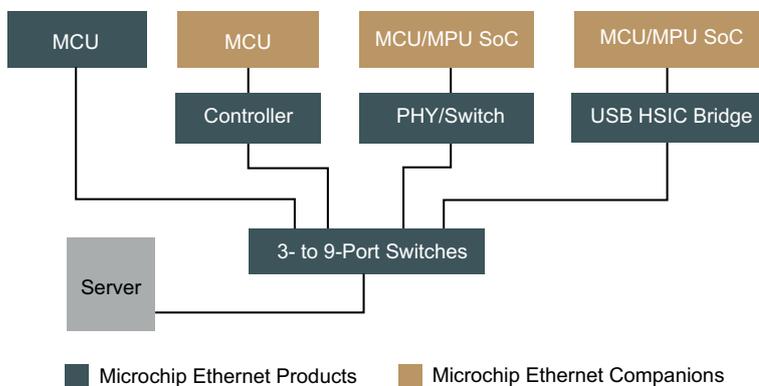
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- Broadband modems and routers

Microchip's Ethernet Products



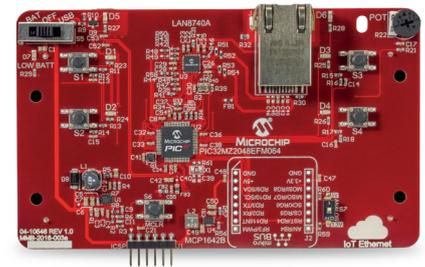
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IoT and Industrial IoT

To address Industrial Internet of Things (IoT) projects, Ethernet connectivity offers the most reliable and stable technology. The IoT Ethernet Kit powered by AWS IoT (DM990004) uses an Ethernet LAN8740A PHY driven by a 32-bit microcontroller with 2 MB of Flash (PIC32MZ EF) that provides ample memory space for your application. On the sensor side, hundreds of different sensors can be plugged into the MikroElektronka mikroBUS™ footprint allowing for prototyping a large variety of IoT proof-of-concepts.



This IoT kit takes advantage of the AWS IoT service and provide a smooth user experience coming preloaded with the corresponding firmware. AWS IoT is a managed cloud platform that allows connected devices to interact easily and securely with cloud applications and other devices. Additionally, the firmware in the kit makes use of MPLAB® Harmony, FreeRTOS™, WolfMQTT and WolfSSL allowing you to quick-start your IoT design.

IoT Ethernet Kit Features

- Developed as a reference for industrial Ethernet environments
- Complete development kit that includes IoT edge device and setup instructions for using AWS IoT
- Easy setup out of the box with your own AWS account
- JSON-based data payload
- MPLAB Harmony: integrated software framework
- Simple 32-bit microcontroller-based design
- Four input buttons, four output LEDs and one analog input potentiometer on edge device to show bidirectional control via AWS IoT
- mikroBUS header for extendability to build any IoT use case using available or custom sensors

IoT Ethernet Kit Bill of Materials

- LAN8740A: Ethernet PHY module
- PIC32MZ2048EFM064: 32-bit microcontroller
- MCP1642B: Boost Regulator

Available Reference Material on GitHub

github.com/MicrochipTech/aws-iot-firmware-pic32mz

- Firmware
- Out-of-box guides
- Compile and programming guides
- Circuit schematics
- Insight on Things desktop application

Software Drivers

Microchip develops, tests and certifies software drivers for MPLAB Harmony, Microsoft Windows, OS X, Linux OS and many proprietary stacks used in MCU, MPU and SoC-based systems. MPLAB Harmony drivers are included in MPLAB Harmony download and support Microchip's starter kits, allowing you to get your application online quickly. Our Windows drivers comply to Microsoft's rigorous Windows Logo Program for Hardware (WHQL), ensuring seamless operation in Windows-based systems. The Linux drivers from Microchip are submitted to the Linux kernel and thoroughly vetted by members of the community, giving you high-quality, peer-reviewed software for your application. See our website for links to software drivers.



Devices with Available Drivers

- PHY transceivers
- Bridging devices
- Ethernet controllers
- Ethernet switches



Additional MPLAB Harmony Software

- TCP/IP stack
- WolfSSL SSL/TSL encryption library
- USB host/device stack

Microchip's 10/100 and Gigabit PHY portfolios are a low-cost way to seamlessly attach to SoCs, MCUs and CPUs with industry standard interfaces (GMII, RGMII, RMII, MII). Designed with energy-efficient Ethernet and Wake-On-LAN, the devices minimize power consumption, while features like Quiet-WIRE® technology minimize emissions and increase immunity to noisy environments. The availability of high-temperature versions make these devices ideal for industrial and automotive applications. LinkMD®+ enables advanced diagnostics, critical to maintaining scalable network deployments. Standard Linux drivers are provided to ensure minimal code development.



Available Features

- Standard MAC interface
- Small 4 × 4 mm 24-pin package
- On-chip termination
- Energy-efficient Ethernet (802.3az)
- Quiet-WIRE robustness technology
- LinkMD+ with signal quality indicator

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Bandwidth	10Base-T/100Base-TX				10/100/1000Base-T	
Interface	MII/RMII		RMII		MII/RMII	MII/RGMII/GMII
Wake-On-LAN	–	✓	✓	✓	–	✓
EEE	–	✓	–	✓	–	–
V _{DD} I/O	1.8/2.5/3.3		1.6–3.3	1.3–3.3	1.8/2.5/3.3	
LinkMD® Technology	✓	✓	✓	✓	LinkMD+ with signal quality indicator	✓
Power	155 mW total		286 mW total	269 mW total	170 mW total + µA standby	448 mW total
Temperature	–40 to 85°C				–40 to 105°C (AEC-Q100)	–40 to 105°C (AEC-Q100)
Packages	24-pin VQFN, 32-pin VQFN, 48-pin LQFP		24-pin QFN	32-pin QFN	32-pin VQFN, 48-pin VQFN	48-pin VQFN, 64-pin VQFN

PHY Evaluation Boards

Getting started with Microchip's Ethernet PHYs is easy. For development in the MPLAB Harmony Software Framework, select the PIC32 Starter Kit for Ethernet II (DM320004-2). For development with processors running the Linux OS, choose from our evaluation boards with standard MAC interfaces. Our most popular options are below but you can find a complete list of PHY evaluation boards at www.microchip.com/EthernetPHY.



PIC32 Ethernet Starter Kit II (DM320004-2)

This kit provides the easiest and lowest-cost method to experience 10/100 Ethernet development with PIC32 microcontrollers. It is combined LAN8720A and Microchip's free TCP/IP software.



KSZ9031RNX Gigabit Ethernet Evaluation Board (KSZ9031RNX-EVAL)

This board features an integrated triple-speed (10Base-T/100Base-TX/1000Base-T) Ethernet physical layer transceiver for transmission and reception of data over CAT-5 UTP cable. The KSZ9031RNX provides RGMII for direct connection to RGMII MACs.



KSZ8061MNX Evaluation Board (KSZ8061MNX-EVAL)

This board enables testing of the KSZ8061MNZ PHY with Quiet-WIRE technology. Additionally, a second PHY, the KSZ8081 (10/100 Ethernet PHY) is used to provide a second-line interface for simple full-duplex traffic through the KSZ8061. This board is not intended for evaluation of the KSZ8081.



LAN8742 10/100 High-Speed Ethernet Transceiver Evaluation Board (EVB8742)

This board has a standard 40-pin MII connector for RMII configurations and supports Wake-on-LAN and cable diagnostics.

For SoCs and MPUs/CPU's that have USB but no Ethernet standard interface, Microchip offers a portfolio of bridge devices. These devices are fully integrated with on-chip USB and Ethernet MAC/PHY, so application size and BOM costs are minimized. Microchip provides Windows, OS X and Linux drivers to enable transparent operation and compatibility. Microchip's Ethernet bridge devices are compatible with USB 2.0, USB 3.1 Gen1 and HSIC, delivering 10/100 and Gigabit performance.



Available Features

- Wire-speed USB 3.1 Gen1 to Ethernet
- Internal or external PHY Interface
- Small 6 × 6 mm 48-pin package
- On-chip configuration OTP memory
- Bridge USB 3.1 to 100Base-T1 or HDBase-T
- Energy-efficient Ethernet (802.3az), WoL and Microsoft AOAC

Choose Your Best Fit Processor

Microchip provides drivers for our award winning MPLAB® Harmony software framework, Windows and open operating systems such as Linux. Whether your application is large or small, we have the driver to cover your needs.

Feature	LAN9730	LAN9500A	LAN9512/3/4	LAN7500	LAN7850	LAN7801	LAN7800
Ethernet Bridge	HSIC to 10/100	USB 2.0 to 10/100		USB 2.0 to 10/100/1000	USB 2.0/HSIC to 10/100/1000	USB 3.1 Gen1 to 10/100/1000	
USB Hub Ports	–	–	2/3/4	–	–	–	–
External PHY I/F	MII		–	–	–	RGMII	–
NetDetach™ Technology	✓	✓	–	✓	✓	✓	✓
Wake-On-LAN	✓	✓	✓	✓	✓	✓	✓
PME Support	✓	✓	–	✓	✓	✓	✓
Integrated Regulator	3.3 to 1.2V		3.3 to 1.8V	–	3.3 to 1.8V		
Energy Efficient Ethernet	–				✓		–
Temperature	–40 to 85°C					–40 to 105°C, AEC-Q100	
Packages	56-pin QFN		64-pin QFN	56-pin QFN	56-pin QFN	64-pin QFN	48-pin QFN

Bridge Evaluation Boards

The low-cost dongle format of USB-to-Ethernet bridges makes getting started a snap. A complete suite of software drivers for Linux and Windows are provided. Our most popular options are below but you can find a complete list of bridge evaluation boards at www.microchip.com/EthernetBridge.



LAN7500 High-Speed USB 2.0-to-10/100/1000 Ethernet Evaluation Board (EVB-LAN7500)

This board is a fully functional, bus-powered USB-to-Ethernet solution with on-board Ethernet RJ45 and USB Type A connectors. The on-board 4K EEPROM loads the USB configuration parameters and MAC address. Software drivers for Windows, OS X and Linux operating systems are available.



LAN7800 Super-Speed USB-to-Ethernet Low-Cost Evaluation Board (EVB-LAN7800LC)

With an ultra-low cost BOM, this evaluation board integrates the USB Type-C™ connector to implement a high-speed data transfer to Gigabit Ethernet with on-board RJ45 connector. Linux, OS X and Windows drivers are available.



LAN9512 High-Speed USB Hub-to-Ethernet Evaluation Board (EVB9512)

This board provides a two port USB 2.0 hub with an integrated 10/100 Ethernet controller and USB connectivity via one Type B upstream USB connector and two Type A downstream USB connectors. An RJ-45 integrated magnetics Ethernet jack with link/activity LEDs provides 10/100 Ethernet connectivity. The board supports both bus-powered and self-powered modes of operation.

You can implement managed or unmanaged networks using Microchip's portfolio of 10/100 and Gigabit switches. These L2+ switches feature multiple ports, extensive advanced switch functionality and a small footprint, assuring optimal network performance. For real-time control, like Time-Sensitive Networking (TSN), Microchip's switches feature IEEE 1588 v2 Precision Time Protocol (PTP) with microsecond precision, traffic scheduling/shaping and path reservation.



Available Features

- Up to Gigabit speeds
- Audio/video bridging (AVB)
- Energy-efficient Ethernet
- IEEE 802.1Q av-based traffic scheduler
- IEEE 802.1X port-based authentication
- Precision time protocol (IEEE 1588 v2, 802.1AS)
- Network fault recovery (DLR/HSR)
- Industrial temperatures
- LinkMD+ cable diagnostics with signal quality indicator
- Synchronous Ethernet support
- Supports TSN

Management Processor Support

Microchip provides switch drivers for our award winning MPLAB® Harmony software framework, or for open operating systems like Linux. Whether your application is large or small, we have the driver to cover your needs.

Gigabit Switch Family

Feature	KSZ989x	KSZ956x	KSZ947x
Bandwidth	10Base-T/100Base-TX/1000Base-T		
Ports	3, 6, 7	3, 7	7
Interface	SGMII/RGMII/GMII/RMII/MII		
Cable Diagnostics	LinkMD® Technology	LinkMD+ with signal quality indicator	
IEEE 1588 v2/802.1AS	–	✓	✓
Audio/Video Bridging (AVB)	–	✓	✓
Time Aware Scheduler	–	✓	✓
Low Latency Cut Through	–	✓	✓
Quiet-WIRE® Technology	–	–	✓
Network Fault Recovery (DLR/HSR)	–	–	✓
IEEE 802.1X	✓	✓	✓
EEE/Wake-On-LAN	✓	✓	✓
Industrial Temperature	–40 to 85°C		
Packages	64-pin QFN	128-pin TQFP	128-pin TQFP

Microchip offers an extensive line of Fast Ethernet switches to meet a variety of consumer, industrial and automotive needs. The following are just a portion of the entire portfolio. For the complete portfolio, please go to www.microchip.com/EthernetSwitch.

3-Port Switches

Feature	KSZ8863	KSZ8873	KSZ8463	KSZ8563	LAN9303	LAN935x	LAN9355
Bandwidth	10Base-T/100Base-TX/100Base-FX			10Base-T/100Base-TX		10Base-T/100Base-TX/100Base-FX	
Interface	MII/RMII			MII/RMII/RGMII	MII/RMII	SPI/SQI/RMII/MII	MII
EEE	–	–	✓	✓	–	✓	✓
V _{DD} I/O	1.8/2.5/3.3				3.3	1.6–3.3	
Cable Diagnostics	✓	✓	✓	✓	–	✓	✓
IEEE 1588	–	–	✓	✓	–	✓	✓
Power	520 mW		330 mW		640 mW	555 mW	
Temperature	–40 to 85°C		–40 to 85°C (AEC-Q100)			–40 to 85°C	
Packages	48-pin LQFP	64-pin LQFP		64-pin QFN	56-pin QFN	56-/64-/72-pin QFN, 64-/80-pin TQFP	88-pin QFN, 80-pin TQFP

5- to 9-Port Switches

Feature	KSZ8864	KSZ8895	KSZ8794	KSZ8795	KSZ8775	KSZ8765	KSZ8565	KSZ8567	KSZ8999
Bandwidth	10/100Base-T/TX, 100Base-FX		10/100Base-T/TX with GigE Uplink			10/100Base-T/TX, 100Base-FX with GigE Uplink	10/100Base-T/TX with GigE Uplink		10/100Base-T/TX, 100Base-FX
Number of Ethernet Ports	4	5	4	5			7	9	
Interface	MII/RMII (x2)		RGMII MII/RMII	GMII/RGMII MII/RMII	RGMII MII/RMII	GMII/RGMII MII/RMII	RGMII/MII/ RMII	RGMII/MII/ RMII/SGMII	MII, SNI
Wake-On-LAN EEE	–	–	✓	✓	✓	✓	✓	✓	–
IEEE 802.1X	–	–	–	–	–	–	✓	✓	–
V _{DD} I/O	1.8/2.5/3.3								3.3
LinkMD [®] Technology	✓	✓	✓	✓	✓	✓	LinkMD+ with signal quality indicator		–
Power	253 mW	435 mW	430 mW	560 mW	460 mW	560 mW	–	–	1472 mW
Temperature	–40 to 85°C (AEC-Q100)		–40 to 85°C				–40 to 105°C (AEC-Q100)		–40 to 85°C
Packages	64-pin QFN	128-pin LQFP	64-pin QFN	80-pin LQFP			128-pin TQFP		208-pin PQFP

Switch Evaluation Boards

You can implement Ethernet networks with ease by starting with Microchip's switch evaluation boards. For development in MPLAB[®] Harmony software framework, select the PIC32 Starter Kit for Ethernet II and the LAN9303 Daughter Card. For development with processors running Linux OS, choose from our evaluation boards with standard MAC interfaces. Our most popular options are below, but you can find a complete list of switch evaluation boards at www.microchip.com/EthernetSwitch.

**LAN9303 PHY Switch Daughter Board (AC320004-4)**

Used with the PIC32 Ethernet Starter Kit II, this board provides an easy and low-cost way to implement 10/100 Ethernet switching. Combined with Microchip's free TCP/IP software, this kit gets your project running quickly.

**KSZ8765 10/100 Ethernet Evaluation Board (KSZ8765CLX-EVAL)**

This board features an integrated 5-port switch with Gigabit up-link. It contains four MAC/PHYs with two fiber ports, two copper ports and one GMAC interface that is configurable GMII/RGMII/MII/RMII interfaces. The board is designed to allow Gigabit up-link with the Gigabit port of any processor.

**KSZ9897 Gigabit Ethernet Evaluation Board (EVB-KSZ9897)**

This board features a completely integrated triple speed (10Base-T/100-Base-TX/1000Base-T) Ethernet switch with seven ports. The board has six physical ports and one USB-to-Ethernet port. The board also features the LAN7800 USB-to-Ethernet bridge and KSZ9031 Gigabit PHY.

**KSZ9477 Gigabit Ethernet Evaluation Board (EVB-KSZ9477)**

This board features a completely integrated triple speed (10Base-T/100-Base-TX/1000Base-T) Ethernet switch with five ports and one SFP port. The ARM[®]-based ATSAM5D3 host processor implements advanced switch management features such as IEEE 1588 v2, AVB, authentication and is reprogrammable.

For embedded applications, like those using MCUs, our Ethernet controller family offers many flexible interfaces, including SPI, PCI and 8-/16-/32-bit parallel host bus interfaces. All of these interfaces work with an integrated MAC and PHY, delivering 10/100 performance with minimal CPU overhead. Microchip offers free TCP/IP stacks for 16-/32-bit MCUs. Our Ethernet controllers are also available in small package options.



Available Features

- Variety of flexible processor interfaces
- IEEE 1588 v2 precision time protocol
- Energy-efficient Ethernet (802.3az)
- Small 5 × 5 mm 32-pin packaging
- Hardware AES encryption engine

Choose Your Best Fit Processor

Microchip provides drivers for our award-winning MPLAB® Harmony software framework, or for open operating systems like Linux. Whether your application is large or small, we have the driver to cover your needs.

Feature	ENC28J60	ENC624J600	KSZ885X	LAN9250	LAN9221	KSZ8441	KSZ8462
Bandwidth	10Base-T	10/100Base-T/TX	10/100Base-T/TX, 100Base-FX	10/100Base-T/TX		10/100Base-T/TX, 100Base-FX	
TX/RX Buffer	8 KB	24 KB	12 KB (RX), 6 KB (TX)	16 KB		12 KB (RX), 6 KB (TX)	
Interface	SPI	SPI, Parallel	SPI, 8-/16-bit	SPI, 16-bit	16-bit	8-/16-bit	
IEEE 1588 v2	–	–	–	✓	–	✓	✓
Wake-On-LAN	–	–	✓	✓	–	–	–
EEE 802.3az	–	✓	✓	✓	–	✓	✓
Number of Ports	1	1	1 or 2	1	1	1	2
Cable Diagnostics	–	–	✓	✓	–	✓	✓
Power	–	–	330 mW	344 mW	522 mW	330 mW	
Temperature	–40 to 85°C						
Packages	28-pin QFN, 28-pin SOIC 300 mil, 28-pin SPDIP, 28-pin SSOP 208 mil	48-pin QFN, 48-pin TQFP, 64-pin TQFP	32-pin QFN, 48-pin LQFP, 128-pin PQFP	56-pin VQFN		64-pin LQFP	

Controller Evaluation Boards

Adding an Ethernet controller to your application is easy. The Ethernet PICtail™ Plus Daughter Board used with the Explorer 16, is an ideal solution for your PIC24/PIC32-based applications. For development in the MPLAB Harmony software framework, select the LAN9250 10/100 Ethernet Controller Evaluation Board. For development with processors running the Linux OS, the KSZ8851SNL Evaluation Board provides SPI-to-Ethernet connectivity. Our most popular options are below but you can find a complete list at www.microchip.com/EthernetController.



Ethernet PICtail Plus Daughter Board (AC164123)

Designed for flexibility while evaluating and developing Ethernet control applications, this board can be plugged into Microchip's Explorer 16 (DM240001) and can be used with the Microchip TCP/IP stack to connect with any Microchip 16-bit MCU.



KSZ8851SNL Evaluation Board (KSZ8851SNL-EVAL)

This board is for the evaluation of this single-port Ethernet controller. With a 32-pin QFN (5 × 5 mm) package, it is ideal for applications requiring SPI and provides a basic software driver and configuration utility.



LAN9250 10/100 Ethernet Controller Evaluation Board (EVB-LAN9250)

The simple, yet highly functional host bus interface provides a glue-less connection to most common MPUs and MCUs, or the device can be accessed via SPI/SQI. You can also fit an optical fiber interface via an SFP module. The on-board PIC32MX MCU can be interfaced to the LAN9250 using an HBI or SPI interface.

Microchip's LAN9252 is a 2/3-port EtherCAT slave controller with dual integrated Ethernet PHYs which are each capable of full-duplex 100Base-TX. The LAN9252 supports HP Auto-MDIX, allowing the use of direct-connect or cross-over LAN cables. 100Base-FX is supported by an external fiber transceiver via LVPECL. This device provides you a highly integrated and cost-effective solution for realizing EtherCAT slave solutions.



Available Features

- Operates with/without Host processor
- Multifunction GPIO
- Flexible operation modes with up to 3 ports
- Fast SPI, Quad SPI or 8-/16-bit interfaces
- Compact 12 × 12 mm 64-pin package

Development Tools

	Development Tool	Part Number	Description
	Add-On for EL9800 Development Platform	EVB-LAN9252-ADD-ON	This is designed to be used as an add-on board (ESC board) with the Beckhoff EL9800 EtherCAT® Evaluation Board. This board supports the SPI and DIGIO PDI modes of the LAN9252.
	PICTail™ Plus for Explorer 16 Platform	EVB-LAN9252-PICTAIL	This board is used to evaluate the LAN9252. It is an expansion board for the Explorer 16 Development Board (DM240001).
	3-Port EtherCAT Slave Controller Evaluation Kit with SPI PDI Interface	EVB-LAN9252-3PORT	This evaluation board is a standalone platform with SPI/SQI as the PDI interface. It supports the on-board PIC32MX or the option for other SoCs.
	4-Port Slave Controller Evaluation Kit in Expansion Mode	EVB-LAN9252-4PORT	This board features a unique design by cascading two LAN9252 ESC in back-to-back configuration through the MII interface. It is a standalone platform to develop an EtherCAT slave device with SPI/SQI™ as the PDI interface. This board supports the on-board PIC32MX or the option for other SoCs.
	EtherCAT Slave Controller Evaluation Kit with DIGIO PDI Interface	EVB-LAN9252-DIGIO	This board satisfies the demand for hardware-only EtherCAT slave devices. The exposed DIGIO interface together with control signals can operate without an attached MCU.
	EtherCAT Slave Controller Evaluation Kit with HBI PDI Interface	EVB-LAN9252-HBIPLUS	This board is a standalone platform to develop an EtherCAT slave device with PIC32 or other SoCs/MCUs/MPUs with more advanced features over the standard HBI board.

Find out more at www.microchip.com/EtherCAT.

Microchip has over 150 PIC® MCUs and SAM ARM MCU/MPUs with Ethernet MAC to support networking applications. Options range from fully integrated PIC MCUs plus 10Base-T MAC/PHY to MPUs with on-board 10/100/1000 MAC interfacing to external PHYs or switches.



Ethernet Companion Processors

- PIC18 with on-board MAC/PHY
- Over 90 PIC MCUs with on-board MAC
- Over 40 SAM 32-bit ARM MCUs with on-board 10/100 MAC
- Over 15 SAM A5/ARM9 32-bit ARM MPUs with on-board 10/100 or Gigabit MAC

Choose Your Best Fit Processor

Microchip provides a free TCP/IP stack for our PIC and SAM ARM-based MCUs. In addition we provide Ethernet drivers for the MPLAB® Harmony software framework, and for open operating systems like Linux OS.

Development Tools

	Development Tool	Part Number	Description
	PIC32 Ethernet Starter Kit II	DM320004-2	This board provides an easy and low-cost method to experience 10/100 Ethernet development with PIC32 MCUs. Combined with Microchip's free TCP/IP software, this kit gets your project running quickly. Features include a socket accommodating various 10/100 Ethernet transceiver (RJ-45) PHY daughter boards.
	SAME70 Xplained Evaluation Kit	ATSAM70-XPLD	Featuring the KSZ8081 10/100 Ethernet PHY, this board is ideal for evaluating and prototyping fast Ethernet for consumer and industrial applications. The MCU is a ATSAME70Q21 ARM® Cortex®-M7 MCU with on-board debugger. Expansion boards can be purchased separately.
	SAM V71 Xplained Ultra Evaluation Kit	ATSAMV71-XULT	Featuring the KSZ8061 10/100 Ethernet PHY with Quiet-WIRE® technology, this board is ideal for evaluating Ethernet for harsh-environment applications. The MCU is an ATSAMV71Q21 ARM Cortex-M7 with on-board debugger. Extension boards can be purchased separately.
	SAM A5 D3 Xplained	ATSAMA5D3-XPLD	Featuring the KSZ9031 Gigabit PHY and the KSZ8081 10/100 Ethernet PHY, this board supports fast prototyping and evaluation of 10/100 and Gigabit Ethernet microprocessor-based designs. It includes a rich set of connectivity and storage peripherals with expansion headers for customization, as well as a Linux® OS distribution and software package. Power and debug with the on-board USB connector.
	KSZ9567 Gigabit Ethernet Evaluation Board	EVB-KSZ9477	This board features a completely integrated triple speed (10BASE-T/100Base-TX/1000Base-T) Ethernet switch featuring five ports and one SFP port. The ARM-based ATSAMA5D3 host processor implements advanced switch management features such as IEEE 1588 v2, AVB, authentication and is reprogrammable.
	PIC32MZ with FPU (with/without Crypto Engine) Embedded Connectivity Starter Kit	DM320007 (without Crypto Engine) DM320007-C (with Crypto Engine)	Featuring the LAN8740 10/100 PHY, the PIC32MZ with FPU Embedded Connectivity Starter Kit provides a low-cost method for the development and testing of USB and Ethernet-based application with PIC32MZ EF family devices.

Microchip's Ethernet Solutions

Product	Bandwidth	Interface (Upstream)	Wake-On-LAN	EEE	Temperature*	Packages
Ethernet Controllers						
ENC28J60	10	SPI	-	-	I	28-pin SPDIP, SSOP, SOIC, QFN
ENC624J600	10/100	SPI/Parallel	-	-	I	24-pin TQFN, QFN, 64-pin TQFN
LAN9217	10/100	16-bit Host Bus/MII	-	-	-	100-pin TQFP
LAN9218	10/100	32-bit Host Bus	-	-	I	100-pin TQFP
LAN9220/1	10/100	16-bit Host Bus	-	-	I	56-pin QFN
LAN9250	10/100	SPI, SQI™, HBI	✓	✓	I	64-pin QFN, 64-pin TQFP-EP
LAN9420	10/100	32-bit PCI 3.0	-	-	I	128-pin VTQFP
LAN89218	10/100	32-bit Host Bus	-	-	A, I	100-pin TQFP
KSZ8851	10/100	8-/16-/32-bit or SPI	✓	-	A, I	32-pin QFN, 48-pin LQFP, 128-pin PQFP
KSZ8852	10/100	8-/16-/32-bit	✓	✓	I	64-pin LQFP
KSZ8441	10/100	8-/16-/32-bit or SPI	✓	✓	I	64-pin LQFP
USB to Ethernet						
LAN9500A	10/100	USB 2.0	✓	-	I	56-pin QFN
LAN9730	10/100	USB 2.0 (HSIC)/MII	-	-	I	56-pin QFN
LAN9512/13/14	10/100	USB 2.0	-	-	I	64-pin QFN
LAN89530	10/100	USB 2.0	✓	-	A, I	56-pin QFN
LAN89730	10/100	HSIC	✓	-	I	56-pin QFN
LAN7500	Gigabit	USB 2.0	✓	-	I	56-pin QFN
LAN7800/01/50	Gigabit	USB 3.1/USB 2.0/HSIC	✓	✓	I	48-pin SQFN, 64-pin SQFN, 66-pin SQFN
Ethernet Transceivers (PHYs)						
LAN8710A	10/100	MII/RMII	-	-	I	32-pin QFN
LAN8720A	10/100	RMII	-	-	I	24-pin QFN
LAN8740A	10/100	MII/RMII	✓	✓	I	32-pin QFN
LAN8741A	10/100	MII/RMII	-	✓	I	32-pin QFN
LAN8742A	10/100	RMII	✓	-	I	24-pin QFN
LAN88730	10/100	MII/RMII	-	-	A, I	32-pin QFN
KSZ8051	10/100	MII/RMII	-	-	A, I	32-pin QFN
KSZ8061	10/100	MII/RMII	✓	✓	A, I	32-/48-pin QFN
KSZ8081	10/100	MII/RMII	-	-	I	24-/32-pin QFN, 48-pin LQFP
KSZ8091	10/100	MII/RMII	✓	✓	I	24-/32-pin QFN, 48-pin LQFP
LAN8810	Gigabit	GMII	-	-	I	72-pin QFN
LAN8820	Gigabit	RGMII	-	-	I	56-pin QFN
KSZ9031	Gigabit	MII/RMII/RGMII	✓	-	A, I	48-/64-pin QFN

Product	Bandwidth	Ports	Interface (Upstream)	1588-v2	Cable Diags	100 Fx	Temperature*	Packages
EtherCAT® Controllers								
LAN9252	10/100	2/3	SPI, SQI™, 8-/16-/32-bit host bus	Clock Sync.	✓	✓	I	64-pin QFN, 64-pin TQFP-EP
Ethernet Switches								
LAN9352	10/100	2	SPI/SQI/HBI	✓	✓	-	I	72-pin QFN, 80-pin TQFP-EP
LAN9303	10/100	3	MII/RMII/Turbo MII	-	-	✓	I	56-pin QFN, 72-pin QFN
LAN89303	10/100	3	MII/RMII/Turbo MII	-	-	✓	A, I	56-pin QFN
LAN9353	10/100	3	MII/RMII/Turbo MII	✓	✓	✓	I	64-pin QFN, 64-pin TQFP-EP
LAN9354	10/100	3	RMII	✓	✓	✓	I	56-pin QFN
LAN9355	10/100	3	MII/RMII/Turbo MII	✓	✓	✓	I	64-pin QFN, 64-pin TQFP-EP
KSZ8863	10/100	3	MII/RMII	-	✓	✓	I	48-pin LQFP
KSZ8873	10/100	3	MII/RMII	-	✓	✓	A, I	64-pin VQFN
KSZ8463	10/100	3	MII/RMII	✓	✓	✓	I	64-pin LQFP
KSZ8864	10/100	4	MII/RMII	-	✓	-	A, I	64-pin VQFN
KSZ8794	10/100	4	MII/GMII/RGMII	-	✓	-	I	64-pin VQFN
KSZ8795	10/100	5	GMII/RGMII/MII/RMII	-	✓	-	I	80-pin LQFP
KSZ8775	10/100	5	MII/GMII/RGMII	-	✓	-	I	80-pin LQFP
KSZ8765	10/100	5	MII/GMII/RGMII	-	✓	✓	I	64-pin QFN, 80-pin LQFP
KSZ8895	10/100	5	MII/RMII	-	✓	-	I	128-pin LQFP
KSZ8567	10/100	3, 5, 7	SGMII/RGMII/MII/RMII	✓	LinkMD+ with signal quality indicator	with SGMII	A, I	64-pin QFN, 128-pin LQFP
KSZ9897	Gigabit	3, 6, 7	SGMII/RGMII/MII/RMII	-	✓	with SGMII	I	64-pin QFN, 128-pin LQFP
KSZ9567	Gigabit	3, 7	SGMII/RGMII/MII/RMII	1588 + AVB	LinkMD+ with signal quality indicator	with SGMII	I	64-pin QFN, 128-pin LQFP
KSZ9477	Gigabit	7	SGMII/RGMII/MII/RMII	1588 + AVB +HDR/DLR	LinkMD+ with signal quality indicator	with SGMII	I	128-pin LQFP

Note: All products above are supported with 3.3V operating voltage

*A = Automotive temperature range, I = Industrial temperature range

Support

Microchip is committed to supporting its customers in developing products faster and more efficiently. We maintain a worldwide network of field applications engineers and technical support ready to provide product and system assistance. For more information, please visit www.microchip.com:

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- Evaluation samples of any Microchip device: www.microchip.com/sample
- Knowledge base and peer help: www.microchip.com/forums
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Training

If additional training interests you, then Microchip can help. We continue to expand our technical training options, offering a growing list of courses and in-depth curriculum locally, as well as significant online resources.

- Technical Training Centers and Other Resources: www.microchip.com/training
- MASTERS Conferences: www.microchip.com/masters
- Worldwide Seminars: www.microchip.com/seminars
- eLearning: www.microchip.com/webseminars

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3D printer outputs stretchable soft circuits hybridized with SMT parts

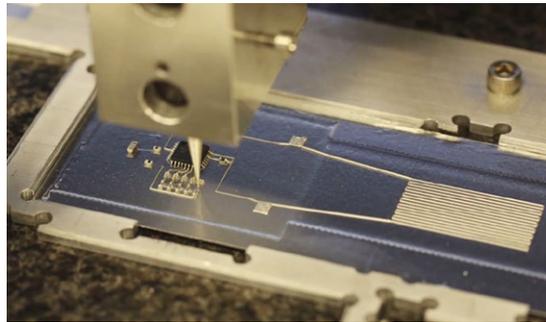
By Julien Happich

Although they can be made thin, flexible and stretchable, the organic materials used for printed electronics can't compete with the processing power provided by hard silicon chips, which somewhat frustrates all attempts to build truly flexible and stretchable wearable electronics.

Hybrid soft circuits connecting small islands of hard silicon-based electronic components is an approach that has been under investigation for some time. Though the main difficulty in these hybrid approaches is to make reliable connections between the soft rubbery circuit areas and the hard rigid pins of silicon devices. Sometimes, this is done by creating progressively thicker and firmer pad areas which will receive the hard components, from there, meandering circuit patterns can alleviate the stress on the connection and on the conductive tracks too. Typically, the soft printed circuit parts are first manufactured, and then placed under a pick-and-place machine to receive the hard silicon parts.

A new approach taken by researchers from the Wyss Institute for Biologically Inspired Engineering, in collaboration with the Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS) and the US Air Force Research Laboratory consists in layering all the soft circuit compounds using a dedicated 3D printer which can also pick-and-place the hard parts in a last pass.

Key to this hybrid 3D printing is the use of a stretchable conductive ink made of thermoplastic polyurethane (TPU) mixed with silver flakes. Both pure TPU and silver-TPU inks are co-printed to create the devices' underlying soft substrate and conductive electrodes and ensuring a very strong adhesion and integration. Simple electrode patterns



SMT parts being placed on a hybrid 3D-printed flexible circuit.

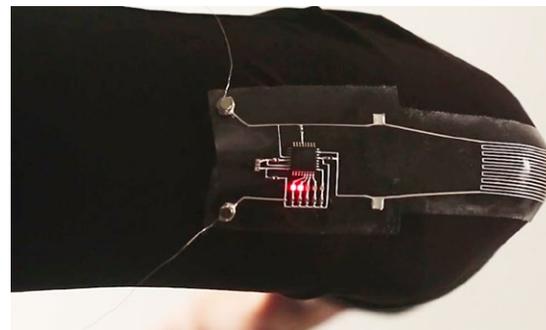
can be printed to create sensors (by monitoring their change electrical conductivity upon stretching) whose data can be processed by a programmable microcontroller.

The novelty is that the same conductive ink dispenser is used as a vacuum nozzle (when empty) to pick-and-place electronic components whose contact pads have first received a blob of rubbery conductive ink. The TPU dots applied beneath each component serve to anchor them and to distribute

the stress throughout the entire stretchable circuit matrix.

This trick allows the fully assembled devices to be stretched up to 30% while still maintaining their function, the researchers reported in the *Advanced Materials* journal.

Their paper "Hybrid 3D Printing of Soft Electronics" relates a number of experiments and a proof-of-concept, with the realization of two soft electronic devices. One was a strain sensor was fabricated by printing TPU and silver-TPU-ink electrodes onto a textile base and combining this with a microcontroller chip and readout LEDs through pick-and-place. The wearable sleeve-like device can indicate how much the wearer's arm is bending through the successive lighting-up of the LEDs.



Strain sensors made using the hybrid 3D-printed approach, conforming to a bending arm. Credit: Alex Valentine, Lori K. Sanders, and Jennifer Lewis / Harvard University

The second device was a pressure sensor in the shape of a person's left footprint, created by printing alternating layers of conductive silver-TPU electrodes and insulating TPU to form electrical capacitors on a soft TPU substrate. The deformation patterns are then processed to make a visual heat map image of the foot when a person steps on the sensor.

The researchers believe their new approach will make customizable wearable electronics both affordable and mechanically robust.

EPC to demonstrate wireless charging table based on GaN

By Nick Flaherty

Efficient Power (EPC) has developed a wireless charging table for the AirFuel standard that can provide up to 165 W through the gallium nitride (GaN) power devices.

eGaN FETs and ICs, operating at 6.78MHz, are featured in the amplifiers that are powering the transmit coils of the wireless power surface and in the receive circuits used in the devices placed on the surface. The wireless power table being demonstrated at the Wireless Power Summit in Denver, Colorado is capable of delivering a total of 165W of power, enabling simultaneous charging of multiple devices with spatial freedom.



Several eGaN products are critical to the wireless power table design. Specifically, the amplifier on transmit side of table uses the EPC9512 power amplifier. The amplifier takes advantage of the performance of the EPC8010 as the main power stage FET, the EPC2038 as the synchronous bootstrap FET and the EPC2019 is critical in the SEPIC pre-regulator. On the receive side, the EPC2019 is also used as a boost FET to accommodate the multiple power levels of the receive devices to be placed on the table-top, which range from 5 W for cell phone charging to 25 W to power the laptop.

Piezoelectric nanowires yield ultra-high resolution fingerprints

By Julien Happich

Kicked-off back in 2013, European R&D project PiezoMAT focused on the use of matrices of vertically grown piezoelectric nanowires to fabricate ultra-high resolution pressure-based fingerprint sensors.

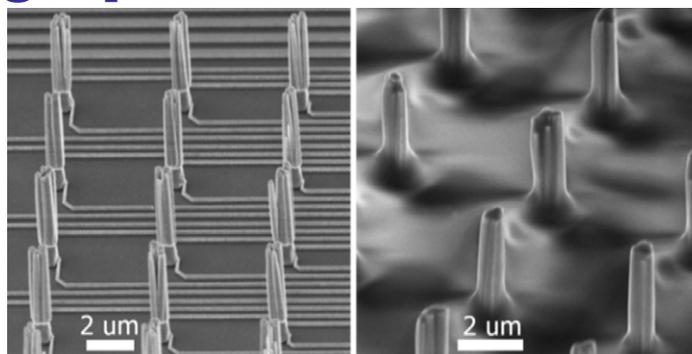
The eight-member project team of European companies, universities and research institutes fabricated a demonstrator embedding a silicon chip with 250 pixels, and its associated electronics for signal collection and post-processing. The chip was designed to demonstrate the concept and the major technological achievements, not the maximum potential nanowire integration density.

The chip featured a matrix of interconnected piezoelectric zinc-oxide (ZnO) nanowires (NW) grown on silicon at resolution of 1,000 dots per inch (DPI), with bundles of nanowires forming pixels less than $50 \times 50 \mu\text{m}^2$ each, encapsulated in a polymer. Under deformation (from a finger), the piezoelectric nanowires



generate potentials whose amplitudes are proportional to the NW displacement and can be used to reconstruct the smallest minutiae (pores and ridge shapes) of human fingerprints.

In one of their implementations, the



Matrix of vertically grown piezoelectric nanowires

researchers narrowed down the sensing pixels to only a few standing nanowires (designed as a 'bending mode' force sensor), creating a 8×8 pixel array at a resolution of 5000dpi.

Coordinated by CEA Leti, the PiezoMAT project also involved Fraunhofer-Institut für Angewandte Festkörperphysik (IAF), the MEMS lab, Institute for Technical Physics and

Materials Science, Universität Leipzig, Kaunas University of Technology, Specific Polymers, Tyndall National Institute, and Safran Identity and Security (Morpho).

The 44-month, €2.9 million EC-funded project also provided valuable experience and know-how in several key areas, such as optimization of seed-layer processing, localized growth of well-oriented ZnO nanowires on silicon substrates, mathematical modelling of complex charge generation, and synthesis of new polymers for encapsulation.

Smart roads for power generation

By Nick Flaherty

Researchers at the University of Lancaster in the UK are looking to develop new piezoelectric materials in road surfaces to generate power from everyday traffic. The research project, led by Professor Mohamed Saafi (above), will design and optimise energy recovery of around one to two megawatts per kilometre under 'normal' traffic volumes, which is around 2,000 to 3,000 cars an hour. This would generate enough power for around 3,000 street lamps. It currently costs around 15p a kilowatt hour to power a street lamp, costing between £1,800 and £3,600 per day. Researchers say the cost of installing and operating new road energy harvesting technology would be around 20 per cent of this cost.

The design is part of the €4m SAFERUP (Sustainable, Accessible, Safe, Resilient and Smart Urban Pavements) programme in the European Commission's Horizon 2020 fund and is led by the University of Bologna.

"This research is about helping to produce the next generation of smart road surfaces," said Prof Saafi.

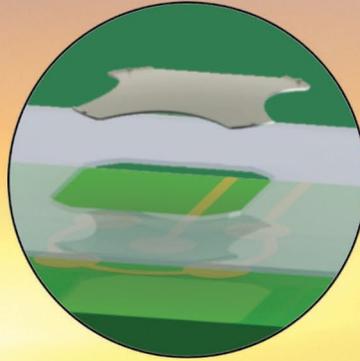
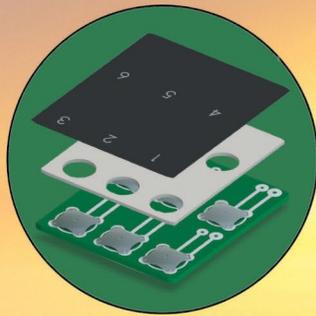


"We will be developing new materials to take advantage of the piezoelectric effect where passing vehicles cause stress on the road surface, producing voltage. The materials will need to withstand high strengths, and provide a good balance between cost and the energy they produce. The system we develop will then convert this mechanical energy into electric energy to power things such as street lamps, traffic lights and electric car charging points. It could also be used to provide other smart street benefits, such as real-time traffic volume monitoring."

When the technology has been developed it will undergo field trials in the UK and other areas of the EU. Partners on the SAFERUP project include TU Wien, Austria, Università degli Studi di Perugia, Italy, University of Nottingham, UK, University of Cantabria, Spain, French Institute of Sciences and Transport Technologies, France, Coventry University, UK, University College London, UK, Lancaster University, UK, Universitaet Innsbruck, Austria, Celu Eksperts, Latvia, Durth Roos Consulting GmbH, Germany and SAPABA in Italy.

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Cognitive hearing aid puts DNNs to work with the wearer's brain

By Julien Happich

Researchers at Columbia Engineering have come up with a new way to make hearing aids smarter, implementing Deep Neural Networks (DNNs) trained to separate speech from selected interlocutors, and comparing their spectrogram with that of a reconstructed spectrogram from the wearer's live neural recordings.

Here, the neural recording serves as a way to identify to which speaker (among multiple interfering speakers) the user is listening to, so the hearing aid can then use its DNN-based audio source separation algorithms to only amplify the speech of the appropriate speaker.

Although this approach could be combined with other more traditional tricks, like audio beam forming, it is more accurate in automatically and dynamically tracking a user's direction of attention.

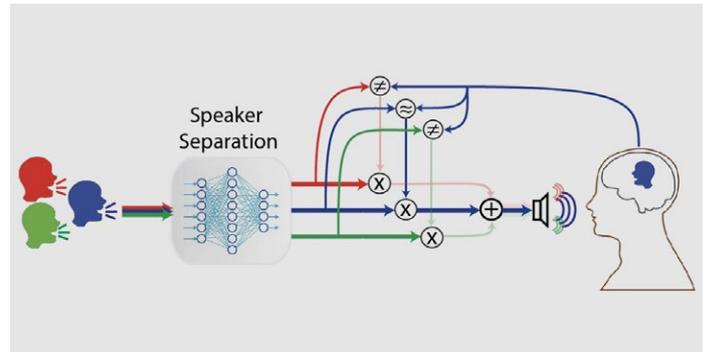
With their paper "Neural decoding of attentional selection in multi-speaker environments without access to clean sources" published in the Journal of Neural Engineering, the researchers claim a breakthrough in auditory attention decoding (AAD), bringing cognitively controlled hearing aids one step closer to reality.

The hearing aid system relies on deep neural network (DNN) audio source separation algorithms that work with the spectrogram of simultaneous speakers. The audio mixture is fed to several DNNs, each trained to separate a specific speaker from a mixture (DNN Spk1 to DNN SpkN).

Simultaneously, as the wearer is attending to one of the speakers, a spectrogram of that speaker is reconstructed from the neural recordings of the user, which can then be compared with the outputs of each of the DNNs. The spectrogram most similar to the neural reconstruction is then converted to audio and added to the mixture to amplify the speech of the attended speaker.

In order to automatically separate each speaker from the mixture, the researchers employed a method of single-channel speech separation that uses a class of DNNs known as long short-term memory (LSTM) DNNs. Each DNN was trained to separate one specific speaker from two speaker mixtures, but the researchers also propose a system that could work in a real-world situation where a device would contain multiple DNNs, each trained to separate specific speakers, any of whom may or may not be present in the environment.

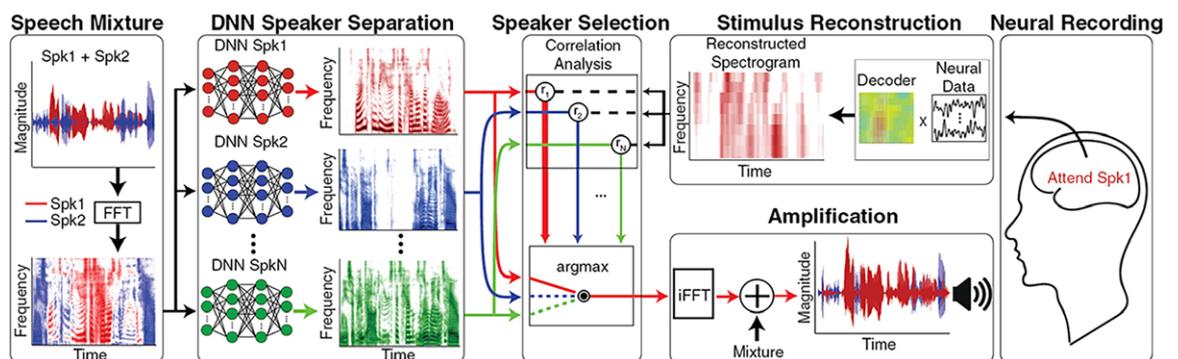
Adding a novel speaker only requires about 20mn of clean speech (for example when the listener would be conversing with



only one person), the authors note, but once trained, the system only takes 10 seconds to identify which speech to track and amplify.

The authors argue that although the number of DNNs (and associated speakers) could be limited by hardware constraints, such smart hearing aids could off-load some of the computing to a nearby smartphone.

What's more, thanks to the live neural recordings, the DNN-based hearing aid system was able to dynamically switch from one recognized speaker to another, naturally following the wearer's focus from one conversation to another, performing a +12 dB amplification relative to the speech mixture. Using audio amplification rather than filtering means the wearers can still hear other speakers in the background, making it possible for them to switch their attention should they choose to do so.



Two speakers, Spk1 (red) and Spk2 (blue), are mixed together into a single acoustic channel. A spectrogram of the corresponding mixture is fed to several DNNs, each trained to separate one of the specific speakers. As the user is attending to one of the speakers (here Spk1; red), its neural recordings can be used to reconstruct a spectrogram of that speaker which is then compared with the outputs of each of the DNNs, before being amplified by the hearing aid.

In the absence of a known target speaker, then cognitive hearing aid could switch to a default operation.

In their study, the researchers relied on invasive electrocorticography (ECoG) recordings, placing electrodes directly in contact with the brain. They did so to determine the varying contributions of different auditory cortical areas to AAD. But in previous work, they have already established the feasibility of applying such AAD techniques to non-invasive neural recordings too, making it more accessible.

ST preps second neural network IC

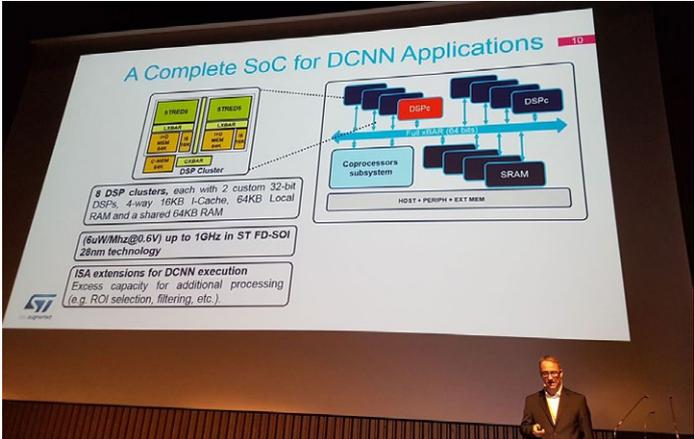
By Peter Clarke

STMicroelectronics is designing a second iteration of the neural networking technology that the company reported on at the International Solid-State Circuits Conference (ISSCC) in February 2017.

This is set to be a product distinct from what is described as a demonstrator IC, and it is a technology that CEO Carlo Bozotti is enthusiastic about. Bozotti spoke about the technology during his keynote speech for the combined European MEMS, Imaging and Sensors summits, held in Grenoble, France. The European summits are hosted by the MEMS and Sensors Industry Group under the auspices of industry organization SEMI.

Bozotti said the technology could be used to distribute artificial intelligence throughout a system based on ST32 microcontrollers and sensors.

Speaking in the main program of the event Thomas Boesch, a member of the technical staff at ST, said his company is now working on a new implementation of the technology for accelerating convolutional neural networks; one that is more optimized and more targeted.



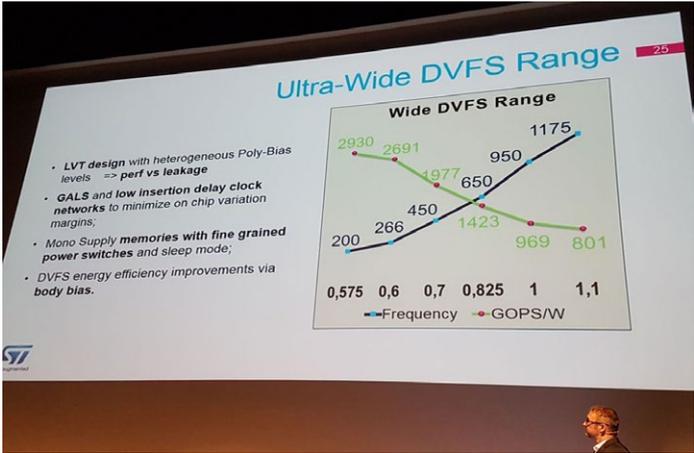
In his talk Boesch laid out the architecture and performance of the dedicated deep convolution neural network (DCNN) SoC re-iterating much of what was disclosed at ISSCC.

The SoC is implemented in 28nm FDSOI and has an extended dynamic voltage and frequency scaling (DVFS) regime that allows it to operate with a clock frequency of 200MHz at 0.575V and then up to 1.1GHz clock frequency at 1.1V.

This is useful for machine learning Boesch said giving an example where the low performance node can be used to efficiently monitor and detect an object while higher performance can be used to identify the object.

The architecture has 8 DSP clusters of two custom 32bit DSPs plus a coprocessor subsystem that includes 8 convolutional accelerators, 16 DMA engines and a universal stream switch that allows unidirectional linking of all these resources.

Each convolutional accelerator includes 36 16-bit by 16-bit multiplier accumulators. In CNNs such as AlexNet or more recent and advanced architectures the convolutions themselves make up 85 to 90 percent of the work load. The architecture allows hardware accelerator to be autonomous of the DSP and



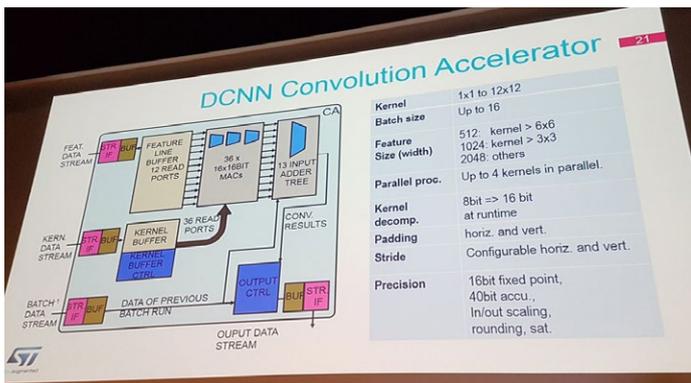
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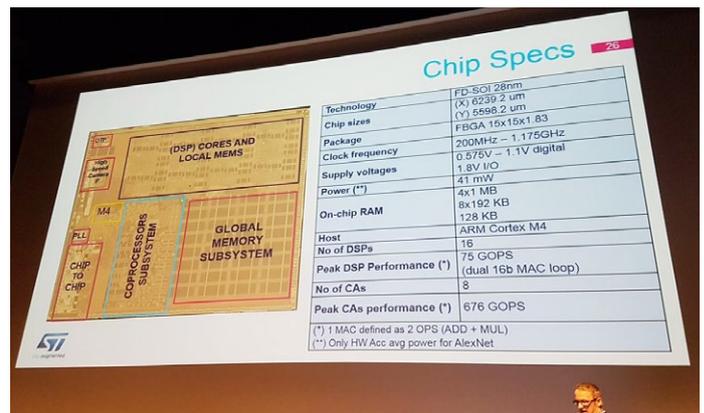
concatenation of MAC operations to exploit parallelism and locality.

The overall chip includes 4Mbytes of on-chip RAM plus 8 by 192kbytes of local memory and it is controlled by a Cortex-M4 processor core operating at 1GHz clock frequency. The chip has a peak efficiency of about 2.9TOPS/W in operation on AlexNet, Boesch said.

Boesch would not reveal much about the second generation of the architecture but there is a clue as to at least one of the favoured application areas. Boesch was speaking in a session on technologies for autonomous vehicles. Deep convolution neural networks (DCNNs) are often used for scene classification and object recognition, vital tasks in taking vehicles towards autonomous driving. It is also notable that ST has long been a supporter of automotive supplier Mobileye, now an Intel company, and that Mobileye has expressed strong views about the need for machine learning in automotive vision.

When asked directly what the market place for ST's re-working of its technology is he said: "We are talking about the embedded world, mobile, you don't want GPUs doing neural networks."

In the automotive sector Nvidia has enjoyed some success re-applying its GPU technology to machine learning but there are signs that the industry is now turning to dedicated neural network accelerators. Boesch said that while ST's first



chip was a demonstrator and a superset of the capabilities, a future design could be stripped down and be more tailored to an application either as part of an SoC or on a microcontroller. It is notable that in 28nm FDSOI the DCNN demonstrator die measures 6.2 by 5.6mm.

It is also notable that Boesch noted the capability to link the demonstrator SoC with more of the same device to cater for large CNN loads and potentially to support distributed computation.

Although Boesch was taciturn, Carlo Bozotti, CEO of STMicroelectronics, was more effusive in his keynote speech.

"This architecture is suitable for integration into a wide range of IoT devices. The sensors can be images videos, sound, motion or environmental information or a combination of these. The neural networking array for deep learning that has been implemented in the device is scalable, depending on the type of input and the flows of training are optimized for industry standards," Bozotti said.

He added: "Thanks to dynamic voltage scaling possible in FDSOI technology and the inherent architecture, the chip is 100 times more power efficient than low-power general purpose GPUs used for AI today and 2 to 5 times more efficient than the most advanced specialized AI and computer vision chips already announced."

Apple, Google enter the AR fray

By William Wong

Augmented reality (AR) can be implemented in a number of ways. One of the primary approaches is to use AR glasses; another is to use a tablet or smartphone equipped with a camera (e.g., games like Pokémon Go). Fundamentally, both approaches aim to deliver a view of reality overlaid with computer-generated content.

One might think that Apple's new ARKit and Google's ARCore will rescue developers from AR oblivion, but a quick look around highlights a plethora of AR options targeting a range of platforms that are already available. Having heavy hitters like Apple and Google in the mix will not hurt, but the likes of Microsoft and Intel have been hitting the AR gong for quite a while already. Likewise, solutions like Scope AR's WorkLink (see figure 1) have been available for a number of years.

Google has also been doing work with its Google Glass, which disappeared for a while but is back as an industrial tool (see figure 2). The main difference between this effort and its ARCore is the target audience. The Google Glass hardware is actually paired with software from Google solution provid-



Fig. 1: Scope AR's WorkLink is a deployable AR solution that that works with tablets and AR glasses to provide support for training and support in the workplace.

ers that work directly with the customers. Apple's ARKit and Google's ARCore target iOS and Android developers respectively, with smartphones being the target platform.



Fig. 2: Google Glass is back, in the factory. Customers actually work with Google solution providers instead of getting hardware and software directly from Google.

the importance of AR.

“Google and Apple’s AR technology is exciting and confirms what we’ve believed at Meta since before our inception: Augmented reality is the next paradigm of computing,” said David Oh, head of developer relations at Meta. “We are working closely with developers to design the most productive and intuitive AR applications, in line with Meta’s just-published Spatial Design Guidelines. Once these applications offer a seamless, natural and productive experience, we are excited to see how quickly and easily these high-quality apps will be ported to glasses and drive the entire industry forward.”

Apple’s ARKit (see figure 3) uses Visual Inertial Odometry (VIO) to track what the iPad or iPhone camera sees and allows mapping of content onto the screen presentation. It uses the built-in sensor system in these devices using the Core Motion framework. Of course, this is the same type of thing that is done within any AR framework or software development kit (SDK). It is just a matter of using different nomenclature. At this point ARKit requires an Apple A9 and A10 processor that is in the latest versions of Apple’s hardware. The support will be found in iOS 11 and Xcode 9 development tools.

Google’s ARCore targets Google Android (see figure 4). ARCore is a relative newcomer to the AR space. Some of its details are a bit sparse. Like ARKit, it supports third-party gaming engines like Unity and Unreal. This is key for generating 3D images to overlay virtual images in AR mode.

ARKit and ARCore have the advantage over third-party solutions because of their integration with the operating system. Likewise, this support will come as part of the operating system package versus an application. This, in theory, will provide potential integration of multiple AR apps in the future.

AR SDKs typically hide much of the underlying complexity of sensor integration, scene analysis, and so on. Applications can then utilize this information and merge it with 2D and 3D content that is then displayed and manipulated by application users. This may sound simple but is actually quite complex, as details like lighting need to

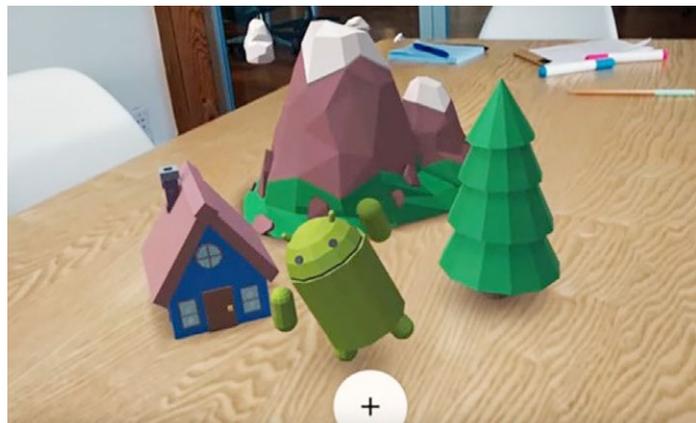


Fig. 3: ARKit targets Apple’s iPad and iPhone platforms turning them into AR viewers.

These look to take advantage of the massive smartphone population that is dominated by iOS and Android. Likewise, even midrange smartphones are coming equipped with high-resolution cameras that blend well with AR solutions. Of course, Apple and Google’s offerings highlight

be taken into account.

Likewise, many AR applications do not simply overlay information but require that this information be positioned based on camera images. This requires image recognition and scene analysis. This can require significant amounts of computing power, and even artificial intelligence and

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Fig. 4: ARCore brings AR to Google Android. The 3D objects on the table are computer-generated and oriented for the real table's placement.

machine learning come into play, as these tools are used to recognize items in a scene and even the relationship between objects.

ARKit and ARCore work within their respective program-

ming platforms and frameworks. This allows access to other app development support from buttons to gesture recognition, since the AR aspect will not be the only part of the app that a user will work with. These SDKs also work with other 3D tools that already exist, such as Apple's SceneKit (which supports 3D animation) and SpriteKit (which handles 2D animation).

I did mention that there were other solutions out there—including support from Microsoft and Intel—but here are a few more that have SDKs and plugins that have cross platform support, including iOS and Android: ARToolkit, EasyAR, Kudan, Maxst, Vuforia, Wikitude, and XZIMG. Many include additional features like face recognition.

All of these can be used to create AR games and applications, but they will require a significant amount of coding and understanding of the SDK to deliver an AR application. Developers will need to know whether they want to work at this level or work at customizing an existing solution like Scope AR's WorkLink.

If anyone is wondering what all that computing power in a smartphone will be used for, they should look at the apps being generated using these toolkits and frameworks.

This article originally appeared in Electronic Design

Audio SoC integrates multiple media decoders

Rohm's BM94803AEKU high resolution audio SoC has been designed to act as the 'brain' in audio applications such as Bluetooth speakers, USB DACs, and mini/micro component systems. The device integrates a processor chip with SDRAM featuring an optimized architecture that leverages software and circuit elements such as ASIC (Application Specific IC), MCU, and various media decoders (developed by the ROHM Group) on a single chip. The media decoder supports a wide range of audio sources and



can ensure stable playback of damaged CDs and even non-standard USB. Rohm's audio SoC integrates both a CD DSP (CD media decoder) and 16Mb SDRAM (Lapis Semiconductor product), which were previously implemented separately, in a single package. This not only reduces mounting area, but also eliminates the need to consider radiation noise between components. With the new Audio SoC, Rohm has built what it claims to be the industry's first high-resolution reference audio design, maximizing the performance of audio devices and peripheral applications by configuring Rohm's amp, CD driver, and other elements around the audio SoC. The company also provides dedicated software to enable the rapid development of audio devices capable of stable playback of a wide range of audio sources, shortening development time considerably.

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Radiation-tolerant FPGA in a ceramic quad flat pack

Microsemi has released high-speed signal processing radiation-tolerant field programmable gate array (FPGA) engineering samples in a ceramic quad flat pack (CQFP) package. The new CQ352 package, which conforms to the CQFP industry standard for space applications, features 352 pins to enable a



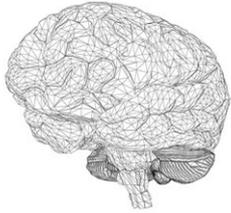
more cost-effective integration than higher pin count packages and is the only CQFP package available for high-speed radiation-tolerant FPGAs in its class. As an industry standard, the CQFP package is well-known for its ability to support a variety of space flight applications, primarily due to their lower costs of integration and well-understood assembly techniques,

making CQFP easier to assemble onto the printed circuit board (PCB) than ceramic column grid array (CCGA) packages. The RTG4 FPGA in a CQ352 package is well suited to control applications which do not require a high number of inputs/outputs (I/Os), including satellites, space launch vehicles, planetary orbiters and landers and deep space probes, as well as others requiring frequent switching and a high number of temperature cycles. The new RTG4 FPGAs feature 166 3.3V general purpose I/Os, four embedded SpaceWire clock and data recovery circuits and four high-speed serialization/deserialization (SerDes) transceivers which can be used for either external physical coding sublayer (EPCS) or Peripheral Component Interconnect Express (PCIe) protocols. They also maintain the same count of look-up tables (LUTs), flip-flops, digital signal processing (DSP) math blocks and static random-access memory (SRAM) blocks as the existing CCGA package with 1,657 pins.

Microsemi
www.microsemi.com

IBM and MIT join forces on AI with new lab

IBM announced its plan to make a 10-year, \$240 million investment to create the MIT-IBM Watson AI Lab in partnership with MIT. The lab will carry out fundamental artificial intelligence (AI)



IBM | MIT

research and seek to propel scientific breakthroughs that unlock the potential of AI. The collaboration aims to advance AI hardware, software, and algorithms related to deep learning and other areas; increase AI's impact on industries, such as health care and cybersecurity; and explore the economic and ethical implications

of AI on society. IBM's \$240 million investment in the lab will support research by IBM and MIT scientists. The new lab will be one of the largest long-term university-industry AI collaborations to date, mobilizing the talent of more than 100 AI scientists, professors, and students to pursue joint research at IBM's Research Lab in Cambridge, Massachusetts — co-located with the IBM Watson Health and IBM Security headquarters in Kendall Square — and on the neighbouring MIT campus. The lab will be co-chaired by Dario Gil, IBM Research VP of AI and IBM Q, and Anantha P. Chandrakasan, dean of MIT's School of Engineering. A distinct objective of the new lab is also to encourage MIT faculty and students to launch companies that will focus on commercializing AI inventions and technologies that are developed at the lab. The lab's scientists also will publish their work, contribute to the release of open source material, and foster an adherence to the ethical application of AI.

IBM

MITIBMWatsonAILab.mit.edu

Single-wavelength PAM4 DSP chip delivers 100G

MultiPhy has unveiled what the company believes to be the world's first 100G single-wavelength PAM4 DSP IC, designed for data center and 5G Cloud RAN connections. The MPF3101 chip includes leading-edge digital signal processing and mixed-signal cores, driving PAM4 single wavelength technology. Moving from parallel optics (typically quad 25G solutions) to a native single 100G solution reduces the number of



optical components, and eases opto-electronic bandwidth requirements. MultiPhy estimates its new chip could yield a 75% BOM reduction, it represents a 400% increase in capacity while slashing power consumption by 25%. The 10x10mm IC can be used in industry-standard QSFP28 optical modules, significantly increasing port density and paving the way for smaller form factors and onboard optic solutions. The MPF3101 is built on TSMC's 16nm high-speed low-power process, it supports links up to 2km for data centers (without repeaters), and up to 10km for 5G wireless infrastructures (up to 80km with repeaters). Together with partner Semtech, MultiPhy has developed a complete reference design optimised with Semtech's SerDes solutions.

MultiPhy

www.multi-phy.com

Intel partners with SecureRF for future-proof FPGA security

SecureRF and Intel announced their collaboration to provide engineers with quantum-resistant authentication and data protection solutions for Intel FPGA-based Internet of Things (IoT) projects. The first security toolkit, available now, addresses Intel's DE10-Nano development board built around the Cyclone V FPGA, along with high-speed DDR3 memory. Low-resource endpoints, often running on 8- or 16-bit processors, limit the options for strong security that must also run on an IoT gateway. Legacy security methods such as ECC are computationally too expensive. SecureRF's security toolkit includes Ironwood Key Agreement Protocol (Ironwood KAP) and Walnut Digital Signature Algorithm (WalnutDSA), which are designed to run on the smallest processors. Basing its security toolkit on Group Theoretic Cryptography methods, SecureRF claims its solutions are up to 60 times more efficient than ECC, consume up to 140 times less energy, and are quantum-resistant to all known attacks. Developers can download an SD card image of SecureRF's security tools from its Security Toolkit webpage. The image includes WalnutDSA and Ironwood, as well as three separate demonstrations showing the operation of the signature algorithm and the key agreement protocol. Ironwood enables two endpoints to generate a shared secret over an open channel, while WalnutDSA allows one device to generate a document that can be verified by another device. Both methods are implemented partially in software on the Intel Cyclone V's ARM Cortex-A9 and partially in the FPGA's fabric.

SecureRF

www.secureRF.com

BrainChip launches neuromorphic hardware accelerator

BrainChip, developer of the Spiking Neuron Adaptive Processor (SNAP) neuromorphic technology, has released a hardware acceleration board featuring a Xilinx FPGA implementation of its technology. The PCIe Gen.3 card is for use as a hardware accelerator for applications developed within the previously released BrainChip Studio, a software product that was



pitched at vision in surveillance, security and defense applications. BrainChip Accelerator is an 8-lane, PCI-Express add-in card that increases the speed and accuracy of the object recognition function of BrainChip Studio software by up to a factor of six, while increasing the simultaneous video channels monitored to up to 16 per card. BrainChip's approach to neural networks differs from other companies offering artificial neural networks, in that BrainChip models the brain and its neuron and synapse architecture more closely and includes models of spiking signals and connection reinforcement and connection inhibition. The processing is done by six BrainChip Accelerator cores within the Xilinx FPGA. Each core performs fast, user-defined image scaling, spike generation, and spiking neural network comparison to recognize objects. Each core consumes approximately one watt while processing up to 100 frames per second.

BrainChip Inc.

www.brainchipinc.com

With narrowband the path to IoT is wider

By Kashif Hussain

If Machina Research, and countless other analyst firms are right, and the number of IoT connected devices grows to something like 27bn by 2025 – then the networks available to carry all the data they will produce are going to need a whole lot more capacity, and quickly.

Of course, there is no shortage of work taking place within standards bodies such as the 3GPP as they try to figure out the best way to service the anticipated explosion in demand. And maybe unusually – at a time when businesses demand, figuratively speaking, ever wider bandwidth for data – one of the technologies being considered to fill that IoT gap is narrowband radio.

One factor at play here is that respected firms like Machina Research also estimate that 11 per cent of these IoT connections, around 3 billion devices, will need the type of Low-Power, Wide-Area Networks (LPWAN) that are ideal for narrowband communications. With that in mind, the attraction of the technology and the level of interest in Narrowband IoT (NB-IoT) becomes clearer.

But that is not the whole story. Because in truth, the interest in NB-IoT goes much further than the suitability of the air interface. In fact, narrowband has a range of deployment options, device advantages, and long-term security benefits that other competing technology approaches, particularly the use of unlicensed spectrum, just cannot match.

The first version of the NB-IoT standard was published in June last year, as part of Release 13 of the global 3GPP standard. At the same time, the 3GPP also released a pure LTE-based solution for IoT termed LTE-M.

But it's my view that there are some significant advantages to NB-IoT that will make it a better solution for the efficient use of the spectrum and of other network resources.

In particular, NB-IoT is very well placed to deliver on some of the key requirements of an efficient IoT – namely device battery-life and cost, radio coverage, and network support.

NB-IoT could enable sub-\$5 devices with ten-year plus battery life, could cope with devices being situated in remote rural or basement locations, and could support as many as 50,000 devices from a single cell tower. But even that's not the full story behind the interest in NB-IoT.

Although NB-IoT is integrated into the LTE standard, it can be considered as a new air interface and therefore – on the face of it – not fully backward compatible with legacy networks. However, the genius of its design is that it can happily co-exist with GSM, GPRS and LTE technologies without interference and with excellent side-by-side performance.

In fact, there are three main deployment options for NB-IoT

within GSM and LTE networks.

GSM is still the dominant mobile technology within many markets, and the significant majority of M2M applications today use GPRS or EDGE for connectivity. Simply by switching a single GSM carrier to handle NB-IoT traffic, operators can ensure a smooth transition to LTE and massive Machine-type Communication (MTC). This deployment approach will accelerate IoT time to market, maximize the benefit of existing infrastructure and future-proof IoT investment.

Alternatively, in LTE networks, NB-IoT can be deployed 'in-band' to provide a highly spectrum-efficient and cost-effective deployment. This in-band option sets NB-IoT apart from any other competing LPWAN technology.

The in-band deployment sees NB-IoT as a self-contained element that uses a single physical resource block (PRB) within the network. Furthermore, the NB-IoT carrier can be switched



to other network uses if there is no IoT traffic. This capability means the network can intelligently multiplex IoT and LTE traffic on the same spectrum to minimize the total cost of the operation and scale with the volume of MTC traffic.

Finally, NB-IoT can also be deployed, with no interference, in the Guard Band of LTE or WCDMA networks. Unlike other LPWAN technologies, NB-IoT has been designed with the requirements of LTE guard-band coexistence specifically taken into consideration.

There's no doubt, that NB-IoT has a lot going for it as technology. It can enable the low-power, low-cost devices that will be required for IoT network efficiency, and it uses licensed spectrum where capacity, performance, and availability targets can be managed and met.

But it is the wide range of deployment options, and the ability of NB-IoT to exist happily alongside and within past, current and future networks, that will be the features which will make it so attractive to operators all over the world.

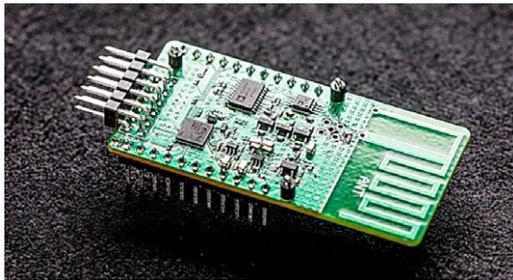
Kashif Hussain is Director of Marketing at Viavi Solutions - www.viavisolutions.com

Backscatter radio range reaches 2.8km

By Peter Clarke

Researchers at the University of Washington have demonstrated passive RF devices that can run on almost zero power and transmit data across distances of up to 2.8 kilometers.

The researchers have used backscatter radio which uses existing RF signals as the power source which is then used to modify and reflect the signal with encoded data. This is the principle behind passive RFID tags but it has until now been used for communications over a few feet or meters and usually much closer, data rates of the order of kbits per second and small data payloads such as an identity code.



Active radio technologies including Wi-Fi, ZigBee, SigFox, LoRa and LTE-M provide reliable coverage and long ranges but consume power and cost \$4 to \$6 in volume, according to the research team.

The University of Washington's has now proposed long-range backscatter radio system that provides reliable long-range communication at

up to 2.8km with sensors that consume 1000 times less power than existing technologies capable of transmitting data over similar distances.

The LoRa Backscatter device prototyped by the research team consumes 9.25 microwatts, operates at 100s of meters and can be powered by printed batteries and button cells. The RF source transmits a single tone in the 900MHz ISM band, that the backscatter device uses to synthesize chirp spread spectrum (CSS) signals. The challenge that the team has faced is to make sure at the receiver that the backscatter signal is not drowned by noise and does not suffer interference from the RF source.

The University of Washington's contribution to the state of the art was the addition of CSS. Spreading the reflected signals across multiple frequencies allowed the team to achieve much greater sensitivities and decode backscattered signals across greater distances even when it's below the noise.

The University of Washington's long-range backscatter system achieved reliable coverage throughout 4800-square-foot house, an office area covering 41 rooms and a one-acre vegetable farm. This could clearly be a major boon to the Internet of Things.

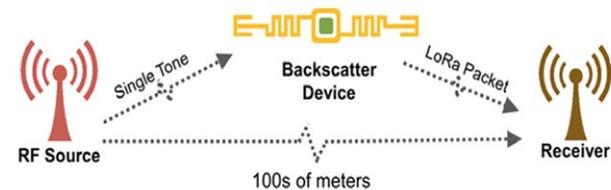
The system has three components: a source that emits a radio signal, sensors that encode information in reflections of that signal and an inexpensive off-the-shelf receiver that decodes the information, in this reported case a Sx1276 receiver from Semtech.

When the sensor is placed between the source and receiver, the system can transmit data at distances up to 475 meters. When the sensor is placed next to the signal source, the receiver can decode information from as far as 2.8 kilometers away.

“Until now, devices that can communicate over long distances have consumed a lot of power. The trade-off in a low-power device that consumes microwatts of power is that its communication range is short,” said Shyam Gollakota, lead faculty and associate professor in the Paul G. Allen School of Computer Science & Engineering at the University of Washington. “Now we've shown that we can offer both, which will be pretty game-changing for a lot of different industries and applications.”

The long-range backscatter system will be commercialized by Jeeva Wireless, a spin-out company founded by the UW team of computer scientists and electrical engineers, which expects to begin selling it within six months.

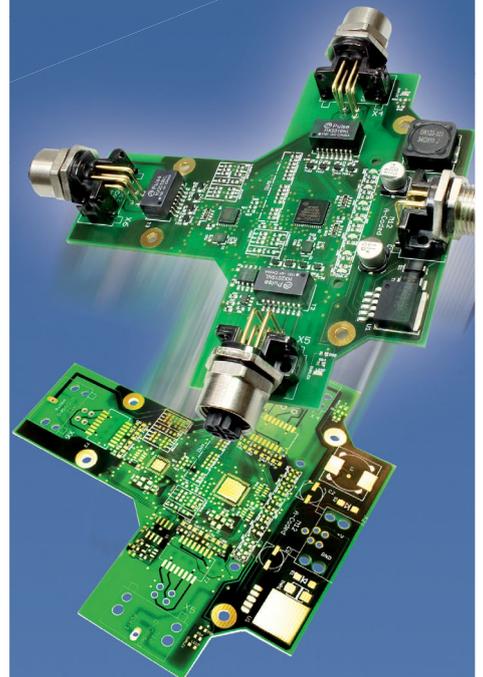
“People have been talking about embedding connectivity into everyday objects such as laundry detergent, paper towels and coffee cups for years, but the problem is the cost and power consumption to achieve this,” said Vamsi Talla, CTO of Jeeva Wireless, who was an Allen School postdoctoral researcher and received a doctorate in electrical engineering from the UW. “This is the first wireless system that can inject connectivity into any device with very minimal cost.”



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Millimeter-wave radar measures vital signs remotely

By Jean-Pierre Joosting

Researchers from Kyoto University's Center of Innovation and Panasonic Corporation developed a radar-based device in early 2016 that could instantaneously and accurately measure the body's vital signals, which has now undergone a major upgrade that increases performance and dramatically cuts footprint.

The sensor combined a radar with signal analysis algorithms to measure how the body moves as the heart beats. Since, body movements vary considerably, the software filters isolate just the heart's minute motions.

"Measuring respiration and heart rate – without attaching cumbersome wires to the body – will greatly benefit modern medicine and home healthcare," explains Toru Sato, lead researcher and Kyoto University professor of communications and computer engineering.

"Moreover, it will reduce stress by not subjecting the individual to a feeling of being monitored."

The original technology showed promise but the prototype was the size of a microwave oven. To improve prospects for

implementation, the group shifted their focus toward refining the device.

"After extensive testing we achieved great improvements,"

continues Sato. "The device now utilizes the 79 GHz frequency band, instead of the previous 60 GHz. We also incorporated CMOS semiconductors. As a result, range and resolution improved, and it's now only about one tenth the size – as big as a smoke detector."

Further the use of a new frequency band enables the sensor to measure the heart rates of multiple individuals in the same room, separated by as little as 7.5cm.

The team hopes that the improved specifications will allow such sensors to be installed in a variety of household appliances – such as lighting – to safely monitor the vitals of residents.

"This technology holds great promise for the future development of devices

to monitor health remotely," concludes Sato. "We are currently considering test sites for observing the multiple applications of our sensor."



KU and Panasonic developed a radar-based device that could instantaneously and accurately measure the body's vital signals. The new model is smaller and more accurate than its predecessor. Image courtesy of Kyoto University.

GPS signal "screening" protects against spoofing & jamming threats

By Graham Prophet

Microsemi – more often cited on these pages as a semiconductor supplier – has developed what it terms a "breakthrough approach" to protecting critical infrastructure against GPS spoofing and jamming threats, in the form of its BlueSky GPS Firewall.

More and more critical infrastructure, in many application domains, depends on GPS for position, navigation and timing (PNT) data. The stand-alone BlueSky unit is designed to provide security protection for GPS PNT data. It can be deployed in-line between any standard GPS antenna and stationary GPS receiver to provide protection against GPS signal incidents, both intentional or accidental, before they enter a GPS receiver system. In response to the growing number of GPS incidents and their potential threat to critical infrastructure, and to assist customers in rapid adoption, Microsemi is making BlueSky GPS Firewall Evaluation kits available in advance of the full production release of the solution.

The dependency on PNT is increasingly important to critical infrastructure sectors such as telecommunications, energy, transportation, emergency services, financial services and enterprise infrastructure, and is mainly provided through GPS. Published best practice documents by the Department of Homeland Security (DHS) Science and Technology Directorate (S&T) describe steps that can be taken to mitigate outages and disruptions with GPS reception. In alignment with these

documents, Microsemi's new BlueSky GPS Firewall provides critical infrastructure sectors with a first line of defence against GPS threats to help build out a secure, robust and resilient PNT platform for their infrastructures.

The BlueSky GPS Firewall filters the GPS signal in real time, removing anomalies from the GPS signal before it is accessed by the downstream GPS receiver. This creates an intelligent and secure barrier against jamming and spoofing, and prevents the GPS receiver from being impacted by such incidents.

Deployment of the BlueSky GPS Firewall does not require any new cabling or alteration of the pre-existing antenna installation and is interoperable with standard GPS receivers. The BlueSky GPS Firewall incorporates an Ethernet interface for remote management



and monitoring and includes a secure web interface that any browser can use for configuration and set-up of the device.

The unit includes a broad range of data validation rules based on real, live sky GPS threats. Similar to network security threats, new GPS vulnerabilities are on the rise and Microsemi is continuously tracking GPS signal manipulation including spoofing threats, jamming attacks, multipath signal interference, atmospheric activity and many other issues that can create GPS signal anomalies, disruptions and outages. These advancements are incorporated into the software platform of the BlueSky GPS Firewall, which can be updated remotely.

Bluetooth Mesh networking software kit targets smart lighting and home automation

By releasing its BlueNRG-MESH Software Development Kit (SDK), STMicroelectronics aims to ease the next wave of



control-by-phone innovation using the latest Bluetooth wireless networking features. The Bluetooth 5 specification standardizes mesh networking: connecting large numbers of devices capable of communicating among themselves

as well as directly with mobile phones. All smartphones currently on the market can connect to objects in Bluetooth Mesh networks without needing a central gateway or router, allowing easier control of smart lighting, general building automation, and other Internet-of-Things (IoT) applications such as environmental sensing, industrial monitoring, and asset tracking. The new SDK enables the creation of networked devices and the smartphone apps needed to control them. The three-part SDK provides two app-developer packages for Android and iOS, and the embedded-development software for building smart objects such as light fittings and sensors. Together, these three packages provide all the software building blocks engineers need to get their applications running using ST's BlueNRG mesh-ready Bluetooth Low Energy ICs.

STMicroelectronics
www.st.com

IoT cloud development kit is Wi-Fi and BT/BLE-ready

Together with partners Cypress Semiconductor and Murata, distributor Future Electronics has launched the Nebula IoT Development Kit, an



IoT cloud ready board that allows developers to quickly prototype and deploy their IoT ecosystems. Wireless connectivity is supported

by the Murata 1DX module, which is powered by the Cypress CYW4343W Wi-Fi and BT/BLE combo SoC. The SoC includes a 2.4 GHz WLAN IEEE 802.11 b/g/n baseband/radio and Bluetooth 4.2 support. In addition, it integrates a high-performance power amplifier (PA), a low-noise amplifier (LNA) for best-in-class receiver sensitivity, and an internal transmit/receive (iTR) RF switch, further reducing the overall system cost and 1DX module size. The Nebula board supports applications development through the Cypress WICED (Wireless Internet Connectivity for Embedded Devices) Studio development platform. Nebula is equipped with 4 different interfaces to access the STM32F429 peripherals to enable developers to create any IoT application: Arduino compatible shield, mikroBUS socket, Pmod connector/interface and USB. In addition, the Nebula board employs easy hardware expandability through a large number of standardized add-on boards.

Future Electronics
www.FutureElectronics.com

Wi-Fi and Bluetooth combo chip slashes power consumption

Cypress Semiconductor's novel Wi-Fi and Bluetooth CYW43012 combo chip leverages 28nm process technology



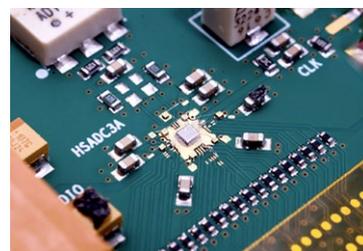
to cut power consumption up to 70 percent in receive mode and up to 80 percent in sleep mode when compared to current solutions. The CYW43012 is IEEE 802.11a/b/g/n-compliant and 802.11ac-Friendly, meaning it is interoperable with 802.11ac access points using standard modes. This enables it to offer

higher throughput and better energy efficiency, along with the enhanced security and coverage of 802.11ac Wi-Fi networks. The chip's advanced coexistence engine enables optimal combined performance for dual-band 2.4- and 5-GHz Wi-Fi and dual-mode Bluetooth/Bluetooth Low Energy (BLE) 5.0 applications simultaneously. It is supported in Cypress' all-inclusive, turnkey, WICED Studio IoT development platform.

Cypress Semiconductor
www.cypress.com

IMEC reports low-power IP blocks for 5G

Nanoelectronics research institute IMEC has developed two building blocks for 5G applications with record-setting low power consumption. The first is a successive approximation



analog-to-digital converter (SAR ADC), designed for consumer electronics, such as mobile phones, operating in the below-6GHz frequency bands. Secondly, IMEC has developed a

60GHz front-end with radio frequency (RF) phase shifting and on-chip transmit-receive switching, targeting 5G fixed wireless access and small cell backhaul applications. The SAR manufactured in 16nm CMOS targets smartphone applications in the below-6GHz band and is capable of 300 megasamples per second. The core area measures 350-micron by 325-micron and achieves a dynamic power consumption of 3.6mW at 300Ms/s and low-frequency signal to noise and distortion ratio (SNDR) of 70.2dB at 204MS/s. The 60GHz radio front-end features 8-way calibration-free beamforming at RF frequencies to support a large number of antennas, making the technology attractive for fixed wireless access and small cell backhaul. The on-chip transmit-receive switching allows to share the antenna array between transmit and receive mode. The 9.6 square millimeter chip is implemented in 28nm CMOS and consumes 231mW in receive and 508mW in transmit mode (0.9V supply). These building blocks are available to interested companies by joining IMEC's industrial affiliation program, or through IP licensing. The IMEC portfolio of circuits for 5G includes analog-to-digital converters (ADCs), reconfigurable low-noise frequency synthesizers, millimeter-wave phased array transceivers, antenna modules and more. Most of them are designed to exploit scaled silicon CMOS and therefore can also be low cost.

IMEC
www.imec.be

Power sequencing verification made easier with an 8-channel oscilloscope

By Dave Pereles, Tektronix

Most embedded systems use more than one power rail and many use four or more. A single IC, such as an FPGA, DSP or microcontroller can require several power rails and these may have specific timing requirements. For example, a chip manufacturer may recommend that the core voltage supply stabilize before the I/O supply voltage is applied. Or a manufacturer may require that supplies come up within a specified time relative to each other to avoid prolonged voltage differences on various supply pins. The power-on sequence between processors and external memory can also be critical.

Chip manufacturers may specify that particular supplies must come up monotonically to avoid multiple power-on resets. This can be challenging since inrush currents can place high transient demands on point of load regulators. In this case the shape of power rail startup is as important as the timing sequence.

Once you combine the various chip supply requirements, bulk supplies, reference supplies and multiple point-of-load regulators for other ICs in a design, you can get up to seven or eight power rails in a hurry.

Using a 4-channel oscilloscope to verify power rail timing in an embedded system can be time-consuming, but this is how most engineers must do it. When we talk to oscilloscope users, evaluating power-on and power-off sequences is one of the most common reasons engineers give for wanting more than four channels. In this article, we'll briefly cover using a 4-channel scope for this purpose, and then we'll show some examples using an 8-channel scope.

Traditional 4-channel oscilloscope approaches

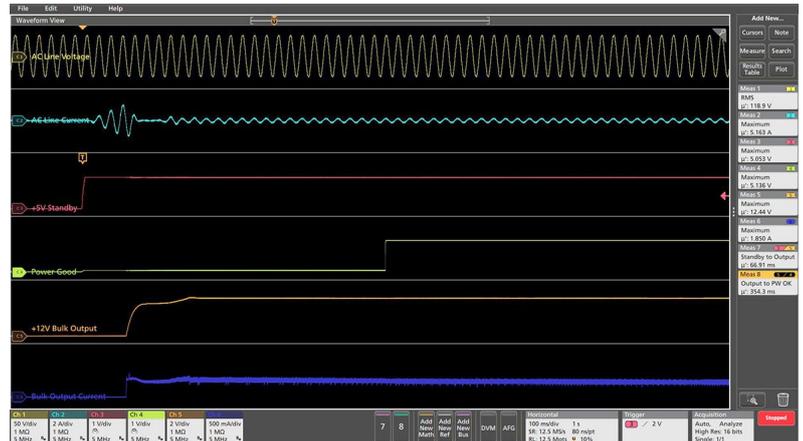
One approach is to analyze the power system in blocks – using multiple acquisitions to check the timing block by block. To compare between blocks, one of the rails or a power good/fail signal can be used as a trigger and multiple captures can be taken, determining the startup and shutdown timing relative to the reference signal. Since acquisitions are taken over multiple power cycles, variations in the relative timing of supplies will be difficult to characterize. However, the range of variation of each supply from cycle-to-cycle can be determined by measuring over multiple power cycles using infinite persistence on the oscilloscope.

Another common approach is to “cascade” multiple scopes. This is usually done by triggering the scopes on one of the power supplies or on a common power good/fail signal.

Both of these approaches are time-consuming and require special attention to synchronization:

- Dealing with synchronization and time uncertainty requires care

Dave Pereles is a technical marketing manager at Tektronix - www.tektronix.com

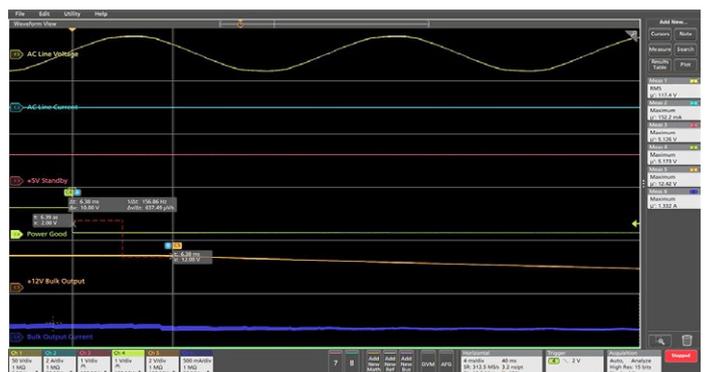


This screen shot shows measurement of an AC/DC switching power supply turn-on after the front-panel switch was pressed.

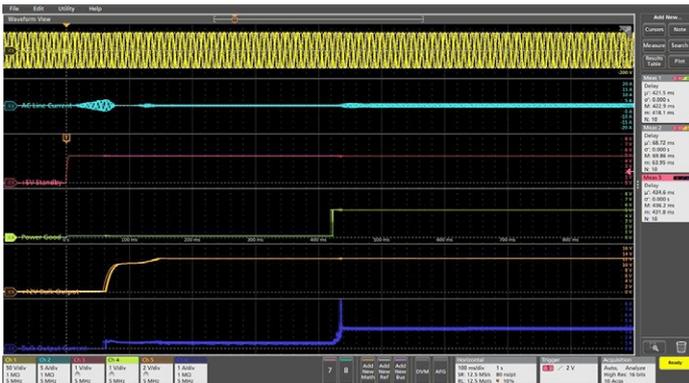
- Aggregating data to develop a system timing diagram is possible, but time-consuming
- Complexity increases with the number of power rails to be observed
- Setups must be perfectly consistent
- One measurement channel must be used to provide synchronization

Using an MSO to extend channel count

A mixed signal oscilloscope can provide additional channels for power supply sequencing. For this to work, the MSO must have suitable voltage range on the digital inputs and independently adjustable thresholds. For example, a Tektronix MDO4000C with the MSO option offers 16 digital inputs with independent thresholds for each channel and a ± 30 Vp-p dynamic range up to 200 MHz, making it suitable for most of the voltage levels you'd find in a typical design. Note that this approach works well if the objective is strictly to measure timing relationships, but it does not allow for measurement of rise/fall times or the shape (monotonicity) of the power-on/off.



A waveform cursor measurement can be used to verify that the PW OK pre-warning signal is operating as specified.



Repetitive turn-on timing measurements can be accomplished using infinite persistence and measurement statistics.

8-channel scopes speed the process

Using an oscilloscope with 8 analog channels cuts the time and hassle significantly versus any of the methods covered so far. With an 8-channel oscilloscope, power supplies with up to eight power rails can be characterized using analog probes. To measure turn-on and turn-off timing relationships on power supplies with more than eight power rails, a mixed signal oscilloscope with digital signal inputs and independently adjustable thresholds can also be used.

Now, let's look at some typical power sequencing measurement applications.

Turn-on delay with remote on/off

The switching power supply under test in the screen shot below produces a high-current, regulated 12 VDC output. This power supply is remotely controlled with a switch on the front panel of the instrument. Shortly after the switch is pressed, the +5 V standby voltage is turned on, enabling the switching converter to start. After the +12 V output is in regulation, the Power Good (PW OK) signal goes high to indicate to the load that the supply is reliable.

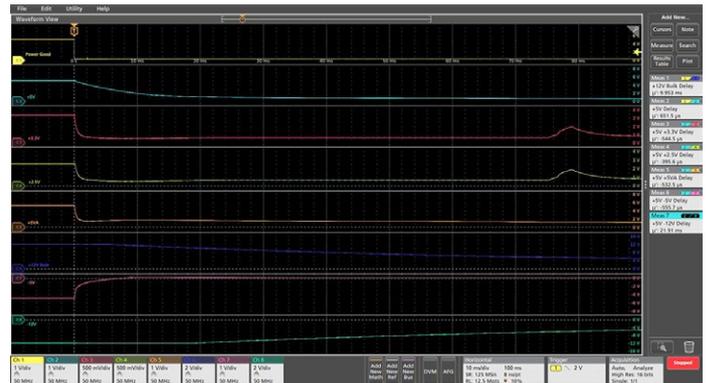
The +5 V standby voltage signal provides a simple rising edge trigger for the acquisition of the relevant signals. Automatic measurements verify that the delay to the output voltage turn-on is <100 ms, and the delay from output voltage turn-on to PW OK is in the specification range of 100 – 500 ms.

Turn-off delay with remote on/off

After the power supply's main switch is turned off, the switching converter is turned off and the output voltage decreases. The power supply is specified to remain in regulation for at least



This measurement shows turn-on timing of seven regulated power supplies.



Some of the supplies are more heavily loaded and turn off more quickly than others, as visible here.

20ms after the switch is pressed. Most importantly, the PW OK signal is specified to fall 5 – 7 ms before the +12 V output voltage falls out of regulation, allowing the load time to react and shut down cleanly.

As shown below, the PW OK signal provides a falling edge trigger for the acquisition of the relevant signals. The waveform cursor measurement verifies that the PW OK pre-warning signal is operating as specified.

Verify timing over multiple power cycles

To verify that the power supply turn-on timing remains within specifications over multiple power cycles, infinite persistence can be used to display the signal timing variations and statistics displays of automated timing measurements quantify the variations. In the setup show below, the 50% point of the +5V standby voltage serves as the timing reference. The turn-on sequence is repeated 10 times and the timing variations over the 10 turn-on cycles are within a little over 1 percent.

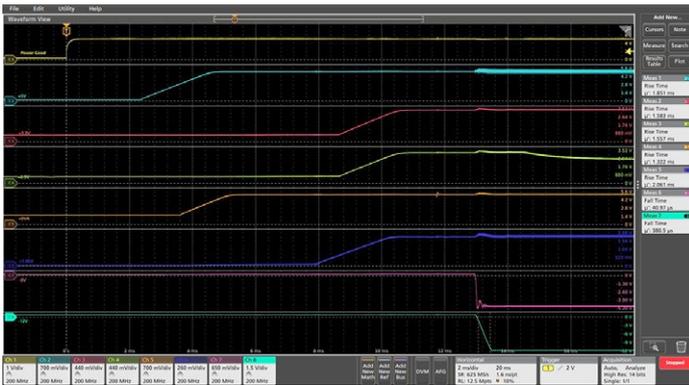
Point-of-load regulated power supply timing

This screen capture below shows the turn-on timing of seven point-of-load supplies in a system board during power-up. The input power supplies to the circuit board are the +5V standby and bulk +12 VDC supply from the previous example.

The automated turn-on delay measurements in this test are made between the automatically-calculated 50 percent points of each of the waveforms, meaning that each measurement has a different configuration with a different set of measurement thresholds. The first measurement shows the delay from the +5 V standby signal to the bulk +12 V supply and the second



This shows the use of digital channels when the turn-on timing of more than eight regulated power supplies needs to be verified.



Rise- and fall-time measurements are shown in the results boxes on the right side of the display.

measurement is the delay to the main +5 V supply. The remaining measurements are the sequence of critical delays from the main +5 V supply.

Turn-off timing of regulated power supplies

The automated turn-off delay measurements in this test are made between the points of each of the waveforms that are 5 percent below their nominal value. Unlike the previous percentage-based measurement thresholds, each measurement has an absolute voltage threshold. As the power supply shuts down,

the Power Good signal falls. As you can see in the screen shot below, some of the supplies are more heavily loaded and turn off more quickly than others.

Turn-on timing of more than 8 rails

Automated timing delay measurements are simply based on the times at which the signals cross their respective threshold voltages. Since each automated measurement configuration can include a unique threshold value (typically 50 percent of the signal amplitude) and each digital channel can have a unique threshold value (also typically set to 50 percent of the power supply voltage), mixed signal oscilloscopes can make power supply timing delay measurements as shown below up to the number of available digital inputs. Depending on the MSO model, the number of channels can range from 8 to 64.

Power supply rise-time measurements

In addition to the power supply sequencing, the rise-times of power supplies must be controlled to meet the specifications of some critical components in a system. Automated rise- and fall-time measurements are also made based on voltage reference points which are, by default, automatically calculated to be 10 percent and 90 percent of the signal amplitude of each channel. In the simple example show below, the rise-times of the positive supplies and the fall-times of the negative supplies are shown in the results boxes on the right side of the display.

XJTAG updates boundary scan tool to v3.6

XJTAG has launched a major update to its flagship software, XJDeveloper. XJTAG v3.6 includes several new productivity and automation-focused enhancements, allowing engineers to setup tests for even the most complex boards in significantly less time. The company's unified development and debug environment XJDeveloper makes it quick and easy to set up and run JTAG tests, detecting faults on high-density boards without costly test fixtures or functional testing. The v3.6 release incorporates a new documentation feature in XJEase files so that users can label methods in the XJEase file which can



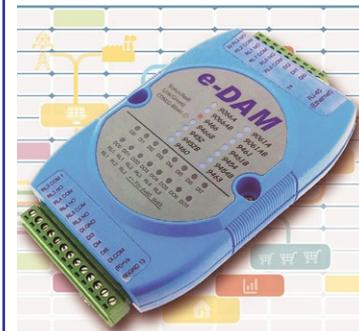
be allocated to testing specific saved devices. These labels are used by the 'automatic test list creation' feature to further accelerate test setup. From now on, there will be no need to create test groups for each type of device and manually add the test function for each individual device to the relevant test group. With the new v3.6 release, CheckChain and Connection Test are automatically added to the test list when a new project is created. When a device is categorised, XJDeveloper will find its relevant test function and add it to the test list. The test list can also be populated at the end of a project setup via the "Suggest Tests..." button. The automated matching allows faster board set up times. The new global built-in test functions RUNSVF and RUNSTAPL simplify the running of SVF/STAPL files which is especially beneficial for in-system programming of CPLD/FPGA using these types of file. The built-in character of these functions allows a noticeable simplification of the programming process. XJTAG now allows users to specify arrays of the built-in XJEase types (INT, STRING, FILE) to make operations much easier to program. Version 3.6 of XJTAG also adds views of the call stack and of the currently-set breakpoints to the XJEase debugger in XJDeveloper, completing its debugging capabilities by enabling a view of the stack of functions which have been called to get to the current point in the code, and allowing the user to easily view and remove breakpoints from the code.

XJTAG
www.xjtag.com

Ethernet IO module fitted with PoE

The EDAM-9466 IO module from Acceed offers six digital input channels and six relay outputs (5 A 250 VAC, 5 A 30 VDC).

Thanks to its power supply with PoE (Power over Ethernet), the module can be used easily and fast everywhere in networks. All the inputs are optically insulated (3750 Vrms). The module, which has the size of a cigarettes pack is aimed



at remote monitoring and simple controlling tasks with a direct link between input and output signals. Acceed provides the match-

ing Node-RED snippet as a free download as well as configuration software and drivers. The casing for the highly compact modules is suitable for top-hat rail assembly, both in the switch cabinet and for wall assembly. Status LEDs display the most important information at a glance. Screw terminals are provided for the signal connection, the voltage range is either provided via an external power supply or, as for the EDAM-9466, simply via the Ethernet. All modules support the Modbus RTU protocol by default as well as TCP/IP, UDP, ICMP and ARP.

Acceed
www.aceed.net

Keysight and Bluetest partners on NarrowBand IoT OTA testing

Keysight Technologies has announced its collaboration with Bluetest on the creation of a narrowband - internet of things (NB-IoT) over-the-air (OTA) system for use in Bluetest Reverberation Test Systems. The OTA test is critical for operators to qualify the interoperability and compliance of their NB-IoT devices. This is particularly important when a third-party enclosure is used with the device since the antenna coverage effects could be limited. Bluetest Reverberation Test Systems are especially well suited for testing of IoT devices with their capability of measuring larger test objects since there is no traditional test zone limitation in the chamber. Recent enhancements to the UXM wireless test set support the very latest NB-IoT specification, which supports RF measurement, power consumption and end-to-end data test.

Keysight Technologies
www.keysight.com

Analog signal post-processing software is preset to ISO, NFC Forum, and EMVCo norms

Comprion has launched a new post-processing software for easily visualizing, measuring, analyzing, and sharing analog signals, with preset configurations compliant to EMVCo, NFC Forum, and ISO. The Comprion Analog Scope Viewer does not require manual configuration. While quick measurements are usually only available as part of complex test tools with an integrated oscilloscope, Comprion now offers this feature as a stand-alone software solution. The Window-based software offers import of external CSV data captured on the contactless (ISO 14443, ISO 18092, NFC Forum, EMVCo) and contact-based (ISO 7816/ETSI 102230) interfaces.

Comprion
www.comprion.com



Modular instrumentation cases come in 3U and 4U height

Pixus Technologies now offers its RiCase Premier line of modular electronics enclosures in 3U height at a 300mm depth and a 4U height at a 420mm depth.



The new sizes expand the range of 10.5" and 19" wide instrumentation cases, offering more standard choices. The instrumentation cases combine a rugged design and an attractive all-metal design with corners rounded for aesthetics and mechanical protection.

Optionally, they can be securely stacked on top of another RiCase enclosure. Three standard color codes can be used to signify the end-user's product line. The RiCase Premier line's modular design now offers a vast range of size options from 1U-10U heights, 19" and 10.5" widths, and 300, 420, and 540mm depths. Customized sizes are also available upon request.

Pixus Technologies
www.pixustechnologies.com

Spectrum analyzer has guaranteed specs 5GHz analysis bandwidth

The R&S FSW85 signal and spectrum analyzer now provides 5 GHz analysis bandwidth, which is required for analyzing wideband signals such as automotive radar FMCW chirp signals, IEEE 802.11ay signals and 5G waveform candidates.

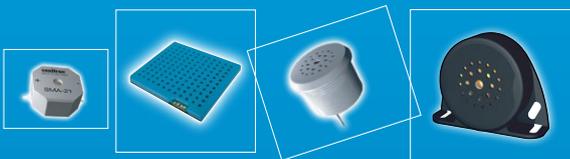
Rohde & Schwarz' new R&S FSW-B5000 option for its R&S FSW85 signal and spectrum analyser, which in combination with the R&S RTO2064 digital oscilloscope as an external digitizer provides an equalized 5GHz signal analysis bandwidth. The amplitude and phase response of the R&S FSW85 together with the R&S FSW-B5000 are fully characterized at the factory across the entire frequency range. The amplitude and phase measurement accuracy are guaranteed throughout the measurement bandwidth. The R&S FSW-B5000 supports centre frequencies between 9.5 GHz and 90 GHz.

Rohde & Schwarz
www.press.rohde-schwarz.com



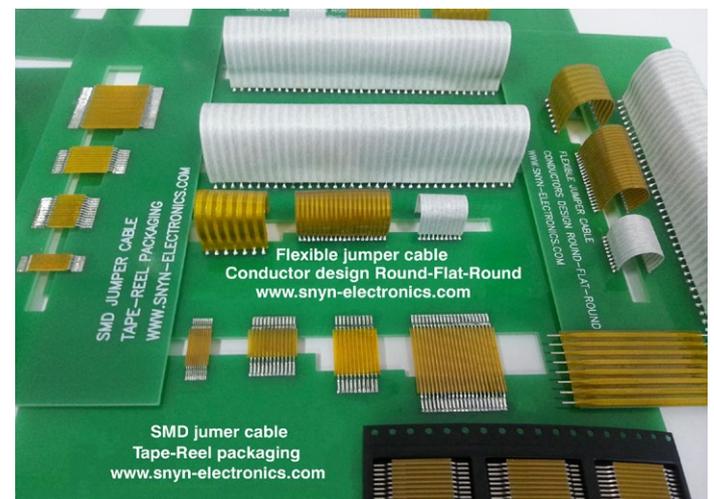
sonitron®

Piezo audio components



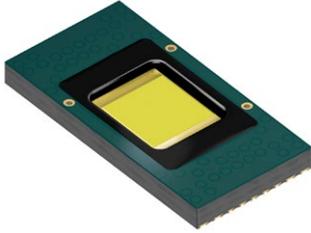
Buzzers Transducers Alarms
 Sirens Piezo Speakers Amplifiers

www.sonitron.be



Osram demonstrates 4x4mm 1,024-pixels LED and driver combo

With its Eviyos hybrid LED prototype, Osram Opto Semiconductors claims it has made major progress toward the first market-ready smart controllable high-resolution LED for adaptive lighting. Eviyos came as a result from the μ AFS research project which was completed in the fall of 2016. The project coordinated by Osram Opto Semiconductors involved various partners



from the industrial sector. The prototype accommodates the 1,024 individually controllable pixels of Eviyos with the driving electronics in a 4x4mm package. The idea of adaptive lighting is that as soon as oncoming traffic is detected, the appropriate pixels are automatically switched off so drivers of oncoming vehicles are not dazzled. Osram Specialty Lighting has integrated the prototype in a demonstrator to be exhibited during this year's International Symposium on Automotive Lighting. The light source has a minimum luminous flux per pixel of 3 lm at 11mA. Initial prototypes have already exhibited more than 4.6lm per pixel. Customers can vary the number of hybrid LEDs in their applications and supplement them with conventional LEDs, depending on the particular requirements that need to be met.

Osram Opto Semiconductors
www.osram-os.com

Radiation-tolerant plastic ICs target small satellite mega-constellations

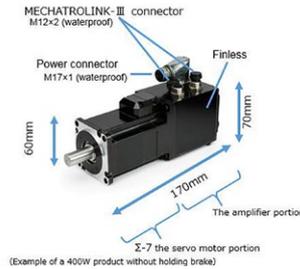
Intersil has released the first three members of its new family of radiation-tolerant plastic-package ICs designed to support the emerging field of small satellites. Intersil's rad-tolerant plastic parts include the ISL71026M 3.3V controller area network (CAN) transceiver, ISL71444M 40V quad precision rail-to-rail input and output (RRIO) op amp, and the ISL71001M 6A point-of-load (POL) voltage regulator. These ICs deliver rad-tolerance performance at a much lower cost point versus radiation assurance tested Class V (space level) products. All three ISL71xxxM devices go through characterization testing, which includes total ionizing dose (TID) up to 30krads (Si) for single event effects (SEE). SEE take into account single event burnout (SEB), single event latch-up (SEL), single event transients (SETs) and single event functional interrupts (SEFIs) at a linear energy transfer (LET) of 43MeV \cdot cm²/mg. The ISL71xxxM are also well suited for high altitude (>40km) avionic systems, launch vehicles that are prone to heavy ions, and medical equipment where radiation is a concern. The ISL71026M radiation-tolerant 3.3V CAN transceiver provides serial data transmission at speeds up to 1Mbps, it operates from 3V to 3.6V, with a quiescent supply current of 7mA (max). Up to 120 transceivers can be connected to a single CAN bus to reduce cabling/harness size, weight and power.



Intersil
www.intersil.com

Servo motor is first to use Gallium Nitride

Yaskawa Electric in Japan has developed the first servo motor to use gallium nitride power devices using technology from Transphorm in the US. Yaskawa's Σ -7 F is the first servo motor to use high-voltage (HV) 650V GaN for a smaller form factor than today's silicon semiconductors. This has been possible by integrating the servo amplifier with the servo motor itself to reduce the size by half. The Σ -7 F series of AC servo motors in a three-phase bridge configuration use the gaN FETs



in a standard three lead TO-220 package. The topology will be deployed across Yaskawa's full Σ -7 F product line, which currently includes three servo motors ranging from 100W to 400W. The integrated motor allows the industrial manufacturing system to simplify cabling in a daisy chain configuration. The design reduces the system's control panel cabinet size by as much as 30 percent by reducing the size of the servo motor, eliminating the power supply cable's terminal block due to a reduction in cabling required and using a smaller heat sink due to lower losses. The Σ -7 F targets industrial multi-axis automation systems commonly used in conveyance equipment as well as food product and packaging manufacturing. "The Σ -7 F servo motor is our second Transphorm GaN product and our second time leading an industry into the future with revolutionary power solutions," said Kazuhiro Imanaga, General Manager of the Servo Drives Technology Department in the Motion Control Division at Yaskawa Electric. "GaN has the potential to radically change what's possible in industrial automation systems. Yaskawa has the vision capable of driving that change."

Yaskawa Electric
www.yaskawa.co.jp

Round OLED display switch is fully configurable

Schurter has developed a Round OLED display switch designed with capacitive touch technology. The switch is intuitive



to operate with a simple finger stroke, wipe or rotation on the touchscreen. Users can make a selection from a menu, then activate their selection with a wipe of the bright round OLED screen. Tapping the home LED returns to the home screen. For maximum design flexibility, transitions can be fully configured as hard image changes, or gentle fade-in and fade-out. Symbol layout on the glass screen over soft-keys can be customized. The capacitive CDS1 display switch comes with internal storage on which all images, graphics and animations can be loaded via a Micro USB 2.0 interface. Standard interfaces include I²C, SPI or RS232. The CDS1 mount on the front panel from the rear, with a special mounting ring with screws. Optionally, it can be sealed to IP67 with an O-ring (versus IP40 without the O-ring).

Schurter
www.schurter.com

AEC-Q101 Trench 9 MOSFETs in rugged packaging

Nexperia's Superjunction MOSFETs in LFPAK56/56E – automotive-qualified Power-SO8 – claim a reduction in on-resistance over previous generation devices of up to 30%. Nexperia has added a series of Trench 9 power MOSFETs, targeted primarily at the automotive industry, which combine low voltage superjunction technology with advanced packaging, combining performance and ruggedness. The Trench 9 devices are all qualified to AEC-Q101, and exceed the requirements of this international automotive standard by as much as a factor of two, on key reliability tests including temperature cycling, high temperature gate bias, high temperature reverse bias and intermittent operating life. LFPAK56E is an enhanced version of the LFPAK56 package, with an optimised lead frame and package design that results in an improvement in RDS(on) and power density of up to 30%. This improvement in power density enables the Trench 9 LFPAK56 MOSFETs to be used in applications previously only possible with D2PAK and D2PAK-7, delivering significant PCB space-savings. The superjunction technology offers an improved avalanche and safe operating area capability when compared to competing technology.

Nexperia

www.nexperia.com/automotivetrench9



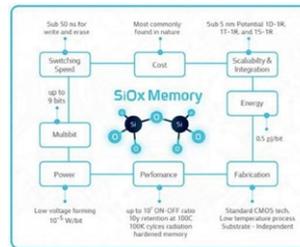
over previous generation devices of up to 30%. Nexperia has added a series of Trench 9 power MOSFETs, targeted primarily at the automotive industry, which combine low voltage superjunction technology with advanced packaging, combining performance and ruggedness. The Trench 9 devices are all qualified to AEC-Q101, and exceed the requirements of this international automotive standard by as much as a factor of two, on key reliability tests including temperature cycling, high temperature gate bias, high temperature reverse bias and intermittent operating life. LFPAK56E is an enhanced version of the LFPAK56 package, with an optimised lead frame and package design that results in an improvement in RDS(on) and power density of up to 30%. This improvement in power density enables the Trench 9 LFPAK56 MOSFETs to be used in applications previously only possible with D2PAK and D2PAK-7, delivering significant PCB space-savings. The superjunction technology offers an improved avalanche and safe operating area capability when compared to competing technology.

Two test vehicles planned for SiO₂ ReRAM

Weebit Nano has two test vehicles planned to show off its silicon-dioxide based non-volatile memory technology; a Kbit array built in a 0.3-micron process and a working memory cell in 40nm technology. Both are expected to be built before the end of 2017. Weebit Nano Ltd. (Tel Aviv, Israel) has already successfully transferred the basic technology, originally developed at Rice University (Houston, Texas), to Leti (Grenoble, France) where it is collaborating on engineering refinement. The move towards a 40nm cell will continue in parallel with the realization of a kbit array in a 300nm process. These will be used as proofs of the idea and allow full chip integration of a 40nm ReRAM prototype and a move to megabit and terabit non-volatile memory in a 40nm or more advanced process. The 40nm node is approximately the minimum geometry used for 3D NAND production. Weebit said it expects the porous silicon-dioxide based ReRAM will show excellent characteristics for use in smartphones, solid-state drives, automobiles, the Internet of Things and artificial intelligence. One of the key advantages Weebit has over other ReRAM developers is that its memory material of choice is already in extensive use in IC production. The company wants to partner with semiconductor memory companies.

Weebit Nano

www.weebit-nano.com



Enhanced chip-scale LED packages boost output efficacy

Samsung Electronics has released new additions to its chip-scale package (CSP) line-up: LM101B, a 1W-class mid-power LED, and LH231B, a 5W-class high-power LED. The LM101B and the LH231B packages are based on Samsung's state-of-the-art, fillet-enhanced CSP (FEC) technology, which forms TiO₂ walls around the chip surface to reflect its light output toward the top, acting as a plastic mould in conventional EMC-based LEDs. With their FEC design, the packages provide a higher light efficacy level compared to Samsung's previous generation of CSP LEDs. The more focused beam also helps to eliminate cross-talk between neighbouring packages and enables the new packages to be placed in close proximity to one another, offering greater flexibility to luminaire designers. The LM101B delivers 200lm/W (Ra80 5000K, 65mA, 25°C) and its low thermal resistance (2K/W) and high reliability (0.5W, 105°C, L90>50000 hours) make it optimised for spotlights and high-bay applications where high efficacy and long lifespan are required. With an operating current of 2A (max. 6W), the LH231B offers an efficacy of 170lm/W (Ra70 5000K, 700mA, 85°C). Thanks to Samsung's FEC structure, the 120-degree beam angle allows for simple optic designs, making it also suitable for outdoor applications, such as street and parking lot lighting.

Samsung Electronics

www.samsung.com



802.11ax Wi-Fi antenna system doubles throughput, coverage

Ethertronics's next-generation Wi-Fi Active Steering platform, based on the EC477 Active Steering Processor and the EC624 Active Steering Antenna Switch are claimed to deliver twice the performance and coverage benefits of Active Steering Technology when combined with the company's patented Active Steering Antenna architecture. The flexible, cost-optimized solution doubles throughput, range, and efficiency for high-performance 802.11ax/802.11ac systems and has been optimized for today's market-leading Wi-Fi access point and client solutions. Additionally, the Active Steering technology implemented in the EC477/EC624 family provides performance and scalability for next-generation 802.11ax applications. The EC477/EC624 solution reduces design complexity and cost via its innovative Data-Over-Coax (DOC) interface, which allows Active Steering signaling to co-exist on the same physical cable as the main RF signal without introducing any degradation of the main Wi-Fi signal. The DOC interface eliminates the need for custom connectors and signaling cables, which significantly reduces the system BOM and enables easier deployment of off-PCB antennas to maximize Wi-Fi radio link performance. The EC477/EC624 Active Steering solution enables any mix of active and passive antennas, in any combination of on-PCB and off-PCB placement.

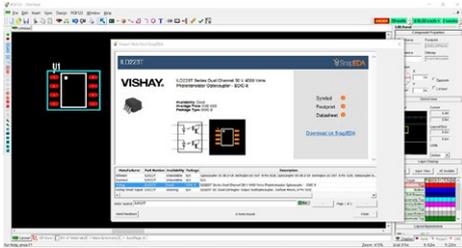
Ethertronics

www.ethertronics.com





PCB123 gives access to millions of cloud-based symbols and footprints through SnapEDA



Sunstone Circuits, creators of the free PCB design tool, PCB123, have partnered with SnapEDA, allowing designers to search for digital models

directly inside the PCB123 design environment. Designers have traditionally wasted days creating digital models, such as symbols and footprints, for their designs. This process is tedious, time-consuming, and error-prone. With today's release of PCB123 Version 5.6, designers can now search and download free, cloud-based symbols and footprints directly during design capture and layout, significantly boosting design productivity. PCB123 is a free, full-function PCB CAD tool, comprised of a schematic editor, physical layout editor, 3-dimensional mechanical previews, and BOM editor. By augmenting the tool with cloud-based libraries, designers will get real-time access to new symbols and footprints added to SnapEDA's catalog, as well the ability to request parts they need for their designs with InstaPart, the company's popular 24 hour parts request service. All new models created by SnapEDA conform to the latest IPC standards (IPC-7351B).

SnapEDA
www.snapeda.com

Ultra-low power CO₂ sensor is yours to evaluate

This month, Gas Sensing Solutions Ltd (GSS) is giving away 10 of its MiniIR CO₂ sensor evaluation kits, worth £200 each,



for *eeNews Europe's* readers to put to the test. Built on GSS' patented LED technology platform, the miniaturised MiniIR CO₂ sensor brings the benefits of solid state electronics to NDIR (Non-Dispersive InfraRed) CO₂ sensors.

The rugged and vibration-resistant MiniIR sensor is designed for use in industrial applications, and is capable of measuring from 0-100% CO₂ concentrations - twice per second, while drawing only 3.5mW in continuous operation. At that sampling rate, the sensor uses between 10 and 100 times less power than standard NDIR sensors, claims GSS, and provides a solution for the real-time monitoring of CO₂ concentration levels. With no warm-up time, the sensor can be powered up/down instantaneously (1.2 seconds to first reading), which directly answers the growing demand for ultra-low power sensors which can be integrated into battery or self-powered wireless systems. The evaluation kit comes with a MiniIR CO₂ sensor from GSS' industrial range, a USB connecting cable, and software documentation on a USB stick.

Check the reader offer online at

www.eenewseurope.com

Offline Flyback switcher IC delivers 94% efficiency

Three years after its first implementation of an integrated switcher IC, Power Integration has added 2% efficiency points to its design, effectively cutting losses by 25% as InnoSwitch 3 enables 94% efficiency over a wide range of line and load conditions.



The InnoSwitch 3 family of offline CV/CC flyback

switcher ICs enable the development of compact power supplies up to 65W without heatsinks and are well suited for power supplies with challenging energy consumption, footprint or thermal constraints, striving to comply with EU CoC v5 Tier 2 specifications. The ICs employ Power Integrations' proprietary isolated digital communications technology, FluxLink, plus synchronous rectification, quasi-resonant switching and a precise secondary-side feedback sensing and control circuit. This results in highly efficient, accurate, reliable power supply circuits without the need for optocouplers. InnoSwitch3 devices are CCC, UL and VDE safety-certified to bridge the isolation barrier,

and the InSOP-24 package provides a low-profile, thermally efficient solution with extended 11.5mm creepage and clearance between primary and secondary sides for high reliability, surge and ESD robustness. The devices also incorporate a number of protection features, including lossless line overvoltage and under-voltage, output overvoltage, over-power, over-current and over-temperature protection, as well as output rectifier short-circuit protection. Device sub-families are provided with either latching or auto-recovery capability, according to the typical demands of each target application space. All InnoSwitch3 ICs feature on-board high-voltage MOSFETs (rated at 650 V for the CP and CE series and 725 V for the EP series). The new ICs are optimized into three application-specific series: CE, CP and EP. The CE or Current External version deliver accurate CC/CV regulation with external output current sense for optimum design flexibility. It targets compact single-voltage chargers, adapters, IoT and building automation. The CP or Constant Power version is aimed at USB Power Delivery (PD), rapid charging and other applications where a dynamic output voltage is required. Then the EP or Embedded Power series features the family's highest-rated MOSFET (725V) and provides full line and load protection with excellent multi-output cross-regulation for demanding industrial applications and appliances. To help designers choose the right part among the many different possible configurations, Power Integration hosts an online selection tool as well as technical support with the PI Expert Online design tool.

Power Integrations
www.power.com

Multi-channel solenoid and unipolar motor driver delivers 80V at 1.5A per channel

Toshiba Electronics Europe's multi-channel solenoid and unipolar motor driver IC (TB67S111PG) incorporates four channels each consisting of one low-side MOSFET and a free-wheeling diode connected to drain. This enables it to control each channel independently and realises a design that is suited to driving the solenoids and unipolar motors. Fabricated with the latest high-voltage analog power process (BiCD 130nm), the motor driver IC offers an output rating of 80V at 1.5A per channel. Power dissipation is minimised by an output ON resistance of 0.25Ω. Thermal and overcurrent shutdown circuits protect and automatically reset IC operation after a specified time. There is also a built-in thermal shutdown flag output. The device supports power-on sequencing for a single power drive.



Toshiba Electronics Europe
www.toshiba.semicon-storage.com

Polycarbonate resin for lighter LED automotive headlights

Plastics-maker SABIC has released new materials for customers producing LED automotive lighting parts. The LEXAN HF4010SR resin is a polycarbonate material which enables the development of complex headlight bezels with enhanced aesthetics. While current high-end LED headlamps weigh close to six kilograms with up to 200 components, SABIC has engineered the new LEXAN resin to address customers seeking to produce complex headlamp bezels with enhanced styling, but at a lighter weight and at a lower overall system cost. The LEXAN HF4010SR resin was designed to allow designers to target draft angles between 0.5 and 1.0 degrees lower than the recommended draft angle for PC tools (typically between 3 and 5 degrees). Bezels that are injection molded in LEXAN HF4010SR can be directly metallized (no need for priming) and gloss and reflectivity performance under high temperature environments are both very good.



SABIC
www.sabic.com

All-round industrial camera comes with GigE or USB 3.1 Type-C connection

IDS' latest uEye SE generation of industrial cameras will be available with either a GigE or USB 3.1 Type-C connection, in each case screw-on, as a housing version or as a board stack version, with a broad range of CMOS sensors with rolling or global shutter. The first 25 models that IDS will launch in October are versions with CMOS sensors from Sony (including Pregius IMX253, IMX304, IMX255, and IMX267 sensors with 8.9 and 12.3 mega pixel resolution), ON Semiconductor and e2v with rolling or global shutter. The housing with C-mount lens connection has a robust design and is equipped with a special dust-proof sensor seal. The cameras have a screw-on 8-pin Hirose connector for trigger and flash – both opto-isolated – and two GPIOs, which allow numerous additional application functions in an industrial setting. All camera models are also supplied as an unmounted board stack version with C-mount front or with no lens holder.



IDS Imaging Development Systems GmbH
www.ids-imaging.com

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150°C compatible chip ferrite beads suppress power line noise

Murata's BLM31KN_BH series of chip ferrite beads are aimed at the automotive market for use as noise suppression components in power line circuits installed in engine bays and LED headlights that require guaranteed performance at high temperatures up to 150°C. The number of motor control circuits (with brushes) or inverter circuits (brushless) has increased with the motorisation of powertrains, requiring noise suppression components that are capable of dealing with large currents. Furthermore, in order to reduce vehicle weight, the ECUs for engine systems and safety systems tend to be located in engine bays that reach high temperatures, and hence require noise suppression components capable of working in, and sustaining those high temperatures. BLM31KN_BH series comes in a 3.2x1.6mm package that supports the large currents suitable for power lines (120 ohm / 4A at 125°C) thanks to specially designed internal and external electrodes for use at temperatures up to 150°C. The BLM31KN_BH series conforms to the all-important automotive test standard AEC-Q200, and is available within the range of -55 to 150°C with derating. The beads' impedance up to 1000 ohm is effective for noise suppression at 100MHz.

Murata Europe
www.murata.com

Deep red, far red and new purple CoB LEDs target horticulture

Lumileds' new Luxeon SunPlus 35 Deep Red and Far Red LEDs combine with the company's Royal Blue to enable spectrum customization, while the its Luxeon SunPlus CoB purple LED ramps up Photosynthetic Photon Flux (PPF) for greenhouse productivity. The Luxeon SunPlus Series of LEDs are tested and binned by photosynthetic photon flux (PPF). The portfolio of colors enables wavelength tuning for maximum crop yield in both greenhouse and vertical farming applications. The addition to the Luxeon SunPlus 35 Line of Far Red and Deep Red will

enable designers of vertical farm and interweaving fixtures to tune the spectrum specifically for the crop being grown. The Deep Red (650-670 nm) and Far Red (720-740 nm) wavelengths join the existing Royal Blue (445-455nm), Lime (broad spectrum) and three shades of Purple with varying contributions of blue (2.5%, 12.5% and 25%) in a 3.5x3.5mm format. In contrast to vertical farming where lighting is positioned a short distance from plants, greenhouse lighting requires deep penetration into the plant canopy, which is achieved with a directional CoB such as the Luxeon SunPlus CoB Purple (12.5% blue). The CoB form factor also means that standard optics, holders and drivers are available to help manufacturers accelerate time to market of their fixtures. The Luxeon SunPlus CoB Purple is available with 15, 19 and 32mm light emitting surfaces.

Lumileds
www.lumileds.com

EMI shielding wire mesh gaskets with or without elastomer cores

Tech-Etch's EMI shielding knitted wire mesh can be used as economical gaskets for EMI/RFI shielding. All knitted mesh configurations are supplied on spools, coils or cut to length as individual gaskets with or without end seals. Standard profiles for a wide variety of applications include round, round with tail, double round with tail, half round (D) and rectangular. Most profiles are available as all mesh and all are available with an elastomer core to enhance compression characteristics and increase the deflection range. Standard wire materials are monel, TCS (tin plated copper clad steel), stainless steel and aluminum. Wire selection should take into account attenuation potential, mechanical characteristics, and corrosion resistance. The use of elastomer cores extends the operating range of the gasket. Free gasket samples are available upon request.

Tech-Etch
www.tech-etch.com

LED panel mount indicators come in 120VAC versions

VCC has expanded its CNX Series product offering to include 120VAC versions for both the 14mm and 22mm

panel-mount indicators. Part of the all-in-one FlexVolt product family, the rugged CNX714 and

CNX722 Series indicators can be used with voltages ranging from 5V to 28V DC circuits, and now 120VAC. Designed for outdoor environments and extreme applications, the IP67-rated LED indicators are moisture sealed and are resistant to shock and vibration. They come in five single colors including red, yellow, blue, white and green. Assembly is eased via fast pitch threads and special nut assemblies that enable quick installation by requiring only a single turn with one's fingers or a 1" hex tool. The CNX 714 and CNX722 Series provide direct sunlight visibility and a wide viewing angle for maximum light detection. Custom LEDs and lens colors are available, along with an optional bezel that is also available in many colors. The CNX 714 and CNX 722 Series indicators are RoHS and REACH compliant.

Visual Communications Company
www.vcclite.com

DISTRIBUTION CORNER

Bennings's TRUE RMS digital multimeter in stock at Conrad Business Supplies

Conrad Business Supplies has extended its range of measuring instruments with the highly accurate and reliable TRUE



RMS digital multimeter MM 12 from Benning. Compared with conventional averaging measuring instruments, the MM 12 is based on a TRUE RMS measuring method and displays the actual effective value of an alternating current correctly. It does

not matter whether the signal being measured is sinusoidal or distorted. TRUE RMS measuring instruments are mainly used in industrial areas when inductive loads cause reactive power. The input sockets offer 1000 V overvoltage protection.

Conrad Electronic
www.conrad.com

Round integrated colour display module with touch interface, Android-ready

Farnell element14 has introduced an integrated colour display module with touch interface, along with the Android SDK (software development kit), for the WaRP7 development platform.



The WaRP7 LCD module incorporates a standard MIPI display with DSI (display serial interface) and I2C (integrated circuit) interfaces, and is

designed specifically for use with WaRP7 products. The screen is round and has an active area diameter of 31.9 mm with 320 RGB x 320 dots resolution and a power consumption of 226mW. The platform consists of a main board and a daughter card. The main board is based on the NXP i.MX 7Solo application processor, and features an advanced implementation of the ARM Cortex-A7 core as well as the Cortex-M4 core.

Farnell
www.premierfarnell.com

Acal BFi signs exclusive pan-European agreement with SightLine Applications

Acal BFi has entered into an exclusive distribution agreement to provide advanced video processing products from Sightline



Applications across Europe. Sightline's advanced embedded systems deliver high performance video processing in compact, lightweight, low-power packages, which can now be integrated into more customer designs with the

support and expertise of Acal BFi.

SightLine's suite of products is field proven and suitable for both aerial and ground based applications, including manned and unmanned systems.

Acal BFi
www.acalbf.co.uk

Arrow Electronics signs SoM supplier SensiEDGE

Arrow Electronics has signed an agreement with Israeli start-up SensiEDGE and will offer the company's products through its operations across Europe, Middle East and Africa. The first product available through the collaboration is the SensiBLE Internet of Things (IoT) system-on-module (SoM). The 20x30mm SensiBLE

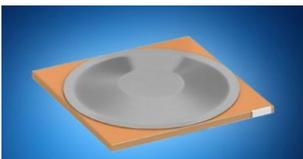


IoT SoM is a fully customisable solution based around an ARM Cortex-M4. It is equipped with Bluetooth 4.1 low energy connectivity and sensors for pressure, temperature, ambient light and humidity plus a 3-axis accelerometer, magnetometer and digital gyroscope. All this functionality is contained within a form factor. SensiEDGE has also signed up to Arrow's newly created SoM Program and sits within the Microcontroller/IoT Program layer.

Arrow Electronics
www.arrow.com

TDK Epcos's slim PowerHap piezoactuators now at Mouser

Mouser Electronics is now stocking PowerHap piezo actuators from TDK Epcos, which come with integrated sensor function-



ality. Designed to provide haptic feedback for human-machine interfaces, the devices can excite the entire stimulation range between 1Hz and 1000Hz for custom high-definition haptic

feedback profiles. The multilayer piezo plates are designed with cost-effective copper inner electrodes, which allow designers to drive the actuators with relatively low operating voltages up to 120V. The PowerHap actuators are available in three types, each in a RoHS-compatible ceramic body with titanium cymbals for displacement amplification.

Mouser
www.mouser.com

Miniature circular connector series fit for industrial data

Lane Electronics has made available a series of miniature circular connectors manufactured by Neutrik. Called etherCON,



powerCON and opticalCON, the connectors have been designed to satisfy a wide range of industrial data and communication applications. etherCON is a ruggedized and lockable RJ45 connector system optimized for industrial network applications. The

connectors feature a diecast shell with what Neutrik describes as a unique chuck-type strain relief with versions and allow the assembly of already assembled conventional RJ45 cables.

Lane Electronics
www.fclane.com

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LAST WORD

LiS batteries promise cheap roll-to-roll production for electromobility

By Julien Happich

Initiated in June 2014, the three-year LiScell (Lithium-sulphur) project led by the Fraunhofer-Gesellschaft in cooperation with other Fraunhofer institutes has come to a conclusion with very promising results.

The in-house project pushed the development of Lithium-sulphur batteries using new cathodes, electrolytes, and anodes that could attractively replace today's Lithium-ion batteries in electromobility applications.

Lithium-sulphur distinguishes itself with its very low material cost and high energy density up to 400 Wh/kg, which the researchers hope could be further optimized up to 500 Wh/kg. These cells already achieve up to 40% higher energy densities than the best lithium ion cells today.

Li-S cells designed with metallic lithium anodes come with their own challenge though, they have a poor cycling ability, and can only be discharged and re-charged 50 to 100 times.

This is due to a chemical reaction whereby the electrolyte attacks the anode surface.

Hence, Fraunhofer's scientists developed a novel cell design based around an anode made of a silicon alloy as a substitute for metallic lithium.

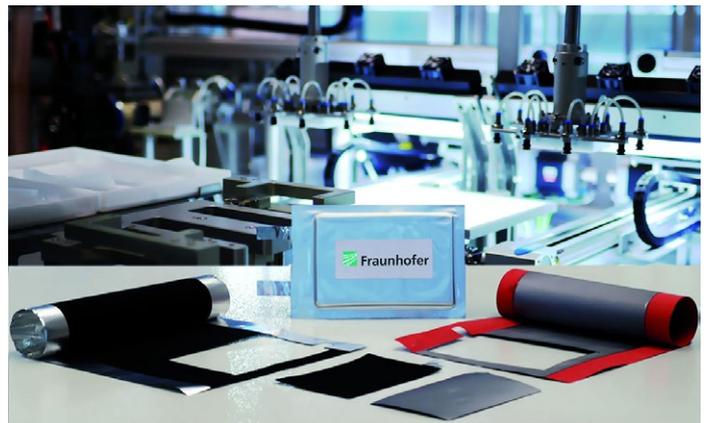
What's more, the new cell design replaces the expensive cathode material of Li-ion cells by the abundant and cost-effective non-toxic sulphur.

Besides their involvement with materials development, the four participating Fraunhofer Institutes – the Institute for Material and Beam Technology IWS (Dresden), Institute for Organic Electronics, Electron Beam and Plasma Technology FEP (Dresden), Institute for Transportation and Infrastructure Systems IVI (Dresden), and Institute for Chemical Technology ICT (Pfinztal) – also worked on the scalability of the fabrication processes for anodes and cathodes in the form of roll-to-roll foils and on the construction of battery modules.

This new anode and cell design has been implemented and demonstrated in Li-S and Li-ion prototype cells at the Fraunhofer IWS and the researchers were also able to efficiently produce the sulphur cathodes.

"Powdered active materials were processed without solvents by using a dry-film procedure at the Fraunhofer IWS to produce high-performance electrodes", stated Dr. Holger Althues, head of the consortium and Department of Chemical Surface and Battery Technology at the Fraunhofer IWS.

The advantages of the Si anode technique were determined in safety tests carried out by the Fraunhofer ICT.



Li-S cells have a performance edge over conventional energy storage media thanks to their high tolerance to overcharging and thermal stress. The researchers combined data- and model-based methods to determine the state of charge and state of aging of their prototypes. To make LiS cells a viable proposition, they have to be fabricated at scale and at low cost. The Fraunhofer FEP was able to develop a roll-to-roll vacuum coating process for the deposition of silicon layers with a specialized micro-scale structure on both sides of a thin charge-collector film made of copper.

"The layers proved themselves to be suitable anode material for Li-S cells as well as for Li-ion cells. They possess considerable potential for increasing the volumetric energy density compared to conventional solutions", explains Dr. Nicolas Schiller, director of the Flat and Flexible Products Division at the Fraunhofer FEP.

E·X·P·O ELECTRONICA

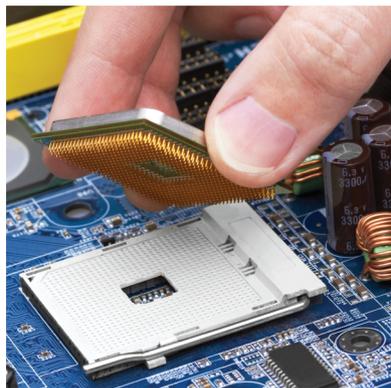
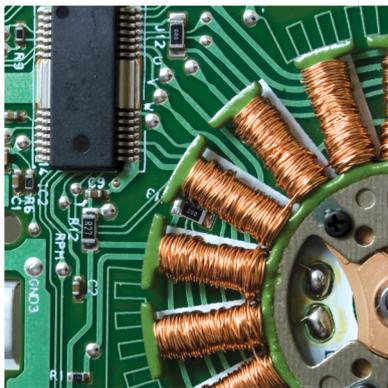


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www.infineon.com/sot-223

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