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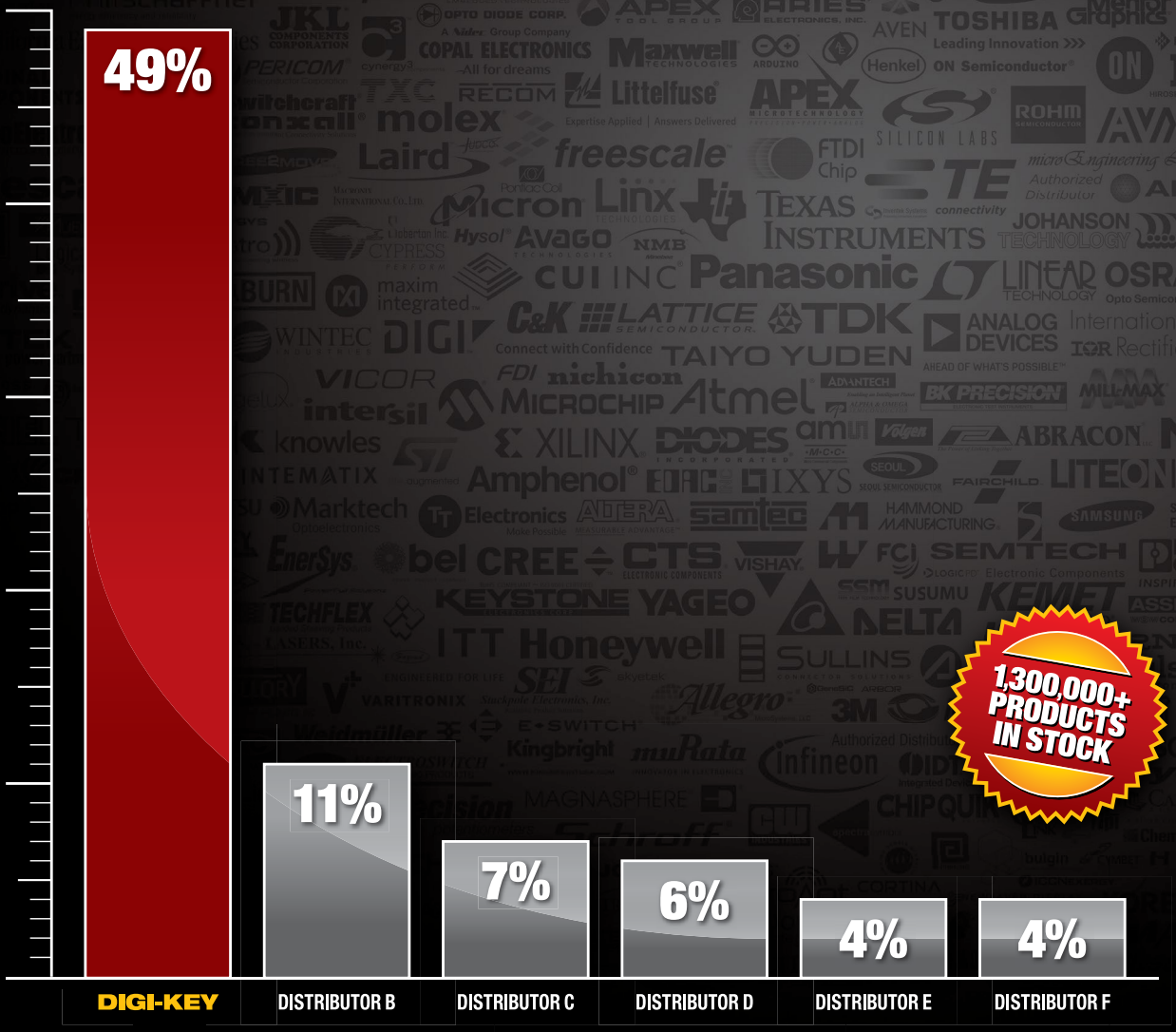

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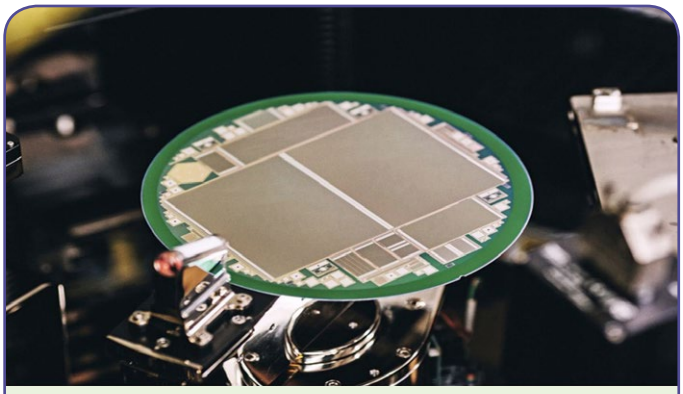
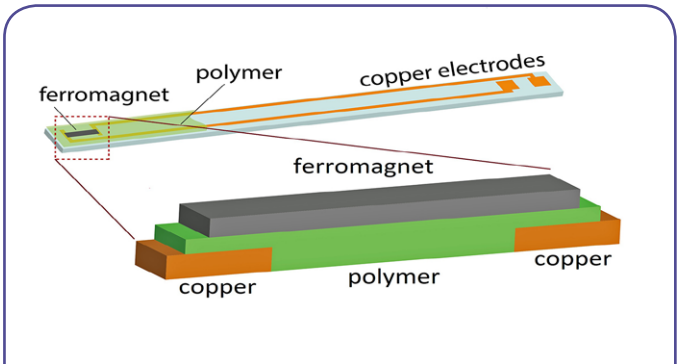
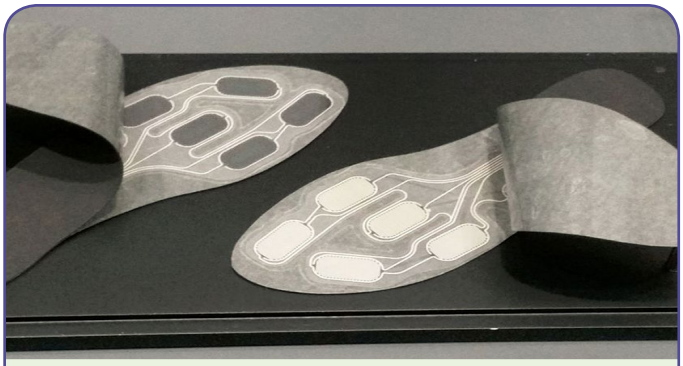
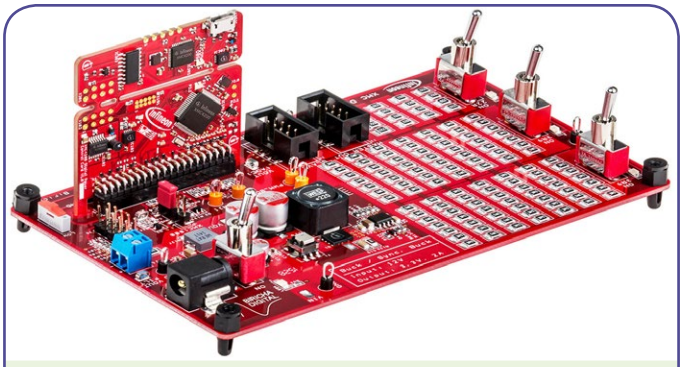








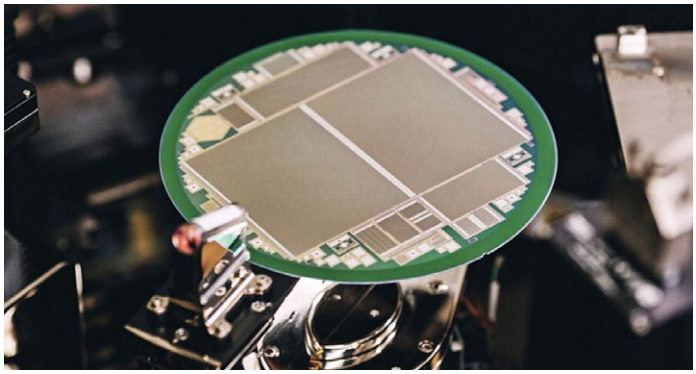
Eight-inch sensor will look for 'dark matter'

By Peter Clarke

Silicon sensor chips measuring 15cm by 10cm made by Infineon Technologies AG are to be deployed at CERN, the world's largest particle physics research centre, in the hope of proving the existence of dark matter.

Dark matter is a hypothetical cosmological construct that is used to explain the behaviour of the universe. Dark matter makes up about 85 percent of the matter in the universe while dark matter and dark energy together are thought to make up 95 percent of universal matter-energy.

However, dark matter's existence has only ever been observed indirectly and there are other theories that attempt to explain discrepancies between cosmological behaviour and the observed mass-energy of the universe.



Elementary particle strip sensor with a size of 15cm by 10cm in the centre of the wafer (Photo: Infineon Technologies Austria AG).

CERN, the place where the Higgs boson was observed in May 2012, is now researching how it might be able to generate dark matter. This would be detected and inferred by the energies, directions of travel and ratios of particles generated by its destruction.

Infineon Technologies Austria and the Austrian Academy of Sciences' Institute of High Energy Physics (HEPHY) worked together to create a silicon sensor for use in two different detectors, ATLAS (A Toroidal LHC Apparatus) and CMS (Compact Muon Solenoid).

The latest sensors are more economical to produce and withstand radiation better and therefore age more solely than previous sensors.

Elementary particle strip sensor released from the wafer (Photo: Infineon Technologies Austria AG).

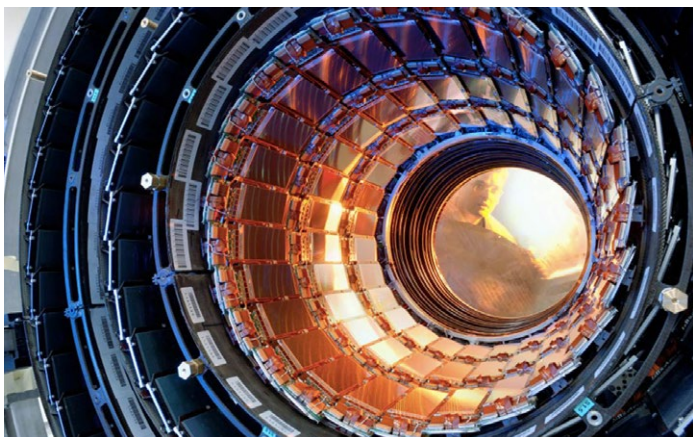
Installation of the world's largest silicon tracking detector in the CMS experiment (Photo: CERN).

One end-cap of the CMS tracker is opened during installation work (Photo: CERN).

As a result they could be used in the tens of thousands at CERN in the near future, Infineon said in a statement.

The ATLAS detector is 20 meters high and the CMS 15 meters high and they have both been working for several years carrying out 40 million measurements per second.

Although such pure science research is done for its own sake and may take generations to impact the everyday lives of people some of the techniques developed could benefit people much sooner. One example is in medical imaging such as proton-computed tomography, which has developed out of CERN-developed engineering.



First half of CMS inner tracker barrel (Photo: CERN).

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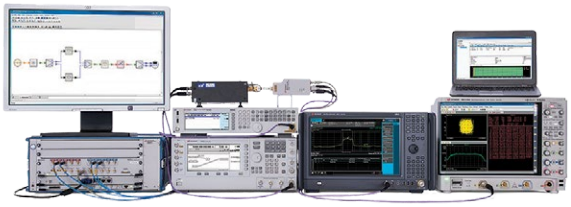

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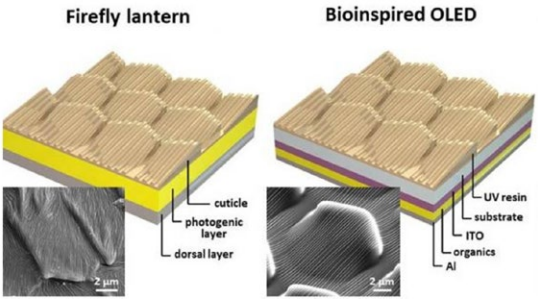
Fireflies inspire OLED efficiency gains

By Paul Buckley



Researchers at the Korea Advanced Institute of Science and Techno-logy have replicated the patterns of a firefly's light-emitting cuticle to create a bioinspired OLED that achieves a 60% increase in the light extraction efficiency and 15% wider angle of illumination.

The research findings have been published in a paper on the firefly-inspired OLEDs in Nano Letters.

Many insects, birds, fish, and amphibians emit light as a way to communicate with each other, but the species that produces light most efficiently is the firefly.

"This work reports the first observation of hierarchical structures, i.e., inclined microstructures with nanostructures existing on the cuticular ultrastructures of a firefly's lantern," said Jeong. "Based on our large-scale photonic calculation, it was clearly revealed that the function of asymmetric and hierarchical structures substantially contributes to the efficient extraction and wide angular illumination of bioluminescent light that would otherwise be entrapped in the firefly lantern. The knowledge learned from firefly lanterns has been successfully utilized for next-generation OLEDs."

The work builds on previous research (some by the same authors) that has shown that firefly cuticles have nanostructures that improve light transmission. The cuticles also have tiny structures that increase light extraction (the amount of light that actually exits the animal) by reducing internal reflection. The problem of internal reflection is one of the biggest challenges facing LEDs, where often more than half of the light produced is reflected back into the device rather than being emitted. Scientists have already mimicked these nano- and microstructures in LED design to improve light transmission and extraction.

In the new study, the researchers have discovered that the asymmetric and hierarchical nature of the cuticle structures also plays a key role in the firefly's light-emitting ability. The researchers created precise molds of these structures to use as the optical layer of an OLED. Consequently, the same features that help fireflies communicate their courtship signals have turned out to also contribute to improving advanced lighting and display applications.

"Our breakthrough technology is the large-scale fabrication of inclined microstructures and highly ordered nanostructures on each inclined microstructure," Jeong said. "We strongly believe that these biologically inspired OLEDs open a new paradigm for engineering biomimetics for lighting applications." The firefly light may become a commercial reality in the near future.

"We are looking for an industrial OLED partner who is interested in commercializing our novel idea, and we will also continue to work on biologically inspired photonics for engineering applications," said Jeong.

DNA strand turns into nanoscale molecular rectifier

By Julien Happich

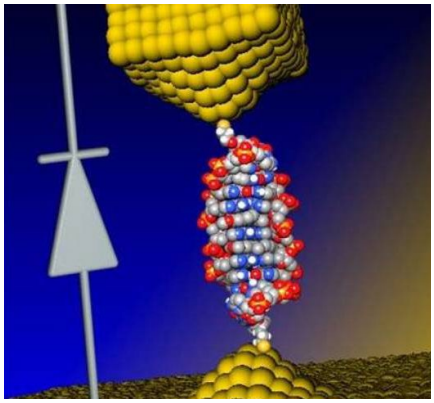
Researchers from the University of Georgia and Ben-Gurion University of the Negev (BGU) have joined their efforts to develop what they believe to be the world's smallest diode, in fact the size of a single molecule.

The study published in Nature Chemistry under the title "Molecular rectifier composed of DNA with high rectification ratio enabled by intercalation" details how the Israeli and American researchers leveraged the predictability, diversity and programmability of DNA to design their first single molecule electronic device.

They constructed a DNA-based molecular rectifier by site-specific intercalation of small molecules (coralyne) into a custom-designed 11-base-pair DNA duplex.

Measuring current–voltage curves of the DNA–coralyne molecular junction exhibited unexpectedly large rectification with a rectification ratio of about 15 at 1.1 V, a counter-intuitive finding considering the seemingly symmetrical molecular structure of the junction.

The researchers wrote a non-equilibrium Green's function-based model, parameterized by density functional theory calculations, revealing that the coralyne-induced spatial asymmetry in the electron state distribution caused the observed rectification.



"Creating and characterizing the world's smallest diode is a significant milestone in the development of molecular electronic devices," stated Dr. Yoni Dubi, a researcher in the BGU Department of Chemistry and Ilse Katz Institute for Nanoscale Science and Technology. "It gives us new insights into the electronic transport mechanism."

The nanoscale diode thus obtained operates like a valve to facilitate electronic current flow in one direction. A collection of these nanoscale diodes, or molecules, has properties that resemble traditional electronic components such as a wire, transistor or rectifier.

The researchers see molecular electronics as a possible route to overcome Moore's Law beyond the limits of conventional silicon-based semiconductors.

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CEO interview: Andes' cores for IoT suit Europe

By Peter Clarke

EE Times Europe interviewed Frankwell Jyh-Ming Lin, CEO of Andes Technology Corp. (Hsinchu, Taiwan), a licensor of a range of 32bit processor cores as intellectual property (IP), and asked how the company is planning to address the European market.

Founded in 2005 to develop and license its own architecture of low-power processor cores and associated development tools, Andes is still privately held but has received significant minority investment from fabless chip company MediaTek Inc. (Hsinchu,Taiwan). MediaTek is also a licensee.

Although Andes may not be well known in Europe it has achieved design wins in numerous wireless connectivity chips and touchscreen controllers and Andes IP has shipped in more than a billion chips to date. Having started in southeast Asia before ramping commercial activities in the United States, Lin now reckons the suitability of the company's AndeStar architecture for low-power nodes in the Internet of Things (IoT) makes it a good fit for European developers.

Frankwell-Lin, CEO and co-founder of Andes.

EETE: What differentiates Andes Technologies processor cores from those of other suppliers such as ARM, Imagination (MIPS), Synopsys (ARC) or Cadence (Tensilica)?

Frankwell Lin: "The AndesCore series comes with differentiations such as CoDense for very compact code size, StackSafe for automatic detection of stack overflow, PowerBrake for a purely digital way to scale frequency and power without a clock divider, FastWakeUp for Automatic CPU state save/restore for fast power-down/power-up, Andes Custom Extension (ACE) for programmable acceleration and energy reduction through the use of custom instructions, Security for Protection against software attacks and physical attacks, and FlashFetch, which is separate IP to speed up internal Flash and allow execute-in-place external Flash support.

EETE: What about voltage scaling for low power?

Andes can also support dynamic voltage and frequency scaling (DVFS), Lin said but that requires foundry support as well as hard IP assistance.

Andes is close to the leading edge of manufacturing processes for deployment with designs aimed at 16nm FinFET in development and 20nm and 28nm CMOS chips in production, he added.

Andes is also familiar with the low-voltage process variants being produced by TSMC and other foundries. "Five years ago we started working with TSMC on a super low voltage 55nm process. We applied our N8 core and had it running at 0.48V in 55nm CMOS," said Lin.

EETE: What markets are Andes cores suitable for?

FL: "We provide deeply embedded controllers for 32 bit MCU, IoT, artificial intelligence, multimedia, virtual reality, touch panel controller, deep learning, ADAS, housekeeping controller, cloud computing controller, networking, video codec, timing controller, event recorder, wireless charging; wireless connectivity WiFi/BT/GPS, Zigbee and Near Field Communications NFC, for security application such as Security SD controller, Security USB controller; flash-based storage controller in solid-state drives, memory card controllers, USB drives, sensor hubs; and wireless displays such as 8K4K TV encoder, 4K2K TV codec, H.264/H.265 codec and so on," Lin said.

"Andes is good for all embedded and deeply embedded applications and we have an open ecosystem and third-party support. But for things like Apple iOS and Android applications we are far behind," Lin added.

EETE: When will Andes bring out a 64-bit processor core?

FL: Lin accepted that Andes customers are starting to get close to a requirement for 64-bit addressing capability. "Our licensees are gaining design wins in novel applications areas such as virtual reality, artificial intelligence and embedded vision. Our 64-bit core will be backwards compatible with our 32-bit cores. We already have a basic scenario but it is too early to disclose," Lin said. He added that engineers should not expect to see a 64-bit core from Andes in 2016.

EETE: Is lower cost of upfront licensing fees and royalty rates another differentiator for Andes?

FL: "We offer value with our technical solutions. Our price may be a strength, but it should be the last thing we discuss. Our customers ask about our technical features first," Lin responded.

EETE: How many core families are there and is there software compatibility across the range?

FL: "We now have eight core series: N7, N8, N9, N10, N13, E8, S8, D10, and we maintain their software backward compatibility, for example, our third generation ISA v3 can run the prior generation ISA v2," said Lin.

The S8 and E8 are based on the three-stage pipeline of the N8 core. The S8 family is a secure processor that protects code and data from physical attacks and malicious debugging. The E8 family targets IoT applications by allowing the creation of custom instructions to increase performance and reduce power consumption of key functions. The D10, introduced in 2015 is based on the 5-stage pipeline of the N10 and adds single-instruction multiple data (SIMD) capabilities to the core.

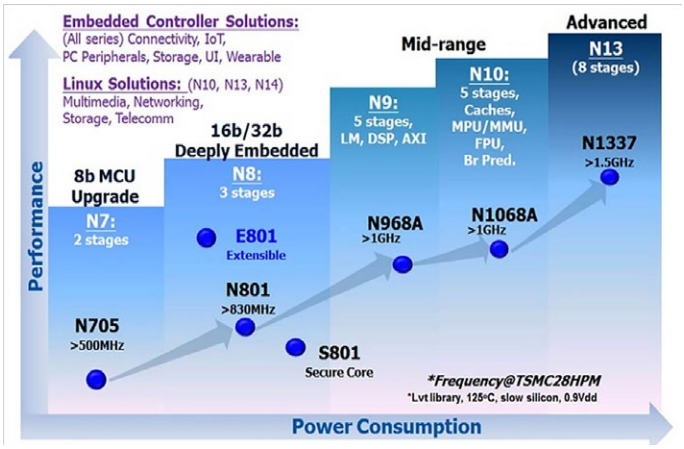
EETE: And do you provide support for multi-core designs such as dual- or quad-core configurations?

FL: "We have customers who leverage our technology to do many-core designs in their application. For an 8K4K encoder there is a design that uses three N13s and five N10s. There are quite a few examples like this," said Lin.

EETE: How is the Andes range supported in terms of compilers and third-party tools?

FL: "Our toolchain is GNU based, including compilers. In terms of third-party tools, Lauterbach, IAR Systems, support us, as do J&D with a product called CodeViser (a software debugger) and CooCox with a GNU-based integrated development environment.

EETE: What next for the company in terms of IP? Do you



Technology Roadmap of the journey so far (D10 not shown).

need to add graphics, or wireless IP?

FL: "We will expand our core product roadmap in two directions: one is to make the core even lower power, that is good for IoT applications; the other end is to have higher performance, which means we will have deeper stage pipelines, more issues, more threads, and more cores design features," said Lin.

"We will derive more differentiation in future series of products we will develop. In terms of peripherals, support for AXI fabric is something we will announce soon. In terms of embedded cores, we will make a formal announcement at the Andes annual technology forum in June."

EETE: How successful has Andes been in terms of chips sold that have included Andes IP?

FL: "To date more than 1.4 billion SoCs embedded with AndesCore have shipped. In 2015 the annual shipment of AndesCore in SoCs reached 390 million units, so we believe it is quite successful in terms of market share and world ranking for 32-bit embedded processor industry," said Lin. "Across world more than 50,000 engineers have learned how to use Andes' toolchains as the installed base is over 10,000 seats. This means that you can easily find engineers who are already trained to design with Andes."

EETE: How will you achieve success in Europe?

FL: "Europe is strong in mixed-signal design, in RF and low power design – these are the key elements in IoT and we expect Europe to be a leader in IoT. With low power, high code density and support for wireless standards such as Bluetooth, Zigbee and more Andes processor cores are ideal for the IoT market," said Lin.

"Our higher end cores are ideal for applications that need to run Linux and need a memory management unit (MMU) or deeply embedded applications. ACE give our customers the opportunity to extend the CPU automatically, be this to give even better code density or to add hardware specific features."

Lin added: "As a new entrant to the market, Andes has to make itself known to the European market. We have engaged CamverTech Ltd., which has three semiconductor business development veterans in Europe with strong track records in semiconductor IP sales. We will also be present at key trade shows. Recently we were at Embedded World and we will have a booth at TSMC Symposium in Amsterdam. Put all these ingredients together and Andes will continue its success in Europe."

Lin continued: "We already have design wins in Europe. One of the notable ones is for an LTE basetation SoC. And we do have a support ecosystem for IoT that is coordinated through the Knect.me website (www.knect.me). We have gathered 40 partners together in less than a year."

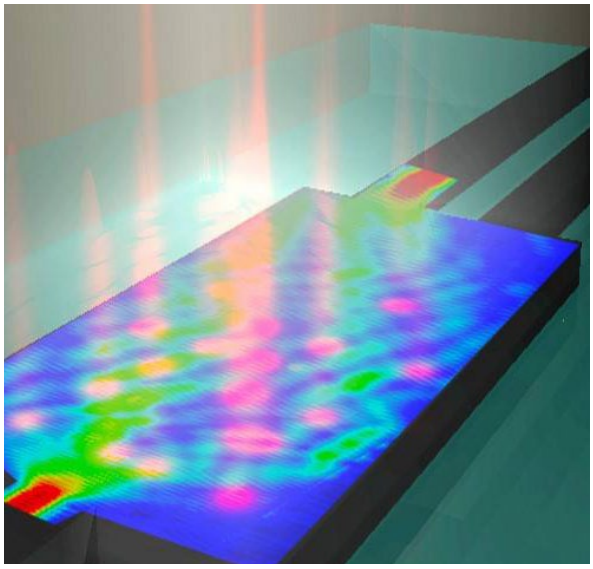
Reprogrammable photonics tune optical path on-the-fly

By Julien Happich

By combining a spatial light modulator with a multimode interference (MMI) device, researchers from the University of Southampton (UK), and the Institut d'Optique in Bordeaux (France) have demonstrated reconfigurable photonic circuits able to change an optical wavefront in free-space optics, on demand.

While a photonic chip functionality is usually hard-wired by design (geometry and layered refractive indexes route the incoming light beams), the researchers were able to alter and control the optical properties of a multimode interference power splitter (approximately 40um long) to freely steer a light beam at the 1550±1.7 nm wavelength.

Re-routing of the light between the ports was performed dynamically, with more than 97% total efficiency and negligible losses, according to the researchers.



An artistic rendering of a silicon-on-insulator 1x2 multimode interference splitter with a projected pattern of perturbations induced by femtosecond laser.

In what they call an "all-optical wavefront shaping" process, the researchers used a digital micromirror device (DMD) as a spatial light modulator to project a pattern of femtosecond ultraviolet laser pulses onto the MMI device surface.

Presenting their results in the April issue of the journal Optica under the title "All-optical spatial light modulator for reconfigurable silicon photonic circuits", the researchers detail how under each illuminated position, plasma dispersion locally decreases the refractive index of silicon (by approximately 0.25 refractive index units).

Modulating the refractive index simultaneously across a large number of positions (around 500) significantly affects the light flow, essentially implementing a dynamically reprogrammable refractive index profile that changes the optical route of the incoming beam (in a static silicon element).

Principal investigator Professor Otto Muskens, from Physics and Astronomy at the University of Southampton admits the current set up is quite bulky due to the external laser source and the use of a digital micromirror.

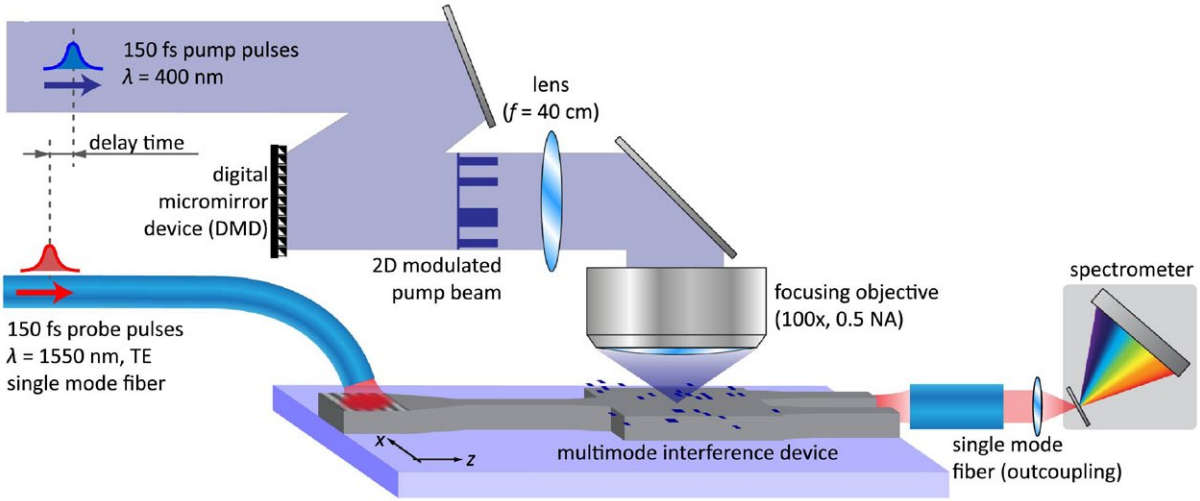
"It is a proof of concept, but in the future, we could design a more compact system, using a laser diode and an integrated LCD mask instead of a micromirror", he told *EETimes Europe,* adding that he was quite open for others to look into new solutions to make these field-programmable photonic circuits a commercial reality.

Such integrated platform could someday find their way into all-optical reconfigurable routers, ultrafast optical modulators and switches for optical network, or even in silicon chips.

Examples cited in the paper include new gradient designs based on transformation optics, or the use of phase change layers for writing nonvolatile patterns for reconfigurable optical memory devices.

Wavefront shaping could also be used to design optical systems with wavelength dependent responses, achieving spectral control, or specific time domain characteristics.

For now, even a bulky setup could be useful for exploratory work, to prototype and test new photonic chips through quick iterative work.



Concept of wavefront shaping by ultrafast photomodulation spectroscopy. The transmission spectra of TE-polarized 150 fs probe pulses with a central wavelength of 1550nm are monitored through a multimode interference (MMI) device. Simultaneously, a 2D pattern of 400nm pump light is projected onto the device (blue overlay), locally decreasing the refractive index of the silicon MMI material by plasma dispersion. The pump beam is spatially modulated by employing a digital micromirror device (DMD), and the pattern of the DMD is imaged onto the MMI surface by means of a lens and a microscope objective.

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Taking the Heat – and Leads – Out of Higher Power Designs

Neil Massey, Senior Marketing Manager Infineon Technologies AG

Applications such as power factor correction (PFC) in computer servers and telecoms systems or hard-switching boost stage in solar inverter designs demand ever-increasing power outputs without corresponding increases in space. The imperative to improve power density means that designers must find ways to meet high-speed performance criteria while driving up efficiency and minimizing heat.

In the case of power switching devices such as MOSFETs, thermal limitations have represented a significant barrier to migrating away from traditional leaded MOSFETs to surface mount alternatives. Now, however, a combination of improved superjunction (SJ) semiconductor processes and advances in SMD package design is delivering 'GaN-like' performance and enabling the first SMD MOSFET technologies compatible with the requirements of today's medium- to higher-power schemes.

Looking at today's data centers, it is no surprise that power densities per rack are rising – space is at a premium and businesses are trying to wring more profit from every square foot. Back in 2006 there was around 6 kW in each rack – by the end of this decade that is predicted to have almost trebled – putting ever-increasing pressure on power system designers.

Clearly, efficiency plays a large part in addressing this challenge. One of the truisms of power is that 'you don't have to deal with heat that you don't generate'. High efficiency means that more useful power is transmitted to the task in hand – computing, telecoms or solar – saving energy costs. It also allows for a greater density of servers, which reduces real estate costs. But that's not all; as less waste heat is generated, the cooling requirements also reduce, which again saves space and reduces energy costs.

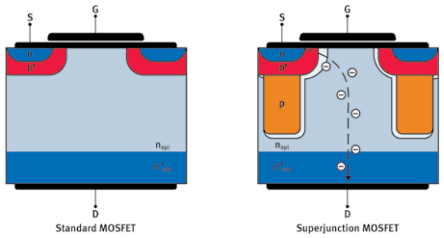


Figure 1: Comparing the structure of a Superjunction MOSFET to a standard MOSFET

The journey to design a highly efficient, extremely dense power system begins with the topology chosen and, in particular, the performance of the main power components. That's why semiconductor companies continue to refine their processes and develop new technologies that improve the key 'Figures-of-Merit' (FoM), which leads to greater efficiency. But, that is only half the story. While the world moved to surface mount devices years ago, power switches have lagged behind; many of the 'latest semiconductor advances' are still housed in pin-in-hole packages (TO-220 and TO-247 being the most popular). Such packages may bring benefits to thermal management but they often necessitate a second production process that drives cost. In addition, the package leads themselves can be a barrier to performance, as we shall see.

C7 Gold Superjunction process

Infineon Technologies' CoolMOS™ process is a proven technology that has benefitted from substantial development since the introduction of its novel drain structure back in 1999.

There are two key principles employed in superjunction CoolMOS™ MOSFETs. First, the on-state resistance ($R_{DS(ON)}$) is lower as the main current path is much more heavily doped than for a conventional high-voltage MOSFET. Without the p-columns forming a charge compensation structure below the cell structure the transistor would have a much lower blocking voltage capability due to the highly doped n-region. The precisely sized and doped p-columns constitute a "compensation structure", which balances the heavily doped current path and supports a space charge region with zero net charge supporting high blocking voltage.

This construction enables a reduction in area specific resistance that improves conduction loss. The attendant reduction in chip area also reduced capacitance and dynamic losses, which allowed the silicon limit line to be beaten.

This MOSFET technology approach has been continually developed – the C7 generation continued to reduce capacitances and achieved an $R_{(ON)}$*A below 1 Ω*mm^2 for the first time. The turn-off losses in C7 were 50 percent less than the earlier CP generation. C7 Gold (G7) takes this well-established manufacturing technology further, reducing turn-off losses by a further 25 percent and ensuring 'best-in-class' FoM in terms of both $R_{DS(ON)}$*E_{OSS} and $R_{DS(ON)}$*Q_g. This leads to higher system efficiency and achieving 'near-GaN' performance in hard-switching topologies, such as power factor correction (PFC).

TO-Leadless (TOLL) packaging

In many mid-to-high power PFC circuits it is not uncommon to see pin-in-hole packages in the power stage. As electronics has improved, package engineering has also seen innovation (TO-247 became TO-220 offering a 50 percent footprint reduction) yet, even the surface mount D^2PAK had pins (albeit surface mountable).

The issue with pins is not just that pin-in-hole technologies require a different manufacturing process such as wave reflow – pins introduce inductance into the package. This parasitic inductance counteracts the drive voltage and the ensuing slower transient reduces efficiency.

This is where the TO-Leadless (TOLL) package from Infineon comes in. Figure 2 shows this package in comparison to previous form factors.

The new TOLL package brings benefits in manufacturing; the totally Pb-free package has an MSL1 rating for easy handling on the shop floor and is

compatible with both wave and reflow soldering, offering high levels of flexibility. Moreover, the tin-plated leads feature a trapezoidal groove next to the PCB pad. This guarantees wetting and means that the joint is fully visible for optical inspection systems, ensuring the quality of the finished product.

A 650 V CoolMOS™ C7 Gold MOSFET in a TOLL package

Bringing together the benefits of the CoolMOS™ C7 GOLD (G7) process and the advantages of a TOLL package for the very first time, the IPT65R033G7 offers engineers some significant benefits when it comes to next-generation power designs.

The package can be connected in a standard 3-pin MOSFET configuration or with the option of an additional connection to the source (Kelvin connection). This can be used as a reference potential for the gate drive voltage, thus eliminating voltage drops due to the (much reduced) 1 nH parasitic inductance in the source pin. This crucial feature enables easy, higher efficiency operation – particularly in full load conditions.

The IPT65R033G7 offers very low on resistance of just 33 mΩ (max). This coupled with a typical gate charge (Q_g) of just 110 nC and an E_{oss} of 13.5 uJ at 400 V ensures that the key FoM for this device are truly best-in-class.

Housed in the new TOLL packaging, the IPT65R033G7 measures only 10.10 mm x 11.88 mm x 2.4 mm. The lead-free approach to die attach is responsible for a typical thermal resistance from junction to ambient (R_{thJA}) of just 35°C/W in the SMD device. Such thermal properties allow an SMD power device to be used in hard-switching PFC circuits up to 3 kW for the first time.

The new C7 Gold (G7) technology delivers real performance benefits that have a material impact on state-of-the-art power designs as can be seen in the following performance charts.

Summary

The key benefits of C7 Gold technology of low Ron*A (<1 Ω.mm²) enables low $R_{DS(ON)}$ (33 mΩ) to be achieved. Improved FOM such as $R_{DS(ON)}$*E_{OSS} and $R_{DS(ON)}$*Q_g together lead to efficiency improvements and the generation of less thermals.

Efficiency is then enhanced further with the TOLL package features of low package source inductance (~1 nH) and the use of the Kelvin Source 4th pin option.

Combined with the small footprint (115 mm²) and improved thermal performance of the TOLL package (R_{thJA} of 35°C/W) , this leads to a MOSFET technology that enables designers, for the first time, to use an SMD package in hard-switching topologies such as PFC up to 3 kW.

This aligns directly with the requirements for modern server, telecom and solar power supplies in the continued push for higher power density and cost reduction through automated production processes.

The high quality of the TOLL package with its MSL1 rating and compatibility with both reflow and wave soldering techniques brings benefits in manufacturing. The package is also qualified for industrial applications according to JEDEC (J-STD20 and JESD22) and will soon migrate to house other technologies such as Infineon's CoolGaN™ product portfolio.

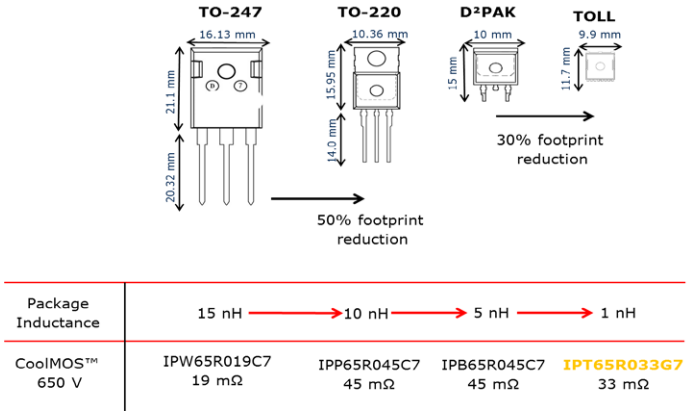


Figure 2: Comparing Infineon C7 and G7 technology, package sizes and inductances plus $R_{DS(ON)}$ max values

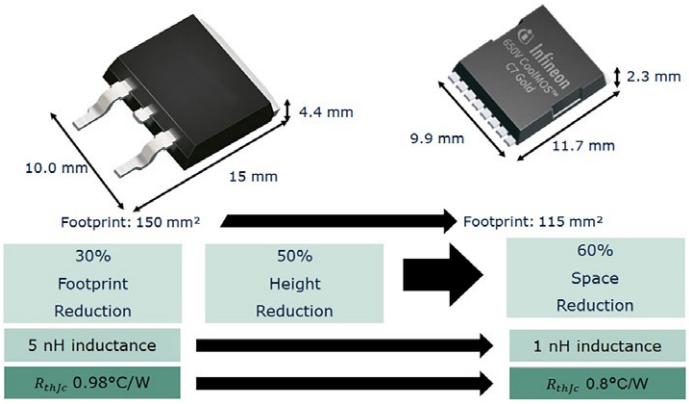


Figure 3: TO-Leadless (TOLL) shows significant size and performance benefits over D²PAK

Figure 4: The higher efficiency from TOLL package vs the much larger and traditional TO-247 package is due to lower $R_{DS(ON)}$ and use of the 4-pin Kelvin Source connection

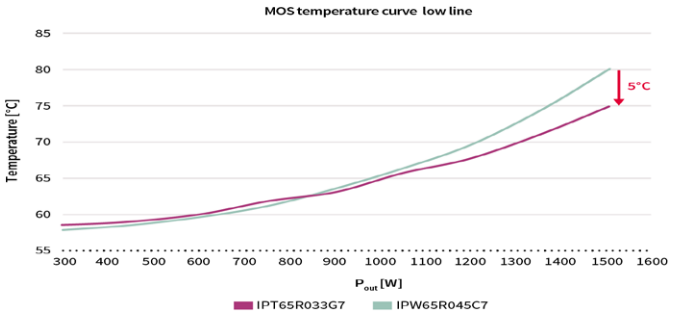
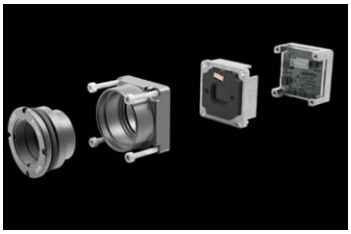


Figure 5: Lower temperature is due to the higher efficiency generated by the C7 Gold technology and the use of the 4-pin Kelvin Source connection

Movidius weds thermal imager and computer vision

By Junko Yoshida



Flir's Boson

The power of thermal imaging is well known. But what happens when a thermal sensor marries a vision processor?

"We are putting together those two separate sensing modalities into one by collaborating with Flir systems," Movidius CEO, Remi El-Ouazzane, told EE Times. Movidius is a develo-per of low-power machine vision technology, while Flir is a leader in thermal imaging technology.

The companies have worked together for two years. Their efforts resulted in adding Movidius' advanced computer vision capabilities to FLIR's newest thermal imaging camera core called Boson. More specifically, Boson integrated with Movidius' vision-processing SoC called Myriad 2 VPU can now implement "advanced image processing, super resolution and noise filtering," according to El-Ouazzane. Compared with Flir's previous generation thermal core called Tau 2, the new module is 10 times smaller and lighter in weight, while consuming only half the power.

"The cherry on the cake is that there is still enough processing power left on this hundreds of gigaflop chip" that's sitting next to the thermal sensor, said Movidius CEO. That can be used for additional image processing and analytic algorithms.

In short, aside from using the new module for the creation of thermal images, Flir's customers can use it for everything from a vision analysis suite to porting their own vision algorithms, he explained.

No one else has yet combined a thermal image sensor with a vision processor. "Nothing like this exists today," boasted El-Ouazzane.

Movidius' Myriad 2 plays three roles inside Boson.

First, it processes raw imaging data from the thermal imaging core, according to El-Ouazzane. As Pierre Boulanger, Flir's CTO, pointed out, "In infrared, no two pixels are created equal. We have to process every single pixel at many different levels—way more than a visual sensor." The highly programmable Myriad 2 "allows us to run those special algorithms," said Boulanger.

Second, Myriad 2 in Boson performs advanced computer vision analysis. Third, Myriad 2 acts as a system-level SoC for the complete system, noted El-Ouazzane, eliminating "three other subsystems."

Boson users no longer need to add such subsystems as input/output, display drivers to monitor graphics and power, and visual analytics, El-Ouzzane added.

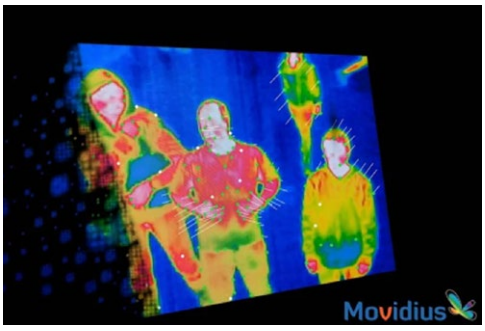
Broad applications

Thermal imagers can detect radiation in the long-infrared range of electromagnetic spectrum. This enables thermal imaging cameras to see warm objects against cool backgrounds—day or night. Its applications range from military equipment and surveillance to automotive night vision and firefighter helmets that can see through smoke.

Once a thermal imaging core is combined with a visual intelligence processor core like that of Movidus' Myriad 2, thermal imaging cameras can not only get smarter. They can also double as embedded cameras that capture images using visible light.

Drones today are already carrying thermal image sensors for security, surveillance or inspection purposes. DJI, the world's leading maker of drones and aerial cameras based in Shenzhen, China, offers, for instance, a drone equipped with Flir's Tau 2 thermal imaging core.

Pedestrian Counting: thermal imaging is well-suited to the task as it performs well in various weather/light conditions, in addition to being able to easily differentiate the background from live subject through heat signatures. (Source: Movidius)



Computer vision algorithms allow systems to understand how individual features move from frame to frame. These basic building blocks support object detection & tracking, pose estimation and gesture recognition. More advanced neural networks are even beginning to understand very subtle cues such as moving with a concealed object, sentiment and erratic behaviour. (Source: Movidius)

Last month DJI launched its Phantom 4 aircraft, with Movidus' Myriad 2 vision-processing SoC in it. The Phantom 4 is said to be capable of sensing and avoiding obstacles in real time and hover in a fixed position without the need for a GPS signal.

The Movidius CEO said, "I can't speak of either Flir or DJI, but it is conceivable that DJI can now use Flir's new Boson core," employing a combination of night vision and visual intelligence processing.

Boson is a configurable thermal camera core that works in VGA and QVGA resolution. Its camera body is 21 x 21 x 11 mm, weighing 10 grams. Its low power consumption starts at 500mW. It offers built-in support for physical- and protocol-level interface standards such as Ethernet, USB, SD card, LCD interfaces, and wireless video.

Boson is a platform-based solution allowing different configurations at different prices, performance grades and image quality, according to Flir.

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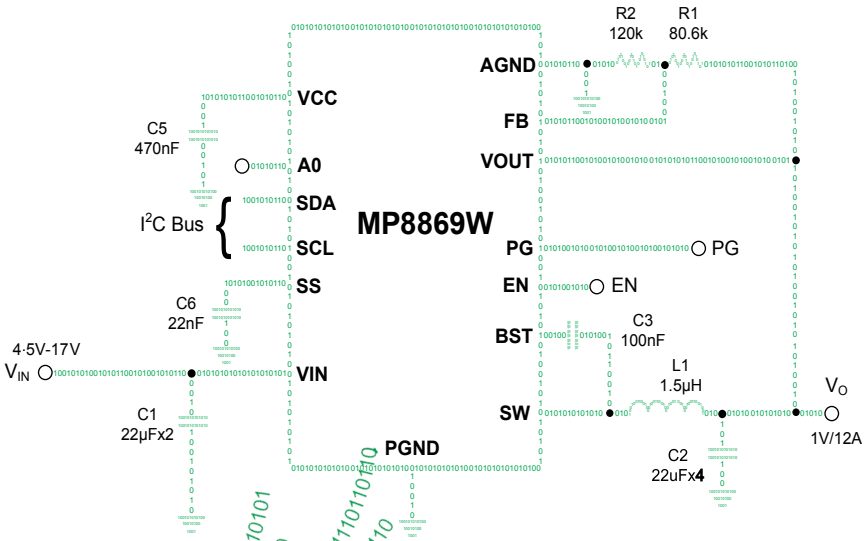

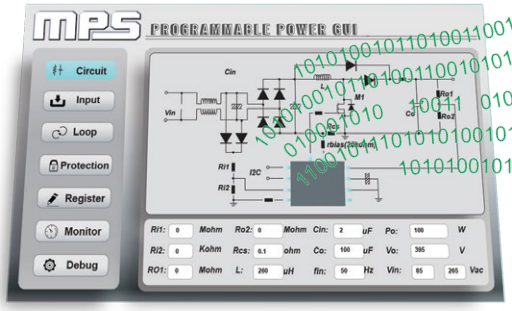

Key Highlights

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Creating a legacy through traditional values

President and CEO of Open-Silicon, Taher Madraswala has a quarter of a century of experience in semiconductor engineering. Here, he outlines his vision of how the market will change over the next five years…

Hanns Windele: You have been with Open-Silicon since 2003, becoming President and CEO in 2014. That was a tough time to take up that job. Did you apply for it?
Taher Madraswala: In the Q4 board meeting of December 2013, I was offered the job. It was a surprise and my first reaction was to decline, because I didn't think I was ready.
A board member then took up the interim position. The board asked me again a few months later, and I said I'd take the job and on the board's request I did, although there was an interim CEO at that time. While I did accept the position, we also agreed that we'd go out and look for a CEO. We spent a few more months searching for one, but the board decided not to bring in anyone from outside. So, in April 2014 I was given the title of President and a year later in April 2015 I was asked to take up the CEO. This time I didn't refuse because I'd had 18 months in the position and was more comfortable running the company and my face was becoming familiar in the industry.

HW: What was it that eventually changed your mind?
TM: For ten years I had run the company from the inside, managing the resources and the business. But I was not the external face of the company. In this business, I believe that you need a leader that is recognised in the industry, because as a services company people will give you the job if they know you. I started going to the CEO events and people started to know me. And that's when I knew I could take the title and not jeopardise the business of the company.

Open-Silicon's CEO Taher Madraswala "If you are in it to build a company and a legacy, then it is a long-term game".

HW: What do you think has contributed most to your success in career?
TM: I think following through on my commitments has helped me get through tough times and good times, too. That's what I attribute my success to.

HW: Is there an example of this?
TM: When I joined Open-Silicon I was part of the inner circle that came up with the idea of finding a way of making ASICs affordable. But when we decided to start the company, I was in the middle of a project at Intel. The team were insisting: 'let's go and get funded.' But I requested that I couldn't because I'd been with Intel for 11 years and had a commitment and I had to finish that job. But the founders of Open-Silicon said that if I didn't join at that point I would not get the title of 'founder' and that carries a lot of weight and has shares attached to it and so forth. But I stuck by the project at Intel, finished the chip, and then joined Open-Silicon. I didn't get the founder title and I didn't get the shares either. But that's okay because I still feel good about my decision and I sleep better at night.

HW: Sometimes it takes a long time for a good decision to come to fruition…
TM: That is correct. I still have relationships inside Intel where we are seen as people of integrity: people who will follow through what they said they would. I look at the long term and look at how I'll be leading my life in five or ten years' time and what kind of legacy I will be leaving behind. These are the values I live by. I come from humble beginnings and my parents taught me values that allow me to work through challenges in a systematic way when you don't have everything going for you.

HW: Can you describe those challenges that you face over the next few years?
TM: I can see the business model moving towards co-ownership rather than a vendor-customer relationship. Five years ago we were seen as service providers where the customer would bring us a spec and tell us what we needed to do and pay us. Then they would own all the IP and the sales and marketing for the product. Today I feel that this will morph into a more co-partnership style of doing things, where we are not seen as people who just do what a customer wants, but we'll add value by putting our skin in the game through investment in time and money.

HW: Does that mean in the future you will retain IP rights and sell IP?
TM: I don't want to go into owning IP. We tried that a few years ago and what we found was that we were infringing on areas where the traditional IP providers have played a significant role. We were creating a mixed message to the world. Are we truly an IP company or an IP integration company? I want to remain an IP integration company. But we will do IP that allows us to help our customers bring their products to the market as quickly as possible.

HW: In other words, you don't intend to compete with your

HANNS WINDELE is Vice President, Europe and India at Mentor Graphics. www.mentor.com

customers?
TM: Let me give you an example. There's a lot of buzz about IoT these days. The infrastructure companies like Cisco and the gadget companies like Apple are all betting on it.
Everybody believes that the industry is gravitating towards a world of gadgets communicating with gadgets. We recognise that, and so at Open-Silicon we started an initiative last year to learn about the different aspects of the IoT eco-system. We started to learn about the sensors, operating systems, communication protocols, security algorithms, data compression and so on. We put together a platform to demonstrate the seamless working of all such elements and we took it out to the world to show that we can do IoT-related systems. The message that we wanted to give is that we don't want to create a product of our own, but we know how to create one for you.

HW: As a global company, what do you see as the next big challenges?
TM: The cost of developing silicon is going to be a barrier for people who want to bring in new ideas. It's a foregone conclusion that development costs will be expensive and that return on investment is becoming a hotly debated subject inside the IP providers' boardrooms. Where should they invest? What should they invest in? The options available for customers are becoming restrictive and the cost of doing IP is going to explode.
But there is an opportunity I see where we can partner with an IP provider who wants to remain as an IP company and does not want to become a semiconductor manufacturer. There are several of them with that desire and I am currently in discussions with some CEOs on how to work together to create solutions that will help reduce the cost of ASIC development.

HW: Once the IP and the silicon are put together, who is selling that? Your organisation?
TM: No. Interestingly enough, the few people who are asking that question are the people bringing us the customers. This is because they already know where the IP can be sold, but they don't want to invest in creating the product. They don't have

the skills in-house or it isn't part of their business model. If there is someone like us prepared to do it, they are happy to bring customers to us and say: 'Remember that other application that you wanted to use your IP for, but you didn't have a solution for that? Open-Silicon is going to do that for you and you can buy directly from them.'

HW: Has your career transition had any profound effects on your life?
TM: Sure enough, it has become a lot harder to find those quality moments with my family. The job comes with certain responsibilities and they dictate a commitment towards serving the needs of the company. Before I took this job I had a conversation with my wife and I give her a lot of credit for allowing me to pursue a passion to do something for our industry. My home is 130 miles from the company headquarters, and so I could only take the job after we agreed that we were okay with the idea of commuting back and forth and my not being at home all the time. She wanted me to take the job, get to the next level and to drive the energy downstream into the company. To compensate for this we also make a point of having two family vacations per year where we go out into the mountains on long hikes where there is nobody else and no Wi-Fi connection.

HW: Do you have any advice for someone about to take up a leadership position?
TM: You must run the business ethically. Never try to create business opportunities where only you are winning. Since I have taken over, there have been opportunities to improve my profit margin, but I have gone back to the customer and handed a lot of it back to help them out on their selling price. I believe that if I enable my customer to improve their margins and get them more money, they will put money in R&D and create more products. Then, guess what? They will remember me and have faith in the guy who won't get greedy. This way I get to build a relationship with my customer for a long time to come. Don't look for short-term gains. If you are in it to build a company and a legacy, then it is a long-term game. These are good business practices.

QUICKFIRE QUESTIONS

What is your perfect idea of a holiday?
I love to go scuba diving on a family holiday. I'm going to Sharm el-Sheikh in Egypt soon.

What's your favourite food?
I like Indian food and I don't like to experiment.

If you end up in prison, who would you share your cell with?
I have to be careful here! But I think my youngest brother.

How many digital comms gadgets do you have?
Two smart phones. One for India and one for the rest of the world.

If you had one extra day per week, what would you do with it?
Assuming it's not a workday, sleep. Don't get that much during the seven days we have in a week today.

What device would you dedicate to a museum?
The microprocessor, obviously. It's an iconic instrument that changed the world. But I'm biased.

Russia, U.S. get closer to universal memory

By R. Colin Johnson

Researchers from the Moscow Institute of Physics and Technology (MIPT), the University of Nebraska (USA) and the University of Lausanne (Switzerland) have collaborated to grow an ultra-thin ferroelectric film on silicon, which they believe could become the favoured "universal" non-volatile memory material of the future, as well as for memristors in brain-line cognitive neuromorphic computers.

Researchers worldwide are seeking a "universal" memory to replace DRAM, SRAM, flash and spinning-disks. Of the many proposals being researched, this one has the advantage of being fabricated on a silicon substrate with conventional tools; it's also potentially fast, dense and non-volatile, plus could be adapted to operate like an artificial neuromorphic synapse, too—a memristor—making it suitable for both conventional computers and the cognitive computers—cognizers—of the future.

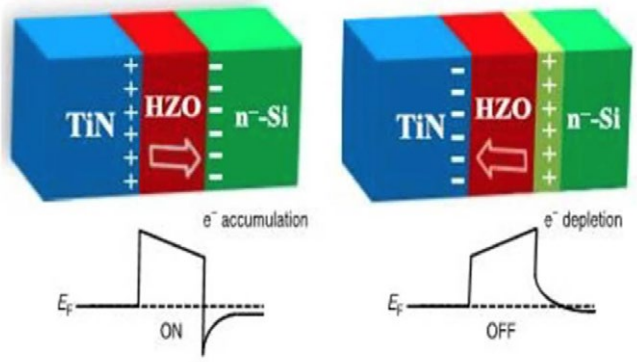
The material is an ultra-thin (2.5-nanometer) polycrystalline ferroelectric film on silicon invented through a collaboration among the MIPT, the University of Nebraska and the University of Lausanne (Switzerland).

"The difference between our approach and other attempts to grow ultra-thin ferroelectric films, particularly, on silicon, is that we grow polycrystalline (rather than epitaxial) alloyed hafnium-zirco-nium [Hf-Zr] oxide films, which retain their ferroelectric properties down to thicknesses of under three nanometers," said Andrei Zenkevich, head of MIPT's Laboratory of Functional Materials and Devices for Nanoelectronics, told EE Times.

Making this ultra-thin ferroelectric material compatible with silicon substrates allows the vast CMOS fabrication facilities already in place to easily switch over to the hafnium-zirco¬nium oxide-material. The plan is to build ferroelectric tunnel junctions using the material, according to the researchers.

"We employ Atomic Layer Deposition technique and use alternate cycles of Hf and Zr precursors combined with that for O (H_2O) to grow initially amorphous mixed Hf-Zr oxide with a predefined composition. The oxide film is further crystallized during ALD growth of the capping TiN layer," Zenkevich told *EE Times*.

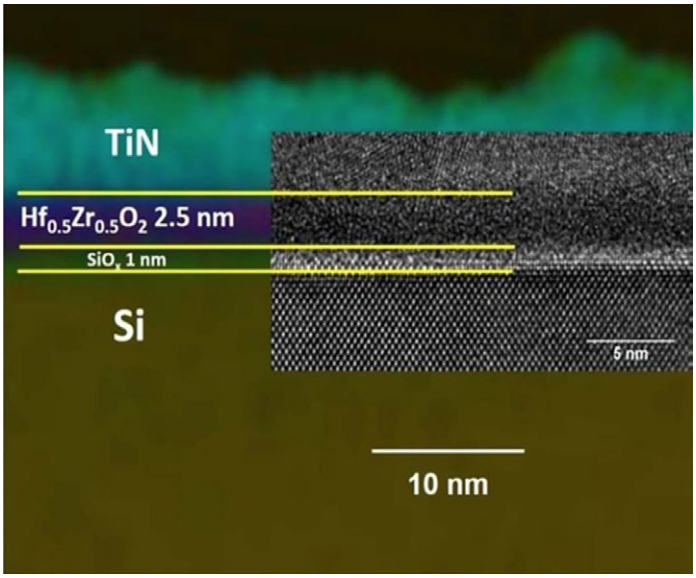
So far the researchers have merely demonstrated the fabrication and characterization of the material itself, next they plan on building prototypes to prove the tunnelling effect can be used for real memory chips, although the theory is already well worked out. The 1s and 0s are stored by virtue of a reverse in polarization across the hafnium-zirco¬nium-oxide layer (see figure one), which could be performed in the manner of a neuromorphic memristor—merely passing current through in the right direction.



A silicon-based ferroelectric tunnel junction is written by applying an external electric field, which changes the direction of the ferroelectric's polarization vector and thus the shape of the potential barrier. (Source: Moscow Institute of Physics and Technology (MIPT))

"The work to demonstrate the so called tunnelling electro-resistance effect in a prototypic memory device is under way now," Zenkevich told us. "Judging from pulsed measurements of the polarization reversal, the prospective write time is within the nanosecond range. The reading of the information occurs non-destructively by measuring the (tunnelling) current through the junction and access time should mainly depend on the electronic circuitry."

The reason ferroelectric tunnel junctions might lead to a universal memory type is that they are very small and yet can retain their values indefinitely without the need to consume power. The best part, of course, is that they can be fabricated in conventional CMOS fabs and appear to be scalable like other CMOS components.



The cross section of the non-volatile memory structure shows a polycrystalline fused film of hafnium and zirconium oxides grown on a highly doped silicon substrate (upper electrode, titanium nitride). (Source: Moscow Institute of Physics and Technology (MIPT))

It should take several years to confirm all these favourable processes, by which time we could be well into the cognitive computer era, where the hafnium-zirco¬nium-oxide could act as the memory element in electronics brains—namely the neuromorphic synapses or memristors.

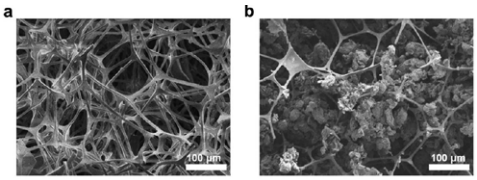
Funding was provided by the Russian Science Foundation and MIPT's Centre for the Collective Use of Unique Scientific Equipment in the Field of Nanotechnology.

Get all the details in Ultrathin HfZrO Ferroelectric Films on Si in ASC's Applied Materials, where the process is fully described.

Spongy tactile sensor emulates human skin

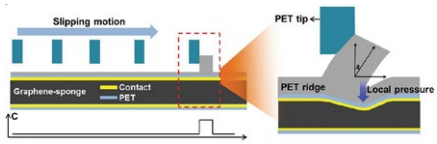
By Julien Happich

In their paper "A tactile sensor using a conductive graphene-sponge composite" published in the journal of the Royal Society of Chemistry, Korean researchers from the Department of Electronics Engineering at Hanyang University, Seoul, have devised a soft tactile sensor able to pick up both minute pressure and vibrations.



SEM images for (a) skeletons of pristine polyurethane sponge, (b) the graphene-sponge composite.

The very low cost and compliant touch sensor is made out of a polyurethane sponge dip-coated in a suspension of graphene nano-flakes, then sandwiched between thin-film electrodes deposited on a protective PEN film. As the conductive graphene sponge is squeezed, the piezo-resistive sensor yields a progressive change in conductance as the graphene flakes get closer. The 15x15x15mm sensor was able to reliably distinguish vertical pressures as low as a few Pa (from placing a 0.11g mass on top) to 20kPa (similar to human pressure perception from 100 to 100 000 Pa). The flexible sensor was also tested in frequency, exhibiting over 20 dB of signal to noise ratio up to a frequency of 50 Hz. Although the signals gradually decreased with increasing frequency, due to the time lag resulting from elastic deformation and restoration of the sponge, SNR did not drop below 10 dB at up to 500Hz, again corresponding roughly to human sensitivity to vibrations (up to about 400Hz) for texture information.



Detecting surface roughness. The slip motion of a PET tip (120 µm wide) generates an interacting force through a touching event between the tip and ridges.

In their experiments to characterize the sensor's ability to detect surface roughness, the researchers applied a PET ridge structure (a 80×200µm tip acting as a probe) to the sensor, emulating at a finer scale the ridges of human skin.

When slipped across a set of two ridges separated by 200µm, the sensor was able to distinguish each ridge pattern without mixing the two pressure peaks. Considering the width of the probing tip at 120µm, the researchers estimated the spatial resolution of locally applied pressure to be 80µm.

Breaking free of the inherent limitations of discrete accelerometers and pressure sensors, the graphene-sponge sensor could find very useful applications in robotics and prosthetics, uniquely solving multi-sensor integration in a single element architecture, conclude the researchers.

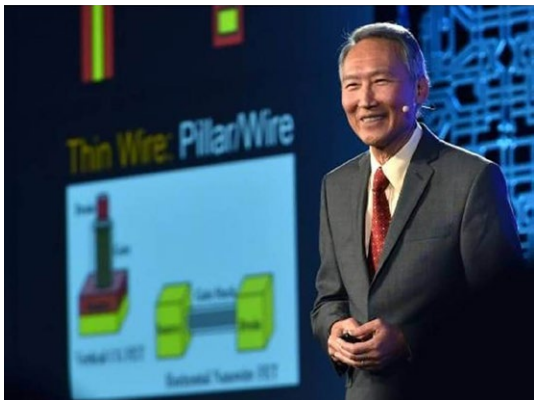
FinFET's father forecasts future

By Rick Merritt

Don't worry about the end of Moore's law, there are plenty of good ideas on the semiconductor road map, according to Chenming Hu, a university researcher credited as being the father of the FinFET.

Hu described new transistor concepts that could fuel the chip industry for decades in a talk at the annual Synopsys Users Group event here. His presentation came a day after the company's chief executive expressed similar optimism, citing progress in software design tools.

"I really mean it when I say this industry goes on another 100 years, in part because there are no alternatives and the world needs us," Hu told an audience of several hundred chip designers here.



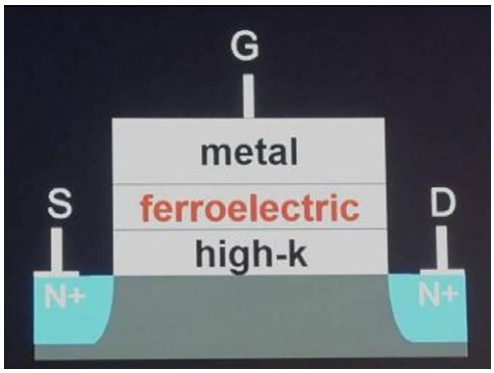
Chenming Hu sees a long future for thin-body transistors like FinFETs and FD-SOI. (Images: Synopsys)

"We all know but don't like to say out loud that transistor size reduction is a game that has an end and we are racing to that end," but that doesn't mean the end of the semiconductor industry and the high tech sector build on top of it, Hu said.

The negative-capacitace transistor (NC-FET) is one of the latest and most significant concepts to emerge from labs at the University of California at Berkeley where Hu is a professor. Hu and colleagues showed work on a 30nm NC-FET made in hafnium zircon dioxide and using a novel 5nm ferroelectric layer.

"Essentially it puts a voltage amplifier into the dielectric…the idea is you get the same performance at lower Vdd," Hu explained.

The design could help engineers reduce Vdd to levels below 0.3 V, overcoming limits that could pave the way to decades of new devices.



NC-FETs add a novel ferroelectric layer to a conventional looking transistor.

The NC-FET has "not been on anyone's radar because we've been developing it on a shoestring but now we see it's promising and we're looking for support," said Hu. "There are orders of magnitude more money going into spintronics than NC-FET, I think we are the only ones in the industry working on it," he said.

Recently, Berkeley set up a new center to focus on the NC-FET. Intel and TSMC joined, paying $140,000 each. "If we could get a handful of members we could do great things, and that's still smaller than a typical government contract," he said.

Separately a handful of companies including Globalfoundries, Samsung, Synopsys and TSMC joined the Berkeley Device Modeling Center that creates BSIM models that translate physical fab data for software design tools.

"We are preparing the compact models for new devices wherever they come from free of royalty, but nothing is really free," Hu said noting the models for FinFETs took 11 years work from more than a dozen researchers.

In parallel with the NC-FET, researchers are developing 2D semiconductors using layers of a dozen candidate materials that could be deposited at the thickness of a molecule or even an atom. "One layer of this material makes a perfect crystal that would be the ideal thin-body material eventually, and we would not need to worry about quantum effects," he said.

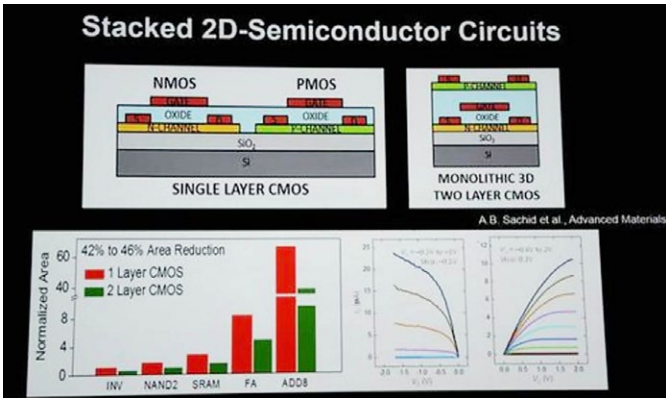
"I'm excited about 2D semiconductors because whether used for memory or logic monolithic multilayer integration…layers of circuits separated by oxides…using self-assembly of atoms such as molybdenum…that's really exciting, and a good interface for us to continue our work," he said.

Hu showed research first presented in December of 2D NMOS and PMOS devices deposited on a single layer of silicon and "folded in on itself." The technique showed a 45% reduction in transistor size.

The new designs are essentially variations of the kind of thin-body devices used in today's FinFET and fully depleted silicon-on-insulator (FD-SOI) processes. Such designs, using a variety of new materials, will have a long life, Hu predicted.

Tall fins will likely continue to be popular given the performance advantages they carry. And future processes are likely to mix fins of different heights to optimize processes for specific uses, he said. "I can foresee thin-body designs through to the end of lithography," he added.

Today's FinFET and FD-SOI structures "could go to gate-all-around or pillar or wires, depending on which is most economical to fabricate…it's all about cost versus performance," he said.



2D semiconductors could be built from layers just one molecule or atom thick.

Hu was less optimistic about tunneling transistors and spintronics. The on-current for tunneling transistors is an order of magnitude or more lower than today's devices, making them only suitable for use in Internet of Things nodes.

Spintronics requires a whole new tool set for logic, making it impractical. "Our design infrastructure is so precious…it would

be really hard to introduce a transistor that used totally different concepts," Hu said.

It's a challenging time in chip design. As semiconductor companies consolidate to handle the rising cost of making chips, design starts and sales of EDA seats are both "flattish" said Synopsys' chief executive Aart de Geus in a brief interview with EE Times. He cited compound annual chip industry revenues of 4.4% and growth "last year and this year closer to zero."

Nevertheless, de Geus was as upbeat as Hu in a talk focused on his company's advances in EDA that opened the event.

"I understand the industry is under economic stress and changes but we are on the edge of a wave that will change the world again…The opportunity to make everything smart is huge and will change the world," he said.

After industry maturation comes rejuvenation, said de Geus.

He quipped that IoT could stand for Immensely Optimistic Thinking, because "it's insufficient to drive semiconductor volumes, but great for connecting us to physical attributes of the real world." Nevertheless, "if we can deliver another 10-100x advances in performance over power it will have enormous ramifications that are unpredictable," he added.

Despite early teething problems with FinFETs, Synopsys has seen more than 50 test chips tape out in 14/16nm processes. For example, a high-end car infotainment SoC from Renesas used a full Synopsys flow in TSMC's 16FF+ process.

Among other advances he cited:

Test algorithms rolling out this summer that will speed runtime and reduce test vectors 25%

A 14nm networking SoC that reduced wire length 17% using IC Compiler II

A 7nm test chip that routed 99% of end points within 1% of PTSI with ICC II

ECO closure in eight hours using one Prime Time system for a design with 50 million instances and 20 scenarios

A new verification algorithm called Cheetah that adapts to the CPU and GPU cores on a processor to speed up work five-fold at the RTL level.

De Geus pointed to the growing security business Synopsys is building around its acquisition of companies including Coverity.

"This is already for us a $100 million business so it's not a hobby, it's a key direction," he said. "Every IoT device is the equivalent of a kitchen window in a bank…the fact is there are kitchen windows in all the software in the world," he said.

IBM neurocomputer detailed

By R. Colin Johnson

IBM unveiled details about the state of development and its future plans for TrueNorth—its neuromorphic mixed-signal chips based on the human brain. Its chip architecture, array of evaluation boards, reference systems and software ecosystem were described by their architect at the International Symposium on Physical Design 2016. ISPD 2016 is an Association of Computing Machinery (ACM) conference on next-generation chips sponsored by Intel, IBM, Cadence, Global Foundries, IMEC, Oracle, Synopsys, TSMC, Altera, Xilinx and other stellar chip makers worldwide.

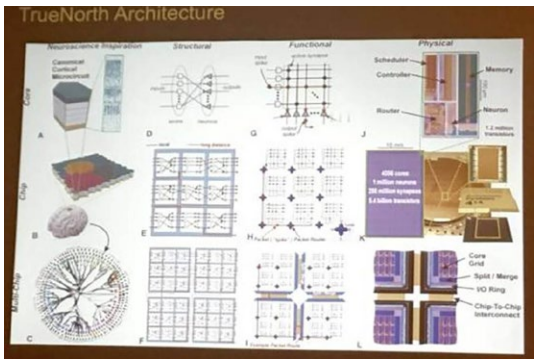
From the first microprocessor to today's supercomputers-on-a-chip, clock speed and power consumption have steadily increased, whereas the IBM TrueNorth designers say we should have been going in the opposite direction - down the curve toward lower-clock speeds and less power consumption, ultimately getting down to the 10-Hz, 20-watt metrics of the human brain.

At ISPD, IBM expressed it aspirations for its brain-like computers, hoping they will become a household name for applications from ultra-smart Internet of Things (IoT) to ultra-smart cars to ultra-smart cameras, ultra-smart drones, ultra-smart medical devices and of course ultra-smart supercomputers.

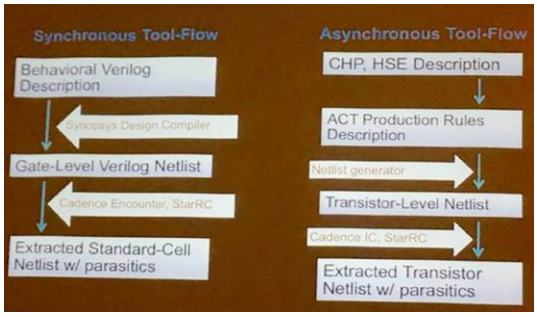
In his invited paper "Design and Tool Flow of IBM's TrueNorth: An Ultra-Low Power Programmable Neurosynaptic Chip with 1-Million Neurons" IBM's Low-Power Neuromorphic Circuit Designer, Filipp Akopyan described the company's hardware, software and growing ecosystem of support.

Akopyan said IBM's target for its TrueNorth chips was Edge-of-the-Net and Big Data solutions, where massive amounts of real-time data need to be processed by ultra-low-power devices—namely its low-cost 5.4 billion transistor neurosynaptic chips that nevertheless consume a mere 700 milliWatts.

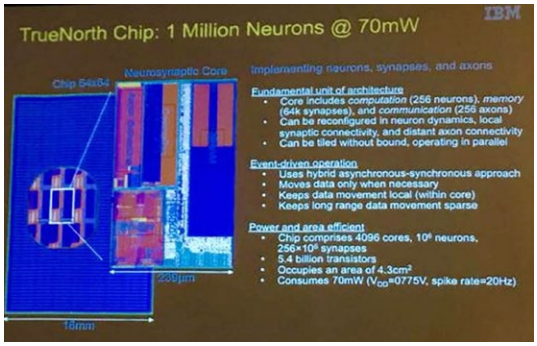
"Today we are producing massive amounts data with our mobile devices which today must be handled by cloud computers, but TrueNorth can be located on the edge of the network where the data is streaming in to intelligently process that data, only sending up to the cloud important items and summaries," said Akopyan. "But computing resources are going the wrong direction to higher power, whereas they should be going to lower power preferably scaling down to biological levels."



IBM's brain-like architecture started in upper left by studying the cortical neuronal structure of the human brain, moving right to structural, functional and finally a physical implementation. Likewise more complex neuromorphic inspirations move from other upper left downward from the core concept, to single chips to multi-chip modules. (Source: EE Times)



The biggest difference with TrueNorth chips is that they have both traditional synchronous parts (for interfaces and timing) and also asynchronous parts (for the brain-like structures) the flow for which has to be developed separately but simultaneously, as illustrated here. (Source: EE Times)



All the specific components per TrueNorth chip are detailed on this diagram regarding its implementation of brain-like functions. (Source: EE Times)

IBM starts with a neuromorphic core—a number of neurons connected with dendrites (inputs) and axons (outputs). Any neuron can send a message—called a spike—to any other neuron as a one or a zero (voltage pulse or "spike"). On-chip neurons can message from-any to-any other neuron within each chip—the preferred method of communications since sparse local communications are not only most like those in the brain, but introduce the least amount of signal latency. Any neuron can send a message to others off-chip or even off-board, but obviously with higher latency.

The key to the 70-milliWatt power consumption of TrueNorth is its use of asynchronous logic that consumes zero power for the entire chip until a particular neuron is used at which point it is turned on only for its period of use communicating with another neuron. Structurally, the 5.4 billion transistor would consume 50-to-100 watts if constructed synchronously, but its asynchronous construction cuts power to the bone.

To enable the any-to-any neuron connection structurally, a gigantic on-chip crossbar switch is used to connect the neurons on the 5.4 billion transistor chip "one of the biggest in world" according to Akopyan.

Unique tools

IBM uses tools from many vendors including Cadence, Synopsys and Spice, but it also had to create some of its own EDA tools to support co-design of its partly synchronous and partly asynchronous architecture. The tool created by IBM was dubbed CoSim which, as its name implies, allow it to co-simulate different parts of the chip on different tools simultaneously.

"We used different simulators to

R. Colin Johnson is Advanced Technology Editor at EE Times

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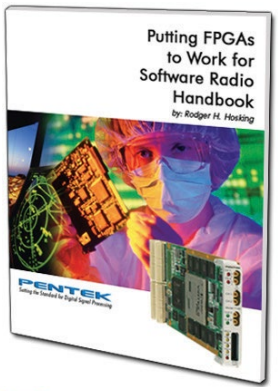

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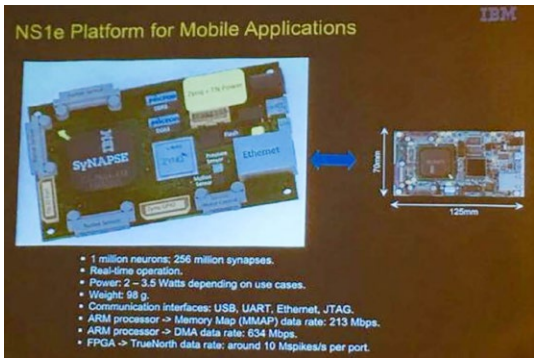
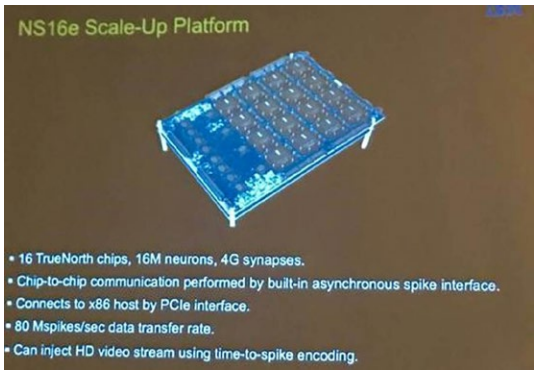


IBM's first board level solution uses a single TrueNorth chip which DARPA and the Lawrence Livermore National Laboratories started with for their Predator drone and nuclear stewardship programs, respectively. (Source: EE Times)



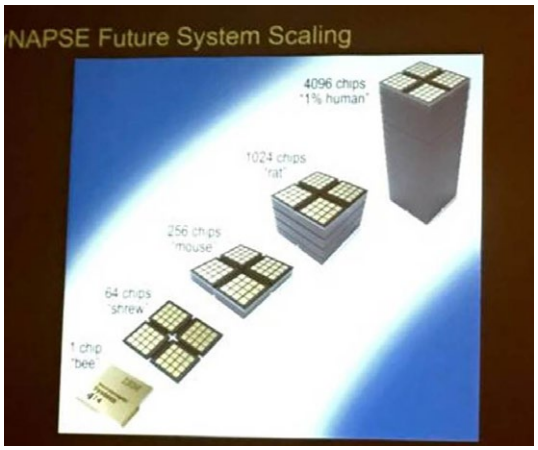
IBM's first sale of its 16-chip board was acquired by Lawrence Livermore National Laboratories, which is currently using the board to simulate explosions of the U.S. aging nuclear arsenal (now that underground tests are banned by international treaty for every nuclear power except North Korea).
(Source: EE Times)

design different parts of the TrueNorth chip," said Akopyan. "Our CoSim tool allows a hybrid tool flow to do custom co-simulations of TrueNorth."

The result is a central array of 64-by-64 neurosynaptic cores for 4096 total each with 256 neurons and 64k of memory synapses for a total of one million neurons and 256 million synapses using 5.4 billion transistors that consume just 70 milliWatts of power. Also, the cores can be tiled without bounds, allowing future neuromorphic processors to be expanded as bigger chips become available. The current chip uses Samsung's 28 nanometer low-power process.

To demonstrate its TrueNorth chip to potential customers—from IoT makers to military drone makers to supercomputer manufacturers, IBM currently has single-chip stand-alone boards, a chassis that holds 16 boards, one holding 48 boards, a single board containing 16 TrueNorth chips with plans for chassis holding 64-, 256-, 1024- and 4096-chips, the latter of which is 1 percent as big as the human brain.

IBM also has an ecosystem of software for development and application development.



IBM's long-term plan is to come out with larger and larger models of brain-like neuromorphic computers, the biggest of which - with the current chip - will be one percent of a human brain. (Source: EE Times)

Besides the neuromorphic brain-like computer itself, IBM has also created an entire ecosystem of design software, drivers, distribution channels and platforms. (Source: EE Times)

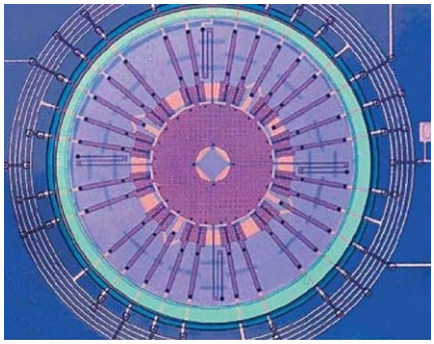
DARPA awards GPS-beating sensor development contract

By Peter Clarke

The United States Defense Advanced Research Projects Agency (DARPA) has awarded HRL Laboratories LLC (Malibu, Calif.) a $4.3 million contract to develop vibration- and shock-tolerant inertial sensor technology. The Atlas project is attempting to meet future system accuracy needs without using GPS.

Military missions typically rely on global positioning by satellite (GPS) for positioning, location and timing information. GPS can provide sub-meter accuracy in optimal conditions but signals can be lost due to natural interference, or malicious jamming.

The Atlas project will combine a MEMS Coriolis vibratory gyroscope (CVG) sensor with an atomically-stable frequency reference to exploit the intrinsic accuracy of the atomic hyperfine transition frequency.



Atlas will break performance, cost, size, weight, and power barriers in inertial sensor technology for military positioning, navigation, according to Logan Sorenson, principal investigator in the HRL sensors and materials laboratory "The engineering challenge lies in developing a system architecture to transfer the stability from the atomic reference to the CVG sensor without introducing unintended noise," he said in a statement.

HRL, formerly the Hughes Research Laboratories, was formed as a limited liability company in 1997 and performs R&D into sensors and materials, information and systems sciences, applied electromagnetics, and microelectronics for Boeing Company and General Motors and government and commercial contracts.

How 48V technology can reduce fuel consumption by 25%

By Christoph Hammerschmidt

Already with its Gasoline Technology Car I (GTC I), automotive suppliers Continental and Schaeffler managed to reduce fuel consumption by 17%. At the Vienna Motor Symposium, these two companies introduced the GTCI II – a feasibility study, devices in close collaboration with Ford motor company that reduce fuel consumption by another 8 percent points to reach the mark of 25%. A decisive role in both cases plays the 48V split-voltage technology.

The reference point for both vehicles in terms of fuel consumption was a series-built Ford Focus, tested according to the New European Driving Cycle (NEDC).

This vehicle already was equipped with a very efficient turbocharged three-cylinder gasoline engine.

The GTC II demonstrates the potential of intelligent 48V hybridisation of the newest generation. The most striking difference between GTC I and GTC II is that the electric motor/generator is integrated between internal combustion engine and transmission, the so-called P2 architecture.

An additional element in this configuration is the electric clutch that optimises manual gear switching. This electrified clutch enables the vehicle to get driving from zero speed solely powered by the electric motor, electric stop-and-go operation as well as recuperation mode almost down to zero speed, said Peter Guzmer, R&D manager at mechatronics company Schaeffler.

Both GTC generations are based on an intelligent interplay between all elements in the powertrain. The hybrid operating strategies are utilising a comprehensive integration approach makes the whole more than just the sum its parts.

However, the GTC II exploits the potential of the 48V technology at a higher degree than its predecessor. For instance, the electric motor is coupled to the system through a belt and attacks between combustion engine and transmission.

Two clutches, one in front of the belt drive and one behind it, make it possible to completely separate the combustion engine from the powertrain and to operate the electric motor independently.

The 48V P2 hybrid architecture enables particularly compact hybrid configurations

This enables "electric soaring", an operation mode that runs under low partial load at constant speed and likewise electric stop-and-go operation, for instance in traffic congestions. This operating mode significantly saves fuel because the combustion engine is "out of the loop" and can be completely switched off.

Since there is also no drag torque, it is possible to utilise significantly more kinetic energy for recuperation.

In addition, operational mode enables better thermal management and reduces the need for exhaust gas after-treatment.

The electrically heated 48V catalyser EMICAT from Continental is ready for operation when the combustion engine resumes again. For these reasons, the GTC II meets the tight emission limits of the Euro 6c standard.

Empowering consumers to control energy use

By Terry Madigan

A joint study by the University of Southampton and University of Essex found that when consumers are provided with real-time feedback on their energy and water consumption, they may be more likely to address waste. Similarly, unless consumers are made aware of how much hot water they are using, they may be unable to assess where they can reduce consumption to facilitate savings.

Millennials have grown up using mobile phones and computers, so they expect to be able to control their household systems through an app. In response to our customers' interest in mobile apps that monitor utilities, we set about developing a cylinder storage system, with additional sensors and relays, that could be controlled through an intuitive user interface running on a smartphone. We wanted to provide our customers with control and feedback, helping them to better manage their electricity, gas and water consumption.

Connecting our hot water storage cylinder

While traditional water and space heating boilers work by filling up a cylinder with cold water and heating the entire volume of water to the required temperature, Systemlink's patent-pending AquaEko system fills the cylinder with hot water from the top, allowing the required volume of hot water to be drawn off as it is needed. This can help to save energy and reduce water consumption and household costs.

It also reduces recovery time, so that householders don't have to wait for a shower. We decided to develop a smartphone app that could communicate with a Home Interface Device (HID) control panel mounted in the home, to control our AquaEko cylinder.

AquaEko seeks to maintain domestic hot water at between 60-65°C, by heating it with a plate heat exchanger, externally to the storage cylinder, and then delivering that heated water to the top of the cylinder using a method of natural stratification.

The heater uses simple physics to reduce the volume of cold water that has to be heated.

Because hot water rises and cold water sinks, our AquaEko method delivers domestic hot water in a stratified hot layer above the cold water layer, without any separating membrane or physical separation of the cold and hot water cylinders. A traditional cylinder will typically heat all the water it contains, even if some sits in the tank going cold again.

Terry Madigan is CEO of Systemlink - www.systemlink.ie

Developing the IoT app

An HTML5 app was developed, enabling consumers to remotely control their home heating and hot water system and monitor their usage over the year from their mobile devices.

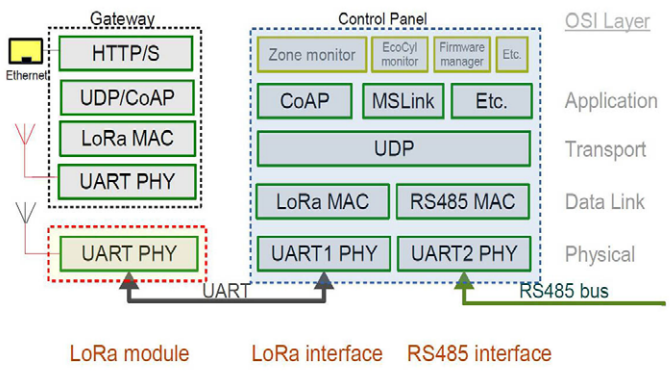
Middleware is important for interfacing between IoT devices and the mobile apps used to control them. We know that mobile apps can require frequent updates and need to be managed throughout their lifecycle, so we needed to select a mobile app infrastructure that could reduce the management burden by enabling updates to be pushed from the cloud.

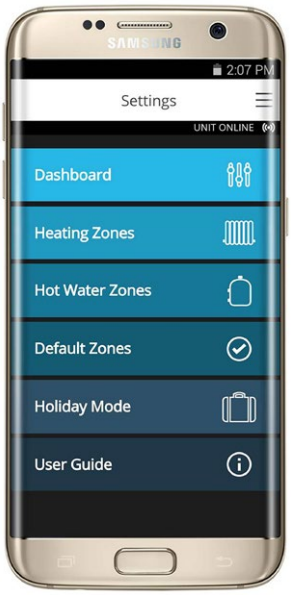
By selecting Red Hat's enterprise-grade Mobile Backend as a Service (MBaaS), with an API infrastructure, we were able to support the IoT app using cloud-based middleware that integrates with Systemlink's databases and pushes updates to customers' devices as required.

Selecting the right IoT partners

While we were open to working with a third party developer to develop the IoT app, and manage it on an ongoing basis, we wanted to ensure that we could update and take control of the app, without being locked into any particular system or development environment. The Red Hat Mobile Application Platform uses open technologies and standard toolkits, enabling developers to use the tools that they are already familiar with. The Node.js-based platform can be hosted in the cloud and uses open standards that allow customers greater flexibility.

We also worked with Dublin-based developer of customised engineering hardware, mSemicon, to create the IoT sensors and controllers for our AquaEko boiler. Red Hat Mobile created a custom cloud API to integrate with mSemicon's hardware.





enabling the app to work with the controller.

The mSemicon controller is connected through a gateway to the Red Hat server and any updates are pushed from the HID control panel via the LoRa wireless network to the Red Hat server, which talks to the app. Time stamped images are updated by the mSemicon controller and the newest requests are acted on.

A lot of people talk about the current lack of IoT standardization. However, LoRa MAC is gaining a lot of traction in the IoT market and we found it to be ideal for this implementation. mSemicon provides the UDP transport layer with a proprietary MS link that then goes back to LoRa MAC.

A key challenge was managing multiple requests to the server if users press the same button on the app interface repeatedly. mSemicon needed to ensure that we didn't have data collisions on the control panel. To manage this, mSemicon opted to use HTTP protocol to cope with the logistics of implementing changes on the app and the control panel if devices turn on and off, or device instructions overlap. While we were aware that there are more sophisticated methods for managing the communication between the controller, server and app, this provided a straightforward approach to neatly manage the logistical issues and keep the data transaction clean.

Two of the biggest enemies of wireless signals are concrete and water. We found that LoRa is a good low power network, which provides our IoT products with greater range, so we chose the LoRa wireless network to transmit data to and from the AquaEko device.

Giving customers control over consumption

AquaEko's "One Touch" hot water or heating zone boost facility gives users easier control over their domestic hot water and heating. We specified a simple user interface and the app developed by Red Hat Mobile has a front page that is self-explanatory. As soon as you open it on your phone it takes you straight into the controls.

The volume of domestic hot water generated is displayed in pictorial form on the Systemlink AquaEko app, showing the numbers of baths or showers that are available to use, rather than litres that have been heated. This makes the app more intuitive and helps our customers to control the amount of energy they use to heat their domestic hot water.

Future plans

The Systemlink AquaEko system already has a frost setting that automatically turns on the heating so that the home temperature should never fall below 5°C.
We are considering including intelligent learning on the system so that it can adjust to local weather conditions. In future, we may integrate with databases such as the local weather report to enable returning travellers to be alerted if there is a cold snap.

The hospitality sector, care homes and hospitals could benefit from our IoT-enabled system. Guests, residents and patients must always have hot water available, but there is also an optimal quantity that can be kept heated without unused hot water going cold.

Now that we've developed our AquaEko app we're considering how this could be applied to other domestic devices. Essentially, our IoT controller and app is a remote control switch. The relays could be expanded to control other household items such as electric blinds and lighting, using the Red Hat cloud-based mobile platform for ongoing management, security and scalability.

Does the Internet of Things make sense for manufacturers?

By David Moss

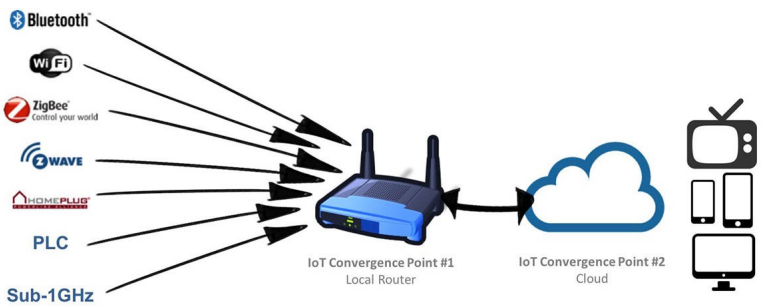
The Internet of Things is the next phase of computing, and the market is poised for explosive growth. Some would argue it's the equivalent of a modern day gold rush, and innovative manufacturers are lining up to sell the shovels and pick axes – the 'things' – that promise to unlock a wave of big data and insights that will transform the lives of billions of people.

There's just one problem: all these 'things' require cloud connectivity. Cloud connectivity requires a data center somewhere on the Internet. It also requires a team of software experts to scale and maintain the cloud.

As a manufacturer, if you sell thousands of cloud-enabled products for a one-time fee this year, are you willing to continue paying for the data centers and software maintenance to keep those products online 5 years from now? The math doesn't add up, and many manufacturers are thinking twice about taking products directly to market.

There are some tough choices a product manager faces when designing a strategy to take on the Internet of Things. One option is to avoid the costs of maintaining a cloud by creating products that only work locally, but customers demand more. Another option is to build a custom cloud, but at the expense of months or years of development, the cost of hiring software experts, the fees of maintaining data centers every month, and the risk of quickly falling behind the technology curve.

Yet another option is to charge customers for hosting services, which transforms the relationship between customers and manufacturers. Hosting fees aren't friendly to consumers, and it's simply not competitive. Interview any of your friends and family, and you'll quickly discover people don't want to pay for a monthly fee for basic connectivity, but they would be willing to pay for powerful services delivered by having access to connected devices.



Fortunately, manufacturers don't have to do everything themselves. Many IoT clouds already exist today, ready for manufacturers to snap their products into and go to market. Cloud services are separated from the physical protocols used in products, so the product's physical protocol usually doesn't matter. ZigBee, Bluetooth, WiFi, Z-Wave, and other protocols ultimately converge to one protocol: the Internet Protocol. Of course, some protocols require an extra gateway, and others do not. Some protocols are more conducive to battery-operated devices, and others are designed for high power. The best option for a manufacturer is to simply choose a common, reliable protocol that will plug into a wider ecosystem and provide the best out-of-box experience for consumers.

The next step is to select a cloud to plug into. This is where manufacturers need to be careful. One thing is clear: most IoT clouds attempt to charge a per-device recurring service fee. And this brings us back to the problem of maintaining services for devices over the lifetime of the product. Do you really want to sell a product for a one-time charge, and be responsible for paying to keep it alive forever? Probably not.

Presto created by People Power Company, is one IoT cloud announced earlier in 2016 that offers free, secure, and scalable hosting for products. As a software company, People Power justifies a free product hosting model by selling white-label and people-centric services through massive service providers, which allows their cloud to be open and available for manufacturers (and provides new channels to market for manufacturers). With over 157 completely open APIs and open source reference code, manufacturers can connect devices with any physical protocol to the cloud and deliver cloud-enabled products and branded apps to market in a way that is compatible with traditional manufacturing business models.

Connected products form connections with cloud services from the device to the cloud, and not from the cloud to the device. By originating communications from the device, devices automatically break through NATs and firewalls that would normally block out external connections.

Products need to upload measurements and state information to the server periodically, and declare themselves 'online'. Because data is the new oil in the Internet of Things, it's generally considered a best practice to upload measurements more frequently when measurements are significantly changing, and slow down uploading measurements when there is nothing happening. This strikes a balance between maintaining a long battery life and delivering a responsive user experience.

Connected products sometimes need to receive commands. Near-instantaneous commands deliver the best user experience around the product, even if the user on the other side of

David Moss is President & CTO of the People Power Company - http://peoplepowerco.com

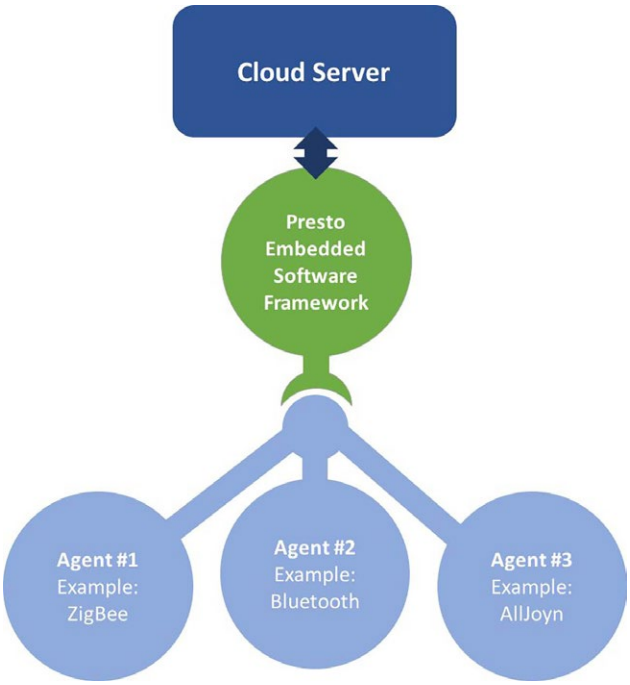


Fig. 1: An infrastructure architecture designed to split the load balancing functionality between the devices and the cloud, handling millions of API calls per day while minimizing cloud hosting costs.

the world. To deliver commands from a cloud to a device near-instantaneously, the device needs to form a persistent connection with the cloud. These connections can be formed with standard HTTP GET mechanisms, WebSockets, or even MQTT, as the cloud permits. But each connection consumes a port on the server and servers only have a finite number of ports, which leads to a scalability problem from the cloud's perspective. In this situation, expensive load balancers fail to add value because every port is already consumed and there is nothing to balance. Clever IoT clouds will split the load balancing functionality between the device and the cloud, allowing the device itself to choose the "best" server with which to connect, and enable the cloud services to scale gracefully.

Figure 1 shows the architecture of the infrastructure designed to process a large number of device API calls. The load balancing functionality is split between the device and the cloud, where approximately every 24 hours, the device will retrieve the address of the 'best' physical server to connect with. In Presto, this architecture has been used to handle millions of API calls per day in live IoT applications while minimizing cloud hosting costs. During the week of February 8, 2016, manufacturers using Presto delivered about 30 million data posts from connected devices at an average response time of 500 ms. In parallel, the server processed 27.5 million analytic requests, or 46 analytic requests per second, adding value to the user experience around those products in the background of user's lives.

The Internet of Things doesn't stop at just cloud connectivity. Rules engines coordinate devices across different protocols and manufacturers. Trusted social networks enable caregiving and neighborhood watch programs. Community social networks drive behavior change in consumers. Real-time big data analytics enable connected products to do things manufacturers never imagined. Command centers enable service providers to deliver services to customers. And intelligently architected mobile apps enable consumers to have one app to control all the products around them, because nobody wants 20 different apps for 20 different devices.

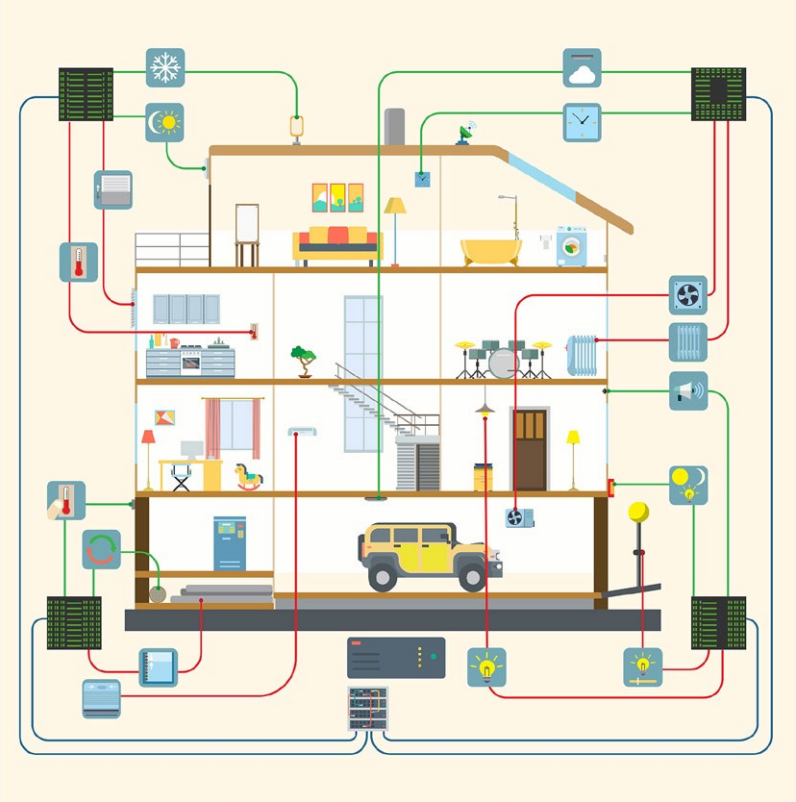
As manufacturers move up the stack of the Internet of Things, they're met by software companies who are working their way down the stack. It's a huge stack of hardware and software combined, and nobody can build it all themselves. Innovative manufacturers and software companies must partner together to make the products not only work for real people, but work in a way that is compatible with manufacturers' business models. That's the only way to make the Internet of Things make sense.

ESD standard vis a vis IoT applications

By Jim Colby

The home of the future – smart appliances that help you track your fresh food purchases as well as advising what and how to cook your meals; smart lighting systems that sense the ambient light conditions and adjust brightness accordingly or shift their color palette to change the mood; smart climate controls that "learn" the habits of the residents to most efficiently use energy to heat or cool; smart gateways that manage data, entertainment and communication; smart wearables and clothing that provide feedback on fitness activity and health parameters and that track those metrics to allow an individual to adjust their behavior to get positive health benefits; smart vehicles and traffic systems that improve traffic flow patterns and that make road travel safer.

Sounds pretty good! This vision of a future with a fully functional Internet of Things is quite bright with many new capabilities that allow individuals to take more control of their surroundings with respect to efficiency, enjoyment and even for better health. Similarly, smart factories will improve their owners' ability to control the process, quality and cost more effectively through coordinated manufacturing, measuring and analyzing systems.



What do all these systems have in common, and more importantly, what does it take for them to be considered "smart"? Communications! The ability to receive and transmit information is crucial to systems being considered for inclusion in modern, smart systems. But, these information paths also provide an entry way for electrical threats to enter the system and damage it. Specifically, the most common threat is ElectroStatic Discharge (ESD). Any time that a cable makes contact with a connector, or a person makes contact with an electronic system, there is a possibility of electrical charge transfer.

For system designers, this provides a threat to the integrity and reliabilty of their piece of the Internet of Things. As the charge spreads out on the surface of the application, some or most of the charge can make its way through the connector (or other interface) and into the sensitive circuitry inside. In order to help system designers understand how to harden their product against ESD, a number of Standards have been developed, with the goal of ensuring the reliability of the integrated circuits, and thus, the application itself.

These Standards are designed to help at different levels of the electronic ecosystem:

Human Body Model: It is based on a model of discharging a 100pF capacitor through a 1,500Ω resistor. Test voltages of 500V to 1,000V are typically used. This test is performed on integrated circuits to ensure they can survive the wafer fab and assembly processes.

IEC 61000-4-2: It is based on a model of discharging a 150pF capacitor through a 330Ω resistor. Test voltages up to 8kV (contact) and 15kV (air) are typically used. This test is performed on finished product to ensure that it will survive interactions with end users.

ISO 10605: This test is specific to the Road Vehicle market and is based on a model of discharging a 330pF or 150pF capacitor through a 330Ω or 2,000Ω resistor. The test depends on whether the circuit under test is accessed inside the vehicle, or from the outside of the vehicle. Similar to the IEC 61000-4-2, it is performed on finished vehicles to ensure that contact from drivers, passengers, assembly personnel and technicians will not damage the circuits. In addition, electronic modules that will be integrated within vehicles are tested prior to installation.

DO 160, section 25: This test is specific to airborne equipment and is based on the same test model as the IEC 61000-4-2; and uses the 15kV air discharge method. The test is performed on finished product and is meant to replicate that action of people accessing the various circuits and applications inside and around the avionics equipment.

After reviewing these test Standards, there is a very clear conclusion. The severity of the ESD models for the completed products are very different to that of the Human Body Model (HBM). In short, the ESD testing that is done on integrated circuits is considerably weaker than the testing done at the application or module level. There is a mismatch, or gap, in the test levels and this means that even though an IC can survive the HBM testing, it may be very easily damaged once it is exposed to ESD levels expected in an application. Put another way, IC-level ESD capability does not infer robustness at the application level.

In order to compensate for the fact that ICs can be damaged by the ESD levels that will be experienced inside the applica-

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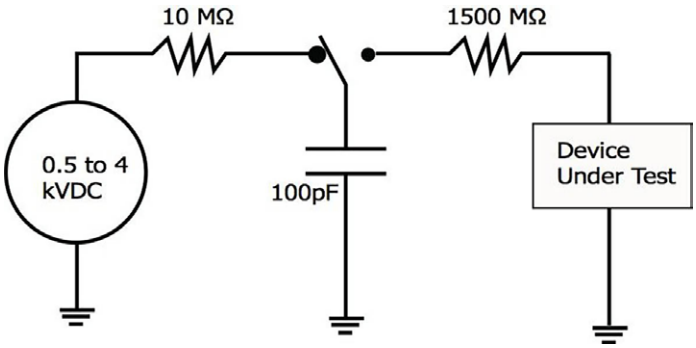


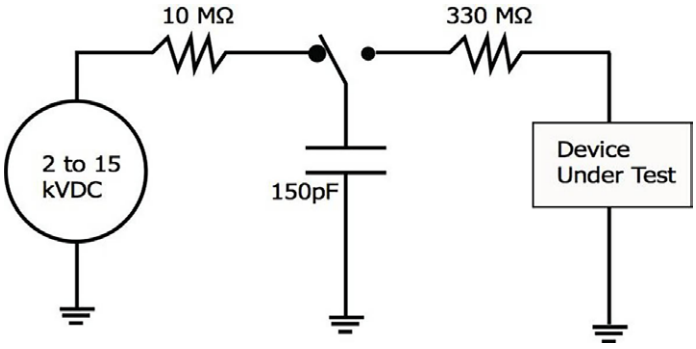
ESD Standard Human Body Model; also known as HBM; in wafer fabs and back-end assembly environments.

tion, board-level ESD components should be added to the circuit. These components act as shunt elements that divert the ESD energy from the I/O or power line to the ground plane or neutral line. The on-chip ESD structures of the IC can then handle the remaining energy and protect the funtional core IC (processing, memory, etc.).

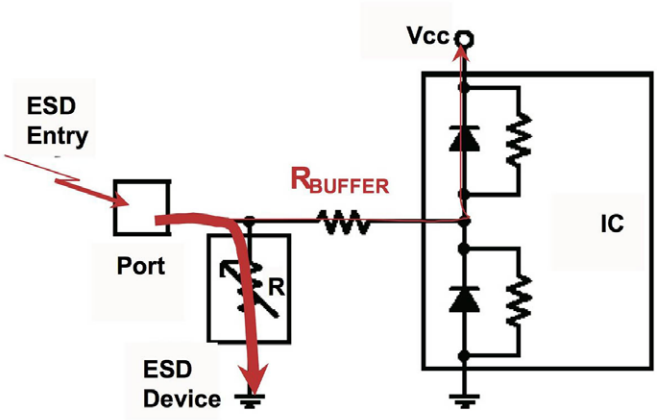
Sounds easy? Well, in the past, it would have been a routine exercise. The ICs from a decade ago were inherently robust due to the large size of the IC structures. However, today, technology in production is now at 28nm, and in the future will move to 18nm and even 12nm processes. For these ICs, the PCB-level ESD components must shunt as much of the ESD energy as possible to ensure IC survival. Many manufacturers name this parameter the dynamic resistance. It must be as low as possible to ensure the clamping voltage is equally low to protect the IC.

A quick note on ESD protection technologies. There are three generally-accepted technologies, each with their own advantages. Polymer ESD suppressors typically have the lowest capacitance so are very compatible with high-speed data lines. But they tend to have the highest dynamic resistance. Ceramic ESD suppressors (multilayer varistors) are typically discrete components in standard sizes from 0201 to 1206, and can handle both ESD and surge transients. Semiconductor-based ESD components are available in a wide range of form factors and tend to have the lowest dynamic resistance value.

So, what is a design engineer to do? Fortunately, organizations like the Industry Council on ESD Target Levels and companies like Littelfuse provide help to the design community. The former is an industry group of professionals with representatives from IC makers, test equipment suppliers, Consumer, Telecom and Automotive manufacturers and component suppliers. Working together, they have created guidelines for understanding the relationship between the IC-level ESD Standard and the application level Standards. More importantly, they also provide a process for designing systems such that they will survive severe ESD transients in the field, taking into account the limitations of the on-chip ESD capabilities of modern ICs. They have named this approach as System-Efficient ESD Design.



ESD Standard IEC 61000-4-2; Focus is on field-level ESD in applications



The key to ensuring system level ESD is to minimize the dynamic resistance of the ESD device so that the vast majority of the ESD current is driven through it, rather than into the ICs protection circuit.

The System-Efficient ESD Design (SEED) methodology takes into account a number of different criteria in order to model the IC and the PCB-level ESD protection device in order to simulte the effect of an ESD pulse hitting this ”system“. The purpose is to determine whether the tested IC will survive an ESD pulse based on its on-chip protection as well as the parameters of the PCB-level ESD components. It is meant to de-mystify the ESD design process and provide a consistent framework for working through the ESD design process. For a better understanding of this process, it is suggested that the reader reviews the White Papers from the Industry Council on ESD Target Levels; they are publicly available on the Internet.

For those designers who do not have the time to perform this research, Littelfuse has partnered with Pragma Design, Barth Electronics and WebSIM to create an online tool that can be used to explore and understand this process. The Littelfuse iDesign™ Online Simulation tool provides a background on the process and then helps the designer to input/select the needed parameters to run the simulation. It takes into account key parameters of the IC as well as those of the intended ESD protection component. The result of the simulation shows the likely and best case system-level ESD robustness. It can be used to understand how the selection of different ESD components affects the system-level capability; also to identify potential solutions that can be tested in the designer’s application.

The Internet of Things promises to provide a wide range of new capabilities with respect to monitoring and quantifying systems our environment and even ourselves. However, these benefits are threatened by our interaction with the IoT systems due to ESD transfer. By recognizing this early in the design process, engineers can improve their design and also their time to market by avoiding failures that would be found later in the design process. In addition, organizations like the Industry Council on ESD Target Levels and companies like Littelfuse provide aid in the form of information and design tools to make the process to achieving ESD immunity easier and quicker than in the past.

IoT for the smarter home

By Pushek Madaan and Gagan Luthra

The advent of Bluetooth Low Energy (BLE) has revolutionized the concept of the Internet of Things (IoT) and has helped take it from concept to commercial reality. The biggest reason for the proliferation of BLE has been its presence in smartphones, tablets and off-late, laptops too. This is where BLE has the advantage over previous proprietary protocols which required custom hardware, usually a USB dongle or an integrated radio, to complete the other end of the wireless communication. This, amongst other reasons like power consumption and standards-based software has caused BLE to become the de-facto choice for IoT applications.

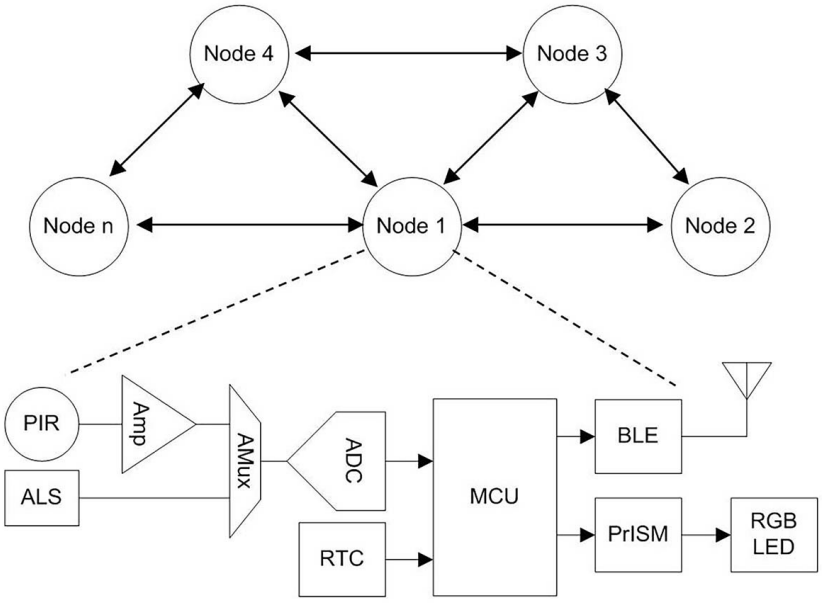


Fig. 1: Smart Home System – Block Diagram

The most popular IoT applications have so far been seen in wearable electronics (e.g. the Jawbone Up), where a device gathers sensor data, runs complex algorithms to extract mea-ningful information, then transmits this information to a mobile device. Similar concepts are now being adopted by home appliances and sensor modules to convert ordinary homes into smart homes. Examples of such appliances include smart coffee makers that brew coffee of your choice and have it ready as you're ready to leave in the morning, or smart lighting control systems that detect your presence in the room and turn lights on or off automatically.

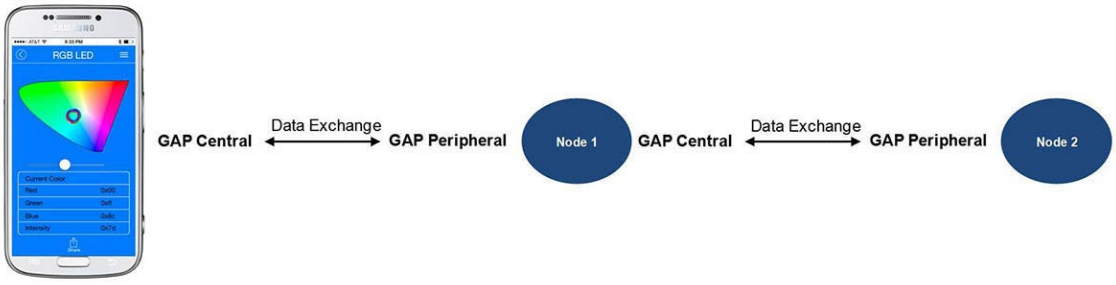


Fig. 2: BLE Interface

One challenge with the current implementation of the BLE standard is its limited network topology. In systems such as smart homes where you may have multiple nodes (sensors and light switches in many locations), each node has to be individually controlled by a common central device, usually a mobile phone. In this article, we take a look one novel approach as a solution to this limitation.

Consider a smart home system with multiple nodes. Each node has a sensor interface, a light control unit, and a BLE communication unit. The sensor interface can detect human presence and ambient light levels. The light control unit can turn lights on or off and also control the color temperature and intensity of the lights. The communication unit implements the BLE protocol to talk with the other nodes in the smart home system.

Figure 1 shows a high-level block diagram of the smart home system.

In this smart home system, all nodes communicate over a mesh network – each working as a master or a slave in a time-multiplexed manner. Each node implements the following functionality:

Sensor Interface: Each node implements interfaces for a proximity sensor and an ambient light sensor. The signals from these sensors are conditioned using an amplifier then digitized using an ADC. The digitized signals are then used for the LED control functionality and for communication with other nodes in the system.

Light Control Unit: The measured signals are processed by an MCU and converted into the control information for the light's color temperature and intensity. The control unit can adjust the light's color temperature and intensity based on the ambient light levels and the time of day (from an RTC), or based on the user's input received via an app running on a BLE-enabled mobile phone.

BLE Communication: In this system BLE serves two purposes. First, it provides a way for a mobile phone to control the lights on the node. In this case the node operate as GAP Peripheral and receives control information from the phone, which is the GAP Central. In the second case, BLE provides a mechanism for the node to control other nodes in the smart home system. During this, the node changes it role to operate as the GAP Central so it can send control information to the other nodes.

Figure 2 shows a high-level BLE mesh implementation for the smart home system:

Dynamically Changing BLE GAP Roles: In this application, all

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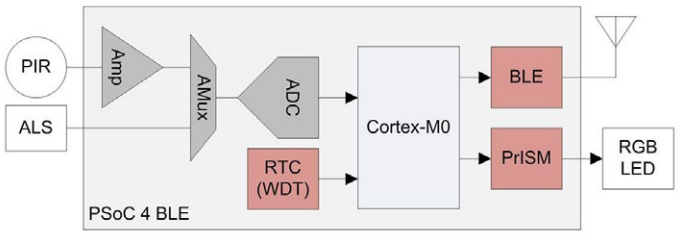


Fig. 3: Smart Light Control Application - PSoC 4 BLE Solution

nodes operate as GAP Peripherals (slaves) and try to establish a BLE connection with the GAP Central (master). Once a node receives control information from the GAP Central or it detects motion from the PIR sensors, it changes its role to a GAP Central and establishes connections with the other nodes in the system to forward the information onwards. By doing so, the other nodes do not need direct control information from the mobile phone, but instead can receive this same information from a nearby node.

Due to the wide range of functionalities required in this application, one would typically need a multi-chip solution. Using multiple chips not only increases the BOM cost but also increases the PCB size, which is critical for space-constrained applications such as these. Cypress' PSoC 4 BLE solution is a perfect fit for such applications. This solution provides BLE communication, which can not only work as both the GAP Peripheral and GAP Central, but also dynamically switch between the two GAP roles. Additionally, PSoC 4 BLE includes programmable analog blocks to create custom sensor interfaces and programmable digital blocks to implement control units – all of which can be used to design a true single-chip solution. This approach provides an economical solution by integrating the BOM and reducing PCB size, while also providing modularity by using the same chip to implement different functionalities for different nodes.

Figure 3 shows the implementation of the Smart Light Controller using PSoC 4 BLE

This device not only implements all three of the above mentioned system features (sensor interface, light control unit, BLE communication), but also makes the implementation easy by providing the BLE Component, that creates BLE GAP Central and GAP Peripheral products in minutes. Cypress application note AN91162 provides information on implementing BLE-compatible Profiles for such custom applications that are not supported by the BLE Standard Adopted Profiles from the Bluetooth SIG. BLE has played a key role in making the IoT successful and has become the de-facto standard for IoT applications. It is not only used for wearable applications but is also proving to be a useful standard for home automation applications.

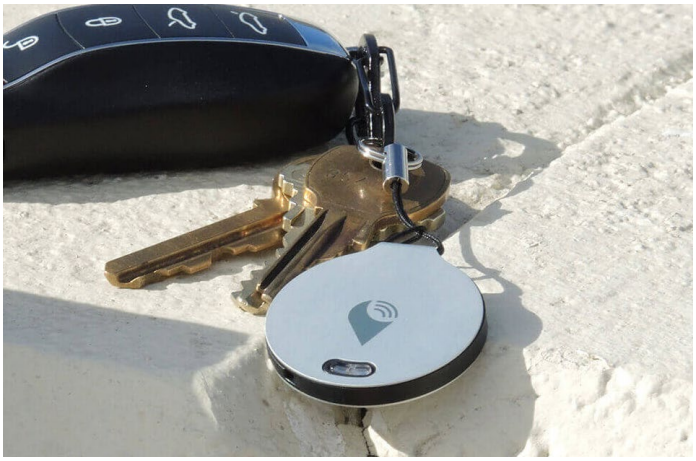
BLE's current limitations in network topologies can be overcome by using novel approaches such as dynamic reconfiguration of GAP roles between Central and Peripheral. Cypress' PSoC 4 BLE provides a solution that integrates all requirements for IoT applications while also making it very easy-to-implement by providing free software tools, low-cost development kits and hundreds of design examples to get you started with.

Tracking your assets through peer-to-peer IoT networks

By Julien Happich

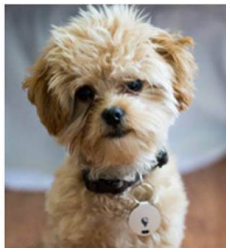
Californian startup TrackR claims to be one of the most successful companies in the growing market of Bluetooth-enabled item trackers.

A plethora of Bluetooth trackers promise users they'll never lose a thing again, or at least that they'll be quick to find their lost items thanks to slim Bluetooth tags paired to their smartphone. Some Bluetooth tags even tap into cloud-based applications to crowdsource a tag's GPS location, by leveraging the proximity of other smartphone users (having adopted the same application) to locate the lost item and share back the data via the cloud.



Such peer-to-peer IoT networks only become effective at returning useful data when a service is massively adopted by end-users, by-passing the need for dedicated subscription-based IoT networks or GPS-enabled tags (whose data is typically shared for a monthly fee).

With over 1.5 million TrackR devices shipped since its 6331% funded Indiegogo campaign in 2014 (raising $1,724,829), TrackR's President and Co-Founder Christian Smith is confident about coverage.



"With tens of thousands of active users, we've got the largest Crowd GPS network running" he told EETimes Europe. With our current user base, you can find your tagged items 24/7 in most metropolitan cities", he said.

The company offers various TrackR tags catering for different applications, including the 3.5mm thin TrackR bravo (31mm in diameter and operating up to a year on a replaceable CR1616 battery), the TrackR wallet (slightly larger but with a two-year battery life), and the TrackR sticker 25mm in diameter and 5mm thick, that will stick to your assets.

And the network is about to expand. TrackR is talking to consumer good manufacturing companies so they embed the Bluetooth tracker module and software into their goods, boasting the number of users relying on its TrackR application.

"HP is about to embed trackers into one million laptop backpacks, and Cross is looking at embedding a tracker capability into its luxury pens", Smith said.

Created in 2009, the startup wants to license its reference design and tracking application to as many partners as possible to grow this Crowd GPS network further. The co-founder sees these peer-to-peer IoT networks evolve pretty much in the same way traditional carrier networks do.

"It remains to be seen what the competition landscape will look like in the future, but similarly to traditional telecom networks, smaller players may band together to compete with larger players". This could mean striking cross network agreements with other brands of tracker devices to share database access at least for the Crowd GPS functionality.

In January last year, the company has differentiated itself from the competition with yet another successful Indiegogo campaign, raising $210,123 for a Wi-Fi-enabled tracker hub that gives users a more granular tracking capability at home. Plugged in power outlets throughout the home or the office, the 48mm long, 38mm diameter TrackR Atlas hubs combine a 70m Wi-Fi range with a 30m Bluetooth 4.0 range to automatically keep track of all Bluetooth trackers, room by room and update the location database via the premises' Wi-Fi router. TrackR Atlas not only maintains a digital map of the TrackR tags, but also englobes any other Bluetooth trackers from third parties, effectively keeping a tab on all devices.

Then users can query their smartphone by voice (the voice function on the TrackR app is powered by Amazon's Alexa Voice Service) to receive a room-specific answer. Once in the room, they can ring the tag (TrackR bravo and many other Bluetooth tags integrate a buzzer).

Even remotely, the hub's Wi-Fi connectivity allows users to ring their tags from anywhere in the world to help roommates or family search for items in the home. Through the smartphone app, users can also set up custom zones and get notifications when items leave a mapped area under the scrutiny of TrackR Atlas. Then again, if a tagged asset leaves the premises, the Crowd GPS network takes over.

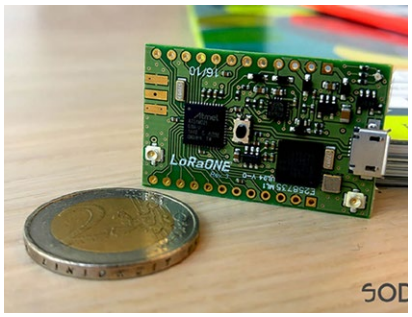
With the number of Wi-Fi IoT hubs flourishing to address the smart home market, often combining Wi-Fi with Bluetooth, and traditional Wi-Fi router manufacturers also considering Bluetooth integration to remain at the center of the connected home, isn't the TrackR Atlas doomed to become redundant at some stage?

Smith admits that endpoint manufacturers could well integrate TrackR's asset monitoring functionalities in the future. This is also a branch of business where the company sees possible partnerships and licensing revenues, hoping that someday, the tracking cloud services and embedded IP licensing deals could override its hardware sales.

Arduino-compatible LoRa board senses it all under the sun

Dutch startup SODAQ (short for solar data acquisition) has launched what the company believes will truly boost LoRa's adoption by makers and hobbyists of all horizons. Measuring only 40x25mm, the sensor-laden and GPS-equipped LoRaONE board was designed to give easy programming access to all of its on-board features, including a 3-axis accelerometer and magnetometer and plenty of I/Os for extensions.

Founded in 2012, the company which defines itself as an IoT solution provider has already had some success launching several Arduino-compatible boards for data acquisition projects. These include the solar powered Autonomo (based on the ATSAMD21G18 Atmel Cortex M0+ 32bit MCU) and the SODAQ Mbili (Atmega1284P 8-bit RISC-based MCU), both all-purpose data acquisition modules with built-in sockets ready to receive any of the company's Bee wireless connectivity modules.



Now, the startup steps up its game with an all-inclusive LoRa-connected sensor board featuring a built-in u-blox Eva GPS module for fast and precise positioning.

When asked which market void such a product would fill, the designer of the LoRaONE board, hardware developer Nick Leijenhorst shared his views with EETimes Europe.

"There is a lot of LoRa going around these days. Just in the Netherlands, national telecom operator KPN is planning to deploy between 1000 and 2000 LoRa gateways nationwide. But what we saw is that there weren't many LoRa development boards. Often, you have to use C-programming tools to program the ARM microcontroller. Also, if you want to build an application using LoRa, you need to connect external sensor boards, maybe a GPS, and all this becomes bulky and draws more power than it should" Leijenhorst commented.

"Our main selling point is that we make LoRa Arduino-compatible, and for every feature on-board, users can download code libraries and demos for easy setup. Your typical hobbyist doesn't want to go into the datasheets of separate parts to get them running"

Leijenhorst is particularly proud of the GPS block, connected in such a way that it can provide hot fixes in less than 5 seconds.

"It draws only a few microA in sleep mode, maintaining its real time clock active, and because it keeps a record of the last position, we only need to wake it up for a few seconds every five minutes to get a hot fix" explained Leijenhorst.

This design draws less than 1% of the power needed for constant positioning by regular GPS, the company says. It is a critical feature for one of SODAQ's backed projects, working with the park rangers in northern Tanzania to protect endangered rhinos from poachers. The rhinos wear the small solar-powered trackers, encrypted localisation information keeps the park rangers ahead of the game. Alternatively, the GPS could be triggered upon event detection (from the sensors).LoRaONE also includes a solar charge controller. In fact, one of the Kickstarter rewards, the LoRaONE Starter Kit, packs the board together with a LiPo rechargeable 800mAh battery, a 500mW solar cell, a base board (ONEbase) for extension and a MicroUSB cable.

Harvest electricity from magnetism

By R. Colin Johnson

With microwaves on the rise worldwide, generated by cell phone towers, mobile devices, WiFi, Bluetooth, 5G and on and on, it's natural that scientists would investigate ways to harness these waves to generate energy. Scientists at the University of Utah have discovered a novel way of converting microwave energy into electricity in organic semiconductors.

In the lab, they have demonstrated a novel effect - called the inverse spin Hall effect - which can convert magnetic spin current into electrical current using microwaves as their source of magnetic spin. It sounds like taking the long way around, since cell-phone antennas already convert microwaves into electricity, however the point of their demonstration is not to preview an application, but to prove that the inverse spin Hall effect can indeed be harnessed and controlled as a tool for the 21st century. They predict applications in batteries, solar cells, mobile devices.

"The energy that we take out of the device is energy that is put into the device through microwave radiation - in that sense, the power conversion does exactly what an antenna does as well, namely convert electromagnetic radiation into an electrical current," University of Utah professor Christoph Boheme told EE Times in an exclusive interview.

"The difference is that the physical mechanism by which our device does this is fundamentally different. It is not induction that accomplishes the conversion, it is the inverse spin Hall effect. As a matter of fact, corroborating the fact that we do not see spurious effects such as electrical induction (such as a simple antenna effect) or other known phenomena was the goal of this study."

The inverse Hall effect was first demonstrated in 1984 by Soviet scientists and was studied more recently (2006) in semiconductors and (2013) in ferromagnetic metals. The concept is relatively simple: just as magnetic spins are induced in the atoms surrounding a wire conducting electricity - the direction of the spin being dependent on the direction of the current--likewise a current will flow in a wire if magnetic spin is induced in the atoms surrounding the wire.

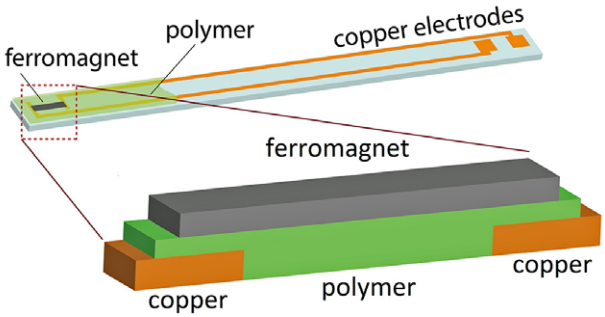
However, the concept is simpler than the apparatus needed to demonstrate it - and that is where the microwaves come in. The earlier experiments with the inverse spin Hall effect used a constant bath of microwaves - like those inside a microwave oven. Unfortunately, that fried the rest of the apparatus making their experiments short-termed and ultimately of very limited success. Their failures may also doom the harnessing of stray microwaves in the environment, even though Boheme and his collaborator, fellow professor Valy Varden, think the idea has merit.

"That is an excellent idea and whether this will or will not become an application of the inverse spin Hall effect has yet to be shown," Boheme responded to my suggestion of harnessing stray microwaves to produce electricity.

He may have just been being polite, however, because his experiments used pulsed microwaves to eliminate the overheating problem. Also his suggested applications sounded much more feasible than mine.

"We know from other spintronics applications, such as hard-disk read heads, that spintronics may fill technological gaps for magnetic-field to electrical-current conversation where simple induction fails - meaning where induction becomes too insensitive and too inefficient (in hard discs this was the case when the read heads became too small)," Boheme told *EE Times*. "It is conceivable to make inverse spin Hall effect devices out of organic semiconductor layers as monolithic, nanometer sized thin-film devices on flexible substrates (essentially foils) at very low cost, so the range of applications can not be foreseen at this point. If efficiencies permit (which we don't know at this point!), then it is also conceivable that this could be used to take microwave radiation out of our environment and use the energy therein for other applications."

The long and short of the inverse spin Hall effect is that it works (see the diagram or read the paper for and explanation of



The device built on a small glass slide (top) exhibits a spin current to be converted to an electrical current using the inverse spin Hall effect. The key is a sandwich-like device (bottom) where an external magnetic field and pulses of microwaves create spin waves in the iron magnet which converted to an electrical current in the copper electrodes they hit the organic semiconductor (polymer). (Source: University of Utah, Kipp van Schooten and Dali Sun)

A view of the University of Utah physics laboratory where researchers showed that a phenomenon named the inverse spin Hall effect works in several organic semiconductors when pulsed microwaves are applied to the materials. The effect converts so-called spin current to electric current and may find use in future generations of batteries, solar cells and electronic devices. (Source: University of Utah, Christoph Boehme)

R. Colin Johnson is Advanced Technology Editor at EE Times

how), that it is a new use of spintronics that in some ways complements the already growing toolbox of spintronic effects and devices that can harness them. Next, their efficiency needs to be accurately measured and some appropriate trial applications need to be tried, in order to gauge just how useful the inverse spin Hall effect will be for organic semiconductors in the future.

"Our study's goal was to show how to measure the inverse spin Hall effect in a 'straight forward' manner [that is] show a strong and directly observable inverse spin Hall effect with no or very little simple microwave induction effects and other signals," Boheme told EE Times. "We have achieved this by building devices and conducting experiments which make the inverse spin Hall effect about a 100 times stronger than what was previously seen and, at the same time, we accomplished the oppression of the spurious effects. So now we have devices on which we can easily observe this effect. For the near future, we (and probably other research groups as well) will use this progress to really study this effect in detail. Part of these studies will, of course, be aimed at the question of how well can this effect be used for potential technical applications."

So the proof is still in the pudding, and these researchers have merely come up with a baseline recipe. It will up to them and others - in future experiments - to gauge the usefulness of the inverse spin Hall effect in future applications. Personally, I hope this ends up solving the "microwave overload" from communications towers that is slowing cooking everybody in their own juices, but if I had to bet, my money would be on small on-chip applications such as new spintronic devices for the ultra-low-power organic semiconductors of the future.

The researchers proved that the inverse spin Hall effect works in three organic semiconductors: PEDOT:PSS and in three platinum-rich organic polymers, two of which were pi-conjugated polymers and the other was spherical carbon-60 molecules (buckey balls) the latter of which proved to be the most efficient. For all the details see Inverse Spin Hall Effect from pulsed Spin Current in Organic Semiconductors with Tunable Spin-Orbit Coupling

Funding was provided by the National Science Foundation (NSF) and the University of Utah's NSF Materials Research Science and Engineering Center. Other contributors were research assistant professors Dali Sun and Hans Malissa, postdoctoral researchers Kipp van Schooten and Chuang Zhang, and doctoral candidates Marzieh Kavand and Matthew Groesbeck.

Energy harvesters to replace batteries in wireless sensors

By Jim Drew

Recent advances in ultralow power microcontrollers have produced devices that offer unprecedented levels of integration for the amount of power they require to operate. These are systems on a chip with aggressive power saving schemes, such as shutting down power to idle functions. In fact, so little power is needed to run these devices that many sensors are going wireless, since they can readily run from batteries. Unfortunately, batteries must be regularly replaced, which is a costly and cumbersome maintenance project. A more effective wireless power solution may be to harvest ambient mechanical, thermal, or electro-magnetic energy in the sensor's local environment.

The LTC3588-1 shown in figure 1 is a complete energy harvesting solution optimized for high impedance sources such as piezoelectric transducers. It contains a low loss full wave bridge rectifier and a high efficiency synchronous buck converter, which transfer energy from an input storage device to an output at a regulated voltage capable of supporting loads up to 100mA. The LTC3588-1 is available in 10-lead MSE and 3x3mm DFN packages.

Jim Drew is Senior Applications Engineer at Linear Technology Corporation – www.linear.com

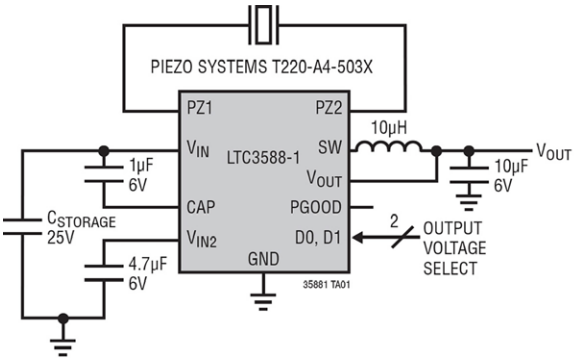


Fig. 1. Complete Energy Harvesting Solution Optimized for High Impedance Sources Such as Piezoelectric Transducers

Ambient energy sources

Ambient energy sources include light, heat differentials, vibrating beams, transmitted RF signals or any other source that can produce an electrical charge through a transducer. Small solar panels have been powering handheld electronic devices for years and can produce 100s of mW/cm^2 in direct sunlight and 100s of µW/cm^2 in indirect light.

Seebeck devices convert heat energy into electrical energy where a temperature gradient is present. Sources of heat energy vary from body heat, which can produce 10s of µW/cm^2 to a furnace exhaust stack where surface temperatures can produce 10s of mW/cm^2.

Piezoelectric devices produce energy by either compression or deflection of the device. Piezoelectric elements can produce 100s of µW/cm^2 depending on their size and construction.

RF energy harvesting is collected by an antenna and can produce 100s of pW/cm^2.

Successfully designing a completely self-contained wireless sensor system requires power-saving micro- controllers and transducers that consume minimal electrical energy from low energy environments. Now that both are readily available, the missing link is the high efficiency power conversion product capable of converting the transducer output to a usable voltage.

Figure 2 shows an energy harvesting power system that includes the energy source/transducer, an energy storage element and a means to convert this stored energy into a useful regulated voltage. There may also be a need for a voltage rectifier network between the energy transducer and the energy storage element to prevent energy from back-feeding into the transducer or to rectify an AC signal in the case of a piezoelectric device.

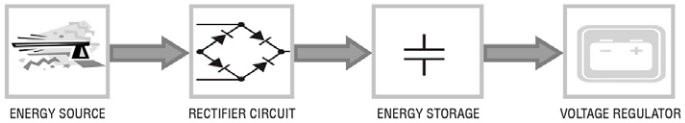


Fig. 2: Energy harvesting system components

Application examples

The LTC3588-1 requires the output voltage of the transducer to be above the under voltage lockout rising threshold limit for the specific output voltage set at the D0 and D1 input pins. For maximum energy transfer, the energy transducer must have an open circuit voltage of twice the input operating voltage and a short-circuit current of twice the input current required. These requirements must be met at the minimum excitation level of the source to achieve continuous output power.

Piezoelectric Transducer Application

Figure 3 shows a piezoelectric system that, when placed in an airstream, produces 100µW of power at 3.3V. The deflection of the piezoelectric element is 0.5cm at a frequency of 50Hz.

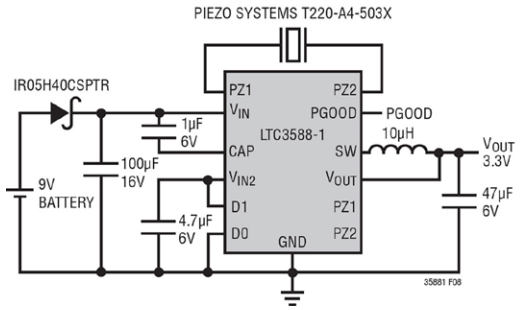


Fig. 3: Piezoelectric energy harvester

Seebeck transducer application

Figure 4 shows an energy harvesting system that uses a Seebeck transducer from Tellurex Corporation. A heat differential produces an output voltage that supports a 300mW output load. Connecting the transducer to the PZ1 input prevents reverse current from flowing back into the Seebeck device when the heat source is removed. The 100Ω resistor provides current limiting to protect the LTC3588-1 input bridge.

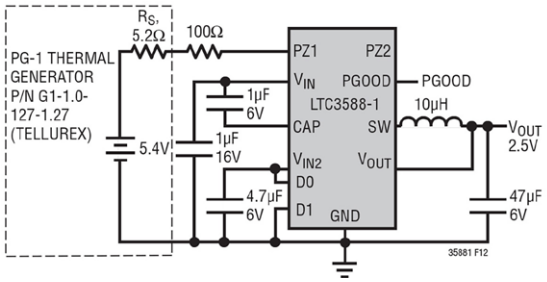


Fig. 4: Seebeck energy harvester.

One can also harvest energy from the EM field produced by standard fluorescent lights. This application requires some outside-the-box thinking. Figure 5 shows a system that harvests energy from the electric fields surrounding high voltage fluorescent tubes. Two 12”x24” copper panels are placed 6” from a 2’x4’ fluorescent light fixture. The copper panels capacitively harvest 200µW from the surrounding electric fields and the LTC3588-1 converts that power to a regulated output.

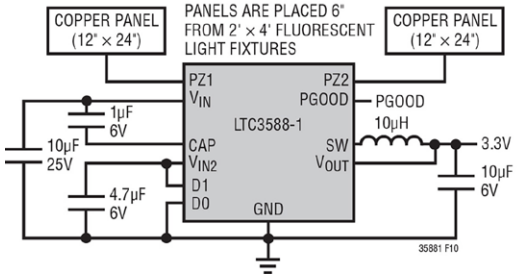


Fig. 5: Electric field energy harvester.

Conclusions

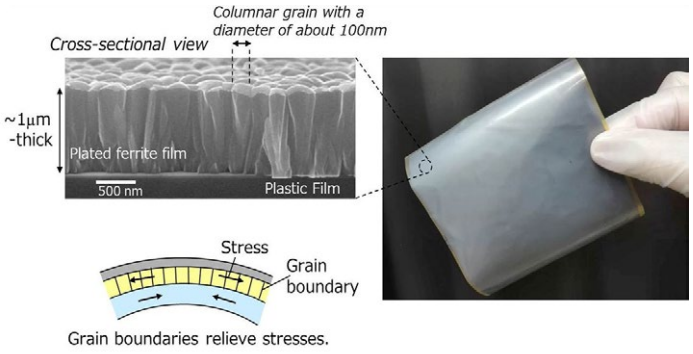
The LTC3588-1 allows remote sensors to operate without batteries by harvesting ambient energy from the surrounding environment. It contains all the critical power management functions: a low loss bridge rectifier, a high efficiency buck regulator, a low bias UVLO detector that turns the buck converter on and off, and a PGOOD status signal to wake up the microcontroller when power is available. The LTC3588-1 supports loads up to 100mA with just five external components.

Japanese researchers develop low-cost thermoelectric thin films

By Julien Happich

NEC, NEC Tokin and Tohoku University have co-developed a thin-film spin Seebeck thermoelectric device which they hope could be cheaply produced at low temperature onto large sheets to wrap around industrial waste heat sources.

Thanks to new materials and a new device structure, the Japanese researchers claim a conversion efficiency more than 10 times higher than prior art relying on the spin Seebeck thermoelectric effect.



Published in Scientific Reports under the title "Flexible heat-flow sensing sheets based on the longitudinal spin Seebeck effect using one-dimensional spin-current conducting films", the paper discloses a ferrite plating method, growing a 1µm-thick $Ni_{0.2Z}n_{0.3}Fe_{2.5}O_4$ ferromagnetic film on a 25µm-thick polyimide substrate at a process temperature of 90°C.

Not only the process is achieved at much lower temperatures than competing solutions (they mention 700°C for conventional methods), but they rely on an aqueous reaction of two solutions, ($FeCl_2 + NiCl_2 + ZnCl_2$) and an oxidizer ($NaNO_2 + CH_3COONH_4$) spread on a plastic film through two nozzles, making the process relatively easy to scale up on large sheets of plastic films or even across various shapes. The paper described how the thin-film TE could be successfully used as a heat-flow sensor for pervasive and large-scale monitoring, but in the future, the three parties participating in this development aim to further improve energy conversion yields to be able to generate electricity from the large amount of waste heat emitted by plants, data centres, vehicles and other heat sources.

The researchers also boast that they were able to replace the expensive platinum typically used as the electrode material to extract electric power in spin Seebeck thermoelectric devices, by new cobalt alloys, significantly reducing production costs.

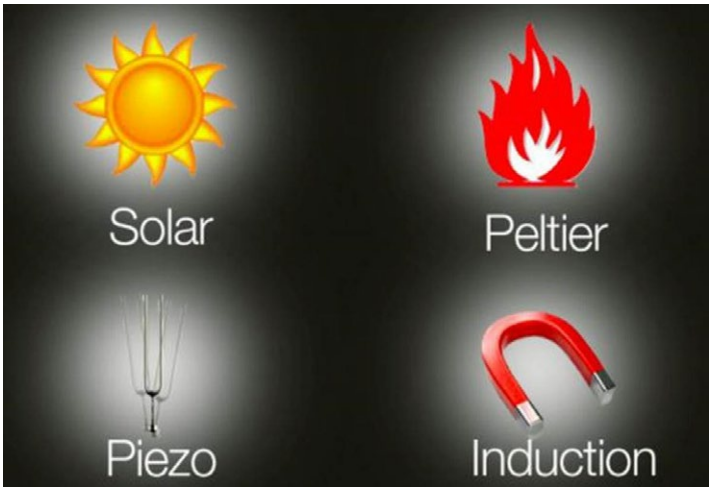
These results were achieved as part of the Exploratory Research for Advanced Technology (ERATO) "SAITOH Spin Quantum Rectification Project" of the Japan Science and Technology Agency (JST), running from 2014 to 2020 under the direction of Eiji Saitoh, Professor of Tohoku University. Note that Saitoh and Associate Prof. Ken-ichi Uchida of Tohoku University were the discoverers of the Spin Seebeck thermoelectric effect in 2008.

Energy harvesting chips are next billion-dollar market, says report

By Peter Clarke

Although energy harvesting has failed to take off to date – usually because it is has been uneconomic compared with installed battery power – it will drive semiconductor sales worth $3 billion in 2020, according to Semico Research (Phoenix, Ariz.).

This drive will be from values of about $200 million and 40 million units shipped in 2015. The key components for an energy harvesting system include the transducer – whether it is thermal, photovoltaic or vibrational – plus a power management IC, microcontroller, and an energy storage device.



Semico Research reckons as the average selling prices (ASPs) for these components decline they are lower costs for energy harvesting solutions, even where they only enhance the battery life of battery-driven products, and thus drive higher market penetration

Annual unit shipments over the period 2015 to 2020 will grow to 777 million with a compound annual growth rate (CAGR) of 80.6 percent. This would put unit shipments in 2015 at about 40 million and shipments in 2016 at about 70 million.

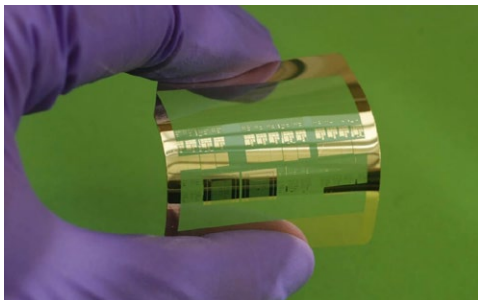
The annual chip market over the same period will experience a CAGR of 71.4 percent and reach $3 billion. This indicates a market size of about $200 million in 2015 rising to about $350 million in 2016.

Applications that will be among the first to make use of energy harvesting include: wireless sensor nodes (WSNs) for bridges, infrastructure, building automation and controls, and home automation of lighting, security and environmental systems. Energy harvesting will also grow in automotive applications, cell phones, wearables.

"The vendors of MCUs, sensors, RF, analog and other components will continue to develop lower power devices", said Tony Massimini, Semico Research's Chief of Technology, in a statement. "While this puts less drain on a battery and will extend its life, it also lessens the load for an energy harvesting solution. Energy harvesting solutions are also expected to improve during the forecast period."

Roll-to-roll flexible electronics to hit the 100GHz range?

By Julien Happich



Researchers from the University of Wisconsin Madison have leveraged the high carrier mobility of flexible silicon nanomembranes (NM) with the scalability of nanoimprinting lithography (NIL) to produce thin-film flexible RF transistors capable of operating at 38GHz.

According to their simulations, their manufacturing strategy could yield 100 GHz-capable thin flexible RF transistors to be manufactured at low cost and low temperature on large rolls of PET.

Their paper "Fast Flexible Transistors with a Nanotrench Structure" published in the journal Scientific Reports details how they overcome the limitations of conventional lithography.

Rather than try to dope selectively a silicon substrate to pattern transistors, the researchers indiscriminately doped a whole silicon nanomembrane, created from a silicon-on-insulator (SOI) wafer, hence keeping the superior charge carrier mobility of bulk silicon versus typically low-mobility organic materials. They then used electron-beam lithography to carve out a nano-imprinting mold which they use to imprint an etching mask pattern through a photoresist layer, subsequently used to etch a deep nano trench in the Si NM (100nm wide by 250nm deep). After depositing source and drain electrodes and undercutting the buried oxide to release the Si NM, the active nanomembrane is flip transferred onto an adhesive coated PET substrate. Further dry etching defines the perimeter of the active region, then an Al_2O_3 gate dielectric and gold gate electrodes are deposited above the 100nm trench to finalise the transistor – see figure 1.

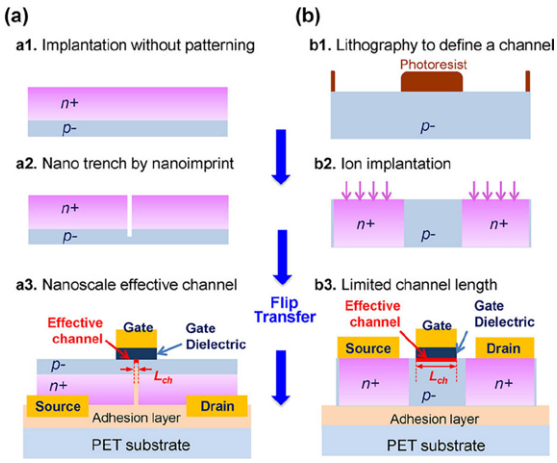


Fig. 1: Comparison of the device structures (cross-sectional view) and fabrication processes between (a) 3-D nano trench Si NM flexible RF TFTs, and (b) conventional 2-D TFTs. The effective channel lengths Lch are marked in red in (a3,b3). The smallest Lch of the nano trench TFT can reach down to 50 nm via NIL and that of the conventional TFT can only reach down to about 1.5 µm. (a1) Blanket phosphorous ion implantation and thermal anneal. (a2) Nano trench formation via nanoimprint. (a3) Final structure of nano trench TFT where the channel length Lch is defined by nanoimprint. (b1) Photolithography to define S/D regions for ion implantation. (b2) Selective ion implantation and thermal anneal. (b3) Final structure of conventional TFT where the channel length Lch is limited by gate electrode and dopant out-diffusion during ion implantation and thermal anneal. Source University of Wisconsin Madison.

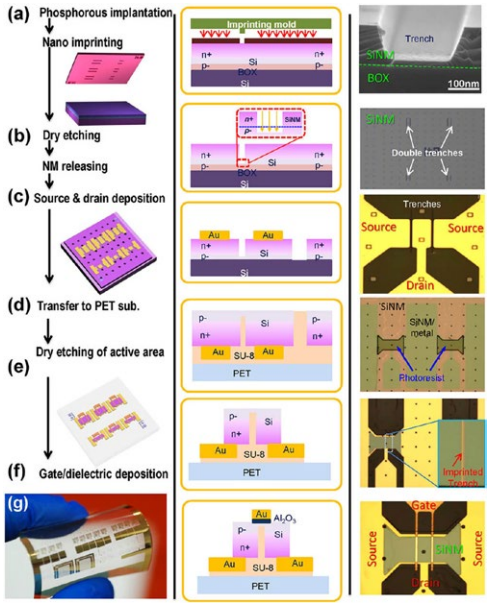


Fig. 2: Schematic illustration (left column), cross section structure (middle column), and corresponding microscopic images (right column) of nano trench Si NM flexible RF TFTs. (a) Defining a nano trench on a phosphorus implanted p– SOI substrate using NIL. (b) Dry etching to separate the n+ area in order to form a path of n+/p–/n+ from source to drain. (c) A partially completed TFT after undercutting the buried oxide to release the Si NM, which forms the active region, and forming the source and drain contacts. (d) Flip transfer of the Si NM with the source and drain electrodes onto an adhesive coated PET substrate. (e) Dry etching to define the perimeter of the active region. (f) Deposition of an Al2O3 gate dielectric layers and gold gate electrodes above the trench. (g) Optical image of arrays of the bent TFTs on a PET substrate.

Remarkably, all of the device fabrication processes were carried out at temperatures lower than 150°C (except for the first doping and recrystallization steps performed in a blanket fashion before releasing the Si NM from SOI).

With a unique, three-dimensional current-flow pattern, the high performance transistor consumes less energy and operates more efficiently.

And because the researchers' method enables them to etch much narrower trenches than conventional fabrication processes would allow them on silicon nanomembranes (notoriously difficult to process due to the diffraction of exposed light on the plastic substrate and the substrate's thermal plasticity), it also could enable semiconductor manufacturers to pack more transistors on flexible sheets, re-using the mold in a roll-to-roll manufacturing process for the mass fabrication of flexible electronics.

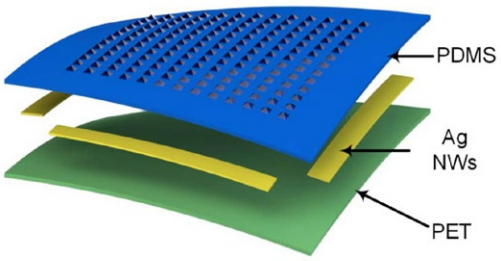
To put things in perspective, the smallest channel length of flexible transistors made on plastic substrates using the semiconductor nanomembranes is about 1µm, report the researchers, an order of magnitude larger than their proposed design.

Triboelectric skin harvests power as it senses touch

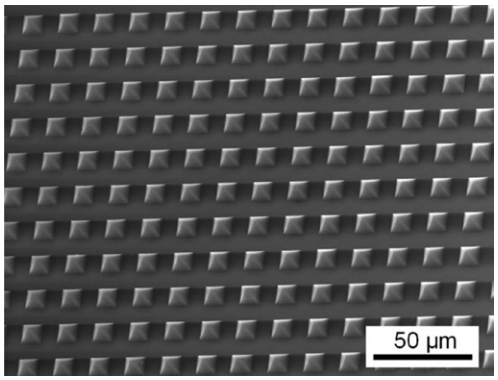
By Julien Happich

Researchers from Peking University in Beijing have developed a transparent and flexible touch-sensing film that is self-powered by the very objects it touches (through frictional contact).

The researchers designed a triboelectric micro-texture on a silicon wafer (patterned with 10µm square windows through a lithographic process) before using it to imprint a spin-coated polydimethylsiloxane (PDMS) film. The resulting film stacked onto a set of four electrodes (using transparent silver nanowires patterned on a PET substrate) uses the spontaneous triboelectric charge that builds up at a contact points to power its sensing ability, eliminating the need for batteries.



Schematic stack of an analogue smart skin.



SEM image of the micro-structured optically transparent PDMS film.

In what they describe as a "self-powered analogue smart skin", the researchers explain how only four electrodes suffice (two pairs of opposite electrodes placed orthogonally) around a two-dimensional analogue smart skin to detect location as well as contact velocity, based on a single-electrode contact electrification effect and planar electrostatic induction (by analysing the ratio of opposite electrode voltages).

When an object, such as a finger, applies a pressure to the smart skin, it generates a current through the skin that induces a voltage on each electrode. Since the distance between the applied force and each electrode is different, the voltage at each electrode will also be different, and the relative voltages can be used to pinpoint the location of the applied force.

The researchers' experiments showed that, when wrapped around a robotic hand, the analogue smart skin can determine the location of an applied force with an average resolution of 1.9 mm. They were able to detect very small forces (equivalent to a few decigrams). This potentially very cost-effective and self-powered touch-sensing film could be used to design touch-capable robots or bionic limbs.

Coal redefined for thin film electronics

By Julien happich

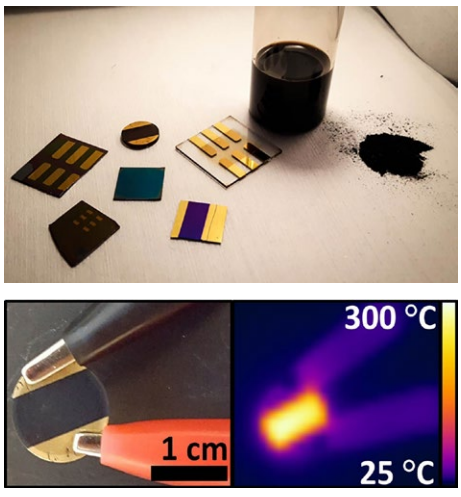
Taking a new look at coal in MIT's Department of Materials Science and Engineering (DMSE), PhD candidate Brent Keller Jeffrey unearthed new value in raw coal, as a prime material for electronics.

Rather than merely considering the material as a fossil fuel or as a raw source of carbon for the petrochemical industry, Keller and his colleagues studied the raw material properties, once processed into thin films.

The student developed a series of steps to crush the material to a powder, put it in solution, then deposit it in thin uniform films on a substrate, in order to fabricate electronic devices and characterize them.

As a first demonstration of what they see as a broad range of potential high-tech uses for this traditionally low-tech material, the MIT researchers have succeeded in making a simple electrical heating device that could be used for defrosting car windows or airplane wings, or as part of a biomedical implant.

In developing this initial application, they have also for the first time characterized in detail the chemical, electrical, and optical properties of thin films of four different kinds of coal: anthracite, lignite, and two bituminous types. Their findings have just been reported in the journal NanoLetters.



A simple heating device made by the researchers from unrefined pulverized coal, shown at left under visible light and at right in infrared light, showing the heat produced by the device. Photo courtesy of the researchers.

This was done with naturally occurring coal varieties, without the purifying or refining that is needed to make electronic devices out of silicon. Different coals can have a range of electrical conductivities that spans seven orders of magnitude, the researchers report, meaning that a given variety of coal could inherently provide the electrical properties needed for a particular component. The researchers also found that by simply adjusting the temperature at which the coal is processed, they could tune many of the material's optical and electrical properties to exactly the desired values.

The simple heating device the team made as a proof of principle provides an end-to-end demonstration of how to use the material, from grinding the coal, to depositing it as a thin film and making it into a functional electronic device. Now, they say, the doors are opened for a wide variety of potential applications through further research.

KEMET to commoditize haptics for wearables

By Julien Happich

Passive components manufacturer KEMET Corporation and haptic and sensory feedback technology provider Novasentis have announced their collaboration to develop Electro-Mechanical Polymer (EMP) film based haptic actuators for wearable devices. Whilst Novasentis will provide the core technology and haptic actuator film, KEMET will develop the manufacturing process for the final assembly and commercialization.

"EMPs are a unique type of electro-active polymer (EAP) that provide piezoelectric effects without the need for high operating voltages. In an unpowered state, the molecular structure of the EMP film is randomly aligned. When powered, the molecules align in one direction and expand, creating a piezoelectric effect" explains Novasentis online. The EMP actuators are created by bonding this material to a rigid substrate, the single-direction expansion of the material causing the substrate to vibrate. The flexible film, customizable in size and shape, can be just under 0.12mm thin. It can be designed to deliver distributed and localized haptics, from simple vibrations to tens of kilohertz in the acoustic range.

"These Electro Mechanical Actuators (EMP) sit in that sweet spot between the traditional actuators like LRA and ERM that have a lot of force but very little elongation and the class of actuators called artificial muscle which has a lot of elongation but very little strength. Our actuators offer decent elongation and adequate force to make them very desirable for many consumer electronics applications", told us Sri Peruvemba, Novasentis' Vice President.

"The frequency range is 1Hz to a few kilo hertz which as you will agree is a very wide range, this is great feature to have for the designer, they are no longer stuck with this one annoying buzz that you get from the traditional actuators, you can get as many as a few dozen uniquely different haptic sensations ranging from a mild tap to urgent wake up calls.

One of the best renditions of the conventional actuator is the one found in the Apple watch – the Taptic engine - and its range is limited, it occupies a huge amount of real estate within the watch (maybe 30%), weighs a lot, probably dictates the thickness of the watch. Our actuator in comparison is about the thickness of a sheet of paper, weighs next to nothing and will literally disappear into the wrist band of a smartwatch".

"We expect to enable OEMs and designers in creating a 'haptic language', such that one does not have to glance at one's watch to understand what the haptic sensation was trying to communicate. It is conceivable that future wearable devices would have 10 to 20 unique haptic 'feelings' that we will learn and each will convey something unique and the smart wearables will not have to turn on the display for secondary confirmation about what the haptic signal meant" continued Peruvemba when interviewed about the devices' capabilities.

"The actual force/displacement is heavily dependent on the substrate it is embedded into, obviously we would do poorly if the strap was made of steel. We are currently working with two of the world's largest companies that make bands for smart devices to evaluate compatibility, our prototypes made of silicone and other flexible materials used in wrist bands, show a lot of promise. When we finalize these materials and design, we might be able to provide a more concrete spec".

So will these film actuators be stacked for increased actuation force, leveraging KEMET's capacitor film stacking manufacturing know-how to yield different actuator characteristics?

"KEMET will manufacture the final actuator product which comprises of a few tens of layers of ultra-thin electro active polymer film. Novasentis will supply the polymer film to KEMET and using KEMET's manufacturing and process expertise in making capacitors, their factory will make the film actuators. KEMET's output will be the final assembly of the actuator".

"Our initial plan is to offer a set of standard parts with a few tens of layers based on the feedback received from customers in the wearables space but yes, the actuation force can be increased by adding additional layers. KEMET is already making parts that have 10x more layers than what we are contemplating so we believe this path is feasible in the future as we tackle applications beyond wearable devices".

Thin actuators could be distributed across wearables

Will you produce discrete surface mount haptic actuators to be placed under discrete keyboard layouts or will these include multiple actuators embedded onto larger sheets to be mounted or moulded under keyboard pads, displays or even conformed to device enclosures? We asked.

"Our initial target is the Wearables space and the intent is to produce discrete actuators that will fit within the wrist band of a smart watch. We had previously built actuators in sheets for keyboards and other applications and plan to focus on those after initial success with the wearables market segment where we currently have the greatest market pull.

We are in serious design activity with several OEMs that are looking to embed the actuators into wrist bands, AR/VR sets etc. There are innumerable applications for this technology which is not available from anyone else but we are focused on delivering to the wearables market before we address the next lucrative application including medical, auto, keyboards, etc"

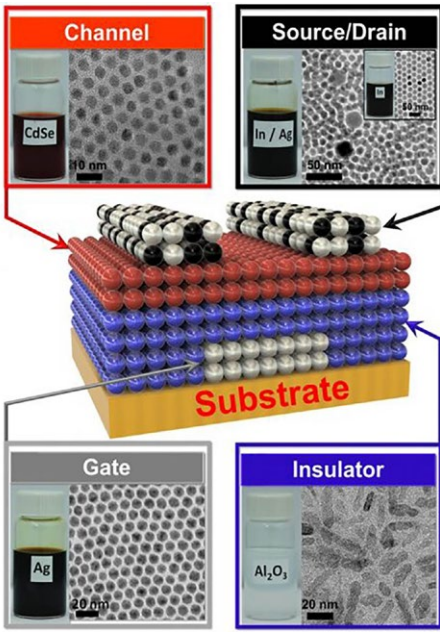
Peruvemba said. In fact, the two companies have already been working together for several months and aim to deliver their first production prototypes this summer, with plans for production starting early 2017. “Our expertise in film-based capacitor manufacturing is a perfect match for the needs of the Novasentis haptic technology. We will be able to use our existing manufacturing lines to develop mass production quantities of actuators,” wrote Dr. Philip Lessner, Senior Vice President and CTO at KEMET in a company statement. Indeed, KEMET would have the means to commoditize SMT haptics and make the technology truly pervasive.

Low temperature inkjet printable transistors can be stacked

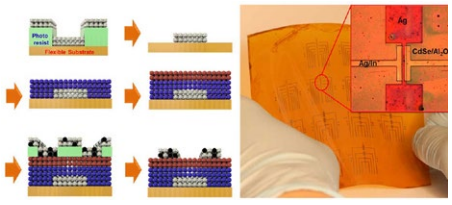
By Julien Happich

Researchers from the University of Pennsylvania have developed a library of four nanocrystal inks whose properties they can tune to print functional transistor patterns.

In a paper titled “Exploiting the colloidal nanocrystal library to construct electronic devices”, co-authors Cherie Kagan, Professor in the School of Engineering and Applied Science, and Ji-Hyuk Choi, then a member of her lab, describe how they exploited the diversity of colloidal nanocrystals to design materials, interfaces, and processes to construct all-nanocrystal electronic devices using solution-based processes.



Tuneable colloidal nanocrystals ink formulations make for printable transistors Credit: University of Pennsylvania



Transistor fabrication process using multi-step spin coatings of photoresists through photolithographic masks, and colloidal nanocrystal inks with subsequent photoresist removal steps. Credit: University of Pennsylvania

The inks formulated with the tuneable colloidal nanocrystals included metallic silver and semiconducting cadmium selenide nanocrystals for the high-conductivity and high-mobility thin-film electrodes and channel layers of a FET, aluminium oxide nanocrystals to form high–dielectric constant gate insulator layers, and a mix of metallic indium nanocrystals and silver nanocrystals to integrate an indium supply in the deposited electrodes, to passivate and dope the cadmium selenide nanocrystal channel layer (through a low temperature dopant diffusion step).

Using a low-temperature multi-step spin coating process involving multiple photolithographic masks, as well as proprietary surface treatments of the nanocrystals, the researchers produced field-effect transistors with electron mobilities of 21.7$cm^2v^{-1}s^{-1}$ on a flexible sheet of plastic.

They are confident that the ink formulations could be used with ink-jet printers to lay transistors and circuits on a wide array of materials, including large and thin substrates for flexible or wearable applications.

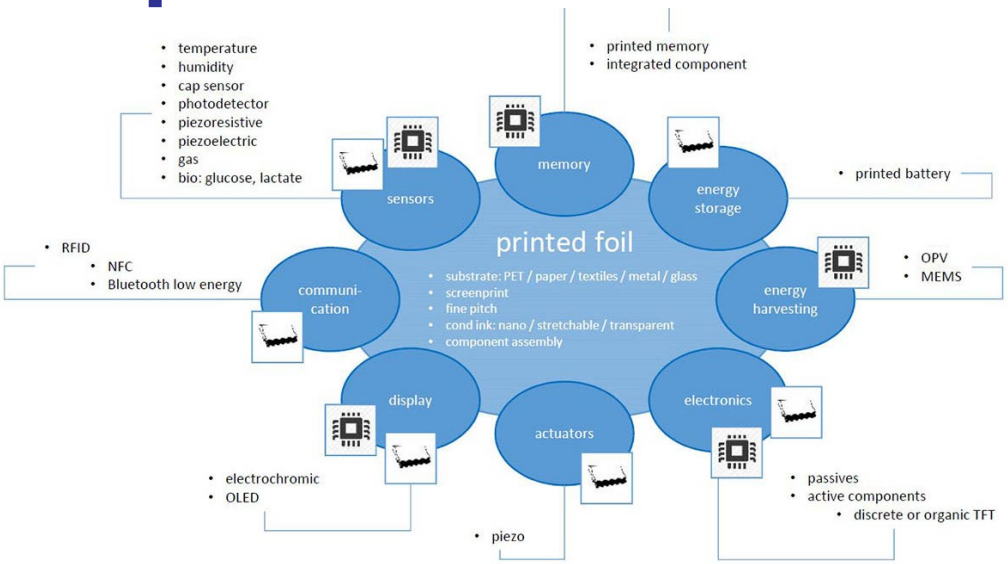
In the future, they envisage that such formulations could become part of 3D-printing processes, adding multiple layers of circuits within the bulk of complex 3D objects.

Printed sensors analyze runners' foot steps

By Julien Happich

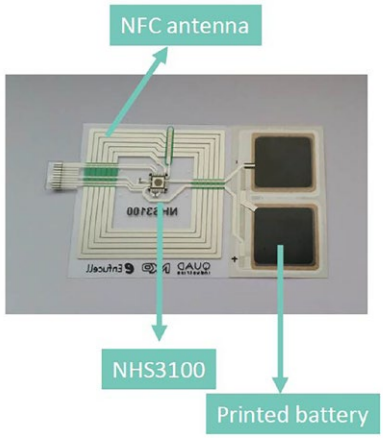
At this year's Advanced Functional and Industrial Printing (AFIP) conference, Quad Industries' R&D Director Wim Christiaens exposed the company's manufacturing know-how in flexible printed electronics.

Promising printed electronics on anything, with volume-ready production capacity for fine-pitch screen printing of functional circuitry, Christiaens unveiled the company's roadmap, combining substrates such as PET, paper, textiles, metal or glass together with special-purpose stretchable inks for the design of sensors, actuators, batteries, displays, or even NFC circuits.



Quad Industries'vision and roadmap for printed electronics.

Typically, the company partners with customers to help them develop a working prototype for their project, to follow up with volume production. Quad Industries is a recent licensee for manufacturing Enfucell' SoftBattery, giving the company more flexibility to integrate custom designed batteries in its customers' projects.



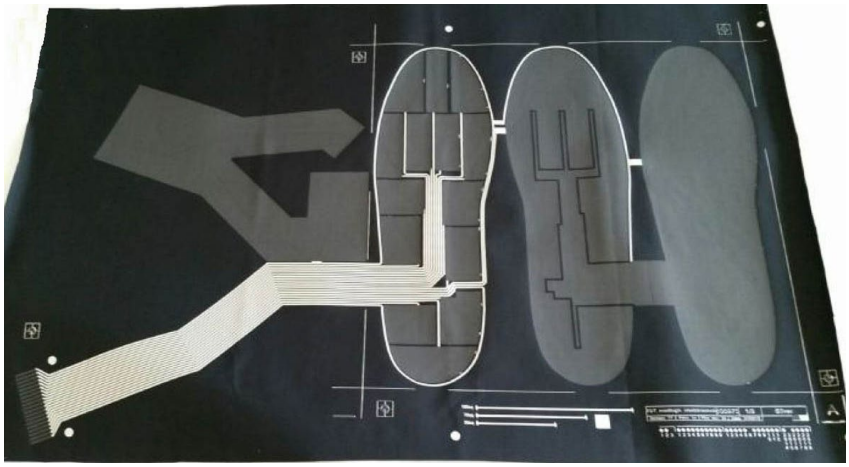
NFC temperature logger developed with NXP

An example put forward in Christiaens' presentation included a temperature logger consisting of a temperature sensor chip from NXP mounted onto a thin PET foil printed with a complementary battery, NFC antenna and all necessary interconnections.

Another interesting example was the insole developed in collaboration with the German company medilogic, offering wireless dynamic recording of the pressure load under the foot inside the shoe, either for rehabilitation or training. For this insole, the company used silver and carbon inks to print capacitive sensors across several plies of textile, totalling 14 sensing areas that connect to a wearable reading device.

The R&D Director would not share the pressure range, only hinting that because each application is custom-designed, the measurement ranges and sensor cells would be tailored for any given application, with the flat-cable layout design maybe the only limiting factor.

However, insole pressure measurement may become a growing business if customer and partner ATO-gear succeeds in its mission to revolutionize the world of fitness wearables for runners.



Pressure sensing insole developed in collaboration with medilogic

Last week, at IDTechEx' Printed Electronics conference taking place in Berlin, Quad Industries showcased another implementation of pressure sensors, this time, resistive-based for ATO-gear's ARION pressure sensitive insole. Embedding 8 pressure sensors at strategic locations, the insole takes thousands of snapshots per second of the runner's foot to measure the way the foot rolls-off the ground.

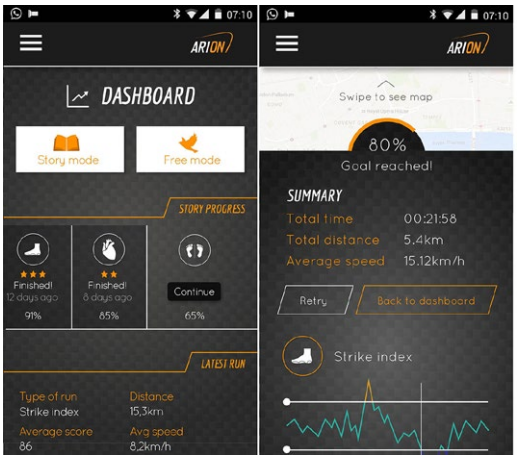
The data is sent via a Bluetooth transmitter add-on to the wearer's smartphone, were the ARION app performs a gait-line analysis using patented algorithms and methodologies.

The app then provides the user with easy to understand metrics and coaching advice to enhance his/her performance, for example to run faster or farther, or to reduce the risk of injury.

Opening up ATO-gear's ARION pressure sensitive insole.

This real-time feedback lets runners adapt their running technique on-the-fly.

The Dutch startup plans to launch a crowdfunding campaign for its ARION platform, expecting full commercial release by late summer 2016.



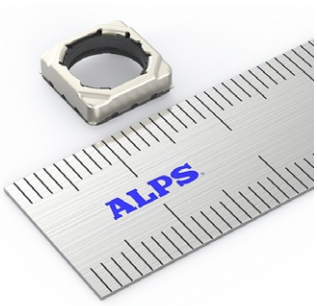
It has already secured some partnerships with a select group of specialist retailers and athletes as part of its product development strategy and is extending its presence throughout specialist running shops across Western-Europe.

At shoe specialist retailers, the ARION system can be used for gait-analyses and to analyse running technique in order to advise shoes matching the runner's running style. The runner is no longer limited to a treadmill or short run up and down the store, but instead, can go for an actual run (storing the data in a cloud environment for later interpretation at the shop).

ATO-gear's ARION app: from the dashboard to the analytics, then back to the shop

Bidirectional autofocus actuator for 16-Mpixel smartphone cameras

The ATMJ1Z95 Series bi-directional type autofocus actuator from Alps Electric is a 2.8 mm low-profile device for smartphone camera modules that have 16 Mpixel sensors, and other applications, such as camera-integrated office equipment. The bi-directional drive provides low power consumption.Generally speaking, for a device to take sharp, high-resolution photos it requires a powerful image sensor, as well as a large-diameter imaging lens for collecting as much light as possible. At the same time, electronic components integrated into smartphones need to be thin to maintain design appeal while also helping to save battery by consuming little power. The ATMJ1Z95 actuator enables both compatibility with large-diameter lenses and low power consumption. The ATMJ1Z95 Series supports large lenses with a diameter of 6.9 mm and has dimensions of 9×9×2.8mm for a slim profile.The new series sets the initial position of the lens at a frequently used focal distance (position) and adjusts focus by moving the lens from that point in one direction or the other (bi-directionally) depending on whether the current is positive or negative. Compared to preload type actuators, this shortens the distance the lens has to travel, thereby reducing the amount of power required to move the lens to around one third and enabling high-speed focusing. High precision achieves a tilt of less than 1/10th of a degree during lens drive.



Alps Electric
www.alps.com

Digitalize your power supply the easy way

This month, Würth Elektronik eiSos is giving away ten of its XMC Digital Power Explorer evaluation kits, worth 119 Euros each, for EETimes Europe's readers to win.

The kit jointly launched with Infineon Technologies last January offers a synchronous step-down converter which can be assembled with two different control cards (XMC1300 - ARM Cortex-M0 MCU and XMC4200 - ARM Cortex-M4F MCU). This makes an easy introduction to the world of digital power supplies for developers of analog power supplies and embedded software programmers. The kit comes as a complete solution with hardware, software and switchable resistance load bank. Developers can compare two performance classes using two different control cards. The high-performance XMC4200 family offers a high-resolution PWM unit (with 150 ps resolution) and intelligent analog comparators with precise slope compensation that can considerably simplify power supply design. The XMC1300 family, on the other hand, is cost-optimized to provide excellent cost effectiveness for simpler power supply applications.

Check the reader offer online at
www.electronics-eetimes.com

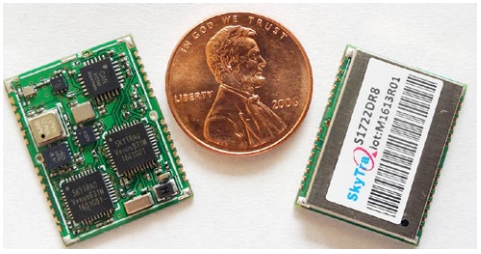
Bluetooth mesh-controlled light engine targets tuneable white linear luminaires

LED Engin's LuxiTune linear dynamic light engine is claimed to be the world's first Bluetooth low energy (BLE) mesh-controlled tuneable white solution for linear luminaires. Adding a comprehensive BLE interface enables end users to wirelessly configure, control and manage linear luminaires to produce dynamic, coherent and fully tuneable lighting schemes seamlessly. Installed in a 4x4x48 inch fixture such as a slot or pendant, the linear light engine delivers 650lm/ft out of the diffuser. At full intensity, CRI is over 90 at 3000K and colour uniformity is three MacAdams or better over the module length. Dimming is smooth, flicker free and goes down to 3%. As well as enabling control via a BLE mesh network, the LuxiTune linear light engine also interfaces seamlessly with third party 0-10V, Dali, DMX and Zigbee controllers. BLE provides multi-level secure access to both the control system and mesh network.

LED Engin
www.LEDEngin.com

3D dead reckoning receiver leverages sensor-fusion for 100% coverage

SkyTraq Technology's S1722DR8 GNSS dead-reckoning receiver integrates a 3-axis gyroscope/accelerometer and a barometric pressure sensor with a GNSS receiver. Using wheel/speed data from vehicle to perform sensor-fused solution, the 17x22mm module can be flexibly mounted in any orientation to achieves 100% coverage for vehicles applications requiring high performance, reliable, uninterrupted positioning.The auto-calibration feature of the S1722DR8 greatly simplifies installation, with a very short calibration time upon first use. The on-board barometric pressure sensor provides highly accuracy altitude information, useful for differentiating floor level of multi-story parking garage or stacked highways. It offers continuous navigation even in GPS signal denied environments such as tunnels or underground parking lot.



SkyTraq Technology
www.skytraq.com.tw

Stacking oscilloscopes and measurement channels

When two or four measurement channels are not sufficient, the TiePie engineering Handyscope series of instruments offers a possibility to combine multiple oscilloscopes to one single oscilloscope with many input channels.

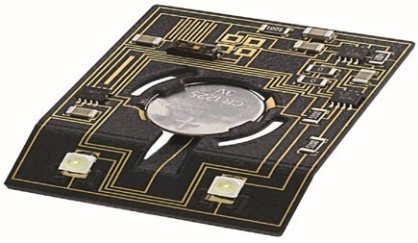
Just a coupling cable is required to combine the multiple instruments to a single combined instrument with many channels.

When the Multi Channel oscilloscope software is started, the coupled instruments are recognized and combined to a large instrument. Combining four Handyscope HS5s results in a unique 8 channel 12 bit 500 MS/s oscilloscope. All channels of the four units sample fully synchronized and can be controlled in one application, any channel or combination of channels can be used as trigger source. The unique CMI (Combine Multiple instruments) interface supports automatic recognition of the stacked instrument. The high speed trigger bus is automatically terminated with the correct impedance and the high speed sampling bus is automatically configured and terminated at the beginning and end of the bus. The high speed sampling bus takes care that each H andyscope is fully synchronized to ensure that even at the highest sampling rate the instruments operate at the same sample clock. The CMI interface has built-in intelligence to detect the connections and terminate all buses properly at both ends of the bus, regardless of the connection order.

TiePie engineering
www.tiepie.com/HS5

3D printed circuit carrier prototyped on demand

Modern electronic equipment typically requires that the circuit must be accommodated within the limited space of a housing or enclosure. When conventional PCBs (2D) are no longer suitable, the switch to three-dimensional (3D) circuit carriers better optimizes available space. Prior to moving to production quantities for which circuit carriers would be manufactured by injection moulding, Beta LAYOUT offers to produce prototype quantities using 3D printing together with laser structuring for metallized interconnects.

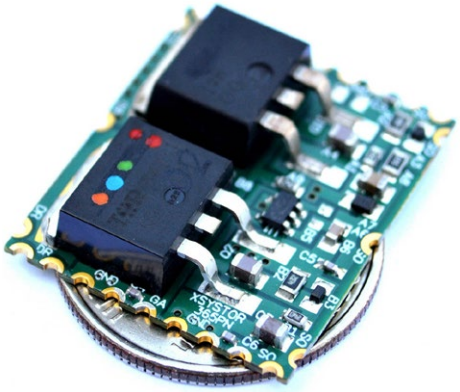


The 3 dimensional mechatronic integrated devices (3D-MID) obtained are coated with a special varnish. Assembly of the 3D-MID is then performed and completed in-house. Beta LAYOUT can manufacture 3D-MID prototypes with a maximum size of 300x200x25mm. It can populate the carrier with electronic components at a minimum contact pitch of 0.65mm, with minimum trace widths of 0.3mm for a 0.3mm pitch.

Beta LAYOUT
www.pcb-pool.com

GaN CMOS power switch delivers 40A to RF PAs

Specialist distributor RFMW has the 365CT000, 40A pulsed switch from Xsystor, Inc., that offers easy integration of GaN amplifiers in high speed, pulsed power systems.

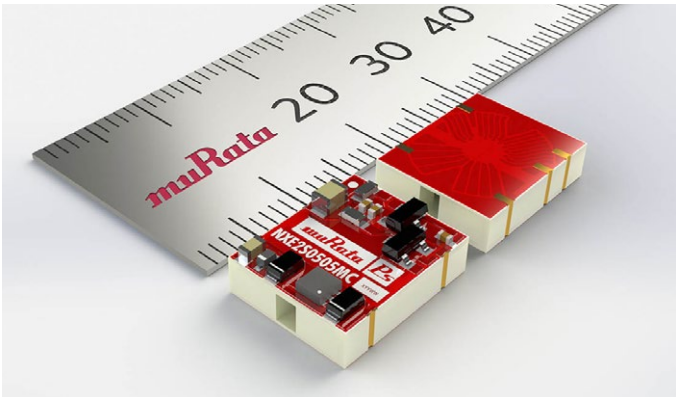


These CMOS, complementary MOSFET switches have clocked speeds of under 200nsec for rise and fall times. Allowing source and drain voltages from 28 to 80V, the Xsystor switch is compatible with standard and high voltage GaN amplifiers and transistors. Operating temperature is specified for -40 to 85C but will withstand 175C with derated voltage and current capacity. The 365CT000 comes in a 23 x 27 mm, castellated SMT package allowing it to be placed on or near the voltage supply line's RF choke. Xsystor also offers inverting and non-inverting voltage controllers and sequencers for GaN implementations.

RFMW
www.rfmw.com

2W DC-DC has under 5mm profile

Murata's NXE2 series of 2W surface mounted DC/DC converters is footprint compatible with similar 1 and 2W devices but measure 12.5 x 4.36 x 10.41 mm, representing more power

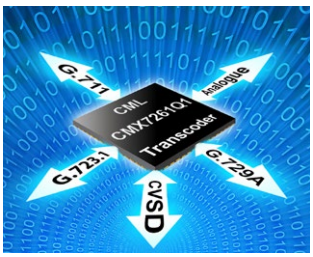


output in the same space. The converter is constructed using fully automated techniques in a halogen-free iLGA inspectable package with an integrated transformer. This approach, Murata says, increases product reliability and repeatability of converter performance. The series comprises four models with nominal input voltages of +5 or +12 VDC and outputs of +5, +12 or +15 VDC. Input to output isolation of 3 kVDC is standard across the range. Murata summaraises the product as a 2-W halogen-free converter in a footprint that has a 50% lower profile. Certification to UL60950 and medical safety is pending.

Murata Europ
www.murata.com

Full-duplex/half-duplex multi-transcoder IC targets VoIP

CML Microcircuits has released a new CMX7261 Function Image implementing the G.723.1 digital voice coding algorithm

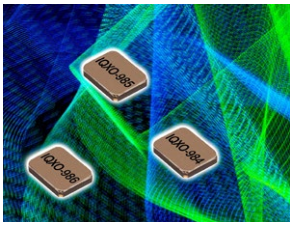


of VoIP applications. The CMX7261 provides a complete end to end function with dual channel encoding, decoding, transcoding with no external DSP or DSP skills required. The device is well suited to software-defined radio (SDR), voice-over IP (VoIP) applications, wireless private branch exchange (PBX) and digital voice interconnect systems. Two Function Images covering Linear PCM, G.711, G.729A and CVSD algorithms and Linear PCM, G.711 and G.723.1 algorithms are available, making the device very flexible and with the ability to deliver high quality speech for a large number of applications without sacrificing performance. Providing complete analogue to digital, digital to analogue or digital to digital conversion, the CMX7261 guarantees quality audio and ensures the shortest equipment design cycle. The device is built on CML's FirmASIC technology, providing a platform for potential future enhancements. Other key features include voice activity detection, C-BUS (SPI compatible) host serial control/data interface, multiple choice of input and output sources, streaming transfers, GPIO and encoder/decoder test mode support that allows verification of bit exactness and high audio quality for supported codecs. The CMX7261 operates from a 3.3V supply and includes selectable power-saving modes and is available in small 64-pin VQFN/LQFP packaging.

CML
www.cmlmicro.com

Smallest 32.768 kHz clock oscillator with AT-xtal stability

IQD positions its latest 32.768 kHz clock oscillator as the smallest available, with a design that also delivers very low



power. Measuring 1.6x1.2x0.7mm, it is housed in a hermetically sealed ceramic package. With a current consumption of 30 µA and with a standby current of 3 µA, it can be used in hand held and battery powered applications and where accuracy is required in real time clocks. The range delivers better temperature characteristic than standard 32.768 kHz tuning fork crystal based oscillators due to the use of an AT-cut crystal normally found in higher frequency oscillators. Start-up time is 7 msec at 3.3V with a rise and fall time of 200 nsec. These CMOS based oscillators are available in three supply voltages: 1.8V (IQXO-986), 2.5V (IQXO-985) and 3.3V (IQXO-984) with frequency stabilities of ±30 ppm over an operating temperature range of -20 to 70C or ±50ppm over -40 to 85C. Typical applications include battery management systems, communication modules and systems (Bluetooth, Wi-Fi, Wireless LAN & Zigbee), LCD lighting systems and smart meters (AMR).

IQD
www.iqdfrequencyproducts.com

Lattice claims lowest cost per I/O FPGA with MachXO3-9400

Lattice Semiconductor has expanded its MachXO3 family of FPGAs with the addition of the MachXO3L-9400 and MachXO3LF-9400 devices available

in multiple packages. Built in response to customer demand, the new devices bring expanded I/O and logic support for control PLD applications, while increased on-chip memory improves picture clarity for low cost video bridging in large monitor applications. The MachXO3 family targets the server, communications, industrial and display markets. The new enhanced features of the MachXO3 family make it ideally suited for implementing control path functions. These include a glue-less 1V I/O interface for out-of-band communication with new, leading-edge processors; hitless I/O enables in-system hardware upgrade along with a switch over from its old configuration to the newly programmed configuration without interrupting the circuit board operation; password protection makes the system more robust against malicious erase commands. The SED/SEC/SEI feature enables recovery from a soft error event in milliseconds. Adding analog I/Os is simple and enables integration of all hardware management while reducing overall cost. Fast 900 Mbps operating speeds supported by MachXO3-9400 FPGA's I/Os ensures that even high-resolution video streams operate smoothly.

Lattice Semiconductor
www.latticesemi.com

Toshiba's M3H MCUs embed flash using 65nm logic process

Based on the ARM Cortex-M3 core, Toshiba Electronics Europe's M3H microcontrollers are the company's first MCUs

to be fabricated with an embedded flash memory process based on the 65nm logic process. The first products from Toshiba's new TXZ Family, the 32-bit M3H group incorporates high-performance analogue circuits and the wide range of basic functions required to support comprehensive motor control and consumer and industrial device applications. The line-up includes low-pin-count packages (32 to 100-pin) and small flash memory sizes (32 KB to 128 KB). The devices operate at up to 40MHz. Integrated features include a high-precision 12-bit A/D converter with a 1.5us conversion speed and an 8-bit D/A converter. The M3H group also features Toshiba's programmable motor drive (PMD) that is suitable for inverter motor control, including A/C motor and BLDC motor control; and versatile general-purpose peripheral circuits including UART, I2C, TSPI, and timers. Samples of the 30 products in the M3H group of MCUs will start shipping in May 2016.

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

The potential of predictive analytics for machine builders

By Martyn Williams

The cost of production downtime varies significantly from one industry sector to another, but without a doubt, when it occurs, downtime is a troublesome and expensive inconvenience for all manufacturers. More often than not, halts in production could be avoided, so imagine just how much manufacturers could save if machine data was available to anticipate breakdowns. The good news for industry is that the rise of the Internet of Things (IoT) is allowing machine builders to design and manufacture intelligent machines with predictive analytics capabilities.

Preparing for the smart era

Common causes of production stoppages on the factory floor include aging equipment, human error or incorrect machine usage. To minimise downtime caused by unplanned maintenance, manufacturers have always sought to predict issues with preventative maintenance initiatives. The advent of the Industrial Internet of Things (IIoT) enables companies to look for ways to exploit increasingly available production data and change the way they operate.

Spearheaded by internet-enabled technology, the manufacturing sector is bearing witness to the next industrial revolution. Connected machinery is causing a shift in the way the industry operates, making production lines more efficient, agile and more self-sufficient. To pave the way for the smart factory, machine builders need to equip their solution with the right tools for data collection, analytics and connectivity.

To simplify this transition, machine builders can future-proof their products to leverage the growing network of smart devices in industrial facilities and the increasing amount of data from the factory floor.

Using data to deliver

Smart data from IoT-enabled equipment can be employed to forecast the degradation of industrial machinery. Predictive analytics enable trend analysis, reviewing the operational data of equipment to uncover if and when a machine is likely to break down. In addition, pattern recognition can decode the relations between certain processes and product failures, enabling fast identification of the cause of equipment breakdown - priceless insight that industrial machine builders can offer their customers.

To collect, archive and analyse complex industrial machinery data, machine builders need HMI/SCADA software capable of high performance. When combined with a cloud computing platform capable of storing big data, such as Microsoft Azure, good HMI/SCADA software provides clear data visualisation for operations, supervisors and managers - giving plant managers and engineers the peace of mind that everything is running smoothly. In fact, predictive analysis for industrial machinery could constitute an entirely new revenue stream for forward-thinking, entrepreneurial machine builders.

Using predictive analytics, machine builders can provide an entirely new service in the form of an ongoing, predictive maintenance plan supported and updated by the industrial machinery itself. Derived from sensor data and predictive analytics, preventative maintenance plans offer manufacturers a sure fire way to avoid unexpected production downtime.

For manufacturers, taking advantage of this technology does not necessarily require a complete overhaul of the factory's machinery. To avoid this costly expenditure, manufacturers could retrofit their current machinery and install independent, IIoT enabled SCADA software, like zenon, on top. This enables manufacturers to feel the benefits of predictive analytics, without a complete system refit. What's more, independent SCADA software will enable their existing equipment to communicate with newly installed machines, regardless of the make or model.

Providing new opportunities

Machine builders could also take predictive analytics one step further. Industrial connectivity and remote access enables machine builders to explore machine-as-a-service (MaaS) business models. Whether it's for quality improvement, sales forecasts or preventative maintenance, predictive analytics gives machine builders an edge over their competitors and the opportunity to create entirely new revenue streams.

Similar to software-as-a-service (SaaS), product-as-a-service (PaaS) or platform-as-a-service (PlaaS), the concept of MaaS refers to physical products, accompanying services and monitoring software.

Instead of a one-time-transaction, the customer subscribes to the product and pays a recurring fee for maintenance or additional services. Machine builders could easily adopt the model and employ predictive analytics for the preventative maintenance of their machines.

Due to the competitive nature of manufacturing, machine builders have to consistently innovate, improve and above all, future-proof their products to stay on top. Reducing downtime remains a core priority for all industry sectors, so the opportunity to anticipate and avoid it is priceless. Sharing production data with those who know, use and maintain a machine can create opportunities for manufacturers, as well as machine builders, identifying problems, reducing downtime an ultimately, preparing industry for the next revolution.

Martyn Williams is Managing Director of industrial automation software expert COPA-DATA UK - www.copadata.com

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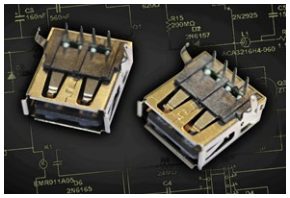
DISTRIBUTION CORNER

USB 2.0 filter connectors come with ESD protection, noise suppression

Luso Electronics is now stocking Elec & Eltek's high-speed USB 2.0 Type A filter connectors designed to provide improved PCB design flexibility, suppress noise from data and power lines. The connectors deliver reliable Electrostatic Discharge (ESD) protection to protect sensitive semiconductor components from damage due to Cable Discharge Events (CDE). This jack offers developers a drop-in replacement for existing USB 2.0 connectors, integrating the Filter and ESD protection, this reduces the board space required without a costly redesign. The MD-R0124F filter connectors offer better ESD protection while ensuring high data speed data transfer of up to 480 MBit/s.



Luso Electronics
www.lusoelectronics.com

Small 3G/2G cellular module in stock at Alpha Micro

Alpha Micro Components is now distributing u-blox's smallest cellular module, the SARA-U201, in a 16- x 26- x 3-mm 96-pin package. Supporting 2G and 3G, the SARA-U201 provides 5-band UMTS, quad-band GSM, and has global radio regulatory approvals. Communication is through UART, DDC and USB interfaces. As with other devices in u-blox's SARA-U2 range, the SARA-U201 offers CellLocate indoor positioning. The pre-integrated AssistNow feature boosts GNSS acquisition performance when used in combination with u-blox GNSS modules and chips. The device is qualified at temperatures ranging from –40 to +85°C.

Alpha Micro Components
www.alphamicro.net

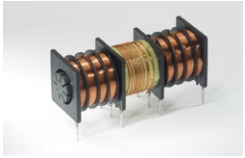
RS Pro branded portable Wi-Fi microscopes boast photo/video feed

RS Components has launched a range of Wi-Fi microscopes designed for use by electronic and mechanical engineers for industrial inspection of electronic and mechanical assemblies and for quality control such as inspecting soldering work on PCBs. Designed to be competitively priced, as well as being small, the range uses Wi-Fi wireless communication, enabling the microscopes to be used and operated via a PC, tablet or smartphone to capture pictures or video and make measurements. The series comprises six microscopes that come with a wide range of features.

RS Components
www.rs-online.com

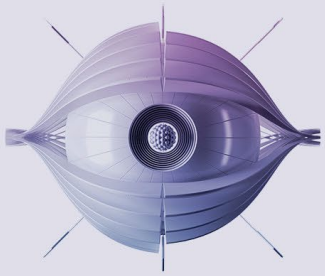
Custom wound power components at Diamond Power

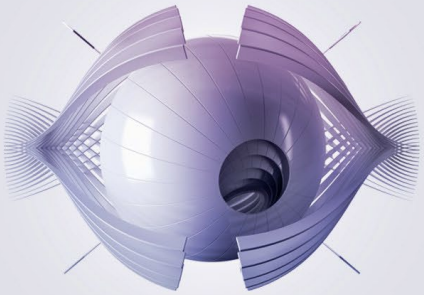
Diamond Power Components, the newly formed specialist distributor of power components, is now making available custom wound power components from Egston System Electronics Eggenburg GmbH. Diamond Power Components will work with customers and Egston development engineers to design and optimise the required inductive component using the latest high-performance software tools. Fast delivery of pre-production samples to prove new designs ensures a smooth transition to cost effective full production quantities. Flexible manufacturing facilities ensure the most appropriate assembly methods are used for each product ranging from manual through to fully-automated manufacture with wire diameters from 0.023mm.

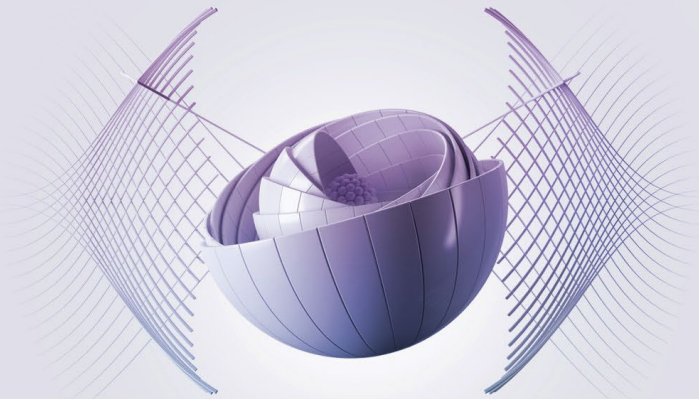


Diamond Power Components
www.diamondpowercomponents.co.uk

imec TECHNOLOGY FORUM 2016







DARING TO TAKE A DIFFERENT VIEW

NANOTECHNOLOGY IN THE HOT SEAT

MAY 24-25, BRUSSELS

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