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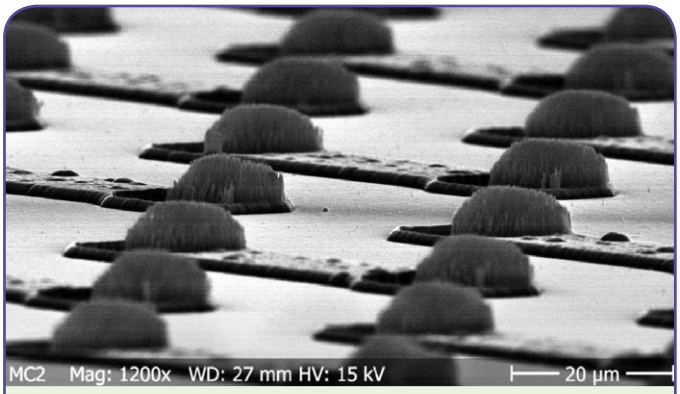

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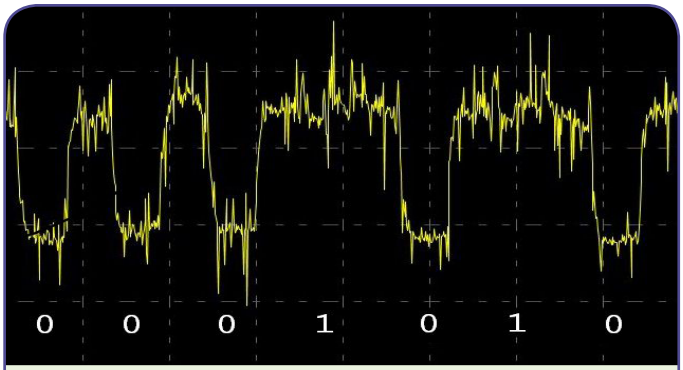

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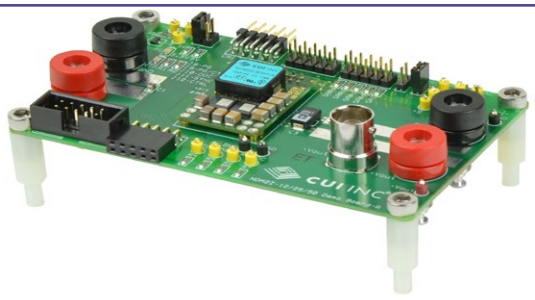

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Days of e-waste are numbered, says French startup Extracthive

By Julien Happich

A spin-off from CEA Marcoule labs (the French Atomic Energy Council), Extracthive aims to leverage the CEA's know-how in hydrometallurgical processes to design and industrialize new metal extracting and recycling processes, and in doing so, ease metal sourcing constraints.

Just over a year old, the startup offers consultancy services, matching the right treatment processes (and identifying potential post-treatment buyers in some cases) for a company's industrial waste. It prides itself in its capacity to scale up processes from lab-scale to pilot lines at its own site, but also in identifying the key players that could interact in a circular economy.

Extracthive is hosted within the Institut de Chimie Séparative de Marcoule and has a 100m^2 testing hall within the fences of the CEA centre of Marcoule. From mid-2017 onwards, it will also have access to the testing platform of the European Hydrometallurgical Institute, a 2000m^2 facility with two separate piloting halls as well as dedicated analytic labs.

At the Smart Manufacturing Summit which took place in Paris – Orly last May, *EETimes Europe* met the startup with some questions on e-waste.

Extracthive's Process Engineer Quentin Ricoux emphasized the importance of the company's piloting capacity. "We read a lot of research papers about new metal extraction processes, but often the researchers stop at the lab-level, which only offers an idealistic view of the process. In many cases, scaling up may just not make economic sense, or collateral effluents once negligible in the lab may crop up at the industrial scale and pose another waste issue".

"In some cases, we'll only have to make a cost simulation of the industrialization process to discard some solutions and orient the company towards other types of treatments, maybe finding alternative ways to value its effluents that are more cost-effective than trying to extract what they thought was the most valuable element in the first place", Ricoux said.

"Often, it's a matter of finding the right waste pre-treatment to turn waste as a raw material that best matches the needs of another buyer" added Christophe Dondeyne, Extracthive's Executive Director. "In the case of e-waste, it may just be finding the optimum process to concentrate it to the right specifications for another player in the recycling chain" Dondeyne said.

"We have formed a joint venture with a Swiss company who used to concentrate e-waste for another company down the recycling chain.

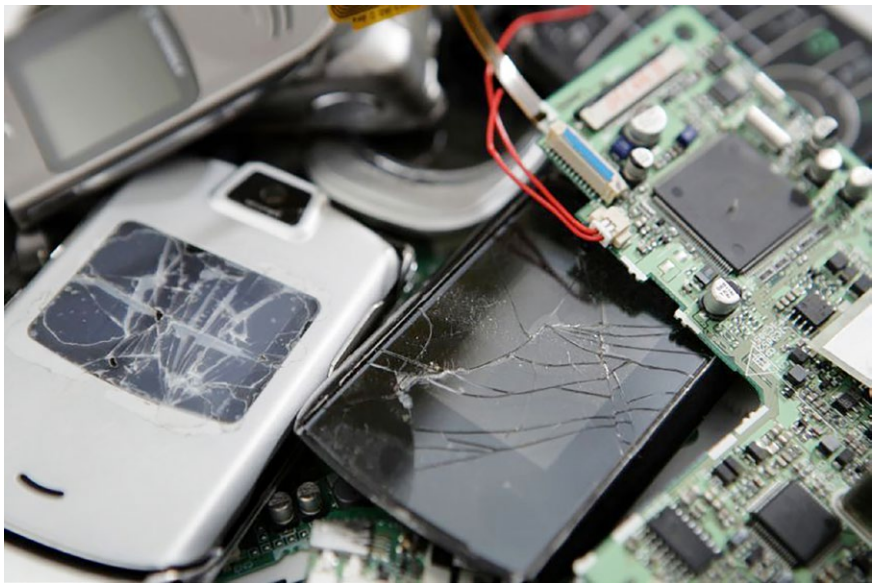
We've figured out a new hydrometallurgical process for them so they can extract some rare metals that are currently not recycled by their customers.

Our pilot-scale project already generated a return on investment, so they are willing to industrialize the process. In the end, they'll keep sel-ling the concentrate but will make additional profits by selling the extracted rare metal".

In all recycling steps, the key is the raw material, and e-waste recycling companies already pay different prices for populated boards, depending on if they host a CPU or not.

"Nowadays, most e-waste recycling companies just crush discarded consumer electronics to pieces and burn the organic material, assuming it will be easier to apply chemistry and concentrate the metals out of that pre-treatment", continued Dondeyne, "but with its Liam smartphone recycling robot, Apple is sending a strong message to the industry."

"In fact, in the long term, such solutions could allow Apple and other large OEMs to keep a tab on their metal resources, remaining the full owner of the metal content of the devices they produce rather than having to pay for more", commented Dondeyne.



"You could imagine some companies leasing the precious metals to consumers rather than selling it" completed Ricoux, "in the future, consumers may pay less for their smartphones and tablets at the condition that they take them back to the shop at the devices' end of life. This is already starting to happen and it may be the future trend".

Large OEMs like Apple or Samsung would follow the footsteps of the electric vehicle industry, with EV manufacturers under so much pressure from Europe to design for recyclability that most prefer to adopt a leasing business model for the lithium-ion battery.

In such a circular economy, OEMs could see enough benefits in recovering themselves the raw materials they processed and assembled into electronic devices to no longer be held responsible for e-waste. Legislation and e-waste shaming surely helps, but intense competition for resources is certainly another driver for the largest players.

Extracthive sees here a window of business opportunities, not only working with OEMs but in many other industries.

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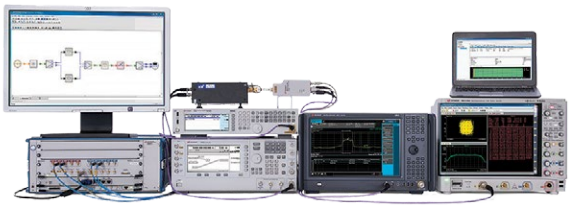

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1000-processor chip churns out 1.78 trillion instructions per second

By Graham Prophet

A team from the University of California, Davis, Department of Electrical and Computer Engineering, has designed a 1000-core processor, with an ultimate throughput rate of 1.78 trillion instructions per second and containing 621 million transistors. The "KiloCore" was presented at the 2016 Symposium on VLSI Technology and Circuits in Honolulu on June 16, 2016.

"To the best of our knowledge, it is the world's first 1,000-processor chip and it is the highest clock-rate processor ever designed in a university," said Bevan Baas, professor of electrical and computer engineering, who led the team that designed the chip architecture. While other multiple-processor chips have been created, none exceed about 300 processors, according to an analysis by Baas' team.

Most were created for research purposes and few are sold commercially. The KiloCore chip has been fabricated and run; it was built by IBM using its 32-nm PD-SOI CMOS technology.

The basic architecture is MIMD (multiple instruction/multiple data) and each of the seven-stage-pipelined cores is a general purpose unit with a 72-instruction set, single instruction/cycle. The team says that none of the instructions is 'algorithm-specific' - so distinguishing it from a GPU-class device. The 1.78-trillion instructions/sec figures comes with a clock speed of 1.78 GHz, at 1.1 V: running at 0.84 V and 1 GHz consumes 13.1 W, while peak power efficiency of 5.8 pJ/Op is quoted at 0.56 V and 115 MHz.

Each core is independently powered and can shut down to leakage-only power if it has no task to perform. Rather than a cache architecture, every processor can store instructions and data in a hierarchy of locations; local memory, one or more nearby processors, on-chip independent memory modules, or off-chip memory.

Each processor communicates via a high-throughput circuit-switched network plus a packet-switched network (both on-chip).

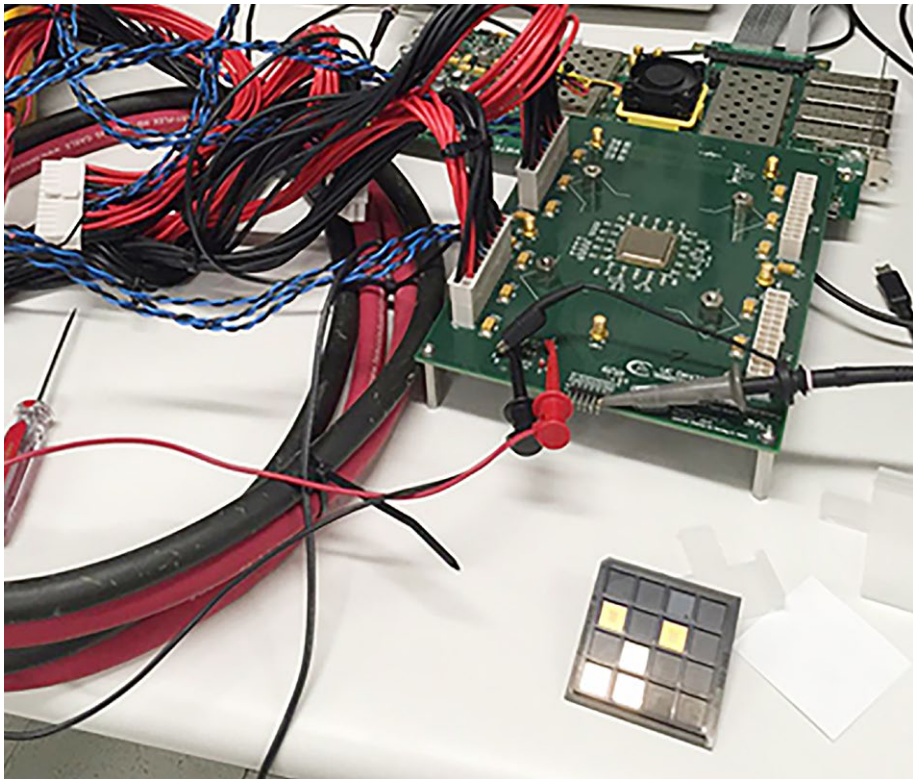
The team says there is little energy overhead to source operands from companion processors some way across the chip, as 'wormhole' routing is employed. That is, messages from an adjacent or nearby core will be routed via the 'circuit' network; those from further away in the processor matrix will travel via the packet network.

Each core has north-south-east-west comms buffers plus a fifth channel for host-processor traffic; maximum throughput is 45.5 Gbps per router and 9.1 Gbps per port at 1.1V. At 0.9V, maximum throughput is 27.1 Gbps at 3.36 mW and at 0.67V, it is 8.1 Gbps at 429 µW.

KiloCore's 1000 processors, 1000 packet routers, and 12 independent memories are clocked by local oscillators that do not use PLLs and may change frequency, halt within 1-5 clock periods, and restart in less than one clock period to reduce power dissipation. The chip measures (nearly) 8 mm square, and has 32 rows of 32 processor cores (=992) with the remaining eight cores in a final row, with memory.

A major challenge of working with high-number core arrays is scheduling tasks and keeping all the cores busy. The team has created a programming model and compiler; they say that programming is by a multi-step process that allocates programs to processors. However, to make use of available packaging, only the central 160 cores have been powered in tests; figures for full-chip performance are presumed to be extrapolations.

Each processor core can run its own small program independently of the others, which is a fundamentally more flexible approach than so-called single-instruction-multiple-data approaches utilized by processors such as GPUs; the idea is to break an application up into many small pieces, each of which can run in parallel on different processors, enabling high throughput with lower energy use, Baas said, adding that the the chip is the most energy-efficient "many-core" processor ever reported.



For example, the 1,000 processors can execute 115 billion instructions per second while dissipating only 0.7W, low enough to be powered by a single AA battery. The KiloCore chip executes instructions more than 100 times more efficiently than a modern laptop processor.

Applications already developed for the chip include wireless coding/decoding, video processing, encryption, and others involving large amounts of parallel data such as scientific data applications and datacentre record processing.

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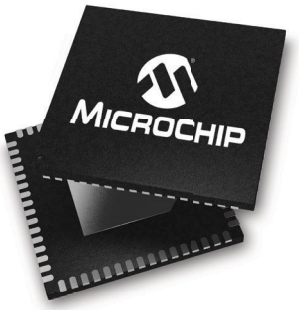

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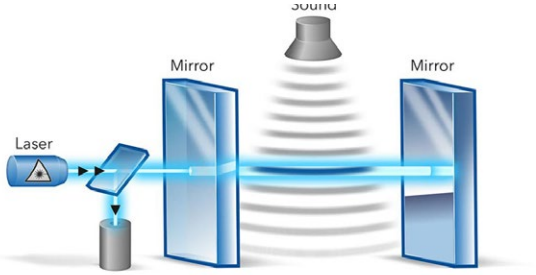
MICROCHIP

Optical microphone "sees" broader sound spectrum

By Julien Happich

Founded in 2012 as a spin-out company by the Vienna University of Technology and the Knowles Corporation, Austrian startup Xarion Laser Acoustics GmbH is bringing a membrane-free optical microphone with unprecedented sound resolution.



Schematic illustration of the optical microphone's working principle

Sending a telecom-grade 1550nm IR laser beam through an open Fabry-Pérot etalon (in effect two parallel optical mirrors only 2mm apart, the solid-state microphone (no moving parts) records sound pressures as minute changes in the medium's refractive index.

These changes alter the optical wavelength and the light transmission which the optical microphone converts into measurable electrical signals.

Xarion's optical microphone can detect faint refractive index changes under 10^{-14}, which translate to pressure changes as small as 1µPa. Due to their rigid construction, they do not suffer from sound-induced mechanical resonances and boast a very flat frequency response, from 5Hz infrasound to ultrasounds in the MHz range (up to 25MHz in liquids).

This enables the optical microphone to capture all acoustic data in one recording across a large spectrum otherwise unattainable by conventional membrane-based microphones.

For now, Xarion's prototypes could be considered fairly bulky compared to today's MEMS-based consumer microphones found in smartphones, and *EETimes Europe* caught up with the company's CEO, Dr. Balthasar Fischer, to better understand which markets the startup is after.

Today's optical microphone implementation, with an optic fibre tail guiding the laser into a Fabry-Pérot cavity open to air or liquids.

A fully integrated optical microphone concept, showing a dual-side emitting VCSEL in between wafer optics.

"Of course, why would you want to record sounds that only bats can hear?" jokingly admitted Fischer with regard to audiophile applications. "The frequencies we can record make more sense for industrial applications such as non-destructive testing, ultrasound metrology, acoustic process monitoring or for medical imaging".

"Also, as a startup, we would not be able to address mass-markets, our current devices would not be cost competitive with consumer-grade products so it makes sense for us to start with niche markets" Fischer said.

"For non-destructive testing, we can operate one-sided, with a sound emitter on the side of the microphone. By scanning a surface across a 2D plane, we can identify internal structural defaults which yield different sound patterns" the CEO explained.

"For process control, we can monitor high-speed CNC machinery in the ultrasound regime way beyond ambient noise, which gives us a richer picture because we can focus on the signal emitted by the tool" he said, "as if you were only listening to the tools in an otherwise silent room".

Another example Fischer wrote about in a recent paper is laser welding, where the amplitude of specific spectral components in the hundreds of kHz is strongly tied to the weld's depth of penetration, a key measure of weld quality.

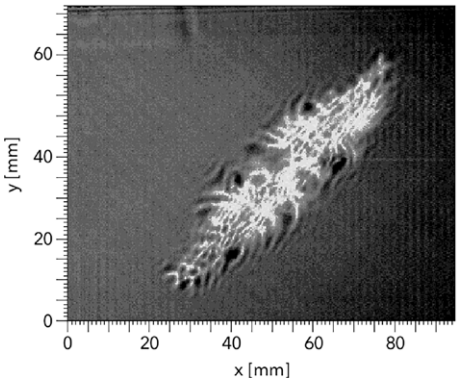
"In cooperation with the Medical University of Vienna, our optical microphone is also being evaluated for endoscopy, designing photoacoustic imaging solutions for surgery. But it can also be used in dermatology, to analyse the structure of the skin very much in the same way as you would for non-destructive testing. We can get very sharp 3D images of dark moles" the CEO revealed.

After addressing these three markets, the startup aims to enter the consumer market via the automotive industry.

"Because our optical microphone has a very good phase response, it is better suited to directional sound recording than traditional microphones.

Using an array of 3 to 7 microphones we could use beamforming algorithms to listen into one spatial direction, say for better voice recognition. We could listen to a well-known spot and avoid 360° surrounding noises" Fischer said, hinting at a driver's head position in a noisy car interior.

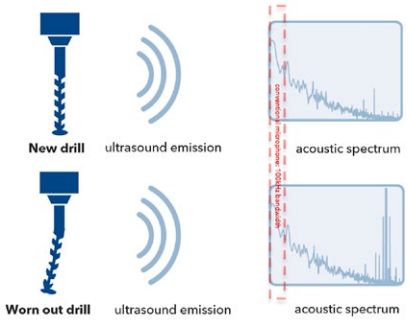
"Since 2014, Mr Porsche is our largest shareholder", he added, confident that such an application could interest car makers in the next few years when the technology matures.



Ultrasound scan of a carbon fibre composite plate exhibiting internal defects (source: Technical University of Munich)

For now, the company aims to ship between hundreds and thousands of pieces a year for industrial applications and is working with partners in the medical sector to go through regulatory approvals.

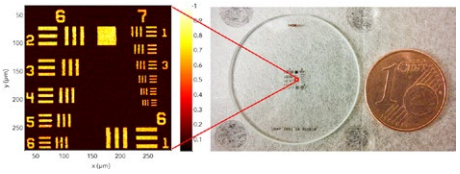
"We are still pre-break even, but we have customers and we are generating some revenues. We just need to follow up with our product development. Though we are not currently looking for more financing because we already have very good backers."



Acoustic signatures of new and worn out drilling bits in the ultrasound range.

The CEO knows well further miniaturization and cost-reductions will be necessary to ramp up production and address consumer applications.

"We are currently developing wafer-level glass interferometers, with integrated VCSELs. The optical cavity here would be 1mm instead of 2mm, we could have thousands of interferometers per wafer. Of course, it would still be larger than MEMS microphones and we would not beat MEMS for pricing, but the comfort these microphones would bring to car drivers when they speak to their navigational system would make up for it."



A US Airforce Resolution Target test chart (a black print on a 1-inch piece of glass) discerned by the optical microphone through an ultrasound scan.

Design parameters could be further tweaked, playing with cavity length, mirror reflectivity or even changing the laser wavelength.

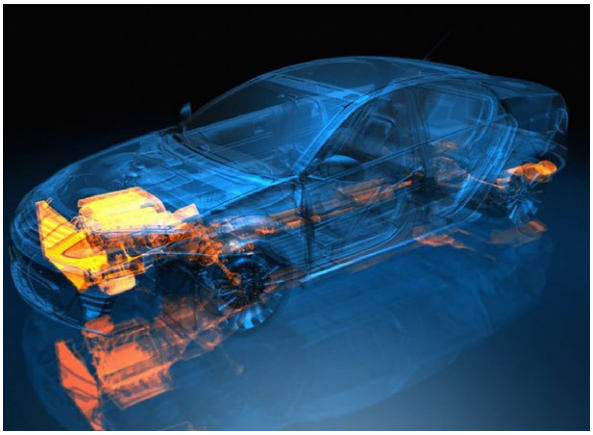
"You could choose to use the UV band for more sensitivity or to listen into a medium where infrared would be too much absorbed" said Fischer, adding that he had received a few requests for such a development. "For a military application, we diminished the reflectivity of the mirrors so we would decrease the sensitivity, to listen at very high sound pressure levels. At 180dB, we had to put on double hear protections" he cited as another example.

Acquisitions jumble up auto semiconductor rankings

By Christoph Hammerschmidt

Last year's acquisitions caused several shifts in the market for automotive semiconductors. After the merger with Freescale, NXP now outdistances Infineon by far – though the latter also improved its strength by taking over International Rectifier (IR). The total automotive semiconductor market almost stagnated amidst slowing growth in the global automotive industry.

The latest figures from market research company value the global market for automotive semiconductors in 2015 at $29 billion, up a mere 0.2 % from the year before. The much discussed acquisition of Freescale through NXP, already before the before the merger each one a heavyweight in this market, catapulted NXP to the pole position with combined sales of $4.2 billion.



Before the merger, NXP had a market share of 6.4%; through the takeover the share climbed to 14.4%. With sales growth of 125%, it can be expected that this share has still some upside potential. "The acquisition of Freescale by NXP created a powerhouse for the automotive market", commented Ahad Buksh, automotive semiconductor analyst for IHS Technology . "NXP increased its strength in automotive infotainment systems, thanks to the robust double-digit growth of its i.MX processors. The company's analog integrated circuits also grew by double digits, thanks to the increased penetration rate of keyless-entry systems and in-vehicle networking technologies."

For the time ahead, NXP will target the markets for machine vision and sensor fusion – both at least as promising as the ancestral markets of radar, engine control and communication systems.

Infineon, always a candidate for the number one position in the automotive semiconductor market, could secure the second place through the takeover of International Rectifier (IR). With IR on board, Infineon has an even stronger position than before in power electronics.

But the Bavarians also hold a significant share of the chips for advanced driver assistance systems (ADAS) and radar sensors. The company's TriCore 32-bit microprocessors also reinforced Infineon's position in the powertrain and chassis and safety domains.

Renesas, always in a neck-and-neck race with Infineon, fell back to position number three on grounds of an unfavorable dollar-to-yen exchange rate.

Though the company's sales to the automotive market grew by 1% measured in yen, it fell 12% if measured in U.S. dollar. In the segment of MCU solutions however, Renesas remains the leading supplier globally, notes IHS.

STMicroelectronics' automotive revenue declined 2% year over year; however, a larger part of the decline can be attributed to the lower exchange rate of the Euro against the U.S. dollar in 2015. STs' broad- based portfolio and its presence in every growing automotive domain of the market helped the company maintain its revenue.

Apart from securing multiple design wins with American and European automotive manufacturers, the company is also strengthening its relationships with Chinese auto manufacturers. Radio and navigation solutions from STMicroelectronics were installed in numerous new vehicle models in 2015.

Texas Instruments has thrived in the automotive semiconductor market for the fourth consecutive year. Year-over-year revenue increased by 16.6 percent in 2015 with design wins across all vehicle domains. ADAS and hybrid-electric vehicles were the primary drivers of growth.

After the acquisition of CSR, Qualcomm rose from its 42nd ranking in year 2014, to become the 20th largest supplier of automotive semiconductors in 2015. Qualcomm has a strong presence in cellular baseband solutions, with its Snapdragon and Gobi processors; while CSR's strength lies in wireless application ICs, especially for Bluetooth and Wi-Fi. Qualcomm is now the sixth largest supplier of semiconductors in the infotainment domain.

Moving from 83rd position in 2011 to 37th in 2015, nVidia has used its experience, and its valuable partnership with Audi, to gain momentum in the automotive market. The non-safety critical status of the infotainment domain was a stepping stone to carve out a position in the automotive market, but now the company is also moving toward ADAS and other safety applications. The company has had particular success with its Tegra processors.

Due to the consolidation of Freescale, Osram entered the top-10 ranking of automotive suppliers for the first time in 2015. Osram is the global leader in automotive lighting and has enjoyed double-digit growth over the past three years, thanks to the increasing penetration of light-emitting diodes (LEDs) in new vehicles.

Market Share of Top 10 Automotive Semiconductor Suppliers ($ million)

Y2015 Rank	Company Name	2014 Revenue	2015 Revenue	2014 Market Share	2015 Market Share	Growth (YoY)
1	NXP	1861	4178	6.4%	14.4%	124.5%
2	Infineon Technologies	2702	2850	9.3%	9.8%	5.5%
3	Renesas Electronics	3032	2671	10.5%	9.2%	-11.9%
4	STMicroelectronics	2144	2096	7.4%	7.2%	-2.2%
5	Texas Instruments	1605	1871	5.5%	6.4%	16.6%
6	Robert Bosch	1621	1478	5.6%	5.1%	-8.8%
7	ON Semiconductor	1069	1142	3.7%	3.9%	6.8%
8	Micron Technology	706	661	2.4%	2.3%	-6.4%
9	Toshiba	729	652	2.5%	2.2%	-10.6%
10	Osram	568	646	2.0%	2.2%	13.7%
	Others	12946	10785	44.7%	37.2%	-16.7%
	Total	28983	29030	100.0%	100.0%	0.2%

Source: IHS © 2016 IHS

NXP outdistances competitors; Osram in the top ten for the first time: The market for automotive semiconductors in 2015.

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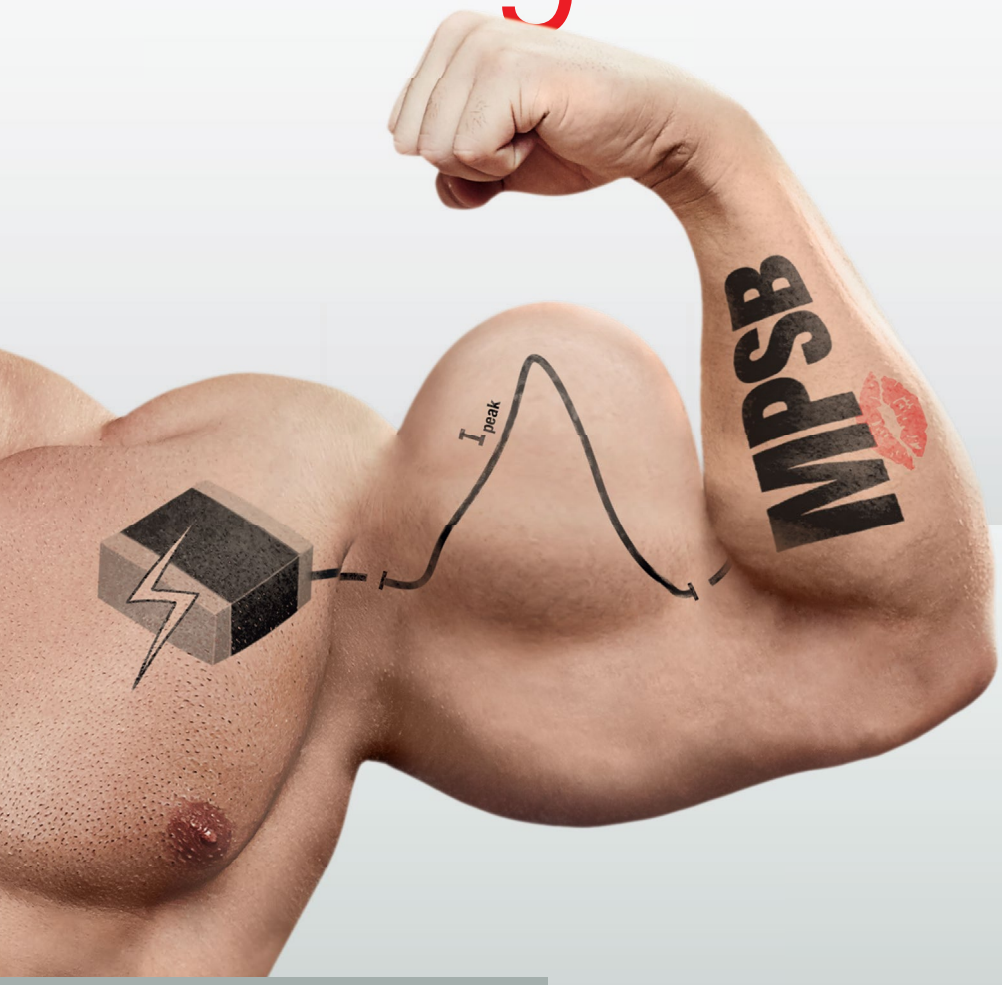

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Products in original size:

Swedish startup to shrink IC packaging with carbon nanofibers

By Julien Happich

Founded in 2005 after having secured a number of patents leveraging the growth of carbon nanofibers (CNFs) on different substrates, Swedish startup Smoltek believes CNFs will play an essential role in shrinking IC packaging.

Smoltek's core technology platform, SmolGROW is what the company claims to be the only process that enables controlled growth of conductive nanostructures at 390°C using CMOS compliant materials and processes.

With this low-temperature CNF growth well under control, the company has secured an IP portfolio covering a number of applications including dense 2.5/3D stacking (SmolINPO), ultra-fine pitch interconnects (SmolINCO), integrated capacitors for energy storage or decoupling (SmolCACH), but also thermal interface materials (SmolTIM) for high performance RF and power electronics components and SmolNIL, making use of the CNFs to fabricate high aspect ratio structures through nano imprint lithography (the CNFs have a typical diameter of 50 to 100nm, being from 2 to 150 micrometres long, depending on process parameters).

Contemplating an IP licensing business model, Smoltek's Chief Innovation Officer & Founder Dr. M. Shafiq Kabir shared his insights with *EETimes Europe*.

"We will licence our IP to both OSATs and foundries so they can offer the process to their customers on top of silicon, either to integrate new discrete components like our SmolCACH, or to integrate the CNFs in new packaging strategies" Kabir said in an interview.

"We are also working on a Process Design Kit (PDK) for the vertical integration of our process into the IC design flow, because everyone has to be aligned to optimize IC and package integration".

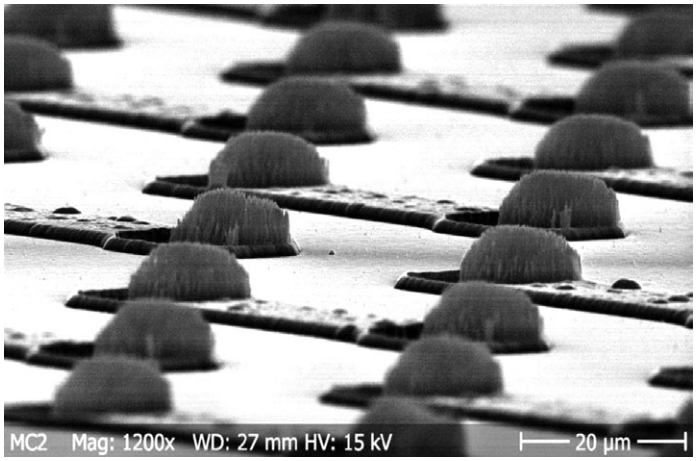
The CIO revealed that his company was engaged in small projects with a number of customers, to do mostly with miniaturized interconnects exploiting the high thermal and electrical conductivity of CNFs to boost traditional micro-bumps (with copper wetting and anchored onto CNF patches).

"You could find our IP in commercial applications within the next two to three years" he said.

"With this technology, we are not aiming at replacing Through Silicon Vias (TSVs) yet, but we'll solve the TSVs/interposer bottleneck. Copper micro-bumps don't scale too well", Kabir explained, "copper electro-migration impacts the lifetime reliability of silicon dies, and only CNF-based bumps will be able to scale down with future nodes".

In a whitepaper "Using carbon nanostructures as the assembly platform in semiconductor advanced packaging beyond Moore", the company mentions the use of selective electroplating, based on the conductive properties of CNFs to further reduce bump pitch without relying on micro solder balls. It sees a potential for 3D-shrinkage orders of magnitude (>10x-100x) compared to existing and well established bump/pillar technologies.

This would allow bare dies to be stacked on each other or bonded to a substrate (interposer) or carrier (lead-frame) with much higher density interconnects.

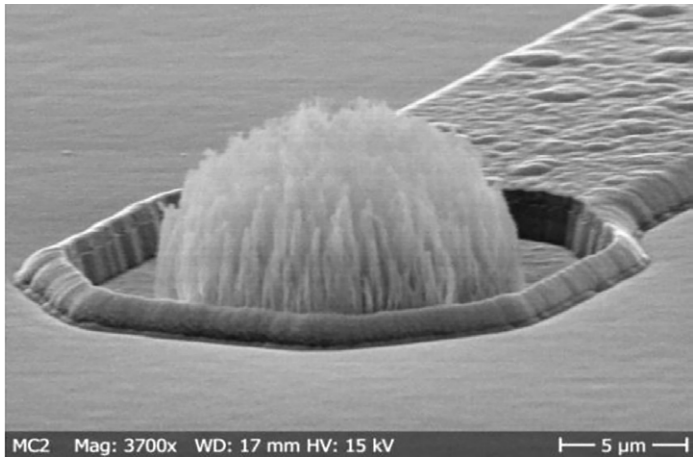


An interesting ongoing development which could interest many OSATs doing Integrated Passive Devices (IPDs) for their customers is the SmolCACH (Capacitor on Chip) Smoltek is working on.

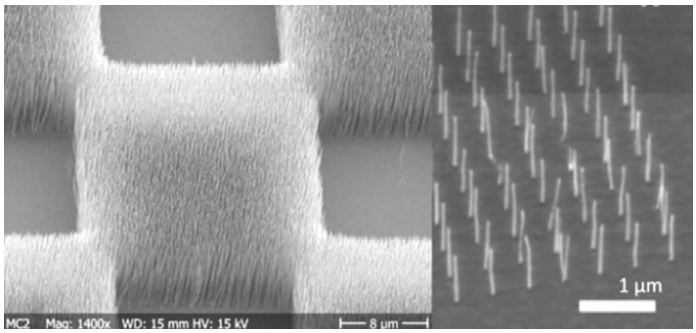
"For the moment we have achieved capacitors with moderate values in terms of capacitance per unit area for the solid state version. However the electrochemical devices show very promising results. The actual values are to be published and we'll have to wait for some final reviews by our tech team" commented Kabir, accepting to share with us a SEM photograph of a newly manufactured 'all solid state' test mini supercapacitor. The SEM photograph shows a carpet of vertically grown CNFs sandwiched between two electrodes.

"The process involves a number of lithography and materials depositions, so you may be seeing some shadows of those different layers", commented Kabir about the faint square patterns within the rectangular shape.

"This particular device has just came out of the lab and has yet to be measured and analysed. However, we have seen an increase of a factor of 5 to 10 of the capacitance per unit area (footprint) compared to the planar counterparts in our first non-optimized version. This new batch is coming out of the lab after some optimization and we will see what it will give us" the CIO



A forest of CNFs grown onto a metal IC bond pad.



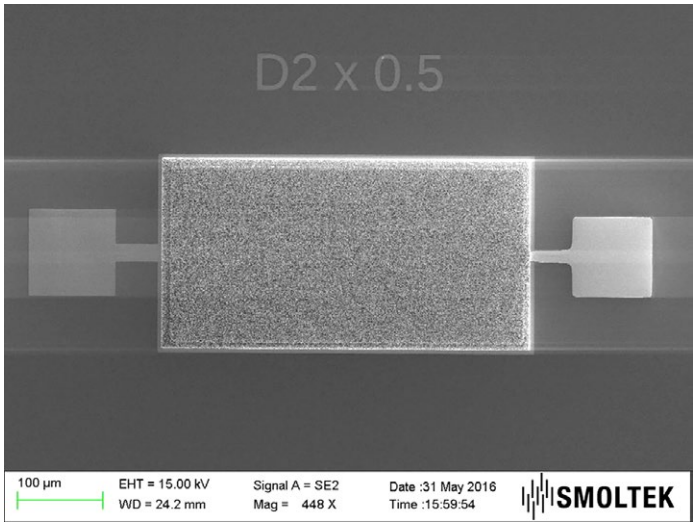
(left) nanostructures grown in "checker box" pattern, (right) an array of nanostructures grown on a substrate.

said when pressed for some characteristics.

"We are always striving to get the best values out through different technical optimizations. Some target values for performances benchmarking include over 500nF/mm^2 in DC with a breakdown voltage to be superior to 2V, and over 1nF/mm^2 with a breakdown voltage over 25V for RF applications".

Last year, Smoltek's co-founder Prof. Peter Enoksson from Chalmers University of Technology (Gothenburg, Sweden) published a paper in the Solid-State Electronics journal "CMOS compatible on-chip decoupling capacitor based on vertically aligned carbon nanofibers", presenting on-chip decoupling capacitors of specific capacitance 55pF/µm^2, 10 times higher than commercially available discrete and on-chip decoupling capacitors at the 65nm technology node, the paper claimed.

The vertically aligned CNFs were integrated directly on



SEM photograph of a newly manufactured 'all solid state' test mini supercapacitor.

CMOS using a low-temperature direct current plasma enhanced chemical vapour deposition (DC-PECVD) technique. The paper explained that because the CNFs were made of cone shaped graphene layers stacked on top of each other, the nanostructures obtained had this benefit over carbon nanotubes that they consisted in a completely filled 100% metallic cylinder. Hence they achieved better conducting properties than CNTs whose typical metallic/semiconducting ratio is 1/3 when grown in bulk.

Silicon nanocones improve hydrogen fuel production from water

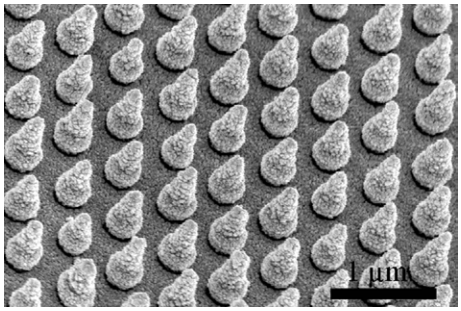
By Nick Flaherty

Researchers at Stanford University (Stanford, CA) have used silicon nanocones to produce a low cost photovoltaic cell for producing hydrogen from water for fuel cells. for a bismuth vanadate cell. "Millions of cars could be powered by clean hydrogen fuel if it were cheap and widely available," says Yi Cui, an associate professor of materials science and engineering at Stanford.

Cui and his colleagues at the Stanford Institute for Materials and Energy Sciences have focused on photovoltaic water splitting, using a solar-powered electrode immersed in water. When sunlight hits the electrode, it generates an electric current that splits the water into its constituent parts, hydrogen and oxygen.

Conventional solar electrodes made of silicon quickly corrode when exposed to oxygen, and other research teams have reduced corrosion by coating the silicon with iridium and other precious metals. Instead, Cui and his colleagues are using bismuth vanadate, an inexpensive compound that absorbs sunlight and generates modest amounts of electricity.

"Bismuth vanadate has been widely regarded as a promising material for photoelectrochemical water splitting, in part because of its low cost and high stability against corrosion," says Cui. "However, the performance of this material remains well below its theoretical solar-to-hydrogen conversion efficiency."



Array of silicon nanocones (Image credit: Wei Chen and Yongcai Qiu)

Bismuth vanadate absorbs light but is a poor conductor of electricity. To carry a current, a solar cell made of bismuth vanadate must be sliced very thin, 200 nanometers or less, making it virtually transparent and allowing visible light to generate electricity as it passes through the cell.

The researchers created microscopic arrays containing thousands of silicon nanocones, each about 600 nanometers tall. "Nanocone structures have shown a promising light-trapping capability over a broad range of wavelengths," Cui says. "Each cone is optimally shaped to capture sunlight that would otherwise pass through the thin solar cell."

In the experiment, Cui and his colleagues deposited the nanocone arrays on a thin film of bismuth vanadate. Both layers were then placed on a solar cell made of perovskite, another promising photovoltaic material. When submerged, the three-layer tandem device immediately began splitting water at a solar-to-hydrogen conversion efficiency of 6.2 percent, already matching the theoretical maximum rate.

"The tandem solar cell continued generating hydrogen for more than 10 hours, an indication of good stability," says Cui. "Although the efficiency we demonstrated was only 6.2 percent, our tandem device has room for significant improvement in the future."

Taking IoT to the next stage

President and CEO of Sequans Communications Georges Karam discusses the future of the Internet of Things (IoT), and why cost and power efficiency are emerging as key factors in monetizing the technology…

Hanns Windele: You have been described as a pioneer of the Internet of Things. What is IoT for you?
Georges Karam: For me if there is no business model to monetize a connected device, then it is just a gadget or it will never happen. At Sequans, we are specialists in 4G. The company has a 12-year history, but when we started we weren't thinking about IoT at all. We were thinking 4G broadband or 4G on smartphones. I still remember in 2003, when the company was right at the beginning, I was saying that there was something missing on the 3G phone. So we took WiMAX and embraced that. We could see the opportunity to make something happen and became the first company in the world to power the 4G phone. At that time iPhone was just happening with 2G and 3G. We were very successful in 4G. But when WiMAX went down we shifted our focus to LTE.

HW: What happened to you when WiMAX finished?
GK: It was the worst day of my life. You wake up in the morning and you're doing $35m per quarter, and then you have a customer calling you to say 'stop shipping.' We don't know why, and neither do they. Then you find that Sprint has put all its money on Apple to get the iPhone on its network, although not supporting 4G yet. In three financial quarters our revenue went down to zero. So you have 300 people, no revenue, no product to sell and nothing you can do to fix it. We knew that LTE needed to happen. So what do we do? Do we give all of the money back to the shareholders and say 'thank you, goodbye'? The big move that we made at that time was not to copy all the big semi guys.

Georges Karam, President and CEO of Sequans Communications "…I want to make Sequans an IoT company"

HW: What did you do differently?
GK: Well, I said that we weren't going to do anything in smartphone anymore. But many guys were saying to me: 'you're crazy. You must work to get 2G and 3G fallback in addition to 4G and address the smartphone market'. But I said that I was going to focus on the future. The last thing you want to do is reinvent the past. The future is about new things and at the time the future was all about 4G. I explained that it was going to be painful because we didn't have short-term revenue and we would have to wait for 4G network coverage. But we were going to be the best guys delivering 4G. The short-term focus was to deliver wireless broadband. But we discovered later that the main one was, of course, IoT.

HW: What sector of the IoT market were you aiming for specifically?
GK: It's a low price, low power and low data-rate market. The old world of IoT was M2M, in other words connecting machines, around 100 million units a year. But we're now talking about connecting everything and there is no limit to the dream. There are billions of things to connect. Applications range from home security, smart city, energy management, tracker, e-health and wearable. We're going for markets where there is high volume and low prices.

HW: How do you compete with someone like Qualcomm?
GK: We're not really like Qualcomm or Intel because we are pure 4G and they are still in 3G and 2G because they need the fallback for voice on mobile phones. Our technology is optimized for 4G only, and by doing so we deliver the best performance with a much lower cost, attacking not the smartphone market, but the home router and IoT. Our approach was to optimize the cost and power consumption of our 4G chip by limiting the speed to 10Mb/s (CAT1 LTE), as 150Mb/s (CAT4 LTE) is not needed for IoT. In fact, CAT1 LTE is part of the 3GPP standard, but no one was doing anything with this. We didn't invent CAT1, but we resurrected it. Everyone was looking the other way: which was speed, speed, speed. But the IoT market doesn't need speed: it needs low power and low cost. So we became leader in CAT1. Two years ago, only Sequans was talking about this. Now, the whole world is, and it is becoming de facto for the M2M applications moving from 2G to 4G. Then the eco-system realized that we needed to define a better standard fully designed for IoT. We could limit the speed to 1 Mbit/s or even lower and reduce the bandwidth of the LTE signal from 20MHz to 1.4MHz or 200kHz. A new LTE standard has been defined with two variants: CAT M1 (machine) and CAT M2 or NB-IoT (narrow-band). Sequans is now sampling a chipset supporting this new IoT standard.

HW: What did you learn working with big companies like Philips and Alcatel?
GK: When you come to a big company, the first thing you encounter is the legacy.

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

It can be a good thing because you learn a process that is built on years of doing things in a certain way. That's not taught in university and so you learn how to make things happen. But the worst thing about big companies is the way politics gets mixed with the decision process. In a big company the CEO is effectively on the moon, and there are all these layers of management. In organisations like this communication becomes very complicated. I am doing everything to avoid this in Sequans, which has only 250 people. A big part of my energy is taken up with communication within my organization.

HW: When do you think IoT will take off?
GK: It's all about the business model behind it. A good example of this is the guy who makes the sensor to transmit data about when a trashcan is full. I asked: 'how much do you sell these for?' He said that he didn't – he gave them away. The local authority was spending, say, €1m sending trucks around the town to empty the bins whether they were full or not. And so the sensor manufacturer says that he'll connect up the bins so that you only need to send trucks to where they are needed, when they are needed. This reduces the cost to €0.6m, for example. The saving is split in half, with the authority making a 20 per cent saving and the manufacturer picking up the remaining €0.2m. This is the sort of model where the IoT can make money for everyone.

HW: How does Sequans take advantage of a model like that?
GK: To make it work you need sensors, a sensor hub, controllers and connectivity. No matter what, you need to connect all this on the internet and if you can do it with LTE technology with low cost and low power, then this is where we can come in and the game is over. To see IoT happening you need two things fundamentally. The connectivity needs to happen and then you need to build your service offerings around that.

HW: Where do you want to take Sequans as a company?
GK: When you manage a company your objective is to grow it. The day I am unable to grow the company I'm dead. I'm lucky because the IoT market is huge and there is a lot of room to play there and make a company with revenue of a few hundred million dollars. I can add more technology, but I want to keep it in IoT because I want to make Sequans an IoT company. I can see how I can take the company down that road. But if someone comes along with a big cheque and the shareholders believe that to sell is good for them, then why not?

HW: Historically speaking, what technology has had the biggest impact on your market?
GK: I'm a signal-processing guy and so I believe wireless technology and wireless communication is key. My kids think of a smartphone as a screen and that is all. They don't think about what's inside it. Indeed, there are two things that are impressive here: obviously the microprocessor, but also the comms technology on the other side, starting from Shannon Theory all the way up to where we are today. Twenty years ago no one could imagine having a 1Gbit/s wireless connection on your phone. People today think that this is nothing, but when I was a PhD candidate we were saying that this would never happen.

HW: What's the most important part of a CEO's job?
GK: At the end of the day, job number one of the CEO is to take decisions. You have to accept that it is your call, even if the following day you realise that the decision was a bad one. I don't care how complicated the decision is. It is the CEO's job to take it and if he can't do that, then he needs to give up.

QUICKFIRE QUESTIONS

What's your idea of a perfect holiday?
One where I can work for two hours a day so that I can keep on top of business and then relax for the rest of the day with my family.

Who would you share a prison cell with?
French philosopher Luc Ferry. I love his books.

How many electronic devices do you have?
I'm not an early adopter and so I just have a smartphone and a laptop.

What gadget could you not live without?
Smartphone. I can stay connected all the time and it's so convenient.

If you could run a business outside the technology space what would it be?
I would open a restaurant. I don't want to cook, but I could welcome the people.

If you weren't a CEO what would your ideal job be?
I'd like to be a politician.

What piece of technology would you donate to a museum?
Maybe an old hard-wired phone.

Apart from business books what do you read?
A lot of philosophy. Paul Davies' 'About Time' and 'The Mind of God'.

Rambus prototypes 2x2mm lens-less eye-tracker for goggles

By Julien Happich

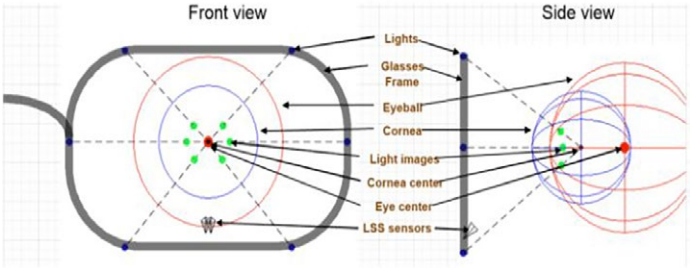
At last month's VLSI Symposia, Rambus presented a poster titled "Lensless Smart Sensors: Optical and Thermal Sensing for the Internet of Things" in which the company not only detailed the underlying technology but also demonstrated a working sensor prototype.

The Lensless Smart Sensors (LSS) rely on a phase anti-symmetric diffraction grating (either tuned for optical or IR thermal sensing) mounted directly on top of a conventional imaging array and co-designed with computational algorithms that extract the relevant information from the scene to be imaged. The grating is very thin and boasts a wide field of view, up to 120°, and the resulting imaging sensor is almost flat (only a few hundred micrometres separate the grating from the image sensor).

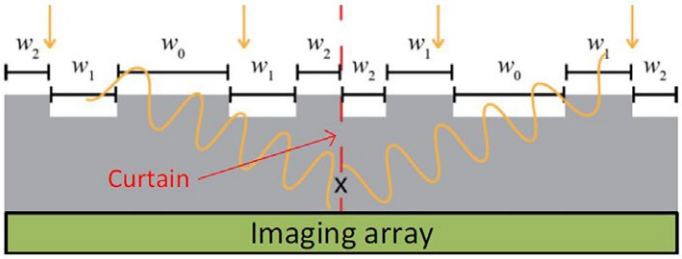
The raw sensed image is encoded by the grating structure, calling for dedicated reconstruction algorithms and image processing, but in some applications such as range-finding or eye-tracking, it may not even be necessary to reconstruct a full image. Instead, extracting distance measurements may suffice and the particular phase anti-symmetric diffraction structure makes it very simple, explains the poster.

Light from left and right of the anti-symmetric boundary (at the centre of the grating) cancels in a curtain under the boundary. And the stereoscopic shift of the Point Spread Functions (PSF) of a point light source viewed through two gratings can be used to determine the distance of that light source with a much greater accuracy than would be feasible with stereoscopy using lenses, the authors write.

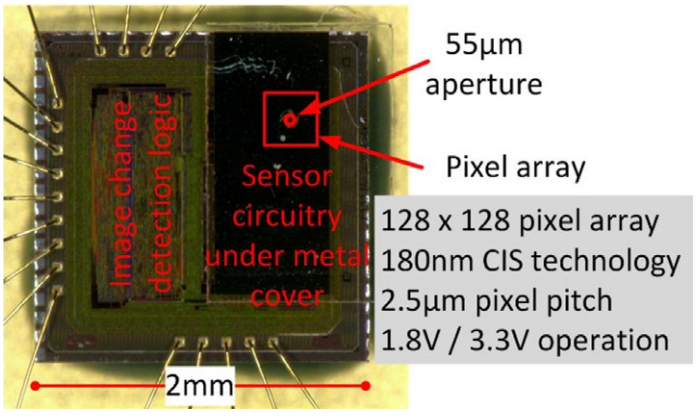
To put their theory into practice, the researchers designed an ultra-low power 2x2mm² image sensor, with a 128x128 pixel array and integrated image change detection circuitry on the same die. They then used two identical phase gratings mounted in apertures on a shared pixel array. The gratings were only 1.86mm apart, each within apertures only 55µm in diameter. This setup was enough to measure distances up to 50cm with an error of less than 8%, they reported.



Eye-tracking principle of operation: reflections in the eye of multiple LEDs are triangulated with a pair of LSS sensors to calculate the gaze direction.



Phase anti-symmetric grating structure of the Lensless Smart Sensor.



Rambus' image change detection sensor in 180nm technology, with attached metal aperture and phase grating.

The wide field of view and the very compact and flat form factor of such a stereoscopic lens-free sensor make it very well suited for wearable eye-tracking applications within smart goggles or head-mount displays.

Here the light sources could be near-IR emitters integrated within the periphery of the glass frame.

"We do see this as a better, more accurate replacement for head-mounted eye tracking systems like those found in Virtual and Augmented Reality systems. We don't target the LSS product for remote eye tracking, such as PC display or television based implementations", clarified Paul Karazuba, Director of Product Marketing for Imaging at Rambus.

"We estimate we can reduce the cost of the optics in a system significantly, but as each application is different, it's hard to place a general cost savings", he added, talking about cost reductions. So what sort of CMOS image sensor resolutions would Rambus typically recommend for such a lens-less eye-tracking application, and for anti-collision or SLAM robotic applications?

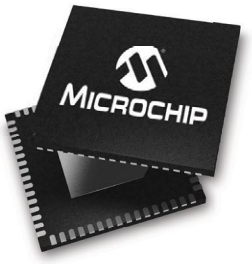
"For LSS in head-mounted eye tracking systems, we would likely use anywhere from CIF (352×288 pixels) to VGA (640x480 pixels), and for LSS in anti-collision or SLAM, we would use anywhere from CIF to 1Mp, application-dependent" Karazuba wrote *EETimes Europe.*

"Rambus has begun exploring licensing opportunities with select OEMs in our target markets. As part of this effort, we are securing a qualified third-party manufacturing chain that will allow our licensees to easily source LSS modules. We also offer licensees the option to manufacture LSS modules in their own facilities as well, if they have proper production capabilities to support LSS. The sensor resolution will be application- and market-dependent" he concluded.

First 2D/3D Development Kit

Out-of-the-box solution for touch sensing & gesture recognition

In an industry first, Microchip combines both 2D projected capacitive (PCAP) touch sensing and 3D gesture recognition in a single development kit.



The DV102014 development kit enables multi-touch finger tracking on the display surface and gesture recognition at up to 20cm above the display, based on Microchip's award-winning GestIC® technology. No Code development is needed which ensures fast and simple set-up and diagnostics with the downloadable Aurea 2.0 graphical user interface (GUI).

For rapid development and prototyping across a range of displays visit:
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-Got self-driving architecture? Show me

By Junko Yoshida

Tell us what your autonomous car's system architecture will look like in 2020. And draw us a block diagram.

Judging from pitches we've heard so far from chip suppliers such as Nvidia, Mobileye and NXP, their conceptions of an autonomous car platform (and how they plan to get there) tend to diverge. As long as everyone's jockeying for market position by leveraging what they already have and what they think can beat the others, that's understandable.

However, it's important to remember that the challenges facing OEMs and tier ones are the same: a growing number of ECUs; a variety of sensors piling into autonomous cars; sensory data that need to be processed, analyzed and fused; and security — the pot of gold for connected cars. Then, there are still evolving factors such as advanced vision processing, deep learning and mapping that will affect processing power demanded in the new system architecture.

So, here's the $64 million question. Do carmakers and tier ones today already know their autonomous car system architecture in 2020?

They don't. At least, not yet, Eric Baissus, CEO of Kalray, told EE Times, in a recent interview.

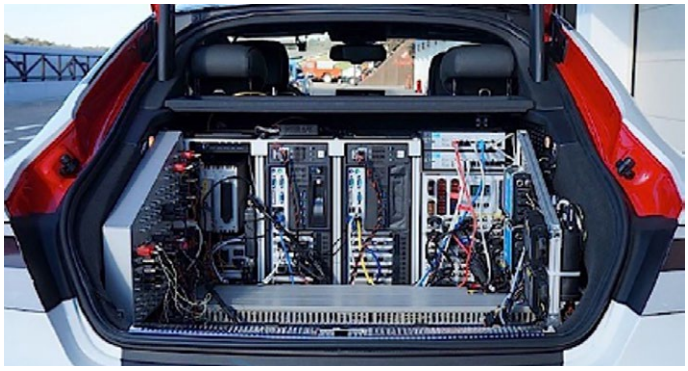
That's why Kalray, a Grenoble-based startup, believes it has a good chance to move its Massively Parallel Processor Array (MPPA) processor featuring 288 VLIW cores into the market.

Kalray's background is in extreme computing originally designed for nuclear bomb simulations at the CEA, Atomic Energy Commission, based in Grenoble, France. Today, Kalray is focused on the critical embedded market (aerospace); and cloud computing.

In Baissus' mind, self-driving cars fall into the critical embedded market, because they absorb a lot of data coming in from external and internal parts of a vehicle, process it fast and then proceed to make quick decisions.

Baissus said that the automobile industry needs "a new generation of processors that will have the ability to handle multi-domain function integration and perform processing tasks at an extremely high level."

Sure, the so-called "manycore revolution" has already come, Baissus said. "But nobody has successfully designed massively parallel 'supercomputing on a chip' with more than 100 cores." Kalray's newest generation 288 core processor, Bostan, integrates 16 clusters of 17 cores, 2MB shared memory (SMEM) at 80GB per second and 16 system cores.



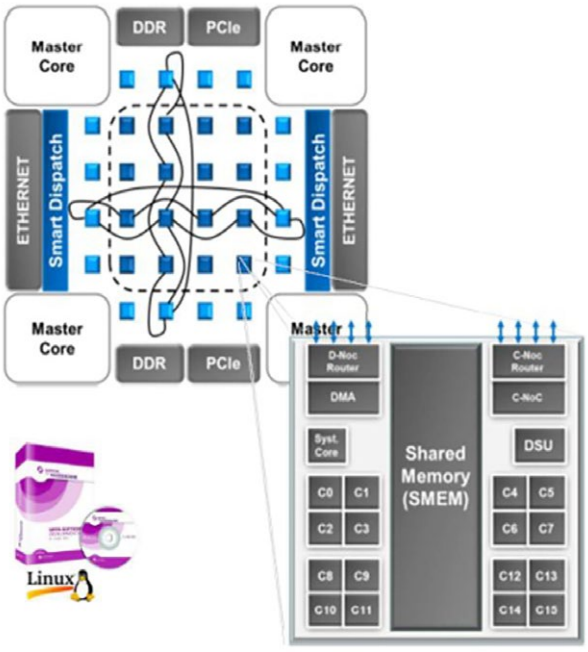
Is this perhaps what today's Google Car looks like inside? (Source: Kalray)

Further, Bostan is a "time-critical enabled network-on-chip," said Baissus, with a high-speed Ethernet interface (8x1 GbE to 10GbE). It's capable of the "on-the-fly encryption and decryption," and it offers "easy connection to GPU/FPGA accelerator." As a result, the Bostan MPPA architecture can offer DSP-type acceleration that's energy efficient and timing predictability, multi-domain support (different clusters, for example, could run different embedded operating systems used in different parts of a car), and scalable massively parallel computing (processors inside can be "tiled together to adapt to system complexity").

Determinism and C/C++

But isn't this "supercomputing-on-chip" pitch for autonomous cars similar to what Nvidia is promoting with its Drive PX?

Nvidia calls Drive PX "the world's most advanced autonomous car platform," combining deep learning, sensor fusion, and surround vision.



Kalray's Massively Parallel Processor Array Architecture. (Source: Kalray)

The big difference, as Baissus contends, lies in two things. First, Kalray's solution is "certifiable." By certifiable, he said, "I mean we can prove determinism, and we can guarantee timing," he said. "In high-performance computing, one-second delay is OK. But in a critical embedded market — such as aerospace and automotive — 10 millisecond delay could be fatal."

Second, for Nvidia's chip, programmers need to know CUDA, he said. "Our chip can run standard C/C++ code using standard tools and Linux." Automakers already have a lot of legacy code, algorithms written in C. Even when carmakers move onto the new autonomous car platform, legacy code will be important, Baissus explained.

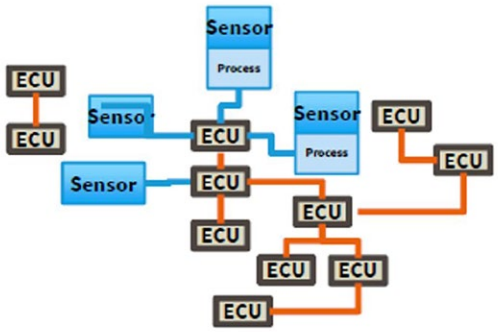
Nvidia is not alone in anticipating the need for a lot more processing power. Mobileye upped the ante, recently, by "pre-announcing" EyeQ5. The company is promising to deliver engineering samples in 2018.

EyeQ5, designed in advanced 10nm or below-FinFET technology node, will feature eight multithreaded CPU cores coupled with eighteen cores of Mobileye's next-generation

vision processors. The company said that the EyeQ5 will produce more than 12 Tera operations per second, while keeping power consumption below 5W.

Nobody, including Baissus, is taking Mobileye lightly. Unlike Nvidia's Drive PX, which many industry observers regard as a "test platform" for autonomous cars, Mobileye is going after the commercial market with increased processing power at a much lower power consumption level.

By leveraging its proven vision processing algorithms, EyeQ5 is now taking on data fusion — combining 20 external sensors (camera, radar or lidar) — into one.



System architecture of Car today (Level 1, Level 2). (Source: Kalray)

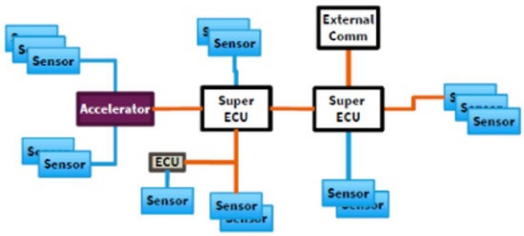
But can EyeQ5 master the ECU inside the autonomous car? A Mobileye spokesman explained to EE Times that EyeQ5 will do not just "data fusion" but also "decision making." But where that decision translates into action will take place elsewhere — on a "low-level ECU" chosen by automakers, he added.

Kalray is positioning the role of its manycore processor somewhat differently from Mobileye or Nvidia.

Need for a Super ECU?

Baissus told EE Times, "There have been a lot of advances made in sensors and machine-learning algorithms" necessary for autonomous cars. "But nothing has been really done in the processor domain." This is where Kalray sees its opening.

In his opinion, the next-generation processors in autonomous cars need to perform functions well beyond data fusion. "They have to act more as open platforms," he said. Kalray hopes to provide an autonomous vehicle open processing hub, which he calls a "Super ECU."



System architecture of Car tomorrow (Level 3, 4, 5). (Source: Kalray)

The super ECU is capable of integrating dozens of multi-domain functions on the same die. It will bring superior results in such critical segments as "sensing, learning, security, network, safety and cost," he explained.

Without naming names, Baissus told EE Times that leading car OEMs and Tier Ones are using current the Kalray platform to build their first prototype fleets. Baissus acknowledged that the autonomous car's system architecture is "still not mature."

But through collaborations with key players, Baissus hopes to learn more about carmakers' needs, in defining Kalray's new generation of solution for autonomous cars.

Asked about his business model, Baissus acknowledged that licensing its MPPA architecture to other automotive chip suppliers is also an option.

System architecture

Asked to compare how system architecture might evolve, Baissus shared the following diagrams. Today's cars have a collection of localized ECUs. They combine sensor, processing and control functions.

Kalray hopes to offer a Master ECU that aggregates ECUs for density and cost and sensor data for smarter control. Note that he isn't saying the Master ECU will do everything. If machine learning, for example, needs to accelerate its algorithm, the "master ECU will connect to accelerators when needed or a dedicated ECU," Baissus explained.

In the end, Kalray believes its manycore architecture can shine in autonomous cars in numerous ways. It can run "dozens of different control and data processing algorithms in parallel and in real time." Further, it can offer highly efficient machine learning. But most important, it offers very low latency.

In-chip supercaps could pack 50mF cm^{-2}, says VTT

By Julien happich

Combining MEMS and nanofabrication techniques, researchers at the VTT Technical Research Centre of Finland have designed a CMOS-compatible micro-supercapacitor structure that leverages the typically unused silicon bulk of chips' substrates to store energy.

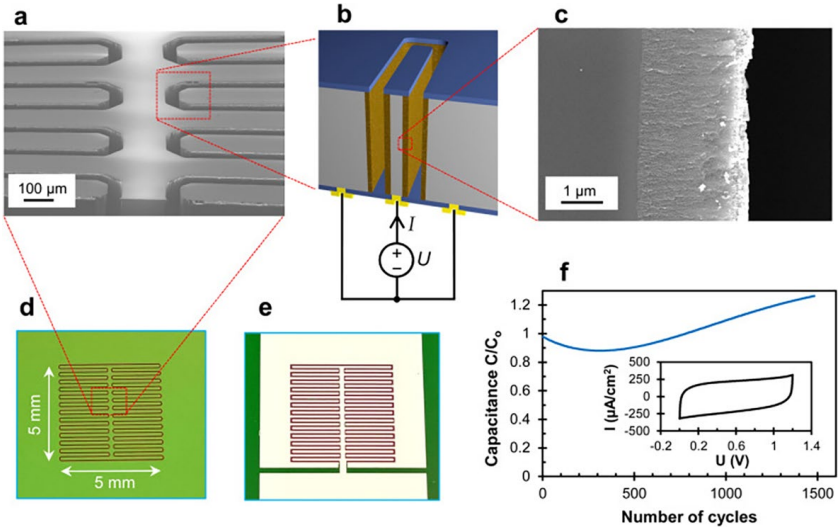
The supercap structure consists in microchannels etched in bulk silicon, whose sidewalls are treated to host a hybrid nanomaterial electrode consisting of Porous Silicon (PS) coated with a few nanometre thick titanium nitride layer (through an atomic layer deposition (ALD) process). The lateral thickness of the coated porous silicon layer as well as the length of the channels determine the capacitance of the whole structure expanding laterally within the chip substrate.

Conformal coating of PS is not straightforward due to very high aspect ratios which can reach 1:1000 and above, explain the researchers in a paper made available on Science Direct and to be published in Nano Energy this summer. But they tuned their ALD process to deposit a 10nm thick homogeneous layer of TiN inside the PS matrix. They then added contact pads and filled the trenches with a liquid electrolyte to obtain very efficient electrochemical double layer capacitors (EDLC) with almost ideal characteristics. This is thanks to the good electrochemical properties of TiN and the large area of the PS matrix, notes the paper.

What's more, the whole manufacturing process does not exceed 450°C, making it CMOS compatible, in effect turning the unused bulk silicon of planar chip designs into useful integrated energy storage pockets.

Characterizing a few prototypes, the researchers report a very high specific capacitance of 15Fcm^{-3}, an energy density of 1.3mWh cm^{-3}, and a power density up to 214W cm^{-3}, all combined with a stability exceeding 13,000 cycles (Prunnila later added that so far the maximum number of recorded cycles had been 50,000 only limited by the measurement time, with no observable degradation for the porous Si-TiN electrode material.

And for the first time, silicon-based a micro-supercapacitor competes with leading carbon and graphene based devices in power, energy and durability, concludes the paper.



In-chip PS–TiN supercapacitor. (a) SEM picture of the trenches separating the electrodes. (b) Schematic illustration of the cross-section of two opposite electrodes of a ready device (TiN coated PS layer and the aluminium contact pads on the back side are also present). (c) Higher magnification SEM picture of the porous regions. (d) Device trench side and (e) the metallization side containing aluminium contacts for supercapacitor electrodes. (f) Cyclic voltammetry curve at 100 mV/s (inset) and capacitance retention.

"The idea is to add these supercapacitors as a backend process, using the remaining bulk of the silicon substrate as free real-estate to stack multiple supercapacitors laterally", explained Dr. Mika Prunnila, Research Team Leader for Nanoelectronics at VTT, "but you could also envisage to connect multiple supercaps from 3D die stacks" he added.

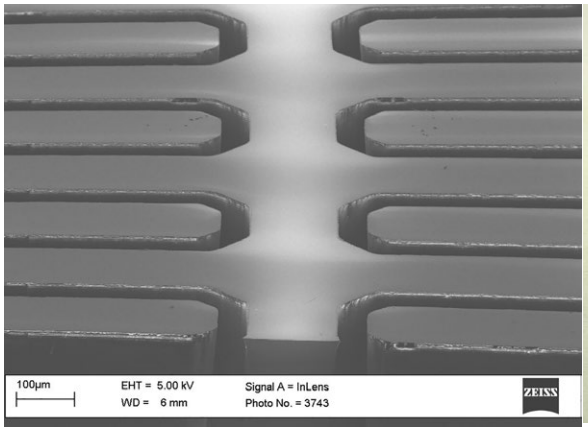
The prototypes were designed with different thicknesses of porous silicon layers within the trenches, only a few micron thick up to 7µm, but increasing that thickness could dramatically increase the capacitance values. As an extrapolation, the researcher estimates that with 20µm thick PS and the same electrode configuration, the device could pack 50mF cm^{-2}.

Prunnila sees commercial opportunities by licensing the IP for the design of embedded passive devices, or even to build standalone surface-mount silicon supercapacitors.

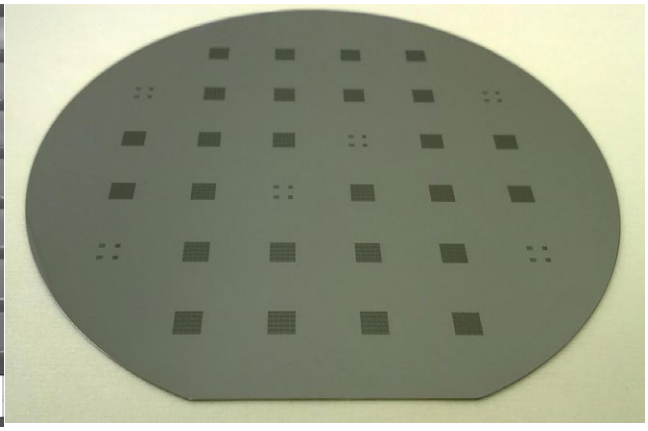
Now, the prototypes were uncapped, as shown on the illustrations.

"These prototypes were proof of concept, but next we need to work on sealing the devices, we are also exploring various solid-state electrolytes" Prunnila concluded.

Such micro-supercapacitors would nicely tie-up with energy-harvesting management ICs for autonomous sensor networks, wearable electronics and other IoT applications.



SEM image of the electrolyte channels.



Electrolyte channels on a 150mm wafer.

IMI Labs formed to accelerate chip materials selection

By Peter Clarke

Intermolecular Inc. (San Jose, Calif.) has divided its business into two halves; IMI Discovery, which licenses out intellectual property, and IMI Labs, which provides a service based business to find material systems.

IMI Labs, which has a 300mm wafer fab in San Jose, makes use of Intermolecular's high-throughput experimentation platform, materials expertise and analytics to speed exploration, discovery, characterization and selection of advanced materials. The use of atomic layer deposition and physical vapor deposition and up to hundreds of experiments on each wafer means that IMI Labs can optimize and bring up material systems rapidly.

Bruce McWilliams, who took over as CEO of Intermolecular in October 2014, pointed out that while 300mm wafer fabs are plentiful in industry they are devoted to mass production and not usually available to run experimental wafers.

IMI Labs therefore provides access to new or exotic materials that are risky to bring into billion-dollar fabs or production facilities.

"The future of innovation in the semiconductor industry is highly dependent on the discovery and selection of new complex materials," said McWilliams, in a statement. "With IMI Labs, semiconductor manufacturers can experiment with various material combinations without bringing new materials into their production fabs."

The company has been working with most of the leading DRAM makers in this way, both on material selection and with combined stacks for which IMI Labs can perform extensive physical and electrical characterization. The company said it now wishes to expand out to also cover digital logic.

Although IMI Labs does not have lithography equipment that goes down to the most advanced geometries for many tests this is not a problem, McWilliams said. He acknowledged that while a research institute such as IMEC or the Albany Nanotech center has access to extreme ultraviolet lithography and 10nm and 7nm geometries such set ups do not tend to be used for mass-screening of materials. Research institutes like IMEC are very complementary to us," said McWilliams. Promising areas for study include non-silicon materials, gate and contact stacks and materials for FinFETs, said McWilliam.

Inorganic materials look to replace silicon in solar cells

By Nick Flaherty

Researchers at the Institute of Photonic Science (ICFO) in Barcelona, Spain have fabricated a solar cell using low cost inorganic materials rather than silicon or perovskite. The solution-processed, semi-transparent solar cell is based on $AgBiS_2$ nanocrystals that can be produced in ambient conditions at low temperatures.

These crystals have shown to be very strong absorbers of light across a wide spectrum and have been further engineered to act as effective charge-transporting medium for solution-processed solar cells.

"They contain $AgBiS_2$ nanocrystals, a new material based on non-toxic elements and the chemical synthesis of the nanocrystals allows control of their properties through engineering at the nanoscale and enables their dissolution in colloidal solutions," said Dr Maria Bernechea. "The material is synthesized at very low temperatures, an order of magnitude lower than the ones required for silicon based solar cells."

The first cells have achieved power conversion efficiencies of 6.3%, which is on par with the early reported efficiencies of currently high performance thin film PV technologies, and the team is looking to double this to over 12%. This highlights the potential of $AgBiS_2$ as a solar-cell material that in the near future can compete with current thin film technologies that rely on vacuum-based, high-temperature manufacturing processes.

The team of researchers at ICFO developed these cells through a low temperature (100°C) hot-injection synthetic procedure. They first dispersed the nanocrystals into organic solvents, where the solutions showed to be stable for months without any losses in the device performance. Then, the nanocrystals were deposited onto a thin film of ZnO and ITO transparent conductive oxide, through a layer-by-layer deposition process until a thickness of approximately 35nm was achieved.

"A very interesting feature of the cells is that they can be made in air at low temperatures using low-cost solution processing techniques without the need for the sophisticated and expensive equipment required to fabricate many other solar cells. This gives AgBiS 2 solar cells significant potential as a low-cost alternative to traditional solar cells," said another member of the team, Dr Nicky Miller.

"This is the first efficient inorganic nanocrystal solid-state solar cell material that simultaneously meets demands for non-toxicity, abundance and low-temperature solution processing," said team leader Prof Gerasimos Konstantatos. "These first results are very encouraging, yet this is still the beginning and we are currently working on our next milestone towards efficiencies over 12%".

Furry LEDs in the making

By Julien Happich

As a first step to designing densely packed arrays of nanowire-sized LEDs, a team of researchers from Berlin-based Paul-Drude-Institut für Festkörperelektronik (PDI) have used a titanium foil as a flexible substrate to grow impeccably detached and vertically aligned GaN nanowires.

Grown through plasma–assisted molecular beam epitaxy, the nanowires they obtained exhibited a similar crystalline perfection, a lower degree of coalescence, a higher concentration of stacking faults, and a reduced density of inversion domain boundaries than those prepared on Si substrates, they reported.

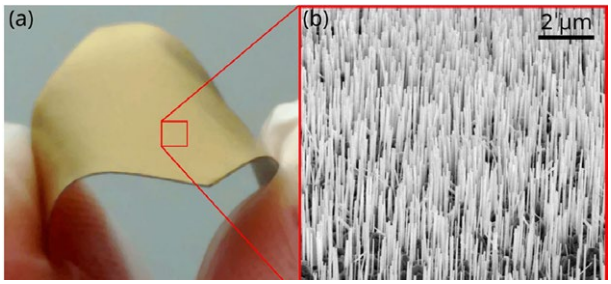
At the same time, bending the Ti foil substrate even to a radius of 4mm didn't affect the nanowires' structure, showing their very good adhesion.

"The next step will be to grow NWs with doped segments and an active region on Ti foils, and then we will adapt our established LED processing procedure to the new type of substrate. We believe that in particular the spinning of an insulating material that fills the space between the NWs will require optimization. The subsequent deposition of a top electrode will be very similar to the processing on Si", explained Dr. Lutz Geelhaar, Head of the Epitaxy Department, pointing EETimes Europe to his team's previous work on the characterization of (In,Ga)N/GaN nanowires-based LEDs.

So would this yield clusters of LED-forming NWs or would the researchers aim at individually addressing nano-sized LEDs from this high density carpet of LEDs?

"By patterning the top electrode, LEDs can be fabricated that can be individually addressed even though they share the same conductive substrate" Geelhaar answered.

Indeed, in prior research, Geelhaar demonstrated clusters of NW-LEDs about 0.2mm² in area, and estimated that the actual density of NW-LEDs that could potentially be designed (each NW being around 100nm in diameter) could be of the same order of magnitude as the total density of NWs orderly grown on a substrate, measured in billions per square centimetre.



(a) Photograph of the Ti foil after nanowire growth demonstrating a high degree of flexibility. (b) Scanning electron micrographs of the GaN nanowire ensemble grown on the Ti foil taken in bird's eye view.

Since (In,Ga)N/GaN nanowire ensembles could be designed with bandgaps ranging from the UV to the infrared, this research not only opens the path to flexible high density LED arrays, but could also lead to very high density, bright and bendable full colour LED displays.

Cheap plasmonics to enable full-colour fast switching e-paper

By Julien Happich

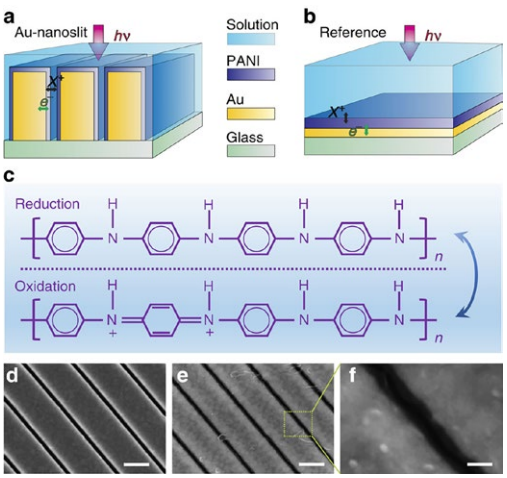
Looking into ways to design high-resolution low cost display panels, researchers from Sandia National Laboratories and the Center for Nanoscale Science and Technology at the National Institute of Standards and Technology have re-visited the concept of e-paper by combining inexpensive electrochromic polymers with plasmonic structures.

Prof. A. Alec Talin and his colleagues presented their findings in the journal Nature Communications with the paper "High-contrast and fast electrochromic switching enabled by plasmonics", showing a candidate technology for the cheap manufacture of thin full colour displays with resolutions two orders of magnitude higher than today's high-definition displays, while boasting switching speeds in the range of milliseconds.

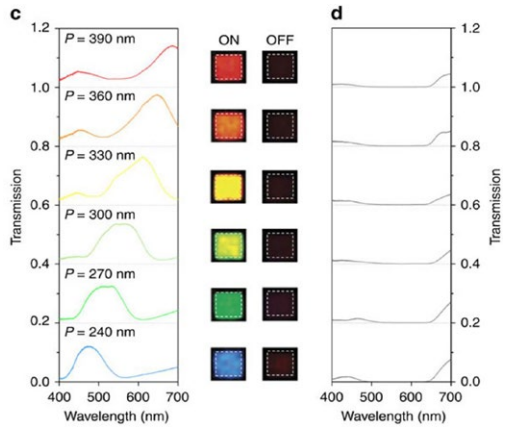
Instead of having to stack multiple layers and colour-specific electrochromic polymers sandwiched with dedicated control electrodes, Talin relied on Au and Al metallic nanoslit arrays (serving as the plasmonic structures) conformally coated with two ordinary electrochromic polymers, PANI and PolyProDOT-Me2. The arrays of vertical nanoscale slits (each slit only 60nm deep and 250nm wide with a pitch of 500nm) are perpendicular to the direction of the incoming light. When light hit the aluminium nanoslits, it was converted into surface plasmon polaritons (SPPs), which are electromagnetic waves containing frequencies of the visible spectrum that travel along the dielectric interfaces - here, of aluminium and electrochromic polymer.

The plasmonic structure would turn into a deep black by simply applying a tiny electric current across the top of the slit, cutting off the entering light and the SPPs within milliseconds. When the current was flicked off, light frequencies passed through the slits and instantly turned on the pixel.

Here, because the pitch of the slits determines the wavelengths of the light being transmitted down through the array, by changing the nanoslit patterns, the researchers were able to demonstrate a whole array of switchable colours using the same electrochromic polymers.



Schematic diagram of a plasmonic electrochromic electrode incorporating (a) Au-nanoslit array and (b) reference planar electrochromic electrode. The pitch of the Au-nanoslit array is 500 nm. (c) Chemical structures of PANI in the reduced and oxidized form. SEM images of the fabricated Au-nanoslit electrode (d) before and (e) after deposition of a PANI to a thickness d≈15 nm. (f) Magnified SEM image from e. Scale bars, 300 nm (d,e). Scale bar, 100 nm (f).



(c,d) Optical transmission spectra of PolyProDOT-Me2-coated Al-nanoslit structures with respective values of slit period P=240, 270, 300, 330, 360 and 390 nm, along with corresponding optical micrographs of device areas imaged in transmission. Transmission spectra and micrographs for (c) ON and (d) OFF states of the polymer are displayed, respectively.

The paper concludes that using such simple plasmonics considerably simplifies the fabrication process and could easily be extended to large areas for mass production, using a flexible substrate through techniques such as roll-to-roll nanoimprint lithography or nanotransfer printing.

For their experiments, the researchers created colour pixels about 10×10µm each, but Talin pointed *EETimes Europe* to an earlier paper "An Integrated Electrochromic Nanoplasmonic Optical Switch" published in Nano Letters, demonstrating that a single slit device could effective switch light on or off.

"However, in order to use the slits array to define colour, several slits with regular spacing on the order of the optical wavelength are necessary, which would require dimensions of around 1 micron or larger" Talin wrote in an email exchange.

When asked if he is envisaging the commercialization of such high definition colour electrochromic displays, either through IP licensing, or through a spin-off company, Talin answered: "Currently neither myself nor any of my co-authors are actively pursuing commercialization of our plasmonic-electrochromic display concept. However, we would be excited to engage any company interested in pursuing this technology, including IP licensing. Although I have considered several possible commercial names for the plasmonic-electrochromic displays, none have been trademarked at this point".

Talking about the technological transfer necessary to take these findings from the lab to commercial success, the researcher said: "The principal technological barriers to widespread adoption, in my opinion, include the demonstration of a reflective version which uses ambient light, then the integration of pixel arrays with drivers, replacing the liquid electrolyte we used in our paper with a solid polymer electrolyte or inorganic electrolyte and the use of a roll-to-roll compatible manufacturing method, such as nanoimprint lithography, to fabricate the nanoslit arrays".

"None of these represent barriers that require new scientific breakthroughs, rather mostly engineering and development" he concluded.

Feeling virtual objects at your fingertips

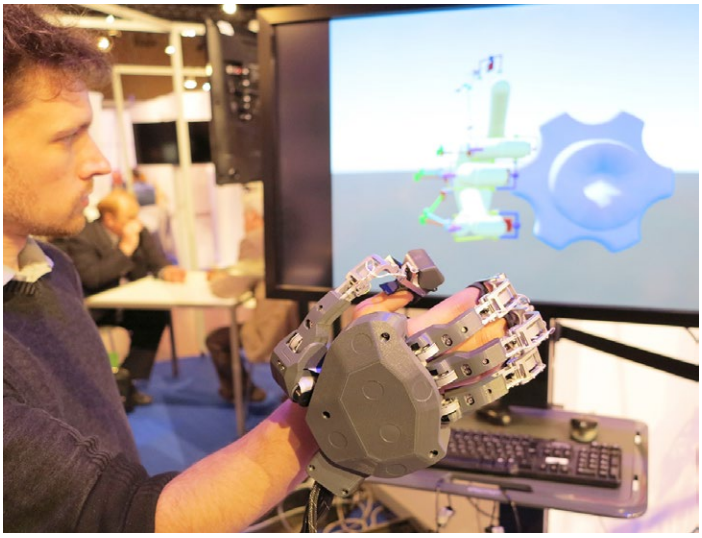
By Julien Happich

Manipulating objects in the virtual world may become a bit more straightforward if you wear CEA-LIST's latest hand exoskeleton, a sort of mechanical glove laden with sensors and actuators. The haptics-enabled contraption gives the wearer actual physical cues about the objects being manipulated in 3D, to finger joints and tips.

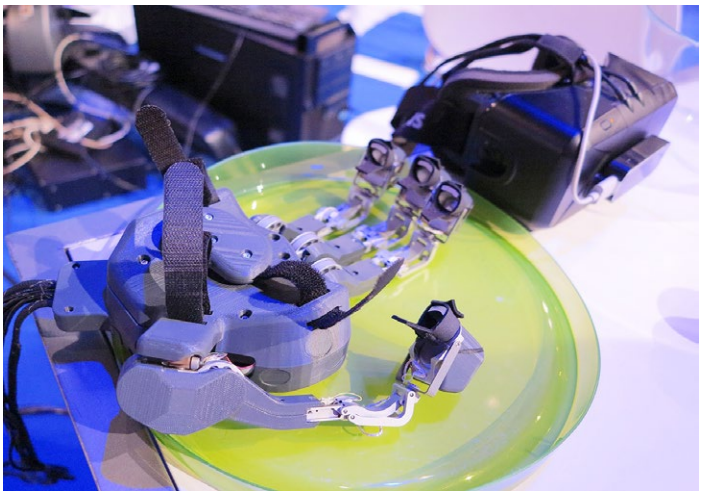
A Research Engineer at CEA-LIST's Interactive Simulation Lab (LSI), Vincent Weistroffer exhibited a first demonstrator at Innorobo, freshly assembled less than two weeks ago as the end result of the MANDARIN project (MANipulation Dextre hAptique pour opéRations INdustrielles en RV which could translate as dexterous haptic manipulation for VR industrial operations).

Backed by the French National Research Agency (ANR) with industrial partners including haptic interfaces provider Haption and car maker Renault, the MANDARIN project, which also involves the Inria Rennes and the Université de Technologie de Compiègne, aims to deliver a virtual object manipulation interface for immersive environments, which industrials could use to intuitively explore complex structures or to train technicians with assembly or disassembly procedures. With force-feedback implemented on four fingers, the exoskeleton glove gives the wearer the sensation of manipulating real physical objects, exactly as they are displayed on screen or in a virtual environment. The glove could also be used to remotely control a slave robotic hand or manipulator.

"Next, we'll implement hand position tracking using IR camera and reflective markers placed on the exoskeleton", Weistroffer told EETimes Europe, showing round recesses in the 3D-printed plastic casing. "In the future, the hand could be mounted on a full haptic arm exoskeleton to implement stronger force-feedback, so you would not be able to force your way through a virtual object" the researcher added.



Weistroffer demonstrates the MANDARIN, delicately turning a virtual knob.



CEA-LIST's freshly assembled MANDARIN demonstrator.

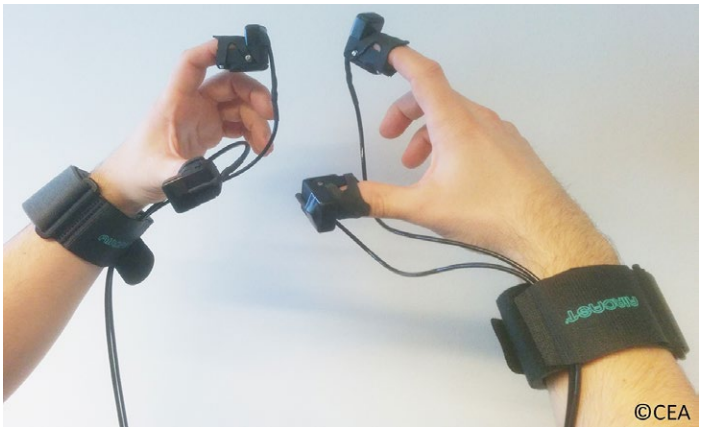
At the finger tips, a small rotating cylinder provides haptic feedback, simulating shear forces exerted on the finger pulp as one drag his/her finger across a surface. At this stage, the bulky prototype is only a demonstrator, but Haption may want to integrate it further, optimizing its construction for industrialization.

"Renault is interested in this project to train its operators disassembling electric batteries", explained Weistroffer, "using virtual environments, they could train several operators at once, and they wouldn't have to re-assemble physical models before the next disassembly session, which consumes a lot of time" said Weistroffer.

We reached out to Florian Gosselin, Project Leader at CEA LIST's Interactive Robotics Lab (LRI) for more specific details about the haptics implementation.

"The hand exoskeleton combines a peak force feedback of over 1kg to the finger tips upon grabbing an object, with additional haptic feedback on individual fingers thanks to a small rotating drum in contact with the pulp of each fingertip", he explained.

"The rotating drums emulate the sensation that the wearer would perceive when sliding their fingers across a surface" Gosselin added, "but we have also designed another haptic combination we call Haptips, where a small tip presses against the pulp of the fingertips".



The Haptip fingertip-mount devices.

Using micro-motors and miniature cable pulleys, the tip is displaced in a plane frontal to the fingertip so as to simulate shear force feedback in 2D.

"The Haptip fingertip-mount feedback actuators do not require a full hand exoskeleton to operate, they are lighter, less obtrusive and offer a one-size fits all solution. In that case, we can keep track of the fingers' positions relative to the palm

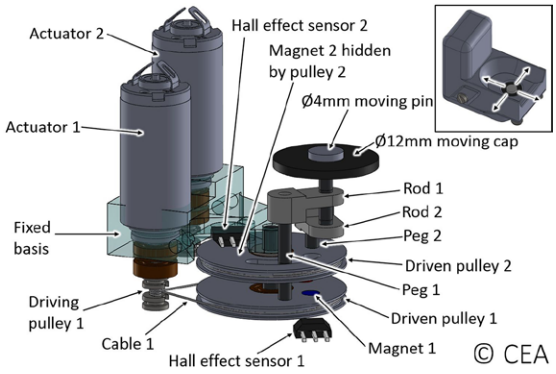
using a commercial LeapMotion IR sensor".

"The Haptips could also be mounted at the tip of the hand exoskeleton in place of the rotating drums."

"With these two haptic effects, we combine full-hand force feedback for the grabbing action with the fingertip-level precision feedback necessary to allow the wearer turn a knob with precision for example", commented Gosselin.

"For a fully integrated exoskeleton solution, we have also designed innovative optical sensors on the joints combined with optical encoders on the motors to detect the individual fingers' positions. The whole hand position is acquired using standard motion capture".

The technology could find other use cases such as health rehabilitation, technical education and in the long term, it may even trickle down into consumer applications such as video games for improved interactivity.



Exploded view of the Haptip device (top right hand corner: the assembled device within its housing).

Micro-VCSELs and silicon photodiodes into flexible micro-fluidics

By Julien Happich

Researchers from the University of Southern California have designed fully encapsulated flexible opto-fluidic fluorescence sensors based on the heterogeneous integration of thin film micro-VCSELs and silicon photodiodes.

Only a few micron thin and measuring a few square centimetres (including the fluidic micro-channels polymer overlay), the flexible sensors were proven to perform multiplexed, real-time monitoring of fluorescent analytes flowing through the transparent-fluidic channels, at luminophore concentrations as low as 5×10^{-5} weight %.

This heterogeneous co-assembly on a flexible PET substrate was only possible thanks to a transfer-printing method the scientists had developed in prior research, enabling them to lift-off micrometre-thin microscale VCSELs from their GaAs growth wafer as well as the silicon photodiodes (Si-PDs) from their SOI substrate before gluing the devices in a predetermined pattern to build the sensor.

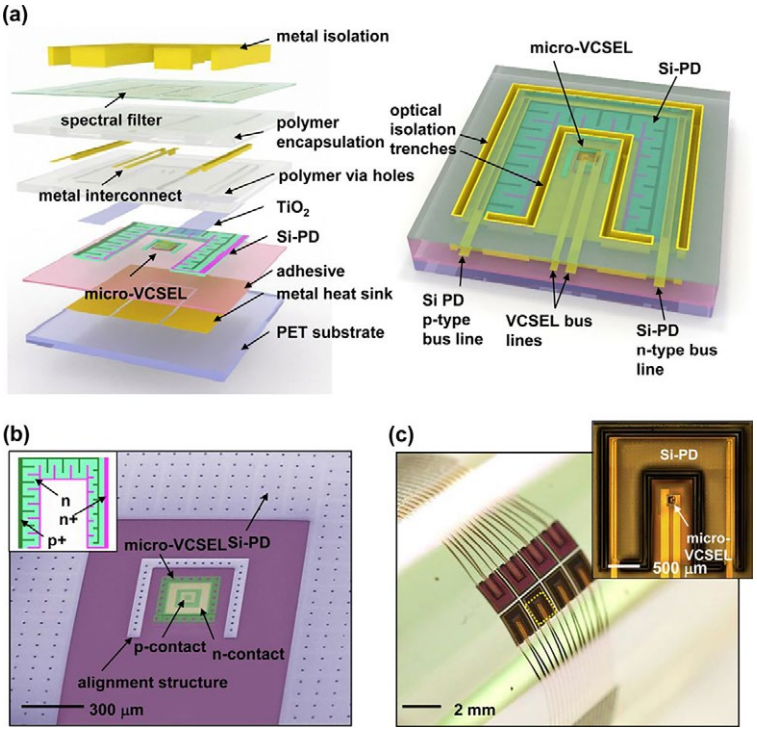
Using this transfer-printing method, the researchers broke free of the limitations of traditional semiconductor substrates. They were able to design sensor arrays over a large area in a flexible, liquid-proof layered construction, each sensor including an 850nm-emitting micro-VCSEL surrounded by a U-shaped array of Si-PDs, the two being optically separated by metallised trenches.

The optical stack also included multilayer-based angle- and wavelength-selective spectral filters to reduce optical cross-talks between the co-integrated micro-VCSELs and Si-PDs, hence optimising the signal-to-noise ratio and detection threshold of the fluorescence sensor as luminophores circulated in the micro-fluidic channels and reservoirs laminated on top of the devices.

The whole laminated elastomeric fluidics and optical sensor assembly was shown to reliably perform fluorescence measurements even under repeated flexure at a bending radius as small as 50mm, the researchers reported.

An interesting note is that rather than losing out on output power, the micro-VCSEL (with an aperture area of $22\times22\mu m^2$) actually increased from circa 4.5mW as characterised on its GaAs source wafer to circa 5.3mW after polymer encapsulation. The researchers attribute this to the polymer layer on top of the laser aperture, resulting in an increase of the transmitted lasing output.

Such flexible sensor arrays could be designed to detect various luminophores simultaneously across large areas with distributed sensors. Ultimately, these flexible opto-fluidics could find their way into wearable diagnostic systems or even implantable devices for in vivo fluorescence sensing or imaging. Here, mechanical flexibility would make the sensors less obtrusive.



(a) Exploded- (left) and tilt-view (right) schematic illustrations of mechanically flexible integrated fluorescence sensors based on heterogeneously integrated micro-VCSELs and silicon photodiodes (Si-PDs) on a polyethylene terephthalate (PET) substrate. (b) Tilt-view colorized scanning electron microscope (SEM) image of an 850 nm-emitting micro-VCSEL co-integrated with a 3µm-thick Si-PD on a silicon substrate. The inset shows the detailed doping layouts of Si-PD including n+- and p+-doped regions in the n-type background. (c) Photographic image of a 2×4 array of the interconnected fluorescence sensor on PET wrapped on a cylindrical support (bending radius: 12 mm).

Paper and graphene yield cheap disposable displays

By Julien Happich

By sandwiching a sheet of ordinary printing paper (impregnated with a ionic liquid electrolyte) between two films of multilayer graphene (MLG), researchers from the Bilkent University in Ankara, Turkey, were able to design reconfigurable and foldable paper displays, which they hope could find their way in cheap disposable applications.

The experiment stems from prior research performed by Prof. Coskun Kocabas' team, demonstrating that the reversible intercalation of ions into multilayer graphene (by applying a bias voltage), can modulates the optical absorption of these layers, turning them from dark metallic to transparent.

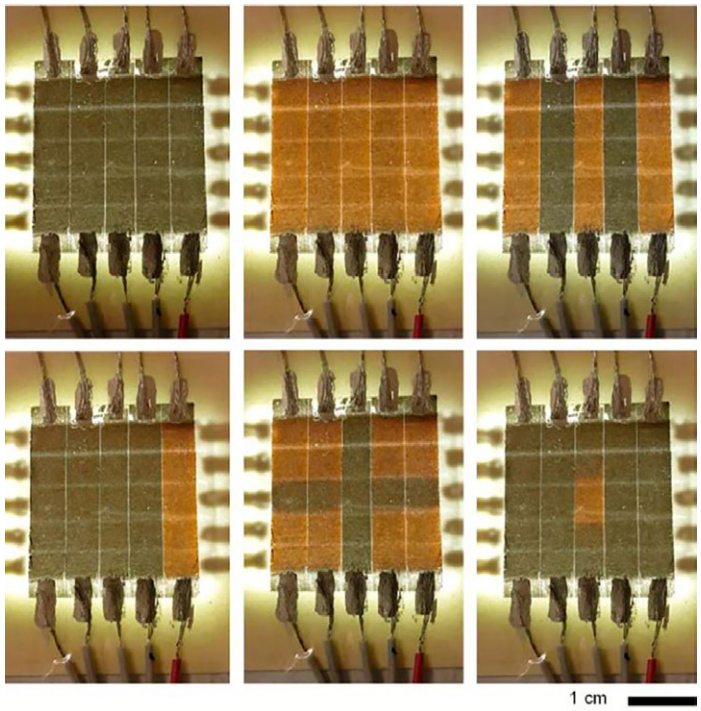
Contouring shape-specific electrodes in the MLG film and connecting them with silver-based conductive paint, the researchers simply used the multilayer graphene films as a high-contrast optically reconfigurable medium to turn on and off segments of the display.

Under a bias voltage, the anions of the ionic liquid intercalate into the graphene layers and block the interband transitions in the visible spectrum, they wrote in a ACS Photonics paper "Graphene-Enabled Optoelectronics on Paper".

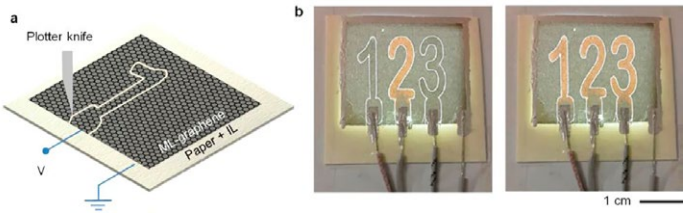
The intercalation cycle (going transparent) takes relatively long, about 4 seconds while the de-intercalation cycle (going back to dark) takes under 0.5s, which suggests such displays would mostly be suited to signage applications where content is not refreshed too frequently.

In their paper, the researchers detail several implementations operating with a bias voltage from 0 to 4V, some with pre-defined electrode patterns that would turn transparent and stand out from their dark metallic background.

They also suggest the printing of matching colour patterns on the paper substrate prior to applying the MLG film, so as to reveal colour when the electrodes turn transparent.



A 5×5 pixel array in demonstration, featuring a cross bar structure of perpendicular graphene electrode strips, 5mm wide and 25mm long.



(left) the planar paper display showing a MLG electrode patterned using a plotter. (right) The number-shaped segment display in operation showing the isolated elements controlled individually.

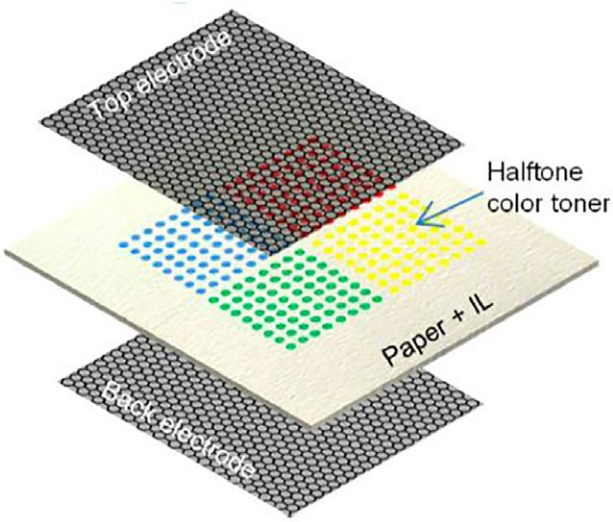
They also demonstrated a 5x5 multipixel paper display using a cross bar structure. The back and front graphene electrode strips, 5mm wide and 25mm long, yield square addressable pixels each 5x5mm in size.

By applying various bias voltage of 0, 2, and –2V to the rows and columns, they could control the colour of the intersecting area, again turning it from metallic to paper-view. The display remained operational upon being folded or even creased.

A limitation though, is the oxidization of the doped graphene layers, but the researchers are confident that coating the surface with a thin polymer layer could drastically improve the durability of such a display.

Next, Kocabas' team went to port their manufacturing method to a roll-to-roll compatible process, transferring multilayer graphene films onto A4-size printing paper.

As the researchers conclude in their paper, cutting, folding, and printing are common processes in the printing industry, which could take this novel paper-display approach to their advantage to design cheap reconfigurable displays with unique 3D shapes and colours.



A colour display could be formed by printing halftone colour toner on the paper prior to sandwiching it between the MLG electrodes.

Soft lightweight data gloves fit VR and musicians

By Julien Happich

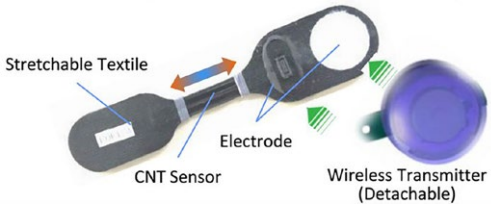
Yamaha's lightweight and unobtrusive data gloves as demonstrated by a pianist.

In cooperation with the Shizuoka University (Japan), Yamaha Corporation is investigating the use of millimeter-long multi-walled carbon nanotubes (MWCNTs) in elastomeric strain sensors for wearables.

The music instrument maker is not only looking into virtual reality applications where lightweight and soft data gloves could replace bulky and rigid alternatives, but would also naturally fit such data gloves to musicians, whose fine finger motion could be better monitored with thin and stretchable fabric-based sensors.

In a recent ACS Sensors paper titled "Rapid-Response, Widely Stretchable Sensor of Aligned MWCNT/Elastomer Composites for Human Motion Detection", the Japanese researchers reported about thin CNT-based strain sensors designed to be integrated into textile-based wearable sensing systems (be it at arm, hand, or finger level).

They used a sheet of unidirectionally aligned MWCNTs impregnated with an elastomer (urethane resin), making electrodes with a conductive paste on each extremity to form sensors a few centimetres long and stretchable up to twice their original length. Only a few micrometres thick (up to 200µm with an added layer to support the device's elasticity), the strain sensors obtained had a response time under 15ms with a gauge factor exceeding 10 (high sensitivity).



The CNT-based strain sensor development kit.

A rugged version of Yamaha's CNT-based VR gloves with tracking markers for VR applications.

As well as repeatability, the strain sensors also exhibited a very high resistance variation linearity. The researchers attribute this to the use of very long CNT bundles (with MWCNTs 300 to 800µm long). While elongation creates cleavages and gaps that increase the resistance, because the MWCNTs are so long, neighbouring CNTs remain in contact as they slide and rub against each other, ensuring a much more progressive decrease in conductivity less affected by created gaps than if their length were on the order of micrometres. Upon contraction, the MWCNTs reorganize more densely and the original resistance is restored.

What's more, the new sensors do not require any special readout circuits or amplifiers, they are resistant to external noises and highly sensitive over a relatively high resistance range, making them easy to integrate into fabric-based wearables.

The paper cites sports, healthcare, rehabilitation, and robotics as different fields of application where such a soft and stretchable strain sensor could be used to measure and analyse motion dynamically.

The researchers then developed a prototype sleeve incorporating the CNT strain sensor connected through conductive silvered synthetic fibres into a stretchable compression fabric. They also devised a soft data glove (as shown worn by a pianist), able to detect the fine motions of the finger joints (the black strips on the glove are the CNT-based strain sensors) without hindering the wearer's movements.

Manager of Materials & Components Group at Yamaha's R&D Division, lead author Dr. Katsunori Suzuki accepted to share with EETimes Europe his insights on the sort of products Yamaha may be envisaging.

"The data gloves introduced in our paper were specifically designed to detect finger movements in a musician's dystonia (a neurological movement disorder) under a joint study with a Japanese university" he wrote us in an email.

"We have no plan to sell it to consumers at this moment, but instead, we'll be releasing a more robust design for Virtual Reality applications in 2016".

Yamaha organized a live piano performance demonstration using its prototype VR glove in the 2nd Wearable Expo held last January in Tokyo, superposing the sensor data in virtual reality over virtual hands as a series of expanding and contracting spheres synchronized with the movements of the pianist's fingers.

"We are investigating applications for the VR glove as a means to help pianists improve their skill. We think the VR glove will be suitable for music learning apps to serve real-time suggestions", Suzuki added, "because our VR glove is much more stretchable and thinner than what's available on the market" he wrote, taking the CyberGlove as an example.

Indeed, coming from a music instrument maker, one could easily envisage internet-connected data gloves with cloud-based analysis related to the specific instrument and partition being played.

The company also held a demonstration of VR manual assembly in a preliminary design phase using the same system, simulating an automobile engine assembly. The glove wearer would also sport an Oculus Rift to display the 3D CAD data for the automobile engine as well as a simulation of the assembler's hands corresponding to the movement of the VR gloves. In that case, the gloves were fitted with extra markers for hand tracking in free space.

Yamaha has started shipping sensor development kits to customers, including two sensor bands and a detachable Bluetooth wireless transmitter. For export, the company is also preparing a "wiring systems" that would connect directly an USB port to display the raw data obtained from the sensors.

Advanced simulations for G.fast, Vectoring & Co

By Daniel Hincapie and Mathias Leibiger

The evolution of copper-based transmission systems has transformed the access network and elevated its complexity. Simulation tools help to enhance the performance of DSL systems: they reproduce the particularities of the provider's network and use simulation studies to provide realistic performance estimation.

For several years, the cost-effectiveness of copper-based transmission systems has been the pillar of broadband internet access for domestic and corporate markets. Digital Subscriber Line (DSL), a family of technologies that provides broadband access over the telephone infrastructure, has continuously evolved aiming at providing faster and more stable services reusing the existing copper network. Its low investment requirements, great coverage and high data rates and stability make DSL a very attractive physical platform for supporting and offe-ring services that demand high data rates.

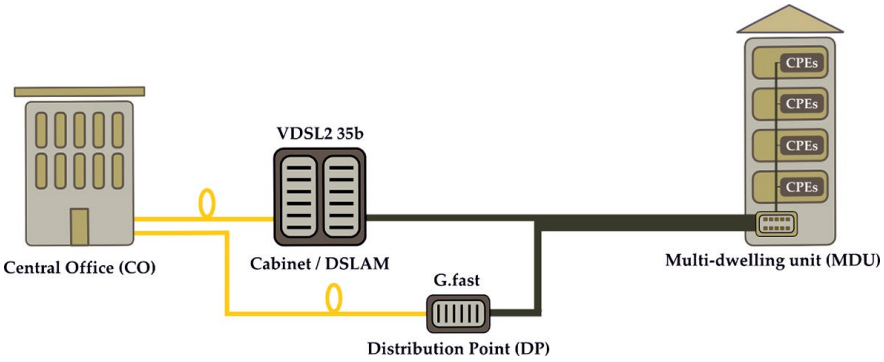


Fig. 1: In the Access Network the DSLAM terminates the optical fiber, and the twisted copper pair establishes a connection to the wall plug unit. Finally the CPE provides access to the internet via wired Ethernet or Wireless LAN.

The evolution of copper networks has been demarked by the necessity of counteracting two issues that limit their capacity: attenuation and crosstalk interference. Long loops, very common in former telephone networks to cover large territories, exhibit high attenuation of the transmitted signals, which reduces the Signal to Noise Ratio (SNR) at the receiver side and consequently, its capacity.

This problem is aggravated by the usage of wide spectrum in new DSL systems that intends to add capacity in high frequency carriers to increase data rates; the attenuation levels are so high that high frequency carriers cannot carry any bit. On the other hand, the copper network is an end-to-end network that groups lines in an electromagnetically coupled medium: the cable-binder. Thus, services operating within the same cable-binder interfere with each other, mutually limiting their achievable data rates. This interference is known as crosstalk.

Vectoring mitigates crosstalk and obtains single line performance

DSL operators have transformed their copper network replacing long copper segments by optical fiber links. Thus, operators' access system so called DSL Access Multiplexer (DSLAM) is installed at locations closer to the Customer Premise Equipment (CPE), reducing the signal attenuation and the number of mutually interfering services. Additionally, manufacturers have introduced techniques that allow DSLAMs and CPEs to compensate the crosstalk interference.

This novel technique is known as Vectoring and uses Multiple-Input Multiple-Output signal processing to mitigate crosstalk and obtain single line performance. Therefore, transmission systems are not any longer seen as independent entities interfered by and interfering with coexisting counterparts.

Instead, they are treated as collaborative entities that constructively use their mutual interaction, i.e. interference, to maximize their performance.

The transformation of the copper network and the new systems implementing advanced algorithms arise new challenges. The complexity of the network is higher since more DSLAMs are required to cover the same number of users, so the network topology becomes more diverse and heterogeneous.

Moreover, regulative issues allowing multiple providers to serve users in the same cable-binder introduce a new degree of freedom with non-controlled services generating crosstalk interference that cannot be compensated by Vectoring.

These factors may attempt against the roll-out success of new DSL technologies such as Vectoring and G.fast. Therefore, service and network operators demand tools that help them to accurately evaluate the potential of new copper-based technologies, while provi-ding useful information for taking solid and strategic decisions for their business expansion and consolidation.

A customized simulation tool for DSL technologies

Through continuous research, Fraunhofer ESK has developed a customized simulation tool for Digital Subscriber Line (DSL) technologies that realistically model the complex network scenarios of the current copper access network. The tool takes the particularities of service provider networks (e.g. cable-binder type, loop length, use cases, etc.) into account and reproduces them using computer-based models of MIMO channels and signal processing units.

Fraunhofer ESK develops accurate MIMO channel models that reproduce access network scenarios and use them in extensive simulation studies to calculate the achievable data of real services under the given network conditions. Providers can then count on simulations results to take strategic decisions; for example, evaluate the performance improvements

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Mathias Leibiger is Group Manager Access- & In-house networks at Fraunhofer ESK

of Vectoring-VDSL2 in comparison with legacy technologies to upgrade their systems; calculate the achievable data rates of G.fast to estimate the possibility of offering new services that demand high data rates; or calculating the potential impact on and of competitors networks, and study possible strategies to reduce it.

Figure 1 depicts a typical access network scenario for DSL services. As a consequence of progressive introduction of new technologies, broadband users at a building may be served by two different DSL technologies with access devices, i.e. DSLAMs, located at different distribution points.

They may either belong to different providers or be part of the same network operator. In this example, we have chosen VDSL2 35b and G.fast since they are the most recent standardized DSL technologies. VDSL2 35b is an extension of the well-known VDSL2 that widens the operative spectrum up to 35 MHz. G.fast introduces new technological changes and enables to achieve gigabit data rates in short-range loops.

The present modelling and simulation approach allows us to obtain very accurate and detailed models of scenarios like the aforementioned. In addition, multiple aspects impacting systems performance can be considered, such as the number of users of each service, the relative position between DSLAMs, the target data rates of services, the loop length of users and their position within the cable-binder, settings of transmission systems (transmitted power, spectrum, upstream/downstream ratio, etc.), among others.

These aspects are varied and statistically analyzed to obtain average indicators and performance ranges that are important to define providers' service coverage, portfolio and expansion strategies. As an example of the usability of our simulation tool for such purposes, figure 2 shows the data rates that G.fast services with loop lengths between 30 m and 430 m can attain for different configuration settings of DSLAMs transmitters.

A service provider can use these results to define the services that could be offered in accordance to the achievable data rates. Additionally, if information of the loop length distribution of operator's network were available, the percentage of potential clients achieving a given data rate, and consequently a given service, could be determined.

Another aspect that concerns broadband service providers nowadays is the coexistence of multiple operators within the same cable binders. As in figure 1, a service provider serving its users with VDSL2 35b from the cabinet may plan to upgrade its services to G.fast. The operator shall then replace a copper segment by optic fiber and locate its DSLAM in a distribution point closer to customer premises, so G.fast can provide higher data rates.

However, relocating DSLAMs impacts both former and upgraded services since topology changes increase interference power. Therefore, it is important to estimate the mutual impact that upgrading services may have to avoid degrading the performance of users that remain with the existing service and calculate the real improvements that deploying the new technology brings.

Figure 3a and 3b shows the data rate achieved by 24 VDSL2 35b (red line) and G.fast systems deployed in the topology depicted in figure 1.

The results evaluate the case when 8 VDSL2 users are upgraded to G.fast (green line) and compare their performance with respect to the initial setup in which all services operate with VDSL2 35b.

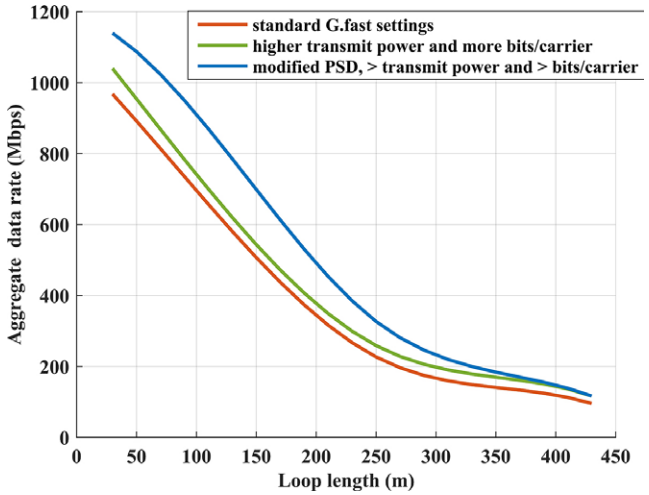
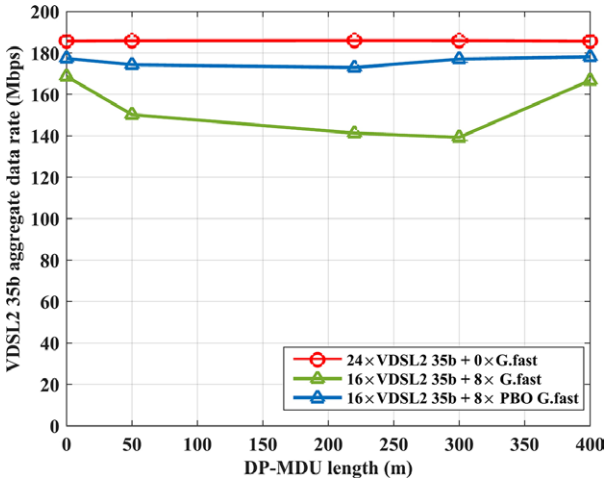


Fig. 2: The data rates which are achievable with G.fast depend on the loop length. These data rates can be optimized with different settings.

In addition, the performance of a very common technique used to mitigate the increment of interference known as Power Back-Off (PBO) is shown.

Therefore, adding new systems without taking the existing system into account will result in a reduced performance of all systems, but simulation enables operators to evaluate the overall performance and get optimized settings for the existing and



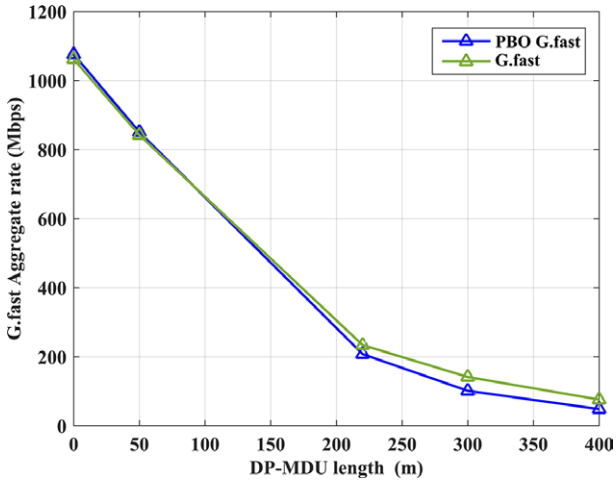


Figure 3a and 3b show the data rate achieved by 24 VDSL2 35b and G.fast systems deployed in the topology depicted in figure 1.

the new technologies.

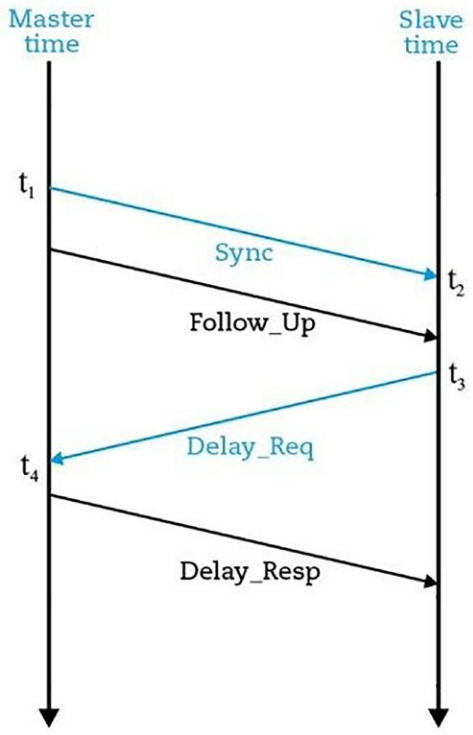
This kind of analysis is not only valuable for estimating the benefits of deploying new technologies, but can also provide a means to optimize the configuration settings of existing systems. Such optimization processes and evaluation of the impact of new technologies for and with several European providers has been successfully carried out in ESK laboratories. This allows operators to take the right investment decisions.

White Rabbit networks for PTP users

By Trinidad Garcia

Precise time synchronization has become an indispensable tool for supporting the proper operation of distributed real-time systems as required on many industrial, telecommunications and safety critical applications. For this reason, there is a growing concern about how to avoid uncoordinated actions and the consequent generation of instabilities that impact the reliability of a distributed system operation. As time synchronization and distribution become more critical, new technologies have emerged to enable the management of core industrial operations and decision-making processes in an efficient and resilient way.

One of the most common protocols for industrial time transfer in a network is the well-known IEEE1588 Precision Time Protocol (PTP). IEEE1588 PTP synchronizes multiple clocks over networks such as Ethernet and provides sub-microsecond time synchronization over long distances using just Ethernet links. This requires establishing which device will serve as Master clock (in a Master/Slave scheme) and properly measure the time skew generated by the clock offsets and the network delays.



Scheme of the message flow in WR-PTP.

Trinidad Garcia is Postdoctoral Researcher at Seven Solutions – www.sevensols.com

The link delay between two nodes (Master and Slave) is evaluated through the exchange of precise time-stamps (typically done using hardware assisted time-stamping mechanisms) in a network segment: An initial message sent by the Master node to the Slave is time-stamped at t_1 and received by the Slave at t_2. Then, during the way back, a message is sent from the Slave at t_3 and received by the master at t_4. Assuming that the time it takes for messages to go from Master to Slave is the half of the total time in the two-way path (link symmetry assumption), the offset with respect to the Master can be calculated as

offset = $(t_2 + t_3 - t_1 - t_4)/2$.

The clock synchronization is achieved by minimizing the offset. Note that the time transfer accuracy is based on the thought of zero delay asymmetry in the round trip which is not always an accurate assumption.

Despite the efforts made to increase IEEE1588 PTP's accuracy, the PTP links introduce accumulative time inaccuracies over the entire network and, for some applications requiring long distance links and asymmetrical links, PTP's scalability and synchronization is poor. An improved approach is PTPv2, an industrial evolution of PTP that better define protocol devices cases and result in significant improvements in the accuracy of time synchronization.

By combining PTPv2 with Synchronous Ethernet, also referred as SyncE, the time information and frequency is distributed to all the nodes. Currently, this combination is the most popular among the solutions for industrial time distribution on telecommunications in a similar way to switching networks. SyncE can also be used in power grid and automation applications and it offers a slight improvement in time synchronization regarding PTP. However, problems related to phase propagation and system scalability (long distance and link asymmetry) remain unsolved and the synchronization level is still limited for some applications that stand in need of timing precision better that 1 nanosecond.

The difficulty to achieve the requirements needed on many industrial applications has pushed the development of rather complex network topologies and device types.

In a PTP network, equipment can assume different roles (ordinary clock, master clock, slave clock, slave only clock, grandmaster clock, preferred grandmaster, server, client, transparent clock or boundary clock) in order to optimize the timing budget available to each device of the network. In the case of White-Rabbit solutions, the network is much more simplified.

White Rabbit-PTP (WR-PTP) is the name of the enabling technology for sub-nanosecond time precision. The next generation of telecommunication systems, defense applications or high-speed computerized trading in financial markets, among others, expect to benefit from ultra-accurate solutions, that otherwise are not achievable with the current PTPv2 protocol. The improvements introduced by WR-PTP can be summarized as follows:

Synchronization and time-stamping with sub-nanosecond accuracy and with a jitter lower than 20 picoseconds.

Distribution through thousands of nodes and up to hundred kilometers over standard optical fiber networks.

Dependable (and deterministic) global time reference. Timing is not affected by network traffic, weather conditions or number of hops.

The White Rabbit Network (WRN)

The WRN consist on a set of multi-port White Rabbit Switches and single or dual-port White Rabbit Nodes interconnected though conventional Gibabit Ethernet (GbE) and expandable to thousands of nodes interconnected with optical fibers links up to 10 km. All elements work as boundary clocks with the exception of the grandmaster which is the master clock reference for all the remaining devices. The sub-nanosecond accuracy is provided for all the devices (switches and nodes) and the protocol implementation and network deployment is significantly improved (there is no need for all these equipment types defined on PTPv2 networks). Furthermore, there is no longer need to hire high experts to implement time sensitive applications with outstanding capabilities.

From left to right: WR-ZEN TP, WR-LEN and WRS

WR equipment

Currently, the WR features are provided by a range of industrial products developed by Seven Solutions. The White Rabbit Switch (WRS) is the main element of the WR technology. It distributes Time and Frequency within sub-nanosecond accuracy to thousands of nodes through standard optical fiber for distances above 80 km. The WRS is fully compatible with Ethernet and provides deterministic delivery and a reliable communication using redundant network topology. In addition, the WRS self-calibrates timing links.

Another interesting product is the White Rabbit Zynq Embedded Node (WR-ZEN). It is the versatile and full-programmable standalone node that provides the White Rabbit features to a wide range of applications exploiting its redundant connections. Moreover, the WR-ZEN Time Provider (WR-ZEN-TP) easily distributes time and frequency to other equipment by implementing standard timing protocols such as PTP, NTP, NMEA, IRIG-B, ToD, etc. Furthermore, the FMC expansion port allows to add additional card to the system to develop market-specific products.

During the last years Seven Solutions has also developed cost effective products to distribute PPS/10MHz signals or IRIG-B protocol. This is the case of the WR Lite Embedded Node, (WR-LEN) that is the competitive WR alternative capable of supporting daisy chain configurations and is also available in its OEM version for being integrated in other systems.

Moreover, several kits have been designed to ease the user's first contact with the WR technology, like the KIT WR-LEN, consisting on a set of WR-LEN nodes. Each node includes two ports and offers several possibilities, including synchronization and time distribution.

Experiments

Experiment 1. WR synchronization over 15 km

The hardware and timing group of CERN carried out an experiment to determine the precision and accuracy of a WR network in 2013. 4 WRS were connected with 5 km fiber rolls in a daisy chain along 15 km. Within this configuration the first WRS was used as Master (in a Master/Slave scheme) and the environmental conditions were simulated by heating the fiber with a hot air gun.

A reference frequency signal of 10 MHz was provided to the Master through an external oscillator. The integrated jitter from 10 MHz to 40 MHz was determined from the Power Spectral

Density of the master and each slave phase noise and the obtained value was about 2 ps. The accuracy, given by the deviation between the clocks of a Master node and the Slaves, was determined with the aid of an oscilloscope measuring during 1 hour. The resulting value was several tens of picoseconds between the master and the second slave. In the case of the other slaves the accuracy was not greater than 200 ps.

Experiment 2. WR synchronization at Tunka-HISCORE

Another experiment was carried out by a team from the Paul Scherrer Institute (Switzerland) and the Germany's largest accelerator center DESY (Germany) in the framework of the Cherenkov Telescope Array (CTA) project. The WR protocol was incorporated to the modern timing system of the prototype Tunkaa-HiSCORe (Hundred Square-km Cosmic Origin Explorer) array. Currently, this detector is under construction at Tunka Valley, Siberia and will cover an area of more than 100 km2. To embody the real behavior, the light arrival had to be measured with sub-nanosecond accuracy.

Before proceeding with the experiment in situ, a laboratory test has been carried out including climate chamber temperature tests from -20 to 40 ºC (in the fiber) and from 0 to 30 ºC in the nodes. The timing precision was better than 0.2 ns and the results showed an excellent trigger time-stamping (in the order of the ns).

Conclusions

Current industrial and scientific facilities incorporate modern timing systems to generate and distribute timing to entire infrastructures. This includes the generation of programmable triggers as well as proper timestamping mechanism to identify machine state. To do this, a set of nodes interconnected in a network performs well-defined functions to synchronize their activities and properly provide a picture of machine operation. Given the need of globally synchronized time, each node no longer need to contain a high-precision clock because the master clock capabilities are transmitted thought the telecommunication network. It enables the node to establish the time the events occur and their duration and because the same timing link can be used to distribute data, it is possible to reduce the wiring necessities.

WR-PTP is the enabling technology to provide sub-nanosecond synchronization to thousands of nodes over tens of kilometers. This technology follows a hierarchical structure its accuracy is provided by means of inserting new calibration procedures and correcting the link delays and asymmetries. It represents a great advance in time and frequency distribution since the Ethernet-based WRN had low-latency, it is highly reliable and distributes deterministic data in a transparent way.

Over the years, significant efforts have been made to include WR into the PTP as an option for ultra-accurate time customers. Standardization will take place in 2018 and is expected to facilitate WR's integration with a wide range of diverse technologies. the new technologies.

This kind of analysis is not only valuable for estimating the benefits of deploying new technologies, but can also provide a means to optimize the configuration settings of existing systems. Such optimization processes and evaluation of the impact of new technologies for and with several European providers has been successfully carried out in ESK laboratories. This allows operators to take the right investment decisions.

Leoni pumps 100 Gbps through copper pipe

Technology megatrends like IoT, cloud computing and industrial internet have a massive impact on shop-floor IT. Currently, in such environments the maximum data bandwidth

over a distance of 100 meters across copper cable is 10 Gbps. The industry already has 25 Gbps and 40 Gbps on its roadmap, but this won't be the limit: Cable and wiring company Leoni AG (Nuremberg, Germany) has proved that 100 Gbps is feasible. As a result of the Data Cable Models research project, Leoni achieved a bandwidth of 100 Gbps across a four-pair, symmetrical cable over 30 meters or more. According to Leoni, this bandwidth is not only feasible in terms of physics but also in economical terms.

The findings of the project which was funded by the German federal ministry of economics will be used for the development of next-generation Ethernet components, the company said. Besides Leoni, the Hochschule Reutlingen University and Harting Electronics were involved in the project. Harting is an expert for connector and networking solutions in industrial and automation environments. Hochschule Reutlingen is one of Germany's most significant research institutions in the area of communications engineering.

Leoni
www.leoni.com

Industrial-grade 4-port isolated USB hub, isolated to 4kV

ACCES I/O Products is releasing a rugged, industrial-strength 4-port isolated USB hub, the USB-104-IHUB, featuring Tru-Iso

signal isolation up to 4kV and an extended temperature operation from -40 to +85°C, with high retention USB connectors and an industrial steel enclosure for shock and vibration mitigation. The USB-104-IHUB now makes it easy to expand the number of USB ports and provide up to 4kV isolation between the host computer and connected USB peripherals. The 50x50x25mm unit is available in a rugged steel enclosure or OEM as a "board-only" device. Users may choose from two power input connectors: a DC power input jack or screw terminals to provide a full 500mA source at 5V on each of the downstream ports. Additionally, a wide input power option exists to accept from 7VDC to 35VDC. Mounting provisions include DIN rail and various panel mounting plates. Available accessories include an isolated medical-grade power supply and a wide variety of standard USB cables for quick and easy-to-use, out of the box, connectivity. To make use of the miniature embedded USB header connectors, ACCES offers an assortment of embedded micro-fit USB header cables. The unit comes with advanced EFT, lightning, and ESD protection at ±20kV on all signal pins (air and contact).

ACCES I/O Products
www.accesio.com

USB 3.1 Type-C compliant interface connector supports 5Gbps

Hirose has developed a mid-mount USB 3.1 Type-C connector with an efficient design that offers a compact footprint to save valuable PCB space. Featuring a depth of only 8.35mm, the shorter design creates additional PCB space for optimizing antenna design and allows for larger batteries capacity. By comparison, conventional Type-C connectors are significantly longer, up to 9.4mm, which consumes valuable PCB real estate. The CX70 Series USB 3.1 Gen1 Type-C compliant interface connector supports 5Gbps for high-speed applications. The Hirose hybrid CX70 Series simplifies retrofit and repair operations by utilizing both SMT and through hole soldering. The hybrid design also facilitates automated optical inspection and eases reworking of the solder terminal joints with a visible lead design. As a USB 3.1 Type-C connector, it features a symmetrical mating design that allows for reversible plug insertion. The mid-mount, 24-position CX70 Series USB 3.1 has a rating of 5 amps for a total of 100 watts of power.

M12 s-coded connectors in three pole (2+PE) versions

The extensive range of binder M12 s-coded power connectors has been enhanced with the introduction of new three pole (2+PE) versions with a pre-engaging contact and featuring both field attachable cable and panel mount versions with wires. Previously only available in 4-pole (3+PE), these new versions are ideal for mains voltage (250V) applications. Male and female cable connectors with gold plated contacts can accommodate cables between eight and 10mm diameter with screw clamp termination of wires up to 1.5mm^2 (AWG 16). The panel mount connectors are supplied pre-terminated with 200mm long 1.5mm^2 (AWG 16) UL rated wires. The rear M16 x1.5mm thread allows for mounting into a threaded hole or clamping with an additional jam nut. The connectors are rated to 12A and 630VAC three-phase and have an integrated pre-engaging earth contact. M12-S coding is typically used for power applications on AC.

binder UK
www.binder-connector.co.uk

Solar panel connector rated at 1500V, allows for cheaper inverters

The reliability of Multi-Contact's MC4 connector for PV solar panels has led it to become a de facto industry standard, with over a billion sold worldwide. The rugged connector now has a further advantage as it has been awarded UL approval for operation at 1500V. This higher system voltage is a significant advantage for larger arrays, as it means more PV panel modules can be connected in series within a string. The number of strings in an array can therefore be reduced, with a consequent reduction in the number of components required, such as couplings, overcurrent safety switch systems, contact breakers and cables. Combined with the fact that inverters are cheaper in this voltage range, installation costs can be as much as 30% lower. The connectors can be supplied preassembled or they can be attached to cables on site using crimping pliers. Cables up to 10 mm^2 in cross-section can be accepted, making them suitable for currents as high as 43A.

Multi-Contact
www.multi-contact.com

Wirelessly powering the IoT: opportunities & considerations

By Jacob Babcock

Wireless power is enabling the ever-expansive universe of IoT, providing IoT product designers with an alternative to plugging in - whether it is to recharge a battery ("wireless charging") or to directly power the device ("wireless power").

An example of wireless charging in IoT is digital door locks that recharge when closed. Wireless transmitters are located in the door frame and re-charge the bolting/communication mechanism anytime the door is closed. This replaces the need for changing batteries (a significant cost and environmental issue in hotels, for example) and enables a more seamless integration into homes, hotels and offices.

An example of wireless power in IoT is the electronic Smart Retail Label ("SRL") and beaconing technology known as Powershelf. Battery free SRLs ensure accurate pricing and enable retailers to remotely change pricing on any SKU in the store in minutes. The system is powered by wireless power so it eliminates the need for battery disposal or paper price tags, creating significant cost reductions and an attractive carbon footprint friendly solution for retailers focused on environmental sustainability.

When designing in wireless charging/power, designers will have key considerations:

- **Are interoperability standards important?** Do you expect users to charge your devices at Starbucks? In their vehicle? If so, you will want to focus on wireless charging solutions that are standards compliant with at least one of the two leading standards, Wireless Power Consortium and AirFuel Alliance.

If interoperability is very important, you can find multi-mode solutions that support all standards simultaneously.

Examples of products that benefit from interoperability: mobile phones, laptops, tablets (so you can charge at the coffee shop, home, rental car, airport, office, etc.).

Examples of products that don't benefit from interoperability: hearing aids, surgical tools, personal products (like some wearables, powered jewelry, etc.), specialty products (SCUBA watches) and non-consumer products (first responder radios, mobile phones/computers specialized for rugged worksites, remote sensors, etc.).

Standards exist to support interoperability. Interoperability is only relevant if users will actual charge/power the product in diverse locations where wireless infrastructure is expected to be installed.

If not, proprietary/non-standard wireless power systems can be a more efficient and cost effective option.

NuCurrent antennas to fit various form factors. The largest antenna is a 210x140mm Class 4 (33 Watt rating) resonator for the AirFuel standard, the smallest is a 20mm round Qi-type coil (2 Watt rating).

A wearable device charging orthogonal to the transmitter. It illustrates the ability of charging without orientation constraints, which can be important for wearables and other IoT devices that can't guarantee precise alignment during charging.

- **Form factor is a major consideration.** The largest components are the antennas and if you have a space constrained device, you will want to look for ultra-thin solutions. From embedded sensors to slim cell phones, space is a major constraint in many electronic devices.

Jacob Babcock is co-founder and CEO of NuCurrent - www.nucurrent.com –
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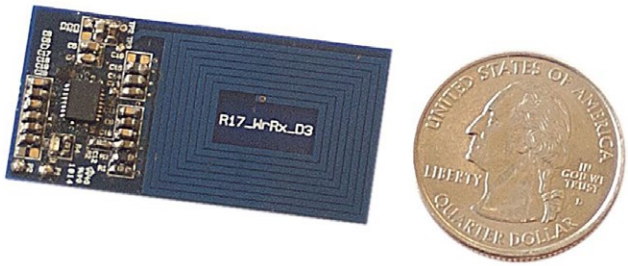

A wireless power receiver module that is size appropriate for multiple devices and capable of charging devices under the Qi and PMA standards up to 5W.

- **Power levels are essential** to make sure your battery charge is adequate or your device is receiving enough direct power. There are a range of products from mW up to 30W+ coming to the market right now. Note that power and size go hand-in-hand - you can't expect to get 30W of wireless power with a device the size of a nickel.

- **Orientation flexibility is important** in selecting frequency of power transfer and if you require some positional freedom, you will likely be better-suited with high frequency systems. Most high frequency systems today operate at 6.78MHz, so there are components available for that frequency.

Higher efficiency, resonant systems allow greater distance of charging. However, component selection is critical because high frequency can be lost in the wrong components. GaN transistors like those from EPC can help minimize switching losses in the PA. MLMT(R) antennas from NuCurrent can help minimize skin effects and proximity effects at high frequency and therefore have lower Electrical Series Resistance and heat generation. Shielding materials customized for 6.78MHz are also essential for appropriate shielding and minimizing losses due to eddy current buildup - your antenna provider should be able to provide the best materials for your application.

In particular, higher efficiency can be useful in applications where larger separation can be helpful. For example, sensors embedded in walls or in hazardous environments will need the wireless power to penetrate through walls or other material to activate the sensor. NuCurrent has transmitted power through 130mm walls to 1W loads - sufficient for many sensors in order to power them up and transmit data back to the source/reader through the wall.

- **What other components are nearby to the wireless receiver?** Shielding may be required to protect the components from EM fields. Shielding is generally required in any application where the wireless power system is surrounded by other electronics. Your antenna providers will help you understand the right application of shielding for you application.

Wireless charging and wireless power are enabling a whole new category of IoT devices and capabilities. If you are designing IoT devices make sure you are considering the potential of wireless power.

Isolated discrete forward DC/DC design

By Bruce Haug

High density isolated DC/DC converters have significantly changed during the course of the past 25 years. The introduction of the full and half-brick form factors back then created a rush to use them in distributed power architectures in telecom, datacom, industrial and medical systems where a bus voltage is routed to every board within a system and each board had its own isolated DC/DC converter. Many of these bricks incorporated several hundred parts making it much easier to utilize them instead of designing a discrete supply on the PCB. At the time, there was much haste by several power supply companies to get into this market and catch up with the leaders in the field. Many went through several years of painstaking development to bring their products to market, creating their own magnetics, topologies and control schemes, always trying to outperform the competitive offerings. Many came out with the same footprint and others with their own patented sizes and pin-outs.

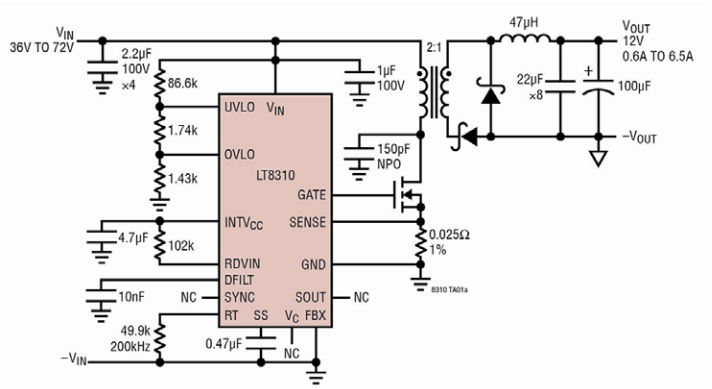

Fig. 1: LT8310 isolated forward delivers 78W output with only 20 parts.

ÍConsequently, these footprints were expanded to include 1/4, 1/8 and 1/16 bricks, along with countless variations of other sizes depending on the output power required.

However, with the introduction of application specific DC/DC controllers and monolithic devices, along with off-the-shelf planar power transformers and inductors have made it much simpler to produce discrete designs. In fact, an isolated design can be done with 15 parts for a flyback and 20 parts for a forward converter. This new era of application specific controllers and monolithic devices has given designers a different avenue for the development of isolated DC/DC converters. Improved MOSFET switching, VDS ratings and RDS(ON) have also helped to make it easier to do discrete designs. Some designs also no longer require an opto coupler or signal transformer in the feedback loop, and many can be used for military applications with operation from -55°C to 150°C.

Isolated outputs are required for a broad range of DC/DC converter applications - not just the telecom and datacom mandated 48V isolation requirements. Isolation can be necessary for noise sensitive devices needing ground separation from a noisy input voltage, such as a car battery, intermediate bus and industrial inputs. Displays, programmable logic controllers, GPS systems and some medical monitoring devices can all be negatively affected by a noisy bus voltage. Examination cameras, dental instruments, sleep and vital sign monitors all use displays that can be adversely affected by a noisy source voltage. Nevertheless, an isolated power supply provides ground separation which can eliminate the noise causing display irregularities.

Linear Technology has a full line of topology specific controllers that can be used in isolated high-density DC/DC converters for flyback, forward, push-pull, full-bridge topologies. Some versions exist with or without synchronous rectification, most without optocouplers, some with a signal transformer to close the feedback loop and others sensing the output voltage from the primary side transformer winding. They consist of teo two fundamental input voltage ranges, one for the Industrial market (9-32V) and the other for the Telecom/Datacom (36-75V) market, along with some that operate over an 18V to 75V input voltage range. Linear Technology has prefabricated designs for all of these topologies and input voltage and outputs voltages ranging from 1.2V to 48V. Users can have access to demonstration boards, electrical schematics, and bill of materials and Gerbers files for each design. A quick start guide provides performance curves, including load/line regulation, ripple & noise, efficiency and transient response.

Isolated forward converters

One of the most popular topology's used in isolated high-density DC/DC converters is the forward converter. Linear Technology offers several types of forward controllers, some of which operate with a single primary ICs for control. Others have both a primary and secondary IC's for control, timing and the driving of synchronous MOSFETs. Buck converter designers have long benefited from their simplicity, high efficiency and fast transient response; made possible by the latest controller ICs featuring synchronous rectification and multiphase interleaved power stages. However, these same features are now available in forward converters and the recently released LT8310 is an example of a device that can be used in a low parts count application. In fact, the LT8310 schematic below in figure 1, uses only 20 parts to complete an isolated forward converter with an output power of up to 78 watts.

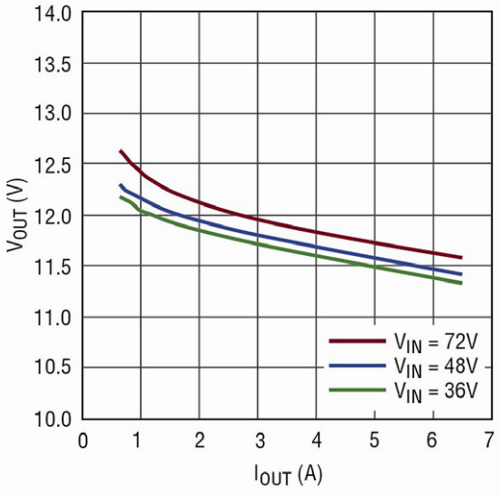

Fig. 2: LT8310 output voltage regulation of figure 1 schematic.

This circuit produces a 12V output at up to 6.5A from a nomi-

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nal 48V input with efficiencies as high as 92%. This primary-side forward controller, with resonant reset operates, over an input voltage range of 6V to 100V and is targeted for power levels up to 200W. This device can be used in either synchronous or non-synchronous applications. For synchronous operation, the LT8310 sends a control signal via a pulse transformer to a secondary-side MOSFET driver for synchronous rectification timing. Synchronous designs are most advantageous for higher power r lower output voltage applications. An output voltage regulation of ±8% can be attained without the use of an opto-coupler as shown in figure 2.

When an opto-coupler is used, ±1.5% regulation can be realized. A programmable volt-second clamp provides a safeguard for transformer reset that prevents saturation and protects the MOSFET. This function optimizes the transformer and MOSFET, reducing overall solution size. The LT8310 is available in a TSSOP-20 package with several pins removed for high voltage spacing.

Flyback converter design

For an even simpler isolated DC/DC converter solution at lower power levels, the flyback topology could be used. Flyback converters have been widely used in isolated DC/DC applications for many years; however, they are not necessarily a designer's first choice. Power supply designers unwillingly select a flyback converter out of necessity for lower power isolated requirements, not because they are easier to design. The flyback converter has stability issues due to the right-half-plane zero in the control loop which is further complicated by the aging and gain variation of an optocoupler. A flyback converter requires a significant amount of time devoted to the design of the transformer, a task further complicated by the normally limited selection of off-the-shelf magnetics and the possible necessity for a custom transformer. Recent advances in power conversion technology have made isolated converters much easier to design. Linear Technology's LT8302 isolated flyback converter solves many of these flyback design obstacles.

The LT8302 eliminates the need for an optocoupler, secondary-side reference voltage and extra third winding off the power transformer, all while maintaining isolation between the primary and secondary-side with only one part, the power transformer, having to cross the isolation barrier. The LT8302 employs a primary-side sensing scheme which is capable of sensing the output voltage through the flyback primary-side switching node waveform. During the switch off-period, the output diode delivers the current to the output and the output voltage is reflected to the primary-side of the flyback transformer. The magnitude of the switch node voltage is the summation of the input voltage and reflected output voltage, which the LT8302 is able to reconstruct. This output voltage feedback technique results in better than ±5% total regulation over the full line, load, and temperature range. Figure 3 shows a flyback converter schematic using the LT8302 with only 14 external components.

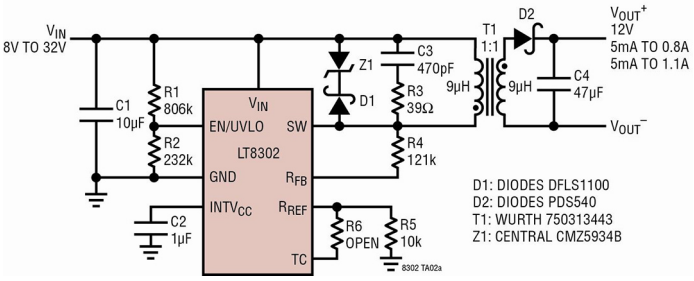

Fig. 3: LT8302 flyback converter with primary side output voltage sensing.

The LT8302 is available in an 8-lead thermally enhanced SO-8 package and accepts an input voltage from 2.8V to 42V. Its on-board 3.6A, 65V rugged internal DMOS power switch allows it to deliver up to about 18W of output power.

Furthermore, the LT8302 runs in a low-ripple Burst Mode Operation at light load which reduces the quiescent current to only 106µA, a feature that increases the battery run-time during sleep mode with the output voltage in regulation. Other features include internal soft-start and undervoltage lockout. The transformer turns ratio and 1 external resistor are all that is needed to set the output voltage.

Primary-side output voltage sensing

Output voltage sensing for an isolated converter normally requires an optocoupler and secondary side reference voltage. An optocoupler transmits the output voltage feedback signal through the optical link while maintaining the isolation barrier. However, an optocoupler transfer ratio changes with temperature and aging, degrading its accuracy. Optocouplers also can be nonlinear from unit to unit which causes different gain/phase characteristics from circuit to circuit. A flyback design employing an extra transformer winding for voltage feedback can also be used to close the feedback loop. However, this extra transformer winding increases the transformer's size cost and does not provide very good output voltage regulation.

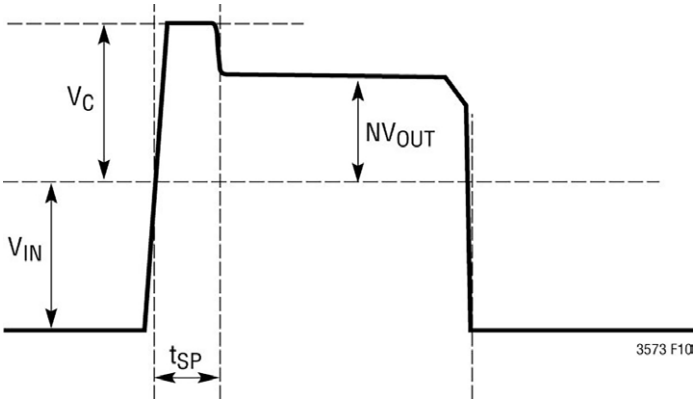

Fig. 4: Typical switch node waveform.

The LT8302 eliminates the need for an optocoupler or extra transformer winding by sensing the output voltage on the primary-side of the transformer. The output voltage is accurately measured at the primary-side switching node waveform during the off time of the power transistor as shown in figure 4, where N is the turns ratio of the transformer, VIN is the input voltage and VC is the maximum clamped voltage.

Transformer selection and design considerations for the LT8302

The transformer specification and design is probably the most critical part of successfully applying the LT8302. In addition to the usual list of caveats dealing with high frequency isolated power supply transformer design of having a low leakage inductance and close coupling, the transformer turns ratio must be tightly controlled. Linear Technology has worked with several magnetic component manufactures to produce pre-designed flyback transformers for use with the LT8302.

The future of wearable medical devices

By Neil Oliver

The technological convergence of portable consumer electronics such as smartphones, smart watches and fitness devices with that of professional medical equipment such as pulse oximetry, ECG and Glucose meters as well as ultrasound scanners and kidney diagnostics, is increasingly blurring the lines between equipment designed for practitioners and devices used by consumers.

Your average smartphone now has more processing power than the supercomputers used by NASA circa 1969 when it sent three astronauts to the moon. It's no surprise then, that there has been a growing surge in recent years of start-ups specifically developing peripheral devices to monitor intimate details of one's physical condition.

This trend was highlighted at last year's consumer electronics show (CES), the world's biggest technology exhibition. Held annually in Las Vegas, Nevada, CES was a perfect opportunity for many original equipment manufacturers (OEMs) to exhibit their latest and greatest inventions; from smartwatches that can track your heart rate and sleep quality to armchairs that exercise you in the comfort of your home. There was even a hearing aid developed by Siemens to allow the user to zoom into sounds.

The rise of wearable devices was attributed to a much larger societal disposition towards the Internet of Things (IoT). Although the IoT, as a concept, has been around for many years, it's only recently started to pick up traction. A maturing ecosystem of mobile operating systems (OSs) such as Android and iOS as well as an improving cloud computing infrastructure and the widespread availability of cheap wireless sensors means that OEMs in the consumer electronics sector have glimpsed the profitability of the medical technology (MedTech) sector and they want a piece of the pie.

The ability to create cheap devices that don't require heavy on-board processing, rather outsourcing this to a server in the sky, means that nearly every household object in sight can now be equipped with a sensor and a screen giving up-to-date information on any number of ailments or long term conditions. Diabetics can use a peripheral plug-in gadgets to monitor blood glucose, chronic kidney patients can save time-consuming visits to the doctor by testing at home and patients with a gruelling pill-regime can track their exact intake with a handy smartphone app.

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The benefits of wearable and portable medical devices are clear. Wearables make patient data readily accessible and they may reduce the frequency of visits to a doctor and in doing so alleviate the burden on our healthcare system. As well as this, it's becoming cheaper to produce wearable medical devices that fulfil the function traditionally limited to large and expensive medical devices in hospitals.

So surely that's that? Wearable medical devices will revolutionise our lives and we can thank Intel's Gordon Moore for bearing witness to the trend for smaller and smaller electronics? Not quite. You see, many experts in the industry are already raising eyebrows at what they believe to be a bad precedent, an incompatibility between two industries that operate in fundamentally very different ways.

Circle of life

The problem i s one of business strategy. The last decade has witnessed unprecedented globalisation, with cross-border trading blocs resulting in international supply chains with highly responsive logistical networks. This has increased competition in the global marketplace and created a price based race to the bottom. As a result, consumer product development life cycles (PDLCs) have shrunk drastically. A typical consumer product life cycle is 12 months. It can stretch to 24 months and be as short as six.

This can be attributed to increased disposable income in emerging economies, more global competition, access to cheap labour and an incessant consumer demand for the next best thing. In contrast to this, medical device PDLCs are much longer, typically 10 years. Due to the lower volume production,

higher research and development (R&D) costs, more lucrative healthcare contracts and a desire to yield a higher return on investment (ROI), medical devices are designed to last much longer.

It's no surprise then, that many in the medical industry are sceptical of the long term reliability, safety and quality of wearable medical devices. Add to this, the fact that we're living longer on average, it's vital that the solution is sustainable. Here at Accutronics we've got 40 years of experience in designing, developing and manufacturing batteries and we've seen devices become smaller over the years. As a result so have the batteries that power them.

As batteries get smaller to accommodate the trend for smaller and lighter devices, we begin to see some trade-offs. The Lithium-ion (Li-ion) cells that make up the majority these batteries have a limited gravimetric and volumetric energy density and subsequently, wearable devices inevitably suffer from inadequate runtime. If your smart phone runs out of juice then it is inconvenient, but if the same device is monitoring your health then it is far more concerning.

This reduction in battery quality is a real concern. The lifespan of a rechargeable consumer Li-ion battery averages around 300-500 charge cycles before its capacity drops to an unacceptable level. Because medical devices outlive their batteries they tend to use removable rather than embedded batteries.

To combat this problem for wearables, Accutronics has already developed a credit-card sized battery for use in wearable medical devices. Today, these batteries are being used to power devices that are worn by patients, monitoring their health or providing medication when the patient requires it. Being removable means the battery can be swapped for another when charging is required and the device does not need to be returned to the manufacturer for a battery replacement when the original set of batteries reach end of life.

Although battery quality is a major problem for consumer medical devices, there are deeper concerns when it comes to the manufacture, testing and regulation of the industry as a whole. Because this industry has seen rapid growth over the last three years, many far east manufacturers have taken shortcuts by producing gray market knock-offs, and sometimes outright illegal batteries, that lack the necessary protection circuits that are needed to prevent Li-ion batteries from overcharging, overheating or becoming unstable and potentially catching fire.

Many OEMs have already taken action to protect their intellectual property rights (IPR) against fake, or copycat, batteries by introducing security features such as invisible inks and holograms. Here at Accutronics we've incorporated an advanced software-security algorithm (SHA-1) into our batteries that ensures only authorised batteries are used in medical devices.

The host device rejects fake batteries when detected and takes appropriate action, as defined by the vendor, such as failing to power up or notifying the user.

Taking such measures however, is only a reactive response. Although the medical industry is one of the most regulated industries in the world, it has struggled to keep pace with the advent of wearable medical devices. One of the biggest reasons for this is that the very definition of a medical device is becoming blurred.

If your smartphone accompanied by a wearable device is able to measure, diagnose and recommend treatment on any given health condition, then should that be regulated as a piece of IT equipment, under the IEC 60950-1 standard or should it be regulated as a fully blown medical device under the IEC60601-1 standard? These medical standards form the requirement for the commercialisation of an electrical medical equipment in many countries.

It was this ongoing ambiguity that led Apple to consult with the US Food and Drug Administration (FDA) on the use of sensors in its devices, which may ultimately lead to regulatory review by the FDA. Although information-only apps are exempt, any apps taking measurements, for example a glucometer that takes readings, would be considered diagnostic in nature. This conversation led Apple to release Healthkit, its software development kit (SDK) for developers.

Likewise, in Europe, the European parliament has set out directives on the classification of medical and in-vitro medical devices to include a broader range of products including non-corrective contact lenses, aesthetic implants and software used in devices. The regulations will also be more selective in awarding CE markings to high risk devices, which must undergo further clinical trials to assess risk.

In the UK, the Medicines and Healthcare products Regulatory Agency (MHRA) has published guidelines making it clear that, "the manufacturer of a device is responsible for establishing that the device is safe and that it is suitable for its intended purpose. To establish this, manufacturers must implement appropriate controls on the device design and manufacture, and evaluate the safety and performance of the device in its intended application".

It is clear that the world of wearable devices is not all that it seems at first glance. On a deeper exploration it is evident that there are numerous economic, cultural and regulatory changes needed before a sustainable and safe integration of wearable medical devices into our everyday lives. With the right power management, design and production controls and when used under the guidance and on the recommendation of a healthcare professional, wearable devices can become a viable asset in improving the health of our increasingly ageing population.

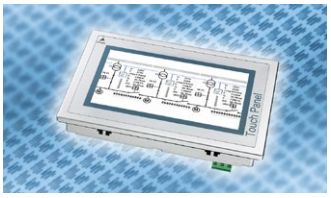
Li-ion battery pack monitor safeguards EV/HEV systems

An automotive-grade battery monitor and battery manager enable ASIL-D compliant systems; Intersil's (Milpitas, CA) ISL78610 12-cell lithium-ion (Li-ion) battery pack monitor provides cell balancing and accurate voltage and temperature monitoring to safeguard Li-ion battery packs in hybrid electric vehicles, plug-in hybrid electric vehicles, and electric vehicles. System designers can use the ISL78610 as a standalone battery-pack monitor or as a redundant back-up device when combined with the high accuracy ISL78600 multi-cell battery manager. This combination enables vehicle manufacturers to achieve the higher ISO 26262 automotive safety integrity level (ASIL) D rating. The ISL78610 monitors and balances up to 12 cells with accurate voltage readings and diagnostics. This lets system designers make informed decisions based on absolute voltage levels rather than simply receiving a "system not OK" signal indicating an out-of-range condition. The ISL78610 includes a voltage reference, 14-bit analogue-to-digital converter and registers for control and data, connecting directly to a microcontroller through its 2 Mbps SPI interface. The device has four external temperature inputs, and includes fault detection and diagnostics for all key internal functions. Together, the ISL78610 and ISL78600 offer internal and external fault detection such as open wire, over and under voltage as well as temperature and cell balancing faults to mitigate battery pack failures. Multiple devices can be daisy-chained together to support systems with up to 168 cells.

Intersil
www.intersil.com

Power factor correction control unit enables parallel operation

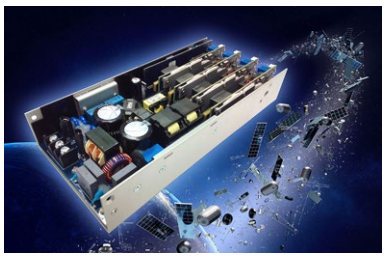
The EPCOS VIP-3-TP control unit released by TDK Corporation facilitates the intelligent coupling of three reactive power compensation systems. The parallel operation of multiple systems on different feed-in transformers necessitates this coupling, as the corresponding sections of the grid may also be coupled temporarily. The reciprocal influence of the power factor correction systems in such coupled grid sections causes a higher number of switching operations, which have a harmful effect on the power factor correction elements. The more systems that are working in parallel, the harder it is to control the undesirable effects. In conjunction with an EPCOS BR7000-I/S485 power factor controller, the new VIP-3-TP touch panel (B44066R1703E230) permits the completely non-retroactive parallel operation of systems with three feed-ins and coupling switches. At the same time, the VIP-3-TP enables symmetrization and the visualization of the measured values.



Epcos
www.epcos.com

User-configurable 600W power supply with efficiencies up to 94%

The CoolX600 Series from Excelsys Technologies is a convection-cooled modular power supply platform that delivers 600W without fan assisted cooling from a very compact 8.5 x 4.5 x 1U package. The only fanless modular power supply on the market, the CoolX600 offers system designers best in class efficiency and reliability in addition to the most comprehensive feature set and specifications available. An industry leading 5 year warranty ensures quality, reliability and the lowest total cost of ownership. CoolX600 provides higher input surge protection of 4KV Line to PE for operation in harsh environments, reverse energy protection without the use of external blocking diodes as well as safety certified operation at altitudes of up to 5000m. An incredible 24W, medically isolated, auxiliary supply is available as a standard feature, offering effectively another output for system intelligence, control, displays etc. With optional Digital Communications available the CoolX600 provides the most flexible, highest specification modular power supply on the market. The CX06S is available with full safety certifications to IEC60950 2nd edition for industrial applications whereas the CX06M carries IEC60601-1 3rd edition & IEC60601-1-2 4th edition (EMC) for medical applications. Stand-out medical features include BF rating (Body Floating), dual fusing, 2 x MOPP, <300uA leakage current. Other features include 4KV input surge immunity and the ability to withstand input voltages of up to 300VAC making it ideal for use in remote locations and those subject to input voltage disturbances.



Excelsys
www.excelsys.com

Wide-input, 20W DC/DC converters have railway approvals

Recom´s isolated RP20-FR series 20W DC/DC converter has been designed for railway applications, as well as industrial and telecommunication applications. The 2 x 1-in. modules have a 4:1 input voltage range (9-36V, 18-75V, 43-160V) and therefore cover all standard battery-board levels including the ±40% tolerance margin. Besides 3.3V, 5V, 12V and 15V single outputs, dual ±12V and ±15V outputs are also available. The control pin logic can be chosen to be positive or negative. The converters have an efficiency of up to 89% and feature a wide Tx operating temperature range of -40°C to +85°C (-HC versions). Cooling is achieved by natural convection, but if required, the modules are also available with a pre-mounted heatsink. The modules are EN50155 certified with EN50121-1-3-2, EN61373 and UL/cUL-60950-1 approvals.

Recom
www.recom-power.com

Industrial level DC-DC converters operate from -40 to +100°C

The VHR Series of industrial level DC-DC converters and EMI filters released by VPT, Inc. includes models ranging from 5 to 100 watts for powering non-flight-critical programs in military, avionics, and unmanned systems as well as manufacturing equipment and controls. For budget-driven programs, the series offers a wide input voltage range for nominal 28 volt input, an average 85% efficiency and low input and output ripple for reliable operational success, even in rugged environments. Designed to operate at full-load over a wide temperature range of -40°C to +100°C, the VHR Series also offers fixed frequency operation, soft-start, magnetic feedback, inhibit and current-limit protection. Additionally, the VHR Series includes companion EMI filters ranging from 1 to 20 amps.

VPT
www.vptpower.com

Power interface module for low-EMI design in ATCA

Ericsson's 600W quarter-brick power interface module (PIM) converter is optimised for Advanced Telecom Computing Architecture (ATCA) based server applications; its low-EMI design meets CISPR Class B with minimal external components, and the module delivers 12A output current at 80°C with 1.5 m/s (300 LFM) airflow. Monitoring is via I2C or PMBus. Ericsson Power Modules' PIM4610PD is an extension of its 3E* Power Interface Module (PIM) quarter-brick footprint range, for blade server applications based on ATCA and PICMG 3.7 systems. Minimal external filtering is needed to meet the CISPR Class B EMC standards required for Information and Communications Technology systems. Ripple and noise characteristics have been minimised, while circuit design has been simplified leading to reduced component count and system costs without compromising performance. Itoperates over an input range of 36V to 75V and delivers 864W with a 54V input, 768W at 48V, and 600W at 37.5V. Efficiency is up to 98.8% at 600W for the main unit. The PIM also offers built-in digital monitoring and energy-monitoring functionalities via its I ²C/PMBus interface. Other features of the PIM4610PD include: protection against input transients, reverse polarity, over-temperature, over-current, input under-voltage and inrush current. The PIM has a configurable feature that enables a well-controlled shutdown procedure.

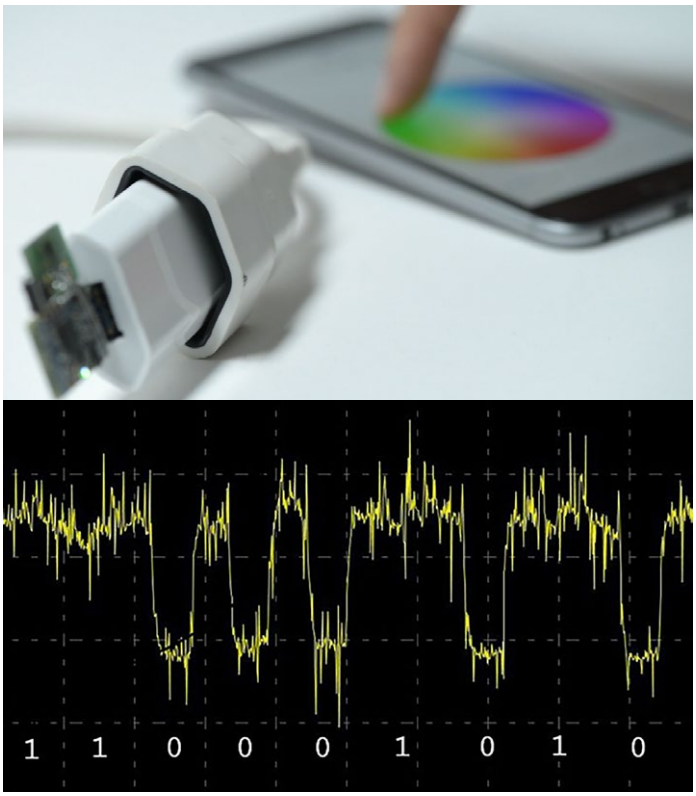
Ericsson Power Modules
www.ericsson.com

Tiny software on a tiny core for security in home automation

By Dr. Cuno Pfister and Dr. Roddy Urquhart

In the consumer space, home automation may be the largest opportunity for Internet of Things solutions.

A home automation ecosystem consists of many different players: cloud service providers, possibly a standards body or a corporate owner of a home automation platform, home owners, their families and guests, installers, retailers, accessory vendors, vendors of bridge devices that connect local networks with the cloud, contract manufacturers, distributors, chipset vendors, and IP providers.



There are a number of requirements for such a home automation ecosystem to become successful on a truly mass market scale. In particular, it must be possible to set up new devices in a simple and consistent way and to be able to simultaneously control devices from different vendors through a simple smartphone app or via voice control.

Secondly, support is needed for remote access via "the cloud" with the possibility for automation across all devices in a house. Last but not least, to be effective there must be robust and credible security measures, and efficient implementations for low-cost, low-power microcontrollers.

Some of these requirements can be addressed by a home automation platform, such as Apple's HomeKit framework.

This article concentrates on the challenge of providing efficient security for microcontrollers used for home automation. Efficiency is needed for cost reasons: if the same cryptographic algorithms can be executed in fewer processor cycles, slower and less expensive processor and memory blocks can be used. If an efficient implementation in software is possible, no gates are wasted for dedicated hardware accelerators.

Moreover, fewer processor cycles also mean correspondingly reduced power consumption – which is crucial for battery-powered devices.

A home automation protocol, like every communication protocol, defines how endpoints exchange messages between them, e.g. between a smartphone and a thermostat.

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Dr. Roddy Urquhart is VP Sales and Marketing at Cortus SAS - www.cortus.com

If the protocol supports security, it also defines the cryptographic algorithms that are used to ensure authentication, integrity and confidentiality of the application data.

As no one wants their front door easily hacked, good algorithms and long cryptographic keys are essential.

Among the candidates for algorithms that are both good and computationally efficient are those developed by Dan Bernstein and his team.

They are based on the properties of elliptic curves and have an excellent reputation within the cryptographic community. They are now being used in TLS, in OpenSSH, in Tor, in HomeKit and supported by an increasing number of cryptographic libraries.

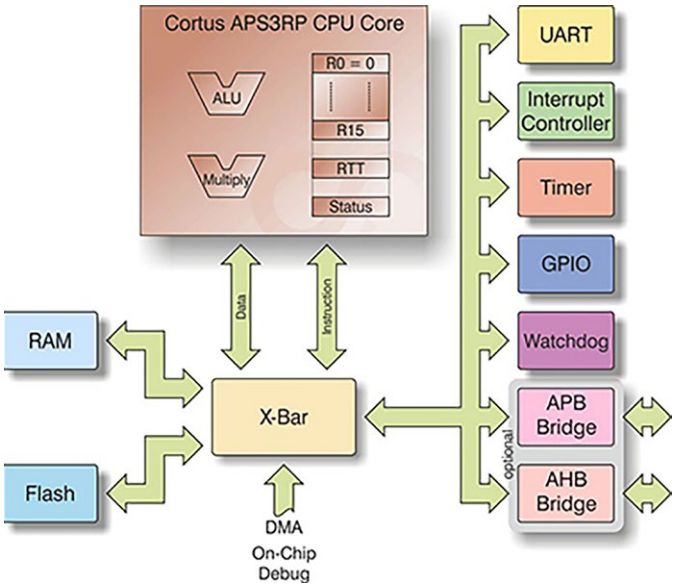
One of the attractive properties of these algorithms is that they are designed to be immune to side-channel attacks. These attacks on a device are relatively inexpensive, because they may only require the non-destructive measuring of power consumption, radiation or other information that is leaked by a chip while it is operating.

If this leaked data in some way depends on the secret data that is currently being processed, then the secret data may be deduced from it. There is a growing range of side-channel attacks, for example the well-known simple power analysis (SPA) and differential power analysis (DPA) attacks. These appear as the most relevant such attacks in practice today.

The Bernstein algorithms make it easier to avoid susceptibility to these attacks, but by themselves they cannot guarantee immunity. Protocol design and implementation aspects also play a role. DPA attacks can be mitigated by a good protocol design, where the protocol does not transmit the same bit patterns even if the same secret data is being transmitted repeatedly.

SPA attacks on the other hand require a careful implementation of the cryptographic code to ensure that no matter what secret data is processed, the same sequence of operations is performed so that there are no variations in execution time or power consumption caused by differences in the secret data (pc-secure program).

This is tricky, because one has to avoid if then else branches. Care is also needed to only use processor instructions that execute in a constant number of clock cycles. For example, an ARM Cortex-M3 implements a more useful multiply instruction than a Cortex-M0, but it should not be used because it does not



Cortus APS3RP core

always take the same number of clock cycles to execute thus creating a data dependency.

As the multiply instruction is the most performance-critical instruction for the algorithms discussed here, a microcontroller would ideally provide a fast, single-cycle multiplier.

This is the case for the Cortus APS3RP, an enhanced version of the widely deployed APS3R core.

It has a Harvard architecture and a 3-stage pipeline. The core uses a simple vectored interrupt structure which ensures rapid, real time interrupt response, with low software overhead. The core interfaces to Cortus' peripherals include Ethernet 10/100 MAC and USB 2.0 Device.

While it is surprisingly easy to integrate a custom coprocessor with an APS3RP core, and while some companies have created secure communications solutions this way, this may not be cost effective for the algorithms that are relevant here. Thanks not least to the fast multiplier, a 50 MHz SoC with the APS3RP could execute all necessary cryptographic algorithms in software, fast enough that it is not distracting to a user.

For the best performance (and to guarantee the timing invariance discussed above), the most time-critical parts of the software have been written in Cortus assembly language, the rest in portable C.

For the OberonHAP crypto component, it was necessary to implement another algorithm used for the initial pairing of a home device with a smartphone or other controller. This is the Stanford Remote Password (SRP) algorithm. During pairing, SRP executes about 64 million multiply instructions. Through a novel algorithmic approach to multiplication in a prime field including modular reduction, it was possible to bring down this number to about 8 million instructions.

Just as importantly, it was possible to bring the RAM consumption of this "memory greedy" algorithm (for a microcontroller, that is) down to 2.5 KB. Some implementations of this algorithm are known to require more than 200 KB, even a good one typically requires more than 10 KB.

As novel algorithms, or algorithm combinations, are frowned upon in cryptographic circles with good reason, a formal correctness proof of the novel approach was developed. This mathematical proof was later reviewed and found to be correct by independent experts in the field.

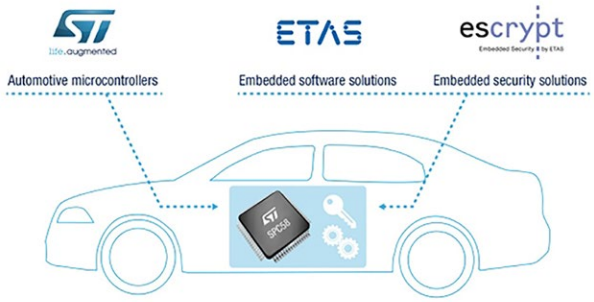
Ideally, hardware and software vendors closely cooperate to achieve an optimal hardware/software fit and bring software, hardware and mathematical know-how to the table. Cortus and Oberon microsystems have cooperated in this way to port the OberonHAP crypto component to the APS3RP core, resulting in high cryptographic performance on low gate-count processors.

The most important cryptographic functions of the OberonHAP crypto component:

- *SRP* is an augmented password-authenticated key agreement protocol.
- *Curve25519* is an elliptic curve offering 128 bits of security.
- *Ed25519* is a specific implementation of EdDSA, a digital signature scheme.
- *ChaCha20* is a stream cipher developed by Daniel J. Bernstein et.al.
- *Poly1305* is a message authentication code created by Daniel J. Bernstein et.al. It can be used to verify the data integrity and the authenticity of a message.
- HKDF-SHA512 is a key derivation function based on HMAC-SHA512.

Connected car partnership aims for hacker-proof ECUs

STMicroelectronics (Geneva, Switzerland), and automotive software specialists ETAS (Stuttgart, Germany) and ESCRYPT (Bochum, Germany), are working together to streamline development of secure connected-car applications. They aim to apply their collective skills to offer a package for developing high-performance, safe, and secure automotive-embedded systems. The resulting end-to-end solution protects against malicious attacks on the car's Electronic Control Units (ECU) and secures communication among ECUs and the cloud; an AUTOSAR-compliant platform software is intended to assist OEM and Tier-1 application developers with time-to-market and standards-compliance. The partnership is between STMicroelectronics, ETAS, provider of solutions for developing automotive embedded systems, and ESCRYPT, an ETAS subsidiary focused on security for embedded software; it will develop a complete platform comprising microcontrollers, software tools, and security solutions for automotive control units. At the same time as the number of ECUs in a vehicle grows, cars are becoming connected to the cloud enabling over-the-air (OTA) software updates, remote diagnostics, and the forthcoming V2X communication. ST, ETAS and ESCRYPT aim to deliver a cost-effective platform for sub-system developers to create ECUs that ensure a high level of protection for vehicle-owners' privacy, OEMs' intellectual property, ECU functional integrity, and secure communication among the car's ECUs and the cloud. It will use the SPC58 series of power-efficient and real-time-capable automotive microcontrollers, which feature a built-in Hardware Security Module (HSM) as well as multiple state-of-the-art CAN FD interfaces, plus LIN, FlexRay, and Ethernet with time-stamping to implement both control units with a functional integrity check and an in-vehicle network with encrypted communication. This approach expands ST's offering for connected-car defence, which also includes Secure Elements, or embedded SIMs (Subscriber Identity Modules), for protection against Internet-based attacks on ECUs and gateways that can steal personal data or compromise important vehicle systems. "SPC58 automotive microcontrollers... have already been selected by a major Tier-1 supplier for a secure OTA (Over-The-Air) application that enables remote software fixes and upgrades without requiring customers to bring their vehicles to a repair garage," ST commented. ESCRYPT is contributing its expertise in secure ECU communication, including distribution of OTA software updates, and provides firmware and middleware for ECU developers to use the SPC58 HSM. Together, the HSM and ESCRYPT's security technologies handle all the necessary authentication of trusted sources and prevention of access by unauthorized agents. "We provide our product CycurHSM, the essential solution that exercises the HSM and our Key Management Solution to secure every aspect of the ECU's activity, including secure boot-up, programming, and updates, as well as secure in-vehicle communication," said Dr. Thomas Wollinger, Managing Director of ESCRYPT. The solution builds on ETAS' proven RTA software products that support ECU code development. RTA-BSW (Basic Software) consists of a full AUTOSAR solution including AUTOSAR R4-compliant basic software capable of supporting safety-critical ECUs for both passenger cars (ISO 26262) and off-highway (ISO 25119) domains. RTA-BSW is complemented by ISOLAR-A and ISOLAR-EVE tools for authoring and testing a full ECU software stack in a virtual environment.



STMicroelectronics
www.st.com

UHD STB chipsets secures 4K digital video services

Set-Top Box (STB) chipset provider ALi Corporation announced the integration of VideoMark, a forensic watermarking solution from Verimatrix on its latest Ultra HD chipset offerings.
The collaboration with Verimatrix delivers solutions in line with the recently introduced Ultra Security specifications that enable rights owners and pay-TV operators to maximize revenue potential amid the rising popularity of premium UHD content. VideoMark from Verimatrix is a core component of the VCAS Ultra revenue security platform that meets the media industry's UHD service requirements, specifically MovieLabs Specification for Next Generation Video and Enhanced Content Protection. It offers protection against illegal redistribution by enabling user-specific traceability with embedded identifying information in copies of premium media content. ALi's UHD chipset implements a host of the latest security technologies including hardware root of trust and Trusted Execution Environment (TEE), enabling a strong base to incorporate VideoMark and together enabling an Ultra Security multi-layered architecture. Furthermore, ALi's UHD chipset embeds a high-efficiency processor and graphic engine and supports HEVC and VP9 video decoding to deliver a high-performing and cost-effective platform targeting DVB, IPTV, OTT and hybrid STB applications.

Verimatrix
www.verimatrix.com

Imagination adds security functions to cores for IoT

IP provider Imagination Technologies (Kings Langley, UK) and silicon-level security specialist Intrinsic-ID (Eindhoven, Netherlands) are collaborating to bring security to products that use Imagination's IP technologies, starting with availability

of Intrinsic-ID's Physical Unclonable Function (PUF) security and authentication technology for Imagination's MIPS M-class M5150 CPU that targets low-power applications such as M2M, IoT, and embedded control. Intrinsic-ID's PUF technology allows efficient implementation of security functions such as device authentication and anti-cloning. Imagination's OmniShield multi-domain security technology, which takes advantage of hardware virtualization technology built into its latest IP offerings, enables the creation of multiple secure domains on an SoC. Products that implement this technology can run multiple, unmodified, isolated applications and operating systems independently and securely at the same time on a single, trusted platform.

Imagination Technologies
www.imgtec.com

Microsemi, Veracity collaborate on IoT security

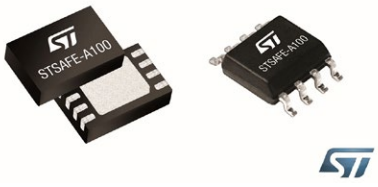
Microsemi Corp. (Aliso Viejo, CA) is collaborating with Veracity Security Intelligence (Aliso Viejo, CA) to develop secure networking systems for industrial Ethernet deployments. Security and the threat of cyberattacks are emerging as key concerns for industrial companies, such as power and utilities seeking to protect revenue, as well as network safety and reliability. This collaboration brings new capabilities to the market as the first security system of its kind optimized for industrial networks, enabling full industrial network security with a simple software installation in managed industrial switches.

Microsemi has also invested in Veracity. This investment is part of an early stage raise allowing Veracity to fund its product development efforts to address security needs of an ever growing landscape of industrial threats. This minority position will enable Microsemi to further collaborate with Veracity to deliver innovative security to its strategic customers.

Microsemi Corp.
www.microsemi.com

2x3mm secure element is optimized for IoT

STMicroelectronics' STSAFE-A100 is an easy-to-use secure element aimed at protecting connected devices in the consumer and industrial Internet of Things (IoT). Certified to the highest security industry standards, the chip can be designed-in

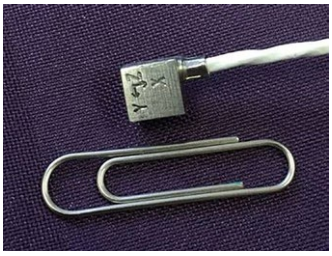


by developers without specialist security expertise thanks to comprehensive support ecosystem. Delivered in a 4x5mm SO8N or 2x3mm UFDFPN8 package, the IC will prevent hackers from counterfeiting, cloning, stealing information, or misusing connected equipment. As a secure element that provides authentication services and can be used in conjunction with an ordinary microcontroller, it features an embedded secure operating system and is certified to Common Criteria EAL5+, banking-level security-industry standards. It is compliant with the USB Type-C device-authentication scheme and secures communications with a remote host using Transport Layer Security (TLS) handshaking.

STMicroelectronics
www.st.com

IEPE tri-axial accelerometer is only 7x7.5x5.6mm

The AT/18 from DJB Instruments UK is an ultra-lightweight micro-miniature triaxial Integrated electronic piezoelectric (IEPE) accelerometer featuring three fully independent ceramic shear/mass sensing elements, welded into a Titanium body to minimise risks of signal failure and cross axis issues. Supplied with an integral 1m cable fitted with an industry standard ¼-28 UNF socket it provides maximum flexibility and can be used with common triaxial cables for extension of signal connection. Weighing in at just 1.2grams and measuring 7x7.5x5.6mm it offers triaxial measurements on the lightest of structures due to its almost invisible impact on mass loading. The AT/18 is machined to the highest levels of precision working with tolerances of just 12 microns. It goes through rigorous testing to achieve an operational temperature specification of 200°C whilst maintaining no loss of dynamic range. Sensitivity options include 1mV/g, 5mV/g and 10 mV/g with other sensitivities available on request.



DJB Instruments
www.djbinstruments.com

Bluetooth LE modules sport ASCII interface, embedded scripting

Microchip's (Chandler, AZ) RN4870 and RN4871 are next-generation Bluetooth Low Energy (BLE) products configured with an ASCII-style command interface that eliminates any complicated code compiling. The modules support the latest Bluetooth 4.2 specification and have a Bluetooth stack on board with a scripting engine to enable standalone operation and eliminate microcontroller (MCU) use for simple applications. The RN4870 and RN4871 deliver up to 2.5 times data throughput improvement over previous generation products based on the Bluetooth 4.0 standard. They offer connection security based on Federal Information Processing Standards (FIPS) coupled with advanced features. The devices can seamlessly transfer serial data over BLE devices and can support different beacon formats such as iBeacon or Eddystone via a single command. Both devices with a shield option are fully certified to meet worldwide regulatory standards and are available with package options as small as 6x8mm. Each module has an on-board software stack and pairs with any microcontroller with a UART interface. The RN4870-V/RM118, shielded with an onboard antenna, measures 12x22mm; RN4870U-V/RM118, which is unshielded with an external antenna, is a 12x15mm module. Similarly, RN4871-V/RM118, shielded with an on-board antenna, is in a 9x11.5mm module, and RN4871U-V/RM118, unshielded with an external antenna, is 6x8mm.

Microchip
www.microchip.com

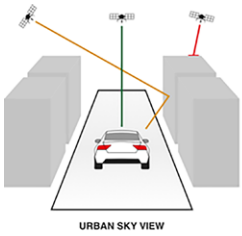
50A POL DC-DC for evaluation: 5 kits to give away

This month, CUI Inc. is giving away five NDM2Z-50HT-DEMO-D kits, worth $405 each, for *EETimes Europe*'s readers to win. The demo kits are designed to give users simple access to the advanced digital features of the 50A NDM2Z-50 point of load DC-DC modules. When mated with CUI's Novum ACE GUI, users can easily test and configure the module to help develop an optimized board-level power system. Providing best-in-class efficiency, the NDM2Z 50A module delivers 91% efficiency at 12 Vdc in to 1.0 Vdc out, 50% load. Input range is 4.5 to 14 Vdc, with a programmable output range of 0.6 to 3.3Vdc. Features include active current sharing, voltage sequencing, voltage tracking, synchronization and phase spreading, programmable soft start and stop, as well as a host of monitoring capabilities. All features are dynamically programmable via PMBus commands or through CUI's simple, easy to use GUI. Delivered in a compact DIP configuration, the DC-DC module is also available in horizontal SMT and vertical SIP versions.

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

Untethered dead reckoning receiver augments GPS with inertial sensor

u-blox' (Thalwil, Switzerland) EVA-M8E miniature Untethered Dead Reckoning (UDR) receiver measures 7x7mm, and is designed as a positioning component for small-sized vehicle trackers. It provides untethered dead-reckoning performance without any electrical connection to the vehicle, using low cost inertial sensors. The EVA-M8E offers continuous positioning even before GNSS signals have been received, improves accuracy when GNSS signals are weak, and enables continuous low-latency positioning at 20 Hz to track highly dynamic events. The EVA-M8E enables maximum flexibility in end-product design, requiring only a direct connection with the MEMS inertial sensor and SQI Flash memory. It adapts automatically to installations anywhere within a vehicle. It supports very low stand-by current consumption. UDR with adaptive signal strength compensation helps reduce the effects of small antenna and poor installations. This technology suits the EVA-M8E to extremely small after-market road-vehicle applications such as usage-based insurance and theft alarms. Along with all u-blox M8 receivers, the EVA-M8E supports GPS, GLONASS, BeiDou, Galileo, QZSS and SBAS constellations. It provides superior positioning accuracy in urban canyons, tunnels, and parking garages. The C93-M8E enables immediate evaluation of the u-blox's Untethered Dead Reckoning technology in most vehicle applications.



u-blox
www.u-blox.com

Sensor beacon design kit uses solar power for IoT applications

Cypress Semiconductor's CYALKIT-E02 solar-powered BLE sensor beacon reference design kit provides an easy-to-use platform for the development of a solar-powered wireless sensor node that can sense the temperature and humidity around its location and transmit the data using Bluetooth Low Energy connectivity. The reference sensor beacon, which is 25 mm in diameter, can be placed and left to operate without maintenance for battery changes, making it suitable to monitor environmental conditions in smart home, commercial building, factory, and agriculture settings. The tiny new reference design integrates Cypress's energy harvesting power management integrated circuits, EZ-BLE PRoC Bluetooth Low Energy module and a 15 x 15-mm solar cell that enable operation using as little as 100 lux of ambient light - less light than a typical warehouse aisle receives. The kit contains the solar-powered BLE sensor beacon, a BLE-USB Bridge and Debug Board.

Cypress Semiconductor
www.cypress.com

Tiny 9-axis motion sensor targets wearable devices

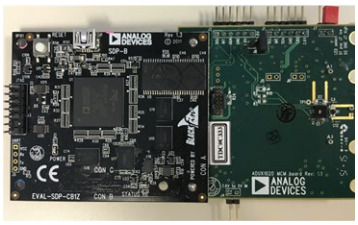
Featuring a compact and low power design for smartphones, smart watches and other wearables, the BMX160 MEMS compact 9-axis motion sensor from Bosch Sensortec, enables smart watch gestures, step counting, magnetic heading and device orientation. Compared to smartphones, wearables face much harsher space and power constraints, an environment targeted by the BMX160, which is housed in a compact 2.5x3.0x0.95mm package, claiming to be the smallest 9-axis motion sensor in the industry.

By combining Bosch Sensortec's advanced accelerometer, gyroscope and geomagnetic sensor technologies, the BMX160 is able to meet the increasingly more stringent low-power requirements demanded by wearable devices. The company's low-power sensor technology makes this the standout 9-axis inertial sensor on the market, reducing power consumption below 1.5 mA.

Bosch Sensortec
www.bosch-sensortec.com

Optical sensor improves gesture-sensing dependability

Analog Devices has added an optical sensor for gesture recognition, which improves sensing accuracy and reliability over existing solutions by measuring a subject's position, proximity, and gestures from a single sensor. Alternative solutions requiring multiple sensors are, ADI asserts, often inaccurate, as the sensors "see" objects differently from varying angles making the signals difficult to combine. The single-point sensing used in the ADUX1020 optical sensor improves reliability of the application and reduces design complexity and cost for the system developer by requiring fewer components. In addition to single-point sensing, the ADUX1020 optical sensor features high ambient light rejection, which allows reliable and accurate operation under challenging lighting conditions. This too results in a more reliable application end user experience. Other optical sensors are often challenged by ambient light from sources like full sun, high frequency LED and fluorescents. The ADUX1020BCPZ comes in a 2×3mm, 8-lead LFCSP.



Analog Devices
www.analog.com/ADUX1020

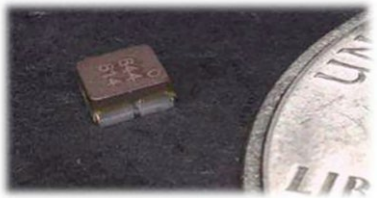
OpenPOWER-based CAPI acceleration on FPGA attached board

Alpha Data (Edinburgh, Scotland) has added a CAPI acceleration development kit for its ADM-PCIE-8K5 board. The kit enables designers to utilize Xilinx All Programmable FPGA devices attached to the coherent accelerator processor interfaces on IBM POWER8 systems. The development kit includes the PSL (Power Service Layer) to provide the infrastructure connection to the POWER8 chip, examples of user defined AFU (Accelerator Function Units), as well as OS Kernel extensions and library functions specifically for CAPI. This solution removes the software overhead for processor communication with the I/O subsystem, allowing an accelerator to operate as part of an application, which significantly reduces the development time required to offload data processing applications to FPGAs. The Alpha Data ADM-PCIE-8K5 PCIe form factor add-in card utilizes Xilinx FPGAs to deliver application-specific acceleration for Big Data workloads. The ADM-PCIE-8K5 is IBM Power8 CAPI capable, featuring a Xilinx Kintex UltraScale KU115 FPGA.

Alpha Data
www.alpha-data.com

Accelerometers, tilt switches filter vibration

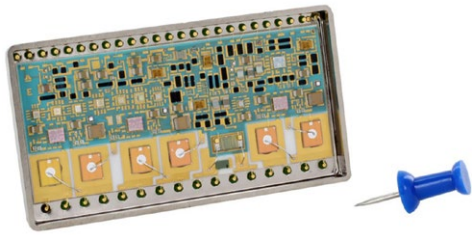
Memsic Inc. has introduced a family of sensors to provide a tilt switch and accelerometer for use in high-vibration environments. The family can be used for tip-over detection in vehicles and includes four new sensors, the MXD6240 and 41AU, MXC6244AU, MXC6245XU. The 624x family uses Memsic's proprietary thermal accelerometer to sense acceleration instead of a mechanical beam structure. As a result the transducer exhibits an inherent low-pass frequency response with virtually no mechanical resonance. The MXD6240 and MXD6241AU are autonomous inclination sensors with 8 built-in, pin-programmable tip-over angle thresholds from 40 to 70 degrees making them ideal for tip-over applications where no microcontroller is available. The MXC6244AU and MXC6245XU are complete 2 axis I2C interface accelerometers each with 1 mg of resolution. The MXC6244AU is ±8g full scale range device. It includes the internal anti-vibration filter and the 8 angle thresholds programmable through the I2C interface. The MXC6245XU is a ±2g full-scale range device and is targeted at cost sensitive applications not requiring the programmable anti-vibration filter or the 8 programmable tip-over angle thresholds. It offers 12 bits of resolution (1 mg) and has the same outstanding over temperature bias performance of typically 0.1 mg/C.



Memsic Inc.
www.memsic.com

Radiation-tolerant three-phase motor drive delivers 5A continuous

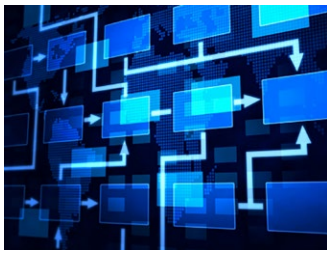
Data Device Corporation's PW-82336 is a high-reliability, 3-phase radiation tolerant motor drive, providing 100k Rad Total Dose protection, and advanced circuit and logic protection to ensure fail-safe operation. The 66x35.6x6.35mm unit uses a high-efficiency, radiation tolerant MOSFET output stage with 100 VDC rating to deliver 5A continuous current (10A peak current) to the motor, along with flexible I/O, enabling a common design to be used across multiple applications. Its flexible I/O allows a common design to be used across multiple application platforms with individual bridge returns and standard logic level inputs to facilitate design implementation. The package eliminates shoot-through conditions with high and low-side input logic signals XOR's in each phase to prevent simultaneous turn on of in-line transistors. Internal logic controls (from +5 to +15 V) support the high and low-side gate drivers for each phase.



Data Device Corporation
www.ddc-web.com

Developer's kit for vision-based ADAS

Xylon, a provider of intellectual property (IP) cores, design services and solutions for Xilinx FPGA and SoC devices, has introduced a new version of its Xilinx Zynq-7000 All Programmable SoC based logiADAK 3.2 development kit for vision-based Advanced Driver Assistance (ADAS) applications. The kit boasts a broad set of new and enhanced capabilities which enables OEM automakers and Tier-1 automotive electronics suppliers to jump-start next-generation ADAS system development. The enhanced automotive driver assistance kit includes a toolset for driver's drowsiness detection based on facial movements monitored through a camera placed in a vehicle cabin. Implemented with Xylon's logiDROWSINE Driver Drowsiness Detector IP core, and based on the face tracking and analysis technology from technology partner Visage Technologies AB, the drowsiness detector continuously tracks eyes, gaze, eyebrows, lips and head movements, and recognizes various behavioral features indicating the drowsiness. The new logiADAK kit now comes with expanded and improved forward camera collision avoidance ADAS based on detection and recognition of vehicles, pedestrians and bikes. Multi-object detections is supported by the logiHOG Object Detector IP core for advanced HOG/SVM object classification, and the logiVDET Vehicle Detector IP core for vehicle detections. The collision avoidance toolset also includes advanced PC software tools for easy configuration, training and verification of multi-object detectors.



ADAS
www.logicbricks.com

Think beyond stop-start in automobiles

By Shaw Lynds

Hybrid vehicles are old hat, and nearly always relegated to a niche market – currently about 3 percent of US car sales. Electric vehicles are sexy, but it'll be a long wait until they're an economically sound choice for the average Joe. As the country's corporate average fuel economy (CAFE) standards rise, what are car manufacturers to do?

The industry's latest answer – and hot topic – is the stop-start method. Basically, this involves turning off an engine when the car isn't moving. This approach saves fuel, but it doesn't add the peppy responsiveness to cars that hybrids and electrics enjoy from the massive low-end torque of their electric motors.

Nevertheless, most major auto OEMs (original equipment manufacturers) have several start-stop vehicles in the works, if not already in their fleets, as it is a relatively inexpensive way to improve fuel economy by a few percentage points.

The costs to add stop-start to a vehicle are relatively minor: an increase in battery size to handle peripheral loads while the engine is off (lights, radio, air-conditioning and power steering), an increase in alternator size to charge larger batteries faster once the engine is back on, and improvements to the starter system to make the restart and acceleration of the vehicle as seamless as possible.

Auto OEMs may love stop-start for its relatively inexpensive boost to their CAFE numbers, but how do they get consumers excited enough for broad market adoption of a system that, at best, has no noticeable impact on the driving performance of a car, and at worst, leaves the car feeling sluggish or non-responsive when the driver accelerates from a stoplight?

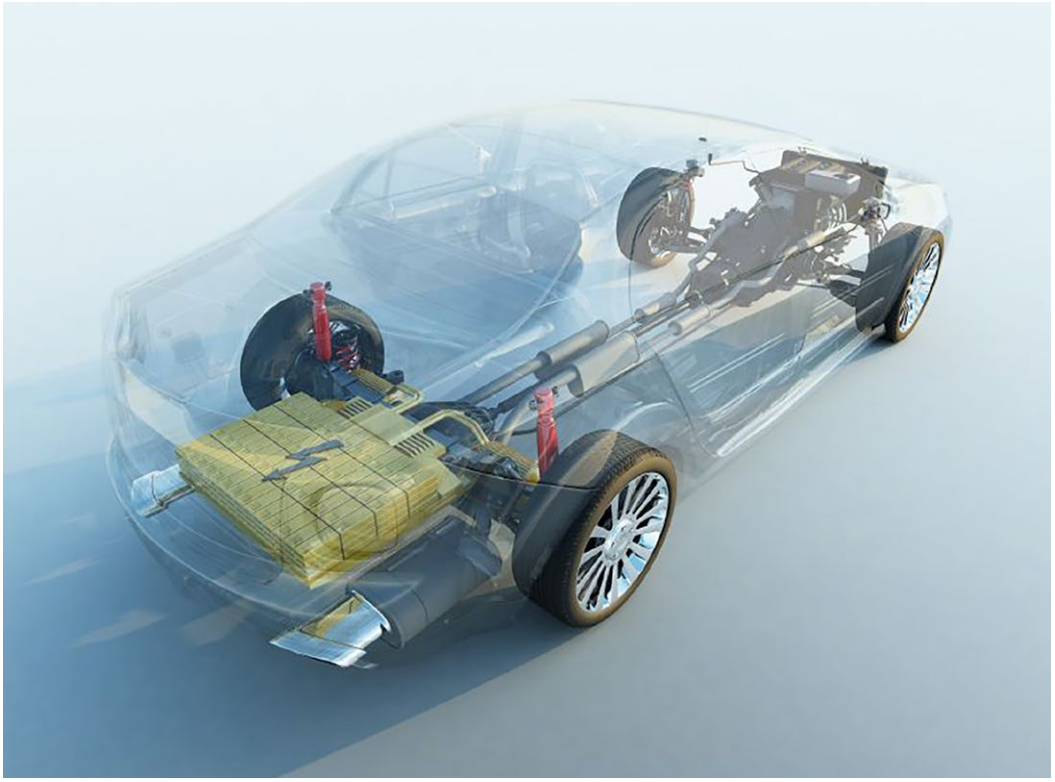
The next logical step is to add intelligence to a stop-start's already upsized alternator and make the vehicle a true micro-hybrid. Typical car alternators are rated for about 80 amps or about 1 kilowatt (kW) of power-run peripheral loads and recharge batteries. In stop-start systems, it is common to see the alternator increased to 2kW or 3kW to handle larger loads.

This might not sound like much, compared to the full engine power of 160 horsepower or 120kW. But, compared to the engine power available during initial acceleration of only about 40 to 60kW, such an upsized alternator can represent more than 5 percent of the available power.

A micro-hybrid with an intelligent alternator could keep the alternator off during acceleration, providing a perceivable performance boost. Better yet, if that alternator is engaged primarily during deceleration, the system can provide a significant boost to the car's fuel economy.

The only example of such a system in the market today is Mazda's i-ELOOP system, which claims to achieve up to a 10 percent improvement in fuel economy in urban drive cycles.

This is impressive when you consider that Mazda states that the i-ELOOP energy storage system only has capacity for seven seconds of braking energy.



For comparison, most hybrid vehicles on the market today only achieve a 25 to 30 percent improvement in fuel economy (according to a 2015 report from the International Council on Clean Transportation), and they require substantial costs and more than 1kWh or 30 seconds of braking energy storage to reach that level.

However, there's no reason to scoff at claims that substantial fuel saving can be achieved with minimal energy storage.

Back in 2008, the National Renewable Energy Laboratory (NREL) demonstrated a hybrid vehicle achieving the same 25 percent fuel economy improvement with 35 watt-hours (Wh) of ultracapacitor energy storage as the vehicle did with its originally designed 1.6 kilowatt-hour (kWh) NiMH battery.

As auto manufacturers start to think beyond stop-start, the next economical gains may not come from bigger batteries or fancy electric-drive trains, but rather from small tweaks to vehicles' alternators and 12V power systems.

Shaw Lynds is a manager of systems technology at energy storage manufacturer Maxwell Technologies - www.maxwell.com . He leads the development of ultracapacitors for automotive and solar energy smoothing systems.

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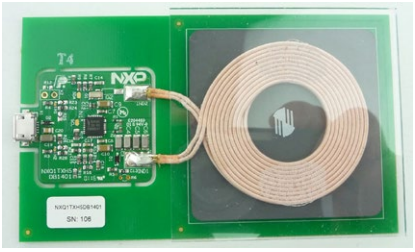
DISTRIBUTION CORNER

Qi wireless power transmitter chip

The NXQ1TXH5 single-chip 5-V Qi wireless transmitter from NXP, and available from Mouser Electronics, is a fully integrated controller and driver IC that enables engineers design a WPC 1.2 Qi-compliant low-power wireless charger with Foreign Object Detection (FOD). The NXQ1TXH5 includes a 5-V full-bridge power stage and integrates all the functions required to control power transfer with a Qi-compliant receiver. It delivers up to 8 W continuous power into a Qi-compliant type A5, A11, A12, or A16 transmitter coil, and requires minimal external components.



Mouser Electronics
www.mouser.com

Avnet Memec-Silica introduces industrial IoT starter kit

Distributor Avnet Memec – Silica has launched the Avnet MicroZed Industrial IoT Starter Kit, an out-of-the-box system backed by industry-leading solutions from IBM, Wind River and Xilinx, designed to simplify customers' prototype and development efforts. The kit integrates the IBM Watson IoT Platform agent on top of a custom-configured, certified image of the Wind River Pulsar Linux operating system, now standard on MicroZed and PicoZed System-on-Modules. IBM's Watson IoT Platform agent enables registered, secure connection to the Watson IoT Platform and additional cloud services and applications from the IBM Bluemix portfolio.

Avnet Memec – Silica
www.avnetmemec-silica.com

Premier Farnell to be sold to Swiss distributor

Premier Farnell plc, a distributor of electronic components, has agreed a sale of the company to Datwyler Holding AG (Altdorf, Switzerland) for a cash offer of 165 pence per share. This values the share capital of Premier Farnell at approximately £615 million (about $870 million) and implies an enterprise value of £792 million (about $1.1 billion). Datwyler is also an electronic component distributor and claims that the combination with Premier Farnell will be a strategic fit. Premier Farnell had sales in the 2015/2016 financial year of £903.9 million (about $1.3 billion) up 2 percent from the previous year's sales of £886.6 million.

Premier Farnell
www.premierfarnell.com

LoRa low-power WAN evaluation kits from Microchip, in distribution

Distributor RS Components (RS) has Microchip's range of LoRa development kits; LoRa implements low-power wide-area networks, and the kits integrate gateway, sensors and local server application, and come with certification for Europe and North America, enabling fast and easy development possibilities for the IoT. The technology is capable of securely delivering two-way communication at data rates from 0.3 to 50 kbps, and over distances of up to 2 to 5 km in an urban environment and up to 15 km in a suburban environment.

RS Components
www.rs-online.com

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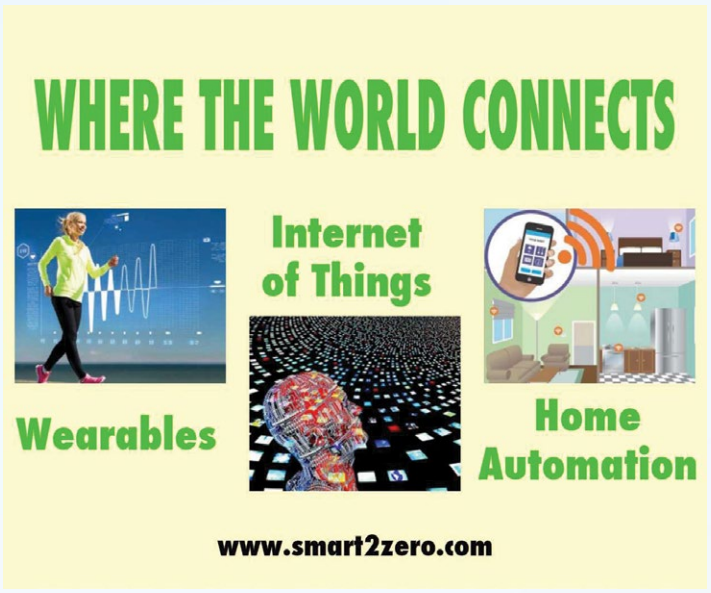

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