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THE GLOBAL STAGE FOR INNOVATION

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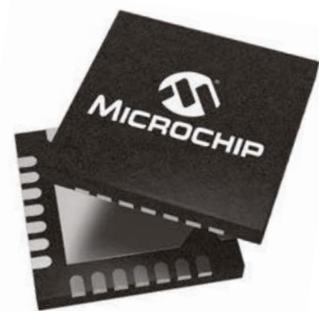
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The only way is up

HOW THE LEADING TECH COMPANIES LOOK SET TO GROW, AND GROW AND GROW!



Not that long ago FAANG stocks appeared to be in retreat. Facebook, Apple, Amazon, Netflix and Google were lagging behind their peers and there were worries of another dot.com bubble bursting. Analysts were warning investors to diversify their portfolios and avoid being too narrowly-focused.

Fast forward and over the past year the aggregate market capitalisation of these tech giants, and Google's parent Alphabet, has jumped by 45% or almost \$1.3 trillion, despite earnings affected by a smartphone market which is saturated and companies seeing much slower upgrade cycles. The effect of the Trump tax cuts, which helped to boost earnings in 2018, is also now wearing off.

Despite these pressures, most analysts and investors expect to see similar rates of growth in the coming year and, in fact, last week Google's parent company, Alphabet, joined an illustrious group of companies achieving a market capitalisation in excess of \$1trillion.

For most analysts the only way for these companies is up – many are talking of the tech giants doubling their current market valuations.

These companies are able to invest heavily in technology and with the vast amount of data that they have accumulated from billions of users, they can now look to reach into and revolutionise almost every aspect of our lives.

It's that prospect that makes so many investors believe that these companies are actually significantly undervalued.

So, what are the risks? The biggest appears to be regulatory, because as these companies have grown so too has their influence on society and that is now becoming a major concern for regulators. There is talk of a need for a new framework, a new vocabulary, to assess and address their dominance.

In Europe, Google has been hit with a \$9bn fine for breaking antitrust laws while Apple was forced to repay \$14.5bn for avoiding taxes.

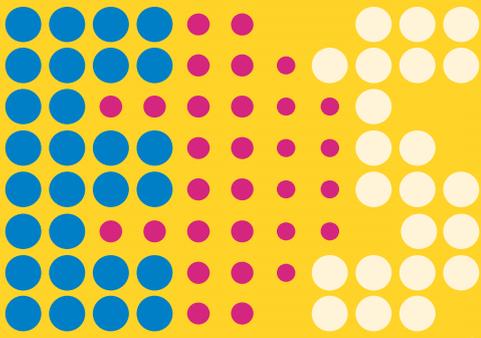
France and the UK have brought forward tech tax proposals. While France has postponed its implementation the UK has said that it will go ahead with a new tax in April, despite US threats to impose tariffs in retaliation.

Consumers are also joining in the calls for tighter scrutiny of the use of data especially in terms of social media advertising.

Whatever happens, in terms of regulation, these companies seem destined to become even larger as they lay the foundations to become even bigger and more intrusive than they are today.

Neil Tyler, Editor (neil.tyler@markallengroup.com)

“In Europe Google has been hit with a \$9bn fine for breaking antitrust laws, while Apple was forced to repay \$14.5bn for avoiding taxes.”



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Researchers unveil artificial ionic skin

ARTIFICIAL 'SKIN' SENSOR COULD BE THE FUTURE OF WEARABLE ELECTRONICS. **NEIL TYLER** REPORTS

University of Toronto Engineering researchers have developed a stretchy, transparent and self-powering sensor that records the complex sensations of human skin.

Dubbed artificial ionic skin, or AISkin for short, the researchers believe its innovative properties could lead to future advancements in wearable electronics, personal health care and robotics.

"Since it's hydrogel, it's inexpensive and biocompatible – you can put it on the skin without any toxic effects. It's also very adhesive, and it doesn't fall off, so there are so many avenues for this material," said Professor Xinyu Liu, whose lab is focused on the emerging areas of ionic skin and soft robotics.

The adhesive AISkin is made of two oppositely charged sheets of stretchable substances known as hydrogels. By overlaying negative and positive ions, the researchers create what they call a "sensing junction" on the gel's surface.

When the AISkin is subjected to strain, humidity or changes in temperature, it generates controlled ion movements across the sensing junction, which can be measured as electrical signals such as voltage or current.

"If you look at human skin, how we sense heat or pressure, our neural cells transmit information through ions – it's really not so different from our artificial skin," says Liu.

AISkin is also uniquely tough and stretchable. "Our human skin can stretch about 50 per cent, but our AISkin can stretch up to 400 per cent of its length without breaking," says Binbin Ying, a visiting PhD candidate from McGill University who's leading the project in Liu's lab.

According to Liu, AISkin could open doors to skin-like Fitbits that measure multiple body parameters or measuring the progress of muscle rehabilitation. It could also be integrated onto soft robots to handle brittle objects.

Over the next year, Liu's lab will be focused on further enhancing their AISkin, aiming to shrink the size of AISkin sensors through microfabrication. The team will also look to add bio-sensing capabilities to the material, allowing it to measure biomolecules in body fluids such as sweat.

Mission-critical modules take to the skies

Mercury Systems has unveiled a new module to deliver the onboard processing power needed for smarter avionics applications.

The EnsembleSeries CIOE-1390 module is intended for rotary-wing platforms and Urban Air Mobility (UAM) vehicles. It includes Intel Atom multicore processors and embedded BuiltSAFE technology to deliver flight safety certification.

Single-core processors often lack the performance required to drive next-generation smart platforms. This new module looks to solve that challenge by delivering design assurance level (DAL) for mission-critical, flight safety-certifiable applications.

The new module delivers a full x86 processing architecture for embedding into applications deployed in harsh environments.

EnsembleSeries CIOE-1390 modules are expected to be available by the end of this quarter.

Printed semiconductor used for wireless comms

Toray Industries has communicated wirelessly across the ultra-high frequency (UHF) band using a printed semiconductor.

The company says this was achieved by using a printed radio-frequency identifier (RFID) it developed employing a high-performance semi-conductive carbon nanotube composite.

Toray said that this technique demonstrates the potential for manufacturing UHF RFIDs by using low-cost printing processes to streamline retail and logistics operations including automating cash registers and efficient inventory management. The company said that it is now looking to accelerate development to commercialise these printed RFIDs.

Toray fabricated this RFID prototype incorporating a 24-bit memory with a low-cost printing technology. Its product goal is to now materialise a 60-bit memory.



Flex Power Designer adds new features

Flex Power Modules has added new features to its Flex Power Designer software making it easier to use for digital power system design, as well as broadening the number of products it supports.

Version 3.2 looks to save engineers time when developing their power systems, as well as reducing the risk of any problems with their design. It adds a time-saving numeric conversion calculator, which makes it easier for designers to calculate linear/Vout and linear/direct formatted values seen from monitoring data. The software also includes a new display address resistor suggestion feature, which calculates suggested values for the resistors SA0/SA1.

The software supports test boards for Flex's BMR480 and BMR490 DC-DC converters and it has also added the ability to monitor common parameters for power products from other vendors, increasing the flexibility available to designers. These parameters, at a minimum, will be input voltage, output voltage and temperature.

This version incorporates all the features of earlier releases and includes the thermal modelling that was added in v3.0. This enables designers to simulate thermal behaviours without building hardware, for example to calculate hotspot temperature and overall system efficiency.

Commenting Olle Hellgren, Director Product Management and Business Development at Flex Power Modules, said: "Flex Power Designer isn't just about converter configuration – it provides an overview of the entire power system, enabling designers to take full advantage of the latest digital power technology."

Using these new features, designers and system architects will be able to track or simulate the efficiency of their entire power system. The software enables configuration and simulation of the control loop, and straightforward configuration and monitoring of digital power modules. An SMBus tool and sample code are also included.

The simulation features enable power-stage analysis to optimise tuning, as well as to visualize design behaviour. Engineers will be able to investigate how a system matches up to their design requirements by looking at specific metrics such as transient response, output impedance and power dissipation.

New Snapdragon mobile platforms

QUALCOMM LAUNCHES THREE NEW SNAPDRAGON MOBILE PLATFORMS. **CHARLOTTE HATHWAY REPORTS**

Qualcomm Technologies has launched three new system-on-chip (SoC) solutions as it looks to enhance user experiences across connectivity, gaming and entertainment.

The Snapdragon 720G, 662 and 460 enable 4G connectivity, deliver Wi-Fi 6 and integrate Bluetooth 5.1 with advanced audio via the Qualcomm FastConnect 6-series subsystems.

The mobile platforms also support Dual-Frequency (L1 and L5) GNSS to improve location positioning accuracy and robustness. Qualcomm says the three SoC solutions are also the first to support Navigation with Indian Constellation (NavIC).

Kedar Kondap, vice president, product management, Qualcomm Technologies, commented, "Today's smartphone users want fast, seamless connectivity, advanced features and long-lasting battery life. This expansion of our 4G lineup enables our partners to offer sophisticated solutions that meet global demand and enable a remarkable gaming experience across multiple tiers and price segments."

The Snapdragon 720G looks to reimagine gaming and entertainment experiences with select Qualcomm Snapdragon Elite Gaming features, improved capture capabilities and more intelligent performance. The 662 brings camera and AI capabilities to the 6-series, and features the new Qualcomm Spectra 340T, which supports triple camera configurations and smooth switching between them.

The third SoC, the 460, offers significant boosts in connectivity and AI along with camera improvements. It features performance CPU cores and an updated GPU architecture that translates into up to 70% and 60% increase in performance, respectively. Devices based on Snapdragon 720G are expected to be commercially available in Q1 2020 and devices based on Snapdragon 662 and 460 are expected to be commercially available by the end of the year.



Additional updates for Bridgetek's EVE Toolchain

In a move intended to extend the parameters of the ecosystem that accompanies its Embedded Video Engine (EVE) graphic controllers, Bridgetek has announced a new version of its EVE Screen Editor (ESE).

Relying on simple drag-and-drop actions, ESE 3.3 is the latest update to the company's Windows-based tool and is intended to assist engineers in speeding up advanced level HMI development, without requiring any prior expertise in that area. Engineers will be able to optimise their HMI layout and create detailed display lists. They can also evaluate the effectiveness of their HMI and make alterations, as well as experimenting with different design concepts and configurations.

This version of ESE is able to connect to numerous items of external hardware,

such as the VM800, VM816 and ME81x HMI development platforms. In addition, the device sync feature enables the latest generation of third party EVE display modules from Bridgetek partner Riverdi to be supported.

A greater breadth of example projects can now be accessed, including ones relating to functions like the Blend_Func and the circular progress bar widget.

For greater convenience, ESE 3.3 allows either horizontal or vertical movements to be accurately charted (with XY coordinates given). The user can also constrain an object's movement along one axis when it is being dragged (for precision placement).

Through the analytical features incorporated, engineers can check a given pixel's value on the status bar (by hovering the mouse over the viewport window).

Sundance launches Lynsyn Lite

LOW-COST POWER MEASUREMENT TOOL FOR CLEC SYSTEMS. **NEIL TYLER** REPORTS

Sundance Multiprocessor Technology, a manufacturer of embedded modules, has launched Lynsyn Lite, a low-cost power measurement tool for the development of embedded and customised low-energy computing (CLEC) systems that require high levels of energy efficiency.

Lynsyn Lite has been designed to provide accurate measurement of a system's energy consumption based on application behaviour, saving on the time-consuming process of tracking down the root causes of power issues compared to using traditional laboratory-grade power measurement equipment.

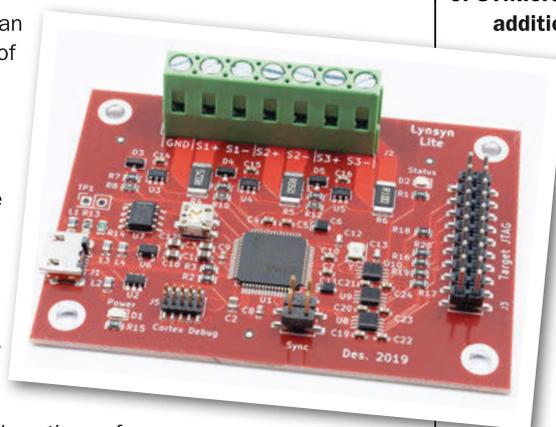
The core technology was developed by the Norwegian University of Science and Technology (NTNU), as part of its involvement in the EU's recently completed TULIPP project, to overcome the challenges of measuring energy consumption in the development of the project's high performance, energy-efficient reference platform targeting the growing range of complex image processing applications.

Developed with technology transfer funding from TETRAMAX, the Horizon 2020 innovation hub, Lynsyn Lite has been engineered by NTNU in conjunction with Sundance Multiprocessor Technology to provide a low-cost, commercial implementation of the core Lynsyn technology.

Lynsyn Lite measures the power usage of individual sections of source code deployed in embedded and CLEC systems. It connects over JTAG to non-intrusively sample the program counters of the system processors and correlate the power measurements with the source code, mapping consumption samples to application actions. A sampling frequency of up to 10kHz is used.

It features three sensors that measure both current and voltage and, although it has been designed to support application power profiling primarily of systems based on ARM Cortex A9, A53 and A57 cores, there is no need to purchase a separate JTAG pod as it is a replacement for the Xilinx Platform Cable USB-II and can, therefore, also be used as a generic JTAG programming device with the Xilinx Vivado tool suite and a remotely controlled current/voltage meter over USB. Lynsyn Lite is compatible with both Linux and Windows operating systems and includes open source software that both samples and visualizes measurement results.

"High-performance embedded and customised low-energy computing systems require a high degree of energy efficiency, the development of which demands accurate measurement of energy consumption based on application behaviour," said Flemming Christensen, Managing Director of Sundance Multiprocessor Technology. "Lynsyn Lite has been designed to perform application power profiling primarily of systems based on ARM Cortex A cores, it can also be used as a generic power profiling tool."



SiCrystal and ST sign SiC wafer supply agreement

ROHM and STMicroelectronics have signed a multi-year silicon carbide (SiC) wafers supply agreement.

The agreement governs the supply of over \$120 million of advanced 150mm silicon carbide wafers by SiCrystal to STMicroelectronics.

Jean-Marc Chery, President and CEO of STMicroelectronics, commented, "This additional long-term SiC substrate

supply agreement comes on top of the external capacity we have already secured and the internal capacity we are ramping. It will enable ST to increase the volume and balance of the wafers we will need to meet the strong demand ramp-up from customers for automotive and industrial programs over the next years."

Dr. Robert Eckstein, President and CEO of SiCrystal, a ROHM group company, added,

"SiCrystal is a group company of ROHM, a leading company of SiC, and has been manufacturing SiC wafers for many years. We are very pleased to enter into this supply agreement with our longstanding customer ST. We will continue to support our partner to expand silicon carbide business by ramping up wafer quantities continuously and by providing reliable quality at all times."

The adoption of power solutions with SiCs is accelerating in both the automotive and industrial markets. With this agreement, the two companies will look to contribute to the widespread use of SiC in these markets.

Littelfuse unveils Gate Drive evaluation platform

Littelfuse has unveiled the Gate Drive Evaluation Platform (GDEV), an evaluation platform intended to help designers evaluate SiC MOSFETs, SiC Schottky diodes, and other peripheral components like gate driver circuitry, to better understand how silicon carbide technologies will behave in converter applications under continuous operating conditions.

The GDEV offers quick connect header pin

terminals that allow for rapid and consistent comparison of different gate drive circuits. The GDEV supports an 800 V DC link input voltage and up to 200 kHz switching frequency.

"The Gate Drive Evaluation Platform (GDEV) is a critical addition to our SiC technology portfolio because SiC is still relatively new and there are some unknowns surrounding the operating characteristics under various conditions," explained Corey Deyalsingh,

Director, Power Control at Littelfuse.

"The GDEV will help engineers understand the operating characteristics of SiC devices. By utilizing this evaluation platform, engineers will be better informed about the incredibly energy efficient opportunities that SiC technologies present. Equipped with that knowledge, we anticipate that designers will be more likely to incorporate SiC into their future designs."

At the Consumer Electronics Show (CES) in Las Vegas, the industry research group, GSMA Intelligence published the 2020 edition of its 'Future of Devices' report.

This report looks at the adoption rates of smartphones, smart speakers, and personal computing devices and looked in detail at consumer expectations around 5G and their willingness to upgrade to 5G services.

It suggests that smartphones remain the dominant form factor, despite a plethora of new products, while the promise of the smart home may finally be within reach due in no small part to the growth in smart speakers. In what is a very fragmented market, the smart home has been held back by a lack of compatibility, according to the report. But it suggests that smart speakers could change this by acting as a single control point with a sophisticated AI-based voice engine.

Falls in price, which have been led by Amazon's Echo devices, have also helped increase take-up, which is up by as much as 10 per cent over the past year, making smart speakers the fastest moving category in 2019.

When it comes to 5G the report says that it is set to provide a boost to smartphone sales, rather than generate a wholesale renewal of the market.

Consumer awareness of 5G is uniformly high at 75% across the 21 countries that were surveyed, however, upgrade intentions vary considerably. Nearly 50% of Chinese consumers say they will get a 5G phone as soon as the service becomes available,

Future of Devices

RESEARCH CONDUCTED BY GSMA INTELLIGENCE SUGGESTS THAT WHILE AWARENESS OF 5G IS HIGH, UPGRADE INTENTIONS VARY CONSIDERABLY AMONG CONSUMERS. **NEIL TYLER** REPORTS

compared to 30% in the US and just 15–20% in Europe. For many 5G is still seen as being solely about speed enhancement.

For many companies market saturation has been a real problem, as is what the report calls 'design fatigue.' So for many the arrival of 5G can't come soon enough.

China, South Korea and a collection of Middle Eastern states offer the likeliest early adopters.

Amongst handset manufacturers the report found what it described as a shift in the competitive balance.

While Samsung wants to establish a 5G first-mover advantage, upgrade intentions in its

heartland markets are uncertain, while Apple has elected to come late to the game and faces on-going price pressure against its premium product ethos.

For both Samsung and Apple, Huawei is becoming an increasing threat with a strong market position in China as well as an expanded presence in both Europe and the Middle East, which should serve as a 'stark warning' to both companies should Huawei

choose to leverage its vast scale economies and take an aggressive pricing approach to 5G handsets. According to the report both Huawei and Xiaomi are now looking to compete on features rather than price alone to establish 5G first-mover advantage.

China holds a commanding lead over other advanced nations such as the US. With 50 per cent of Chinese consumers saying they will get a 5G phone as soon as it is available, China is set to vastly outweigh any other country in the early years of 5G take-up.

There is also growing evidence that handset prices are falling faster than initially thought, which will accelerate as chipmakers such as Qualcomm and MediaTek service the mid end in 2020. However, the report goes on to warn that if 5G smartphones are priced at only a small premium to 4G devices, questions of functionality trade-off may arise as well as whether services are 'true' 5G or just enhanced 4G.

In the light of these finding it is no surprise that China has become the global epicentre for smartphone manufacturing and consumption, accounting for 75% of production and 30% of sales.

The report says that market saturation and weakness in consumer incomes has resulted in a two-year global smartphone sales downturn, but that the trend over the last six months gives grounds for cautious optimism among OEMs as 5G arrives.



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Andrew is a recognised trade compliance expert and previously worked as Head of Global Trade Compliance for a large distributor of electronic components, so he understands the regulatory challenges around global trade in the electronics industry.

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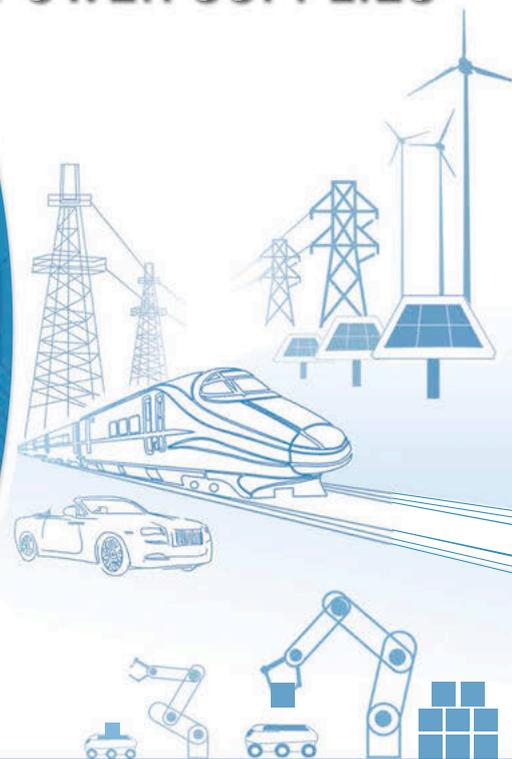
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The Consumer Electronics Show (CES), held in Las Vegas last month, provided a showcase for over 4,400 exhibiting companies.

Organised by the Consumer Technology Association (CTA), the trade association that represents the US consumer technology industry which is currently valued at over \$400bn, it attracts business leaders, thinkers and regulators along with companies such as Samsung, Microsoft, Amazon, and Facebook who use the show to unveil new products and float new concepts.

While artificial intelligence and 5G certainly grabbed the headlines, new smartphone, laptop PC and television innovation continued to attract coverage, which should come as no surprise when you think that the annual market for smartphones alone is worth \$75bn and that for laptop PCs is over \$33bn.

Yet, for many, this year's show lacked what is referred to as a, 'Next Big Thing'. As one commentator put it, while there was a lot being thrown at the wall, in terms of ideas, the consumer electronics ecosystem is still maturing.

Prior to CES, New Electronics spoke with the CTA and we discussed the importance of having a more diverse range of speakers in terms of gender, race and culture at the show. Back in 2017, for example, there were no female keynote speakers scheduled so when we met a lot was made of the work the organisers were putting in to addressing this.

Unfortunately, a lot of that good work, undertaken by the CTA, was somewhat over-shadowed by the decision to invite Ivanka Trump to Las Vegas. That decision met with a backlash from industry figures, who denounced her 'privilege' and lack of tech qualifications.

Trump was interviewed by Gary Shapiro, the CEO of the CTA, and during her interview looked to address technology's role in creating and enabling the workforce of the future.



THE GLOBAL STAGE FOR INNOVATION

CES 2020 has come and gone. So, what were some of the highlights at this year's show? By Neil Tyler

Critics called her inclusion, 'a lazy attempt to emulate diversity', and it was a shame that her appearance 'crowded' out the work the CTA had put into the event.

Turning to the show proper there was, once again, a large presence from the automotive industry and the companies that supply it with technology.

In-vehicle technology, for example, has a significant place at the show and with annual growth of over 6 per cent the use of safety systems, driver assistance, navigation and infotainment technologies has helped to create an in-vehicle market that's now worth over \$18bn.

This year, many companies talked about delivering 'experiences' and how they could be used to differentiate brands.

Both Audi, who demoed the AI:ME

Vision, a fully autonomous car that the company described as a, 'lounge for the city of tomorrow,' and BMW which showed off its all-electric i3, talked about transforming the interior experience. So much so that BMW appeared rather carried away when it described the i3 as having the 'feel of a boutique hotel'.

The talk of experiences was carried over into the keynotes when Samsung Consumer Electronics' President and CEO H.S. Kim heralded a decade of human-centric innovation that would, "seamlessly combine hardware and software to create personalised experiences that would make life more convenient, more enjoyable and more meaningful."

According to Kim this 'Age of Experience' will transform how we care for ourselves and our family, how we customise our homes to meet

individual needs and help us build safer, more sustainable and intelligent cities.

Practical innovation

Turning to the technology that will be used to support these 'experiences', Harman International announced a new audio and communications solutions bundle – the EV Plus+, that the company, now a subsidiary of Samsung, has designed specifically for the fast growing electric vehicle (EV) segment.

As growth in the EV market continues to accelerate, consumer demand for premium, personalised in-cabin experiences from vehicles is set to increase and Harman's EV Plus+ looks to provide designers with a range of solutions - from branded audio to improved entertainment and communication features.

For many companies CES is an opportunity to unveil concept vehicles, and Fiat's Centoventi demonstrated the brand's vision of electric mobility. The car's instrument cluster, storage compartments and seats are interchangeable and customisable and the vehicle's range can be adapted to meet customer needs - whether that's touring or urban commuting.

In terms of charging, EVBox unveiled its fast charger, the EVBox Troniq 100 and a redesigned ultra-fast charger, the Ultroniq. The Troniq 100 has been designed to provide 100 kW charging and to ensure high reliability uses high performance components that allow maximum power to be delivered at all times.

The Ultroniq offers ultra-fast charging with an output of up to 350 kW – with a modular design it can provide different configurations making it compatible with more vehicles.

Crucially, the two charging platforms have been designed to operate in extreme weather conditions and the use of a larger integrated touch screen now makes them easier for the EV driver to interact with.

Also on display was Toyota's

Concept-i model, a battery-electric car which will have a cruising range of around 180 miles. Toyota announced that it would be testing self-driving electric cars in 2020, which will use AI to engage with drivers.

The i model is able to converse with its driver and build up knowledge of their preferences, habits and emotions through deep learning, according to the company.

By monitoring the emotions and alertness of drivers through reading their expressions, actions and tone of voice, it's able to take over driving responsibilities when necessary and interact with the driver and passengers.

Toyota has, in fact, committed \$1 billion through 2020 to develop advanced automated driving and AI technology.

Toyota also announced a prototype environment called the Woven City, which it plans to build on a 175-acre site at the base of Mt. Fuji in Japan.

The City will provide a platform for research on automated, connected, shared and electrified/hydrogen technologies. The Toyota booth at CES displayed a vision of what life in the Woven City would be like, with automated technology to move throughout the city, including concept vehicles, personal mobility devices and a robot.

Below: The Woven City by Toyota



Most of the carmakers at CES talked about how they intended to develop AI capabilities to enhance the driving experience.

Ford, who acquired Argo AI earlier this year, said that it was looking to develop an on-demand self-driving car service, while General Motors has been investing in AI start-ups.

One of the highlights was from Hyundai which showed off its S-A1 Concept vehicle, which is a full-scale air taxi that was announced in conjunction with Uber with whom they have formed a partnership to develop the Uber Air Taxis for a future aerial ride-share network.

The S-A1 has a range of 60 miles and comes with an electric vertical take-off and landing (eVTOL) capability. It has been designed for a cruising speed of 180 mph at an altitude of 1,000 to 2,000 feet.

While initial iterations will be piloted, once the technology is developed further, it will become autonomous and be able to carry four people and their luggage.

Emerging consumer electronics

Every year, when it comes to consumer electronics, sees a host of new products and innovative concepts on display and some are expected to see strong growth in 2020. Those growth categories include: wireless earbuds, digital health devices, smart speakers and smart home devices.

With CES the breadth and depth of products on display can be overwhelming and in the following section we highlight just a few of the products that were on display.

No CES would be complete without robots and Samsung's Baillie stole the headlines at the beginning of the show. It combines a voice activated smart home device with a robotic companion and the ball-shaped device, which is equipped with cameras, is able to control smart home devices, take photos and send you updates when you're away.

Samsung also demonstrated

several other smart home devices including robotic vacuums and smart refrigerators which can suggest menus and order food.

Foldable displays also made an appearance with the ThinkPad X1 Fold from Lenovo. A foldable 13.3 inch display, it is supported by a magnetic keyboard.

Sony pushed its new 8K TVs and 360-degree reality TV and also announced that it would be introducing its latest video game system towards the end of this year. The PlayStation 5 will feature 3D audio, ultra-high speed SSD and ultra HD Blu-ray.

Talking of gaming, another interesting product was from Samsung with its curved PC monitor, the 49 inch Odyssey G9. Designed for PC gaming it has a 1440p resolution, a 1m/s response time and can support refresh rates up to 240Hz.

And this wouldn't have been CES without technology that addressed the needs of those individuals wanting to meditate more effectively – accordingly the Core is a handheld meditation trainer that can use vibration, metric feedback and even on-demand meditation classes to improve your levels of relaxation and mindfulness – perfect after a day wandering the halls at the show.

Many of the products at CES were certainly innovative but it is also a show where you can end up seeing products that can leave you baffled and confused. This year those products included a suitcase which follows you and a nappy with sensors to detect waste.

Health technology

Health technology always has a big presence at CES and this year the show was focussed on at-home diagnostic testing and examination devices rather than wearables, which was the case last year.

Samsung showed several health-related products including a Galaxy watch able to detect stress and



Above: Sony used CES to push its new 8K TVs

offer stress relief suggestions, while an exercise system used motion capture to evaluate yoga poses and other exercises and then suggest improvements.

A cardiac rehab system offered home-based guidance using wearables and a smartphone while the process was supervised by a remote therapist.

Samsung also demonstrated a gait enhancement and motivating system (GEMS) which uses a gadget, placed around a person's waist and legs, along with VR glasses to analyze motion and provide coaching.

With so many people suffering from diabetes there were a number of devices on display that provided non-invasive blood glucose monitoring, using AI to estimate a user's glucose level.

Add Care, a company based in Hong Kong, has developed a

Below: Health technology always has a big presence at CES



smartwatch, the Glutrac, that it claimed was able to measure blood sugar levels having collected various vital signs and then, using AI, to calculate the level of blood glucose.

This space is using AI in all manner of products. The MedWand is a tool that can provide different medical diagnostic functions enabling a doctor to examine a patient remotely, while the Heart Hero is a portable atrial defibrillator that can use AI to detect heart events and alert the emergency services.

A smart bathroom mat – Mateo – is able to track a person's weight, body composition and even their posture, sending information to the user's phone.

New to this year's show was the more obvious presence of sex tech, which in the past has caused the organisers some problems – such as prizes awarded and then withdrawn in 2019, which left the CTA embarrassed.

Companies who sell sexual wellness-related products said they have not always found it easy to find a home at the show but in a statement the CTA said that tech-based sexual products would appear as part of the Health & Wellness product category or in the Health & Wellness start-up area, but those products had to be innovative and include new or emerging tech to qualify.

So this year Bluetooth-enabled music-driven vibrators together with micro robotic stimulation sexual wellness products appeared alongside more traditional devices and appliances.

What the inclusion of these companies demonstrates, however, is that almost every company, in whatever sector, is now turning into a technology company.

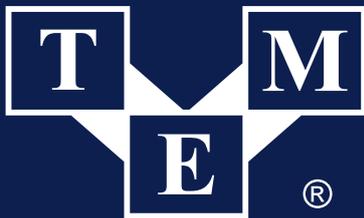
CES 2020 saw the growing impact of AI and 5G, but also showed that non-traditional companies are rolling out technology and using it to transform their businesses.

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Enhancing the driving experience

Harman has unveiled a suite of new solutions that it claims will deliver improved connectivity and a better driving experience. By **Neil Tyler**



Earlier this month Harman used the Consumer Electronics Show (CES) to launch the ExP Integrated Solution Suite, which looks to deliver a range of new connected driving solutions. It does this by bundling together core technologies into a unified offering, capable of delivering enhanced connectivity along with a better set of driver experiences.

The company's ExP solutions are able to create a 'specially-curated' collection of connected car, audio and service technologies to deliver 'experiences' that are able to provide specific driver benefits, whether that's well-being, infotainment or improved levels of connectivity.

"Instead of just creating technologies for a vehicle, today we're designing experiences for drivers and passengers," explained the company's president and CEO, Dinesh Paliwal.

"With the ExP Integrated Solution Suite, we are looking to help OEMs create a consumer-centric driving experience by developing customised technology bundles that will be able to meet virtually any need. By building with the end experience in mind, we

want to be able to deliver on consumer expectations while helping OEMs make strategic and future-ready technological investments."

The suite of solutions includes an Advanced Driver Assistance Bundle that blends the cloud, ADAS and telematics technologies and features awareness technologies such as: Blind Spot Warning, Directional Sound Steering and Vehicle-to-Pedestrian ADAS, which warns drivers and pedestrians about any potential safety risks through the use of Vehicle-to-Everything (V2X) technology.

Harman also demoed assistance technologies including a Virtual Personal Assistant (VPA) which enables voice messaging, navigation and media selection.

The company's Marketplace is a collection of apps and services that have been designed to enable diverse media like podcasts, music and other content using partners like Spotify.

The company said that drivers and passengers will have greater freedom to personalise their 'connected driving experience'.

Harman's Multi-Modal Experience

Above: Harman's ecotect system design

Bundle leverages Ultra-Wideband (UWB) technology to support vehicle access and connectivity but also significant personalisation and instant access to personalised features and vehicle functionality.

According to Bill Wyman VP Global Marketing, Lifestyle Automotive at Harman,

"Everything that's happening in the car today is all about the experience, compare that to just five years ago when it was all about performance. Now it's about what does the car do for me when I'm sitting inside the cabin."

Wyman says that OEMs are having to work hard to differentiate.

"Most companies in the automotive space have realised that as we move to greater autonomy the vehicle will become little more than a pod, so they're having to invest in delivering something that's unique and valuable to the consumer. What will their brand stand for and what are consumer's expectations of that brand? Going forward differentiation will become a huge issue for the industry."

Wyman believes that audio has a critical role to play in this space.

"If you're looking to deliver improved audio then you need to address issues in the cabin such as noise cancellation and isolation, if you're determined to provide really smooth, clean communication."

The company's HALOsonic noise management solution employs acoustic noise cancelling techniques to reduce unwanted road noise inside the cabin, while reducing reliance on traditional heavy dampening materials.

For clear in-car conversations, the company has developed Voice-Sensing Volume Fade specifically for

electric vehicles making it possible to differentiate in-car communication from music, seamlessly adjusting the audio volume level down when conversations are taking place and automatically turning the music back up as soon as the conversation ends.

Wyman also sees navigation prompts leveraging audio in order to provide a more seamless experience for the user that is also much easier to understand.

“Technology has always tended to migrate from high end vehicles, but that’s changing. I think the experiences being developed today are going to migrate into entry level emerging markets significantly faster than other technologies in the past.”

When it comes to voice recognition and the impact that’s going to have, Wyman believes that the industry will have to be very careful as to how and where it is deployed.

“If you think about how people are using voice in their life outside of the car, it’s everywhere. They’re used to it, they understand it and it should really be able to migrate into the car.

“In truth, however, voice has been in the car for several years now, and it hasn’t been the best experience. We need to make sure that the consumer experience is seamless. If you can deliver that you are making it far easier for people to interact. Haptics will still have a role as there’s probably certain things that you will still want to be able to ‘feel’, but, while I understand that, I do think that voice will become how everybody will interact with almost everything going forward. It’s just a very natural method

of communication.”

A lot of investment in voice technology is about trying to make it more conversational in practice.

“At present much comes across as really fake, despite the best efforts of developers to create a ‘normal conversation’.”

EV Plus+

Harman also used CES to unveil EV Plus+, which looks to overcome challenges unique to the fast-growing electric vehicle segment.

“We want to provide consumers with a no-compromise level of entertainment, communication and comfort, flexibly and sustainably, without impacting range performance,” explained Wyman.

By 2040, Bloomberg NEF expects over half of all global vehicle sales and over a third of vehicle fleets to be electric.

“We are seeing rapid growth in this space and the listening environment is very different - there’s no engine so you have a different noise profile within the cabin.

“You can put speakers in different places so we’re looking to create solutions that have been engineered to address pain points specific to EVs, so we’re having to look at range anxiety.”

Range anxiety remains a major barrier when it comes to electric vehicle adoption. Vehicle charging is a concern for 83 percent of non-EV owners, according to research carried out by Cox Automotive and such concerns have made the inclusion of popular in-car features that require a power draw, including premium



“What will their brand stand for and what are consumer’s expectations of that brand? Going forward differentiation will become a huge issue for the industry.”

Bill Wyman

audio and entertainment, especially challenging when engineering for an electric vehicle environment.

“It’s certainly a lot better but there’s still a sense that when you get into an EV you’re going to have to compromise when it comes to infotainment and the EV cabin experience,” Wyman suggests.

“We’re looking to tackle this by reducing weight, while having the same level of performance of a more traditional system.

“We don’t want OEMs to have to compromise on the vehicle’s audio performance and the audio experience of the driver.”

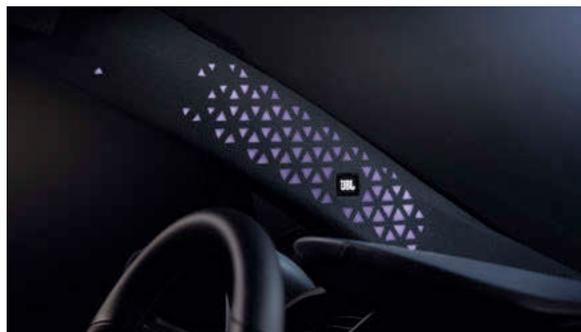
Leveraging efficient acoustic technologies and cloud-based software innovation, EV Plus+ offers a scalable, low weight, and reduced complexity system architecture that provides double the acoustic power and performance without impacting range when compared to a traditional audio system with comparable performance.

It includes a number of new offerings: Ecotect which ensures powerful audio performance with half the parts, reduced weight and complexity, as well as lower power consumption when compared to a traditional system; MarketPlace, as mentioned earlier, and software-enabled branded audio.

Consumer demand for premium, personalised in-cabin experiences is only going to increase, according to Wyman, so the unveiling of EV Plus+ is being described as a first-ever approach that looks to truly deliver branded audio and personalised experiences on demand in a sustainable way and intended specifically for electric vehicles.

“We believe the next-generation of mobility should convert the time you spend in your car into time well spent – and electric vehicles are no exception,” said Wyman. “Environmental concerns are guiding purchase decisions more and more, but the demand for premium experiences hasn’t changed.”

Below: EV Plus Solutions NatureScapes Screen (Left) EV Plus Solutions JBL Speaker Front (Right)





THE EV ADOPTION ROADBLOCK

Charging the UK to power an electric vehicle future. By **Julian Skidmore**

Electric vehicle development is progressing at an accelerating pace and electric vehicles are now selling in their millions. Mainstream manufacturers like Nissan, Renault and BMW have all joined Tesla in launching their own electric vehicles. Driven by concerns over global heating and improvements in battery technology, electric vehicles are the most promising solution for emissions-free transit, but one barrier to EV adoption is the slower-developing EV charging infrastructure which can be inconsistent and difficult to use.

EV ownership is growing rapidly

An Opinion and Pure Planet survey revealed that 43% of UK residents would consider driving an EV while AA research in 2018 found that half of young people in the UK would like to own an electric vehicle.

Battery electric vehicle sales in the UK are projected to reach 100,000 by the end of 2019 and the government has set a goal for half

of all new vehicle sales by 2030 to fall into the “ultra-low” emissions category. Yet, at current growth rates over 2010 to 2019, all registered vehicles will be BEVs by the mid-2020s.

The availability of public charging points is an issue though as the AA survey found that 85% of respondents didn't think there were enough.

Will charging availability and technology hold back EV adoption?

The charging of electric vehicles is a barrier to their adoption. While battery capabilities have grown rapidly, from a range of 100 miles to between 200 and 300 miles, EV prices are falling, consumer choice is growing and EV performance is rising. So how can EV charging infrastructure keep up?

AC/DC Charging

I recently showcased “Smart Charging” solutions for EVs at the Engineering Design Show (EDS). ByteSnap designed charge posts for the London

Olympics in 2012 and is working on a number of intelligent EV charging projects, so we have strong expertise in this field.

AC chargers, like those at home, with slower charging and lighter loading are best for grid management with local or urban driving. That's because most journeys are short, so their energy requirements won't change over time. Home chargers obviously keep up with EVs sold, but public ones aren't so they should be targeted, because they're cheap and cover most cases.

However, rapid DC charger rollout is catching up and these are essential for longer journeys, because the charging rate has a much bigger impact on average speeds than battery size. If we want to put EVs on the highway, rapid charging matters more than a large battery, but for local or urban driving there will be a market for smaller batteries, slow charging EVs. Some of the new cars in 2020 will have modest batteries, short ranges and 7KW

charging as standard.

EV chargers are less user-friendly than we'd expect from something that is powering our driving future. Payment methods can be inconsistent and billing mechanisms "nasty"; connections can be faulty or intermittent; systems can crash and some user interfaces are on the opposite side of the charger from the plug.

We wouldn't accept this lack of service at a petrol station and that "EV journeys shouldn't have to be that stressful."

Infrastructure

We are at the beginning of the EV revolution, and this presents an opportunity without the constraints of fossil fuel powered cars which need piping, tankers, stations, and Just In Time logistics.

However, better government support and initiatives may be needed to support charging locations and a good geographic availability of chargers. Subsidies for charging network providers may also be needed while the EV economy stabilises.

There is also an issue of load balancing as distributed energy could cause intermittent supply. Usage restrictions and non-standardised interfaces represent wasted engineering effort that actually slows down adoption.

Lastly, charging points are unmanned, resulting in maintenance issues but perhaps presenting an opportunity for a new service industry.

Charger manufacturers would like a comprehensive networking

protocol between the charger and the car, but the IEC 61851 and 62196 specifications have led to a plethora of (crude) PWM, CAN bus and IP over Power communications along with incompatible plugs. Manufacturers' reluctance to provide useful EV battery charging states (to protect their patents) will also continue to inhibit the potential for Smart EV charging.

Vehicle to Grid technology

Electric Vehicles can be part of the energy solution, because batteries also represent a source of base-load microgeneration.

ByteSnap, in collaboration with a consortium of partners, is part of a two year project called VIGIL (Vehicle-to-Grid Intelligent Control), which will see the development of a new communication and control platform for vehicle-to-grid (V2G) and vehicle-to-building (V2B) systems.

V2G technology could mean that electric vehicles can return energy to the power grid when stationary and plugged in, increasing energy grid resilience and providing payback for EV drivers. V2G connectivity could also take advantage of the new phenomenon of renewable energy surplus. Germany is one country where too much green energy is available and consumers can experience negative energy prices.

VIGIL would promote comprehensive charging communications, in turn aiding EV adoption, with ByteSnap's smart communications controller (called RAY) managing the charge going back into the smart building, or substation.

In turn, substation energy can flow into the smart building; charge EVs or return power to the grid.

The future of EV charging

Appless charging, where EV owners can tap a credit or debit card on a charging post to start and stop charging is something every EV driver would like and is becoming available. Some Polar Ultrachargers have a contactless payment method and Ecotricity Electric Highway plan a similar upgrade, even though it will result in higher charging costs.

Combining substations with urban car parks could help solve issues of kerb-based charging sockets which can be inaccessible or easily damaged.

We could knock down a house in a street (there's always someone who wants to sell theirs) and replace it with a secure multi-storey car park with built-in charging facilities. The infrastructure stays in one place so it's much cheaper to implement, upgrade and maintain; streets are cleared of EVs; the car park provides security; V2G facilities, load balancing etc.

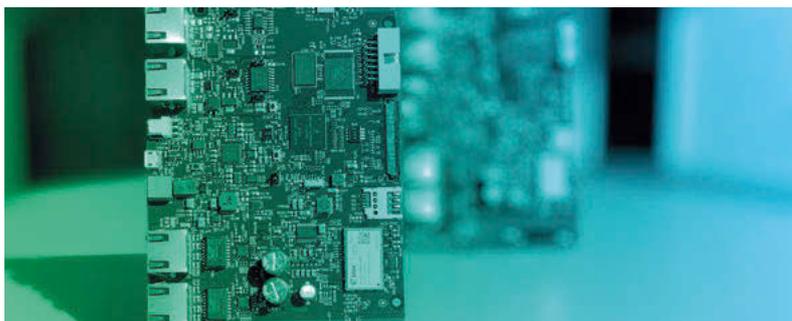
Fully automated charging is the ultimate ideal, perhaps in the form of robots plugging in charging cables, but more likely, inductive charging though this requires charging mechanisms to change yet again and therefore may be some time in the future.

At the end of my presentation "The EV Charge Point Journey: What's the Final Destination," I summarized that EVs are the most likely technology to replace fossil fuelled vehicles and that the nascent world of EVs is a rapidly accelerating, disruptive market; and charging technology and infrastructure is as critical to their deployment as the vehicles themselves.

The challenge for UK government and industry, and for other countries around the globe, is to not only drive the development of EVs but also the charging infrastructure and supporting systems to make EV driving as effortless and attractive as a petrol or diesel vehicle.



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THE ONLY WAY IS UP

Chipmakers look to the third dimension to continue scaling. By **Chris Edwards**

Rumours of the death of Moore's Law have, so far, been somewhat exaggerated. But there is going to be a point at which in the process of scaling planar structures you simply run out of enough atoms to create viable semiconductor interfaces.

When the inevitable happens, the only option is to follow in the footsteps of NAND flash and start stacking.

The December 2019 International Electron Device Meeting (IEDM), demonstrated the various ways in which chipmakers are thinking about taking that direction. Multichip 3D is already with us thanks to improvements in packaging. But that form of packaging does not have the manufacturing efficiency that has kept Moore's Law on track so far. That needs monolithic integration and a means to stack transistors on top of each other on the same base wafer.

It's possible to see the beginnings of a trend towards 3D as a means to improve density in the shift to finFETs over a decade ago. You can easily boost the drive strength of a single transistor simply by adding fins rather than physically widening the device, just as long as you can make the fin pitch tight enough.

This has boosted the effective density of the standard-cell libraries used to design SoCs and demonstrated by a steady reduction in average height of cells, usually measured in terms of the metal tracks used for routing. Where ten- or twelve-track cell libraries were common in the past, advanced processes are now using between seven and nine. And the chipmakers and EDA-tools suppliers are looking to even fewer.

With finFETs, the process can

only go so far. Each fin still takes up horizontal space and that is hitting the limit. So, the next step is to stack the fins on top of each other using so-called nanosheets or nanosheets. Imec sees even more potential for cutting out horizontal space by moving to the "forksheet". This stacks complementary n- and p-doped sheets next to each other, built out of a common pillar. With that you have a full CMOS inverter built into single transistor structure, albeit one that is wider than a single nanosheet device. The overall saving is about 30 per cent, Imec claims, with a track height of five for a workable cell library. But the research institute's people think three is possible.

The CFET

The previous year at the VLSI Symposia in Hawaii, Imec described another way of building a compact CMOS inverter structure in the space of a single transistor. This was the CFET, a structure that stacks an n-channel device right on top of its complementary p-channel partner. Although it boosts horizontal density even further it leaves the designer with a problem: how to get power in and out as well as logic signals. Rather than take up valuable space and interfere with signal lines, much of the

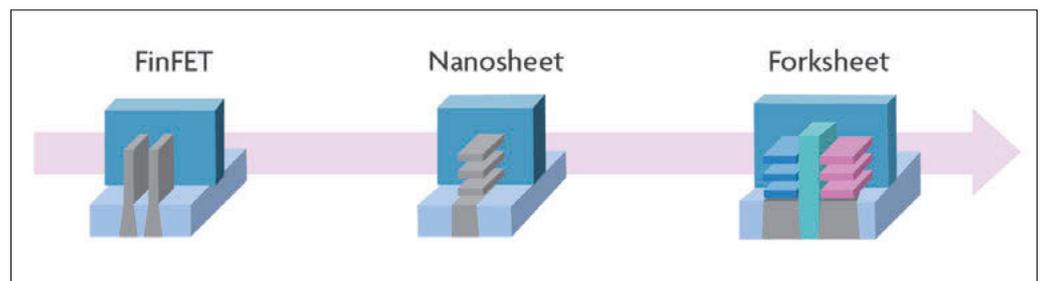
power can go underneath using buried vias. The coarse power grid still takes up routing above the base layer but by diverting much of the local power interconnect underneath, Imec expects to be able to achieve significant and practical layout-density improvements and may not have to wait for the CFET to become a reality to implement the idea.

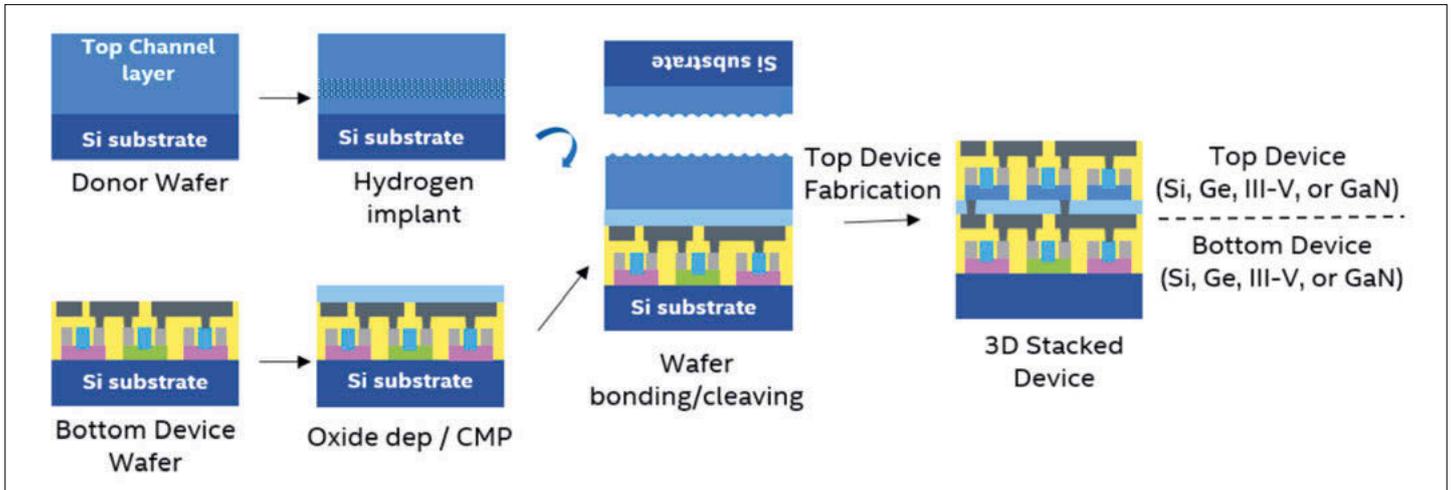
Stacking could go further though there are practical difficulties that may prove difficult to overcome.

CEA-Leti has pushed ahead on developing processes that make it possible to put one complete layer of connected transistors on top of another, using reasonably conventional deposition techniques. There is a catch with this approach. Every process has a thermal budget and transistors need high temperatures to heal their crystalline structures after bombardment during the doping steps. With only one base layer of transistors, it is easy to account for that. Doing the same to a second layer risks damaging the interconnect needed to wire up the first layer as well as the devices themselves.

Annealing using high-energy lasers limits the damage though it is slower and more expensive than just baking the wafers in an oven. Even with that more precise form of annealing, it may not be possible to create a second layer with the same performance as the first. This may not matter in practical situations. CEA-Leti has pointed to applications such as artificial intelligence that, with the right architecture, can use slower transistors.

Below: The finFET, nanosheet and forksheet structures (from Imec)





Analogue circuits might also go into the upper layer. Some teams at IEDM late last year looked at taking that idea further and moving the transistors even further up into the metal stack.

The ability to even countenance structures with ten or more layers of metal dates back well before finFETs to the early 1990s when chemical-mechanical polishing (CMP) first appeared. Up to that point, three layers of metal were the limit of production techniques.

The cross-sections showed why: the transistors formed hillocks above them that were amplified by each successive layer of routing. Beyond three, it was impossible to create reliable connections. CMP changed that by making it possible to flatten each surface before the next layer went on. If the materials are up to the job, CMP creates planar substrates suitable for making transistors and memory devices.

2019's IEDM demonstrated the options are expanding. Working with researchers from UC Berkeley, TSMC engineers developed a form of finFET that can be fabricated, again with the help of laser annealing, in between regular metal layers high up in the stack, above those used to route logic signals. These finFETs are much larger than their base-layer cousins and use multiple fins to reduce resistance so that they can form the basis of voltage-regulator circuits.

With this type of design, it becomes possible to create very fine-grained voltage control to drive cores at specific speeds to save energy. Another team from TSMC used a similar approach to create SRAM arrays in the metal stack.

Alternative materials

Rather than stick with conventional silicon-based materials, researchers at the Japan-based Semiconductor Energy Laboratory opted for materials that have been proposed for integrating electronics into flat-screen displays: these have the advantage of using near room-temperature processes though they do not produce fast-switching transistors.

They used a combination of oxides based on indium, gallium and zinc to create a flash memory based on a transistor with a gate length of 72nm. Like TSMC's SRAM, it cannot compete on density with base-layer devices because of the coarse nature of upper-layer metal but the team claimed it could offer better retention times for IoT sensors and can be stacked over multiple layers.

Another option is the graphene-like material molybdenum disulphide – commonly used as an industrial lubricant today – which some believe might ultimately replace silicon entirely. A couple of years ago, TSMC explored it as an option for transistors in the metal stack because like the

Above: The Intel layer-transfer process

oxide-based semiconductors it does not need high-temperature processing.

CMP enables another way to approach 3D integration: layer transfer. IBM first proposed this idea in 2003 as a way of mixing crystal orientations on the same wafer. Typically, mobility in p-channel devices is better on a lattice that is rotated with respect to the one favoured for n-channel. One of Intel's demonstrations last year used germanium in the channel of the PMOS devices formed on a wafer that is polished down and placed on a receiving layer that holds the silicon n-NMOS devices before the donor wafer's substrate is cleaved away and again polished smooth. The second demonstrator opted had gallium nitride in the NMOS layer, to support RF circuits running at up to 7GHz.

Layer transfer is unlikely to be the cheapest option because of the need for multiple wafers. However, raw polished wafers are cheap compared to the processes that put devices onto them.

Where performance demands balanced CMOS performance, layer transfer may be the best option.

But for integration density, monolithic processes that implement unbalanced devices may prove to be the best mass-market alternative to 3DIC stacking – and the approach that extends Moore's Law beyond the last nanometre generation.

Voltage references serve a crucial role in precision analogue systems, often setting the noise/resolution floor within an analogue-to-digital converter (ADC) for precision measurement systems. For the design engineer, the specifications and options for packaging can involve many design pitfalls that could easily undermine the μV or nV accuracy noise target they want to achieve.

How does the engineer protect against damaging environmental effects while preserving analogue performance?

Environmental factors like moisture and temperature can affect electronic performance. Temperature causes mechanical stress due to the different thermal expansion coefficients of the materials that make up the package and the board.

Moisture causes mechanical stress since both the plastic and the board absorb moisture, causing them to expand. The results of environmentally induced mechanical stress often take the form of increased drift over temperature/time in the case of plastic-packaged voltage references, or the form of increased offsets in plastic-packaged MEMS accelerometers.

For plastic packages, the mechanical stress created by humidity is significant, and one way to manage this humidity effect is to package integrated circuits in ceramic or hermetically sealed packages, however, this comes with the additional cost of a premium package, and often a larger sized component.

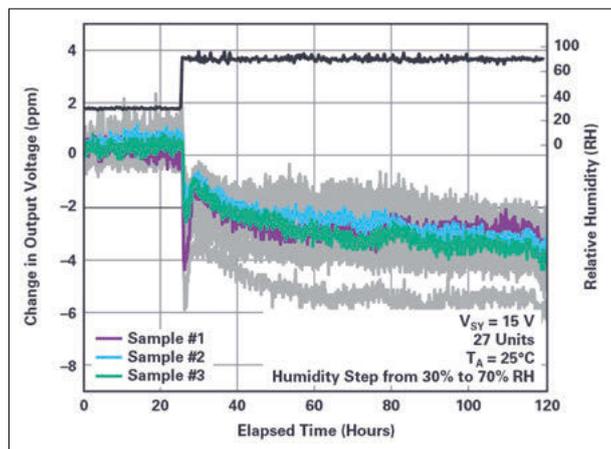
Conformal coating options

Another method to isolate these stresses is to use a conformal coating in the PCB manufacturing process so that any mechanical stress at the board level translates into less stress at the voltage reference.

A thin layer of a coating compound across the voltage reference and corresponding PCB ensures that any

COATING OPTIONS

How can you manage humidity and performance in precision analogue systems? By **Paul Perrault** and **Robert Kiely**



stresses induced through moisture or temperature applied to the PCB don't translate to a differential stress to the voltage reference chip package and induce offsets. This also ensures that humidity from condensation due to cold temperatures has less effect on humidity ingress into the package.

A variety of conformal coatings that include acrylics, urethanes, silicones, epoxies, and water-based coatings are available for the protection of sensitive devices in PCB manufacturing. One of the parameters is called moisture vapor permeability (MVP), which is the rate at which moisture vapor passes through a coating.

The test method for MVP is to take a dry cup with the respective coating applied, put it into a temperature chamber and then periodically weigh the cup to assess how much moisture is traveling through the material and into the dry cup.

Examining the table yields an

important insight - in all cases (with the exception of a very thick UV-cured coating material called UV40), all of these coatings allow some amount of vapor through the coating over time. This is measured in the weight of water that permeates the coating through a given surface area in a given period of time.

While the popular 1A33 coating, a polyurethane coating, is simple to apply it is more than 10 times less effective at slowing down the rate of water vapor absorption than the rubber-based 1B51 coating. The key message here, though, is that none of these coatings provide complete blockage against humidity.

It's useful to understand the environment in which the electronics will be deployed. Will the exposed electronics only experience short periods of high water vapor? Will the packaging/container of the electronics block water vapour? Does the environment of the electronics change so frequently that the purpose of the conformal coating is simply to block fast changes in the electronics? All are important for the product owner to consider before embarking on a conformal coating path.

Conformal coatings can, in some cases, increase mechanical stress problems because the coating, if improperly applied, can add stress to the package. For instance, if in the PCB manufacture stage, the surface of the voltage reference package has moisture on it prior to coating, it will migrate into the hydrophilic plastic package. So keep surfaces free of moisture, dirt, wax, grease, flux residues, and all other contaminants.

Does it hold water?

Analog Devices has produced a set of test boards to test coatings. Each board has 27 of the same high performance voltage references soldered to the PCB using the recommended J-STD-020 reflow profile. The boards are placed in a humidity chamber and measured

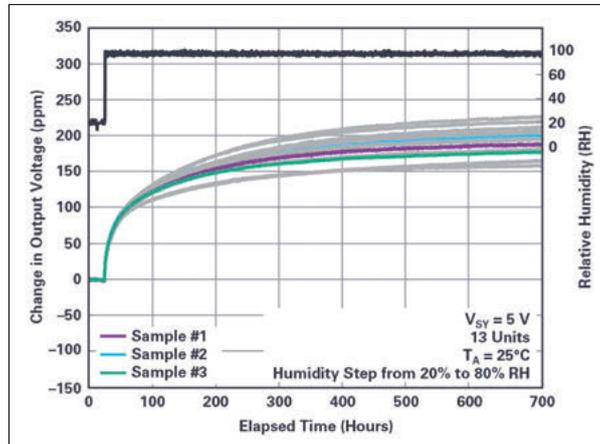
using a Keysight 3458A 8.5 digit digital multimeter (002 model) that achieves a 4 ppm/year drift by using the LTZ1000. The chamber is maintained at a constant temperature and humidity while the boards are allowed to settle. The boards sit in the chamber for up to a week before the humidity step is applied while keeping the temperature constant.

Two different conformal coating processes were used on the plastic-packaged voltage references to assess the effect of humidity in the presence of the coatings.

Using the ceramic packaged ADR4525 as a baseline (Figure 1) establishes that 100 hours of being subjected to 70% humidity shows a change in the voltage output of ~ 3 ppm, or 0.075 ppm/% RH, which is an excellent level of stability. The initial peak in the data is due to a jump in temperature that is caused by the sudden shift in humidity. The humidity chamber slowly recovers the temperature back to 25°C, as can be seen in the data.

In contrast, the same voltage reference die when placed in plastic packages in the same environment and test conditions shows a voltage output change of ~ 150 ppm, as shown in Figure 2. Normalising the data from Figure 2 with a 60% RH shift shows that the output drifts at ~ 2.5 ppm/% RH with no conformal coating applied. It also looks apparent that the drift hasn't completely settled out after 168 hours of soaking the boards in the high humidity environment.

The HumiSeal 1B73 acrylic coating was tested next and the data is shown in Figure 3. The application procedure consisted of first washing and baking the board (submerge the boards quickly a few times into 75% isopropyl alcohol and 25% deionized water, lightly hand brush, then bake at 150°F for 2 hours), and then spraying the 1B73 coating to the specified thickness. The entire board was coated with the exception of the edge connector, which is required to be



clean to enable measurement of the output voltage.

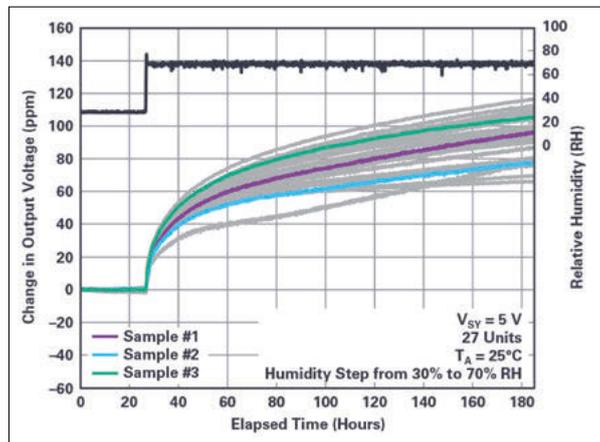
While the oven used in this test limited the humidity stress to 70% RH, the normalised drift looks like ~ 100 ppm/40% RH or 2.5 ppm/% RH, which isn't that different from the drift with no coating applied.

It's possible that the coating didn't fully adhere to the underside of the voltage reference package along with the edges of the parts as well. It's also useful to note here that the ~ 168 hours of testing under the high humidity may still not be long enough as the voltage reference looks like it hasn't fully stabilized yet, similar to the uncoated parts.

However, it is useful to see that the humidity effect does appear to have been slowed down in rate of change, at least at the initial time step, which lends credence to the concept of the moisture vapor permeability rate,

Figure 2. The ADR4525 voltage reference in a plastic package when subjected to a humidity step of 20% to 80%

Figure 3. ADR45xx voltage reference coated with HumiSeal 1B73 acrylic coating using a spray application



where the coating isn't stopping the moisture, but is instead slowing it down.

Another test tried the same conformal coating (HumiSeal 1B73) but with a three-step application process that used a dip coating process to better ensure complete coverage of the board.

Issues with the oven prevented more than 96 hours of testing for this test. Normalising the data set for a 30% RH to 70% RH step shows ~ 90 ppm or 2.3 ppm/% RH, which is not the massive improvement that was hoped for with this application process, but a slight improvement over the spray coating - although it's fair to say that if left for a longer test, this slight improvement may disappear.

Future testing could include other types of conformal coatings and cross-section analysis. In short, the data from these experiments show that the ceramic hermetically sealed package is the single best defence against humidity ingress.

Conclusion

In a design that is only targeting 10 bits of accuracy there is a lot of room for hiding inaccuracies, but if your precision instrumentation system is targeting 16 bits and even 24 bits of accuracy, it's imperative to look at a whole system design, including PCB manufacture, to ensure complete accuracy over the life cycle of your design.

To ensure humidity performance is to use hermetic packages like ceramic, and that conformal coatings can slow down the humidity effects within precision analogue electronics.

As designs move through to manufacture, it becomes necessary to leverage skills outside of electronics, consulting with coatings companies to get the absolute best performance in challenging environments. While following best practices will ensure that your voltage reference won't hold water, it will help to deliver the performance you need.

Analogue design will be needed until you or I turn into robots

Cadence Design Systems' Steven Lewis talks to **Charlotte Hathway** about why analogue design will persist, and why the analogue world often finds itself grappling with the same problems.

Steven Lewis has been at Cadence Design Systems for 30 years. Over that time, the Electronic Design Automation (EDA) industry has been transformed. The advantage of being on the EDA side of the fence is that, in order to build the right tools, you have to be ahead of the what design engineers will want to do in six months' time, or in a year's time.

Lewis is a Director for Custom IC and PCB Group Product Management, and works in the company's analogue group. He has seen how analogue has changed, but also how some challenges have persisted. Whenever a new electronic component emerges, he explains, there is a role for analogue design.

Lewis discusses the different behaviours exhibited by different transistors when they are used in electronic circuits. The emergence of FinFET transistors, for example, meant the analogue world had to do a lot of learning and experimentation in order to adopt that new type of transistor. Using it within even a classic analogue circuit would throw up variables that had not emerged before. But the importance of analogue is far simpler than that.

"Let's start with the overarching,

non-refutable premise that the world is analogue. We may do digital programming and digital circuitry, but sometimes we forget that we're still working with transistors. The way they're analysed and used might be slightly different from the analogue side, but we're all still working with transistors."

He adds, "When I say that the world is analogue, the point is, anytime electronics interface with the real world – whether that's a consumer, a human, an animal, the earth, space – when you do that, you're talking about analogue circuitry."

What is analogue? Lewis uses the example of a mobile phone. To have a conversation on a phone, a real-world voice has to be translated into a digital format, sent to the other person's phone, and then put back together. Crucially, the sound that comes out the other end must still sound like the person's voice. Lewis explains, "That's the work of analogue. Fidelity, accuracy, a replication of the real world into the digital world. Once it is sent into the digital world, it may be processed, converted, and sent back out into the real world again. That process is also the work of analogue."



Above: Analogue plays a big role in enabling humans to interact with electronic devices.

Technological advances mean that humans are increasingly interacting with the electronics world, and this trend will continue. Lewis says, "If you think about buying a car today, that automobile is probably loaded with all kinds of safety features – anti-lock brakes, the ability to sense oncoming traffic, the ability for the car to stop itself.

"The interaction of the car with the real world requires analogue. It's analogue sensors that are collecting the data from the real world."

In this example, analogue circuitry is being used to detect what is happening in the real world. In time, and with the growth of self-driving cars, those electronics will then make decisions about what should be done. That might mean the vehicle comes to a stop having sensed a person is in the road or that the road is icy, or that it adjusts its speed having sensed it's being driven too fast or too slow.

The robots aren't taking over

There's a lot of chatter about automation taking jobs. Lewis recalls a recent visit to McDonald's. You order your meal and pay using computers. The only human interaction is when you collect your order.



You start to imagine machines replacing humans, but the robots aren't taking over just yet. Those electronic devices still require human interaction. Lewis explains, "We still have to input data, we still have to get data out. That is the world of analogue – humans interacting with electronics."

He adds that there are still a lot of questions around "the future of automation and what kind of disruption it will bring for the human workforce", but for the electronics industry "analogue plays a big role in that, because we're still interacting with humans".

A big question that will be answered over the next decade is how humans and electronics work together. The analogue world has a big role to play in this as "all of those interfaces take some sort of analogue circuitry".

Will all analogue become digital?

"When I was in school a million years ago, in the prehistoric age, everyone was saying everything will be digital. Digital, digital, digital!"

The problem? "Every time someone says we're going to replace analogue; we always find new applications for analogue because the world is analogue. Over the years, of course,

we've been able to do digital signal processing, we've been able to do memories. We've been able to do a lot of things on the digital side of the world, where we can speed things up, we have good fidelity of signals going through that, and we've been able to shrink the transistors.

"Lo and behold, what's happened with smaller and smaller transistors on the digital side is that they start to exhibit analogue behaviours. The design might be regimented, but because we're dealing with a billion soldiers or 10 billion or 100 billion, it's possible that one of those soldiers goes rogue. Trying to find one rogue soldier, and what that might impact, can become a bit of an analogue-type of a problem that we need to look into."

Of course, the regimented nature of digital, does have some advantages. Lewis explains, "It becomes a very easy to write a test pattern or to be able to flip a bit – when a signal should be on but it's off or vice versa – and then test for that. I can send a foul signal into my digital world, and then I can see what comes out on the other side.

"In analogue, because there are so many different variables, it's not so regimented. It's regimented by physics. It's regimented by engineering, but it's not as regimented in terms of preciseness of design that is always repeatable. And because of that, when you test analogue and try to figure out what is going on, it is a lot harder."

Figuring out likely faults

Testing is one area that is seeing a lot of progress. The analogue world has made great strides in developing new tools that analyse analogue circuitry, but it has been missing the automated testing that is widely used in the digital world. This is changing.

Lewis explains, "New test methods and techniques are emerging now. You'll hear talk of fault simulation, or fault testing, and IEEE [the Institute of

Electrical and Electronics Engineers] is working to bring up standards here.

"In analogue, one test isn't enough, and neither is a million. There's always something more that could happen. Fault simulation is trying to be more judicious in what we test. We can run to a million variables, but of the million variables, ten of them are likely to happen, and 990,990 are not likely.

"They could happen, because it's the real world and anything can happen, but we have to determine these ten things that could cause us the most trouble and figure out how we test for them."

IEEE, together with the electronics industry including Cadence and its competitors, is working on defining what standard analogue fault testing will be. The idea is that, if an analogue circuit is built with a certain set of things and it passes certain tests, the designer can know that that the circuit is likely to function correctly during its lifecycle.

"The variability of the human world, that's the hardest thing to test for. We have to figure out how we can test so a design is safe, but it doesn't take a million years to get it off the designer's desk."

The analogue world has a huge role to play in shaping the development of emerging technologies.

Lewis says, "Technology changes, people change, how we want to interface with technology changes. It's constantly changing and evolving. The world doesn't go backwards. We push forwards. We will continue to do more with electronics.

"As long as we have that forward progression, there will always be analogue. And analogue will always have something new, something that we hadn't thought of before that we now need to test for. That's my philosophy as an old man with a grey beard."

Analogue design, Lewis joked, will be needed "as long as you and I haven't turned into robots".



"One test isn't enough, and neither is a million. There's always something more that could happen."

Steven Lewis

Released from the bonds of wired charging

When it comes to charging consumer electronics devices, everyone agrees wires are inconvenient. **Alex Brinkley** looks at some options for a wire-free world

Most major smartphone brands have Qi (pronounced “chee”) wireless charging technology. Although Samsung has integrated wireless charging technology into its phones for some time, it was only when Apple joined the Wireless Power Consortium (WPC) in 2017 and adopted Qi for the iPhone 8/8 Plus models that people really began to take notice.

The induction charging technology is based on Michael Faraday’s discovery that moving a permanent magnet in and out of a wire loop induced a voltage. Qi uses a copper wire loop induction coil which carries a charging current at a high frequency. Ferrite is used to limit the magnetic field around the copper wire to improve conduction. Matching a receiver in a device to the induction coil (transmitter) instigates charging.

Qi is a low power charging technology which transfers low-frequency (100kHz to 205kHz) over short distances.

Last year, NuCurrent introduced what it claimed is the first Qi-qualified 15W wireless charger that increases the charging distance to 12mm.

The development extends the range of the transmitter so that precision placement is not as critical as in conventional designs which require 3mm to 5mm separation between the transmitting and receiving coils. It also means that, instead of having to carve a trough into pieces of furniture to integrate the chargers, under-table chargers or through surface chargers



can now be deployed in furniture and automotive design.

The MP-A17 is a Qi Extended-Z Tabletop Charger design that “dramatically advances the [Qi] standard,” said Jacob Babcock, NuCurrent CEO. It has been approved by the WPC and will become part of the Qi specification version 1.2.4.

The company has also produced a development kit for manufacturers developing cordless appliances and transmitters as part of the WPC’s emerging standard for wireless power in the kitchen.

The NuVerse Cordless Kitchen development kit can also be used for products that comply with the Medium Power Qi standard. This was introduced in 2019, delivering

Above: NuCurrent’s development kit brings wireless charging to kitchen worktops

30W to 65W and expected to reach 200W for electric bicycles, drones and portable power tools. The kit features development boards and a Near-Field Communication (NFC) - based software stack, which establishes communication between the worktop (transmitter) and appliance (receiver) to initiate the transfer of power and to communicate and manage the status of the appliance. There is also a user-customisable Application Programming Interface (API) and development services to help kitchen appliance manufacturers incorporate wireless power into product designs.

As well as creating a smart, wireless kitchen, wireless charging can also make a statement on a desk or table.

Dutch company, ZENS revels in the technology to the extent that it has produced a charging mat that puts it on display. The Liberty 16 is available with a tempered glass surface which displays the 16 overlapping charging coils in the pad. The multiple coils maximise the active charging area and provide more freedom in placing the device than conventional designs. It can charge two devices placed on the pad at the same time and a 2.4A USB port allows for an additional device to be charged.

There is also a version with a textile cover and aluminium Apple Watch USB stick is available for use with the Liberty or with a powerbank or laptop.

“For now, this is the first 16 coils wireless charger worldwide, which is already a huge step forward, but a lot is possible, so who knows what the future may bring,” commented Lieke Neijens, Marketing and sales support, at ZENS.

The alternative to Qi has been resonant technology, promoted by the AirFuel Alliance, which is focusing on magnetic resonance and RF wireless power technologies.

Maria Singer, marketing and sales manager at PowerCast explained: “Qi is great for higher power devices because you can transfer more power between the two coils than you would with an RF solution. The downside is that you have to be within a few millimetres for that charging to take place”.

PowerCast specialises in RF-

based, long distance wireless charging technologies to power or charge devices at distances of up to 80 feet (approximately 24.3m).

“It works by creating an RF field using a PowerCast transmitter and then with our receiver chips and an antenna, you can grab the RF back out of the air and convert it into DC power. And that DC [power] is used to charge batteries,” she continued.

Although longer distances are possible, RF is a lower power charge

Below: The Nintendo Joy-Con controller grips automatically charge when they are within meters of the PowerSpot RF wireless power transmitter



Above: The PopPower charger’s Cosmic Cloud design

than Qi, and the company and were used to wirelessly recharge industrial and automation sensors and more recently IoT sensors.

“As more consumer devices are coming to market that are low power, like headphones, smart watches, RF has been gaining in the home setting,” Singer told New Electronics.

An example of this is the wireless charging grips for the Nintendo Joy-Con controllers, which were introduced at CES 2020 earlier this month. The controllers snap into the plastics grips into which are embedded PowerCast’s Powerharvester receiver and a battery. The receiver sends a charge over the air to the embedded battery which charges the Joy-Con controller. They automatically charge when they are within metres of Powercast’s PowerSpot RF wireless power transmitter. Bluetooth Low Energy monitors consumption to request power from the transmitter when the batteries are low.

The company’s chips operate with an antenna which can be in different form factors, depending on the application. Users are not restricted to using a PowerSpot transmitter, explained Singer, although it is recommended for dedicated RF applications, it ensures there will be a power source to recharge a device. Where there is ‘expected RF’, i.e. a retail environment with an RFID infrastructure, or ambient RF, i.e. in offices and homes Wi-fi or Bluetooth traffic, the RF sources may not be relied upon to recharge devices using RF energy, Singer advised.

“Our transmitters operate at 915MHz, which is the same as the US RFID systems,” Singer said. “We don’t have a transmitter yet available in Europe but, on the receiver side, we offer development tools and a lot of our customers are able to use our receiver chips in Europe. . . . We typically partner with companies who have existing products that we can make wirelessly chargeable all over the world,” said Singer.

A hole in the market

Just when consumers thought that wireless charging was the answer, another problem arises. The use of phone grips, extendable buttons placed on the back of phones to help users keep a tight hold, creates an obstacle for wireless phone charging pads. The grip can block the induction coil in a wireless charging pad and the Qi transmitter in the phone. One of biggest phone grip suppliers is PopSockets, who has collaborated with NuCurrent, to create a doughnut-shaped wireless charger pad. The PopPower home charger fits around the PopSocket. It supports Qi’s Extended Power Profile (EPP) to continuously deliver up to 15W for faster charging.

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early on that will, in many cases, preclude them for certain career paths. Compared to other countries, the UK is unusual as we start narrowing down the subjects pupils take at around 13 and again at 16. Both EngineeringUK and the Royal Academy are strong advocates of changing this - keeping specialisation to a later stage.

Maths lynchpin

Mathematics really acts as the lynchpin, as it is a prerequisite for any engineering degree, but this isn't something our schools are currently excelling in. Research done by the Nuffield Foundation showed that the UK as a whole did particularly badly with respect to the number of children taking mathematics above the age of 16. In fact, it was only one of three countries out of the 21 surveyed with less than 50% of upper secondary pupils taking mathematics.

"Mathematics A level is on the rise in schools again, after a really bad patch, but a lot more still needs to be done to get the numbers to where they should be," says Dr LeEVERS.

Numerous universities are starting to offer foundation courses to help bring students into the engineering sphere who didn't originally study it at A level. "We need to stress its value as a key enabler meaning people don't have to backtrack further down the line."

Poor A level mathematics uptake is particularly acute when it comes to girls, and this goes some way to explaining why a huge gender imbalance still exists within the engineering sector.

Though 47% of the total UK workforce are female, they constitute just 12% of our engineering fraternity.

In terms of the individuals currently in education/training the tally isn't that promising either. Females make up only 16% of STEM-based degree entrants and, even worse, a mere 8% of engineering companies' overall apprenticeship intake. There is also

a major pay disparity between men and women once they are qualified - something that is probably putting off aspiring female engineers and leading to them taking other career options instead.

Why now, well into the 21st Century, are traditional gender stereotypes still apparently so steadfast? Most are agreed that role models will be pivotal in combatting them.

As Dr LeEVERS noted, "There are actually plenty of really good exemplars out there, it is all about elevating them so they can be an asset to this cause." Towards the end of last year, she and her EngineeringUK colleagues staged the annual Tomorrow's Engineers Week.

Now in its seventh year, the objective here is to highlight the ventures being undertaken to strengthen Britain's pool of engineering talent - with contributions from primary, secondary and tertiary education, plus government agencies and the private sector.

The core theme on this occasion was developing technology to improve people's health and wellbeing.

The centrepiece of the whole affair was the 'Big Assembly' live video-cast, in which over 52,000 pupils and teachers from 850 schools across the country were involved. Some 550 schools participated in the Robotics Challenge that took place during Tomorrow's Engineers Week - with pupils constructing, then subsequently programming Lego-based robots (using the popular Mindstorms platform), in order to perform certain environmentally-focused tasks.

This is Engineering

Complementing this, the Royal Academy, in conjunction with EngineeringUK and various industry partners (including BAE Systems, Rolls-Royce, Centrica, BP, National Grid and BT), launched the 'This is Engineering Campaign.' It is all about giving youngsters a better

understanding of what a career in the field of engineering could entail. An important part of the campaign has been the promotion of different 'Meet the Engineer' profiles (each including short video interviews with the individuals themselves). These encompass a broad array of occupations (with many of those interviewed being female engineers). As well as avionics, civil engineering and suchlike, there has been a considerable push to showcase more creative opportunities for would-be engineers (in virtual reality, special effects, etc.) - thereby underlining the point that engineering doesn't have to be mundane.

There have been many schemes and initiatives over the last couple of decades looking to encourage more young people into the engineering sector, yet there still seems to have been a lack of traction to date.

"It's been important to invest in mechanisms for gauging the impact of our campaigns and evaluating their effectiveness. That way we can see what is working best and target available funds accordingly," LeEVERS explained.

"Also, in the past, supporting people on their journey into engineering tended to be handled in a very fragmented way. Though the intentions were good, there wasn't enough coordination.

"Now the focus is on greater cooperation between stakeholders, meaning our individual and collective efforts have greater reach," she continues. "Consequently, overlaps between the actions of different bodies are only likely to reaffirm what's being done by their counterparts."

This is echoed by the IET.

"There is now a willingness of those within the STEM community to collaborate with one another, and to share resources. The result is that we can deliver a more consistent message that has far better clarity," Lakin concludes.

Championing young engineers - Dr Hilary LeEVERS (top), David Lakin (middle), Rhys Morgan (bottom)





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According to Patrick Moorhead, president and founder of Moor Insights & Strategy, "Technology trends like 5G connectivity, cloud-based analytics, factory automation and the smart home are driving demand for embedded vision solutions that support machine learning. However, the data latency, cost and privacy issues associated with cloud-based ML analytics have sparked interest among developers in moving more data processing from the cloud to the Edge. But doing so requires OEMs have access to Edge AI/ML inferring solutions that offer high performance data processing, low power operation, and a small form factor."

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Power Integrations Delivers One-Millionth GaN-Based InnoSwitch3 IC

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Power Integrations (Nasdaq: POWI), the leader in high-voltage integrated circuits for energy-efficient power conversion, today announced the delivery of its one-millionth InnoSwitch™3 switcher IC featuring the company's PowiGaN™ gallium-nitride technology. In an event at the Shenzhen headquarters of Anker Innovations, Power Integrations CEO Balu Balakrishnan presented the one-millionth GaN-based IC to Anker CEO Steven Yang. Anker is a leading manufacturer of chargers and adapters, supplying retailers worldwide with powerful, compact USB PD adapters and a wide range of chargers and adapters for laptops, smart mobile devices, set-top boxes, displays, appliances, networking gear and gaming products.

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Rugged, modular MIL 83513 1.27mm pitch connector

Rugged, modular MIL 83513 1.27mm pitch connector with captive fixings suits thick PCBs and AWG24 cable.



Nicomatic's easy-to-use EMM series suits harsh-environment defense applications

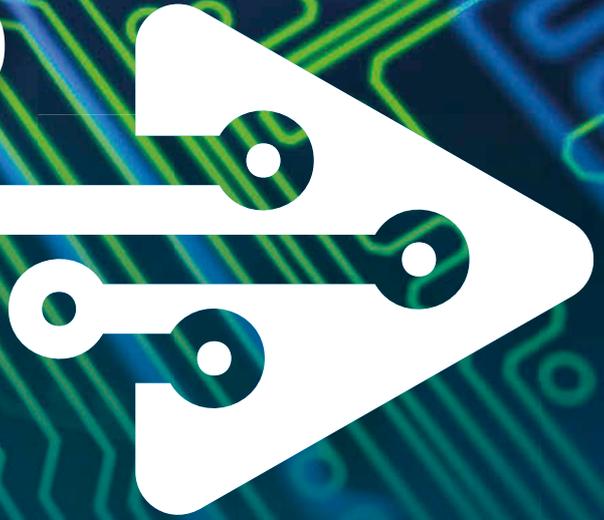
Nicomatic SA, the leading manufacturer of high-performance interconnect systems, has announced new features for its rugged micro connector, the 1.27 mm pitch EMM series, which targets defense and other high-reliability applications. The MIL 83513-style connectors that require a significantly smaller footprint than the closest industry competitor now feature captive screw fixings and can be used with thicker PCBs and larger diameter cables. Captive screw fixings provide the fastest locking solution available, since there is no need to tighten alternative sides repeatedly. They also ensure that screws are never lost. EMM miniature connectors are also now optionally available with longer straight-through and 90° contacts enabling them to be used on PCBs that are up to 3.5mm thick. Finally, EMM connectors can also be used with AWG24 cable, larger than competing devices.

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