THE QUEST FOR POWER

The race is on to develop new battery chemistries and manufacturing processes — and the UK is looking to take the lead.
COMMENT 5
Voice interfaces were prominent at this year’s CES, but not everything on show was quite ready for ‘prime time’

NEWS
Nanostructured gate dielectric boosts organic TFT stability and could enable large scale rollable displays 6

Millimetre sized vision processing chip could use up to 20 times less power than current devices 7

There is a resurgence of interest in the use of FPGAs, supported by new Cloud based services 8

Long term industry watcher Malcolm Penn makes his predictions about market growth for 2018 9

COVER STORY
The quest for power
The race is on to develop new battery chemistries and manufacturing processes - and the UK is looking to take the lead, with the Government providing £264million of funding

CES REVIEW
Voice dominates
At this year’s CES in Las Vegas, voice took centre stage, with the ‘big technology’ companies appearing to view it as the next major evolution in computing

TECHNOLOGY WATCH
Silicon stowaways
Trojans aren’t restricted to the software domain; in some instances, hardware Trojans could be used to open backdoors in custom silicon. And manufacturing processes could also be targets

MICROS
Pushing the envelope
The demands of the IoT are pushing wireless MCU developers to create devices with more processing power, a range of connectivity options and ultra low power consumption

COMMUNICATIONS TEST
Test complexity grows
As test complexity continues to grow, understanding the USB Type C connector helps to identify those areas where additional tests, instruments and test fixtures are needed

POWER
Having negative thoughts?
While many recent devices don’t need a negative voltage, there are some that do. What’s the best way to generate a negative voltage in your system?

DESIGN PLUS
Providing a head start
When looking to secure that all important competitive edge, more companies are turning to ‘ready to go’ partner solutions, taking advantage of a range of benefits

MISSION STATEMENT
‘New Electronics keeps designers and managers abreast of the latest developments in the world’s fastest moving industry’
Microchip’s Power Delivery (PD) Controller, UPD360, is a USB-IF certified USB Type-C™/PD Controller. UPD360 integrates the functional blocks required for USB Type-C and PD communications, which includes VCONN FETs and port power controllers. UPD360 can operate in a standalone mode or a companion mode, interfacing to MCUs, embedded controllers or USB hubs over PC/SPI interface. UPD360 can be designed into applications that require USB connectivity, alternate protocols (viz. Display Port) and manage power (as a Source or Sink) up to 100 W over USB Type-C connectors.

**Highlights**

- USB Type-C and power delivery functionality
- Integrated power switch
- Integrated VCONN FETs
- Dead battery support
- PC/SPI interface

www.microchip.com/UPD360
As usual, the Consumer Electronics Show (CES) saw a bewildering array of smart gadgets and devices vying for the attention of consumers. But while not every new product launched at the show will succeed – and there were more than 20,000 – it was certainly possible to identify some key trends.

One overarching trend was the rise of voice enabled devices, which appeared to be everywhere. Many technologists now see voice as the next major evolution in computing, with a potential impact similar to that of touch technology more than 10 years ago.

Alexa, Google Assistant and Siri, among others, dominated the news from Las Vegas, where there was a huge range of gadgets using voice on display.

Google, Amazon and Microsoft appear not only to be competing directly with their voice technologies, but are also looking to ensure that their assistant platforms become deeply embedded across all consumer electronics as they look to maintain and deepen consumer engagement with voice. Meanwhile, Apple seems to have lost ground.

Both Amazon and Google have certainly recognised the need to integrate their technology and improve time to market through greater collaboration and partnerships with third parties, as well as through open platforms.

Alongside voice, artificial intelligence (AI) also took centre-stage and was deployed in many different products.

It will certainly have a far-reaching impact on people’s lives, whether that’s at home, in terms of transportation or just walking down the street. However, when it comes to AI, how much is simply smart software and how much is true AI?

The term ‘AI’ was certainly over-used, with rather too many companies using it as a blanket marketing tool in order to gain attention – and that’s not really surprising when you walk around CES and see how crowded the marketplace is.

While Samsung’s keynote address devoted much of its time to AI, the consumer electronics giant acknowledged that truly smart, connected devices are still many years away.

A suitable metaphor for much of the technology on show this year was LG’s disastrous demonstration of Cloi, its home-helping robot. The company’s vice president of marketing engaged in a one-way conversation as he desperately tried to elicit a response from the device, highlighting the fact that much of the technology on show isn’t quite ready for ‘primetime’.

Neil Tyler, Editor (neil.tyler@markallengroup.com)
Organic semi obstacle solved

NANOSTRUCTURED GATE DIELECTRIC BOOSTS ORGANIC TFT STABILITY IN FLEXIBLE ELECTRONICS. GRAHAM PITCHER REPORTS.

According to scientists from Georgia Tech, a nanostructured gate dielectric could remove a significant obstacle to wider use of organic semiconductors for thin-film transistors. A potential application for the technology could be in very large flexible displays that could be rolled up when not in use.

The structure — a fluoropolymer layer, followed by a nanolaminate made from two metal oxide materials — not only serves as gate dielectric, but also protects the organic semiconductor from damage. A further benefit is said to be greater stability.

“We have now proven ... that organic circuits can be as stable as devices produced with conventional inorganic technologies,” said Professor Bernard Kippelen. “This could be the tipping point for organic thin-film transistors, addressing long-standing concerns about the stability of organic-based printable devices.”

The dielectric architecture features alternating layers of aluminum oxide and hafnium oxide — five layers of one, then five layers of the other, repeated 30 times on top of the fluoropolymer. The resulting nanolamine, about 50nm thick, is said to be ‘virtually immune’ to the effects of humidity.

The team says an obvious application for its development is for transistors that control pixels in OLEDs. The technique could also allow development of inexpensive paper-based devices, such as smart tickets, that would use antennas, displays and memory fabricated on paper through low-cost processes.

Topological materials for better thermoelectric devices

MIT researchers claim to have discovered a way to increase the efficiency of thermoelectric devices through the use of topological materials.

Researcher Te-Huan Liu said: “We can push the boundaries of a nanostructured material in a way that makes topological materials a good thermoelectric material, more so than conventional semiconductors.”

The study found that some topological materials can be made into efficient thermoelectric devices through nanostructuring. Liu and his team explored the effects of changing the grain size of telluride and found that when the diameter was decreased to 10nm, more than three times as much electricity was produced than with larger grains.

Liu said: “We can shrink a topological material’s grain size more than previously thought and, based on this concept, we can increase its efficiency.”

Other topological materials are yet to be explored, but if the ideal grain size can be determined for each, Liu believes it may be a better way of producing clean energy.

Space junk recovery processes set to be tested

Surrey Satellite Technology has shipped the RemoveDEBRIS spacecraft to the Kennedy Space Center ready for launch to the International Space Station. The RemoveDEBRIS platform features four space debris removal technologies and two target cubesats. Currently, it is estimated there is around 7000 tonnes of space debris in orbit and the RemoveDEBRIS consortium is leading efforts to develop active debris removal technology.

In the first of two capture experiments, a net will be discharged in an attempt to capture one of the deployed target cubesats. The second experiment will see a harpoon launched at a deployable target plate made of representative satellite panel materials. The third experiment involves vision-based navigation using the second cubesat and rendezvous navigation based on cameras and LiDaR. Finally, the RemoveDEBRIS spacecraft will deploy a large drag sail to speed de-orbit, where it will burn up as it enters Earth’s atmosphere.
Small, but mighty

A chip designed to capture visual details from video frames is said to draw 20 times less power than existing best-in-class devices, according to a team from the National University of Singapore.

The low power consumption means the battery could be 20 times smaller and this has the potential to reduce the size of smart vision systems to the millimetre range. The team aims to develop millimetre-sized smart cameras with a near-perpetual lifespan.

Associate professor Massimo Alioto, said: “Vision electronic systems with a long lifetime are currently not feasible for IoT applications due to their high-power consumption and large size. Our team has addressed these challenges through the EQSCALE chip and we have shown that ubiquitous and always-on smart cameras are viable.”

According to the NUS team, the EQSCALE chip can perform continuous feature extraction while drawing as little as 0.2mW.

Wavy transistors deliver ultrahigh definition displays

Using a novel transistor architecture, researchers at the King Abdullah University of Science and Technology have developed a flexible ultra high resolution display that could benefit next-generation mobile electronics.

Wavy transistors have enabled transistor channels with modest mobility, but shrinking these transistors is expensive and creates short-channel effects that increase power consumption and degrade performance.

Lead researcher Muhammad Hussain says an alternative is non-planar vertical semiconductor fin-like structures interconnected laterally to form wavy transistor arrays. The researchers selected zinc oxide as the active channel material and generated the wavy architecture on a silicon substrate before transferring it to a flexible soft polymer.

Due to the vertical orientation, the researchers increased transistor size by 70% without using any more pixel area. In a proof-of-concept, the transistors drove flexible LEDs at twice the output power of their conventional counterparts.

Electrochemical logic circuits

A team from Linköping University says it has developed the first complementary electrochemical logic circuits that can function stably in water for long periods. According to the researchers, this is a ‘significant’ advancement in the development of bioelectronics.

The dominant material to date has been PEDOT:PSS; a p-type material. In order to construct effective electronic components, the team required an n-type material. However, it was difficult to find a sufficiently stable polymer. Simone Fabiano, head of research in the University’s Organic Nanoelectronics group, has developed such an n-type conducting material.

“This may appear to be a small advance in a specialised field,” Fabiano noted, “but it has major consequences for many applications. We can now construct complementary logic circuits – inverters, sensors and other components – that function in moist surroundings.”

Alongside bioelectronics, applications include logic circuits that can be printed on textile or paper, low cost sensors and flexible displays.

49 qubit test chip unveiled by Intel at CES

Intel showed a 49 qubit superconducting quantum test chip at CES. The test chip is said to be another step on the road to Intel’s goal of developing a complete quantum computing system. The 49 qubit test chip will allow researchers to assess and improve error correction techniques and to simulate computational problems.

Intel is also researching spin qubits in silicon, which could have a scaling advantage because they are much smaller than superconducting qubits.

Dissolvable sensor

A biodegradable pressure sensor has been developed by engineers at the University of Connecticut. The flexible and dissolvable device is designed to replace existing implantable pressure sensors that contain potentially toxic components and to avoid the need for invasive surgery.

The sensor is made of two layers of piezoelectric Poly(L-lactide) film, sandwiched between molybdenum electrodes and then encased with layers of polylactic acid.

Thanh Duc Nguyen, an assistant professor at UConn Health, said: “We are very excited because this is the first time these biocompatible materials have been used in this way.”

The team’s goal is to extend the functional lifetime of the sensor and to create a completely biodegradable sensor system.

Year of Engineering

As the Year of Engineering gets underway, the EPSRC is investing £6.6million in 28 pioneering research projects which could have a ‘transformative impact’.

EPSRC’s chief executive Professor Philip Nelson said: “The Year of Engineering is a fantastic opportunity to celebrate the UK’s proud heritage in this field and highlight the impact that engineering has on the UK and the world.”

The 28 projects at 17 universities cover research areas such as intelligent driver seats, the use of diamond quantum technology to investigate neurological diseases and the use of novel materials in solar power generation.
At the Xilinx Developers Forum, held in Frankfurt earlier this month, hardware and software developers gathered to consider how best to address development issues at a time when CPU architectures are no longer scaling to meet increased workloads.

In his opening address to the Forum, Ramine Roane, Xilinx’ senior director, software and IP, said that as CPU architectures were failing to meet demand, there had been a resurgence of interest in FPGAs as designers look to address the need for both higher performance and lower latency.

“Processor frequency scaling stopped around 10 to 12 years ago and while the move to multicore architectures initially addressed this, we’re now seeing multicore architecture scaling flattening,” he argued.

“There are too many transistors switching at the same time and current leakage at lower geometries is hitting power constraint limits, and this is all happening at a time when workload demand is growing exponentially both in the Cloud and at the edge,” he suggested.

“We’re seeing increased demand for video transcoding in the Cloud, which requires both high performance and low latency, for example. Likewise, at the edge, we are seeing similar increased workloads, especially when it comes to data analytics.

“Processor speeds are not scaling, so there has been a need for application specific accelerators, whether that’s for video, AI, machine learning or search services.”

The problem, however, according to Roane, is that application specific accelerators can only be justified if developers are looking to address the needs of a particular ‘killer app’.

According to research undertaken by Google into workloads at its datacentres, so-called ‘killer apps’ – such as search and video transcoding – were found to account for just 9.9% of total CPU cycles.

“Over the past few years, Google has found that its data centres are seeing workloads becoming more diverse, with demand changing rapidly.”

As a result, Roane suggests that there’s been a move away from building application specific accelerators, even for video.

“We are seeing a move towards reconfigurable accelerators which are, in most cases, the only viable option for addressing this type of flexible workload – and this is not only valid in the Cloud, but also at the edge.”

Reconfigurable accelerators

According to Roane, this move to reconfigurable accelerators is playing to the strengths of FPGAs and SoCs.

“They provide configurable processor sub-systems and hardware that can be reconfigured dynamically. Their key advantages are that design engineers can build their own custom data flow graph which can be customised to their own application with its own custom memory hierarchy, which is probably the biggest advantage as it lets you keep data internal to your pipeline.”

While FPGAs can offer massive computational throughput and miniscule latency, the problem remains of how to program these devices because despite being incredibly powerful they have proved to be difficult to engineer.

“It’s fair to say that FPGAs are not the easiest devices to program, compared to CPUs,” admitted Roane, “and historically they have been costly to manage and develop.”

Roane conceded that the cost of FPGA engineering has been one important reason why they haven’t become mainstream, along with the complexity of programming them.

However, Xilinx and its growing ecosystem of partners are now delivering a much richer development stack so that hardware, embedded and application software developers can program them more easily by using higher level programming options, like C, C++ and OpenCL.

“We are now able to deliver a development stack that designers are increasingly familiar with and which is also available on the Cloud via secure cloud services platforms,” explains Roane.

For example, Amazon Web Services (AWS) FPGA EC2 F1 not only makes it possible to program Xilinx FPGAs, but is also helping customers to move their workloads to the cloud. AWS also provides a hardware development kit for FPGA configurations.

“The ability to gain access to FPGAs via the Cloud as a service has been a significant development in recent years and provides much broader access to FPGAs via platforms provided by Amazon or Alibaba Cloud and means that FPGA development, as a service, is expanding worldwide.

“I think there’s a trend here,” he concluded, “and it is one in which things are going to get more accessible.”
After a blistering 2017, it looks like the semiconductor industry will see continued strong growth in excess of 19% this year, according to Future Horizons.

Last year saw device sales growing by 22% to $413 billion and sales of equipment rising by 31%, compared to the previous year.

Future Horizon’s chairman and CEO, Malcolm Penn, voiced his surprise that the IMF’s GDP forecast for 2017 not only held its unit growth projection, but was also increased to 3.5% and then 3.6%. “For the first time in eight years, we actually saw that the economy was really starting to accelerate – and sustainably.” The 2018 GDP outlook has now been revised from 3.6% to 3.7%.

The yearly long-term average unit growth rate, which has remained steady at 10% for some 30 years, had dipped to 5%, before growing unexpectedly by 14 to 15% last year, presenting supply issues.

Penn said: “The problem is the assumption that unit growth will remain at 5%, meaning manufacturers are unable to cope with the amount they’re expected to supply because they’re only prepared for this particular growth rate and not the increased sales we have seen.”

Presently, there is more demand than supply, which Penn does not think will change any time soon.

Brexit is also creating some hesitation within the industry. “The brinkmanship that’s going on both sides is unbelievably uncertain,” Penn said. “The last thing business wants is uncertainty, so they’re starting to plan for the worst case.”

Neither does Penn think the merger and acquisition frenzy is over, as the only option now for big companies is to grow horizontally.

According to Penn, substrate suppliers are also struggling to meet demand for 200mm and 300mm wafers, while more mask steps are increasing production times and reducing capacity. There has not been a capacity shortage in a long time and, for many industry executives, this is a new experience.

Although 300mm wafers have grown in popularity, demand for 200mm is starting to rise again. “The new products we see today didn’t exist 15 years ago and their volumes aren’t large enough to support 300mm wafers. Every time you make a bigger wafer, the capacity of that factory effectively doubles. Unless you can fill it, you can’t run the factory very efficiently.”

Despite supply concerns, Future Horizon’s forecast for this year looks bright, with Penn stating unit growth is back on track. Although there has been discussion that memory has been the main cause of this growth, Penn stated that, currently, “all sectors are boasting strong levels of unit growth”.

Last year, semiconductor growth hit $413bn and Penn says it may hit £500bn this year. While Penn is optimistic about long-term average unit sales, Gartner forecasts 2018’s worldwide semiconductor revenue at $451bn.

“It annoys me that organisations are saying growth is going to be less than 10%,” Penn commented. “They are effectively saying there’s going to be a disaster.”

However, while Penn has a positive outlook on 2019, he believes that 20% growth a year will be difficult to maintain in the future.

Gartner’s principal research analyst Ben Lee believes that semiconductor revenues in 2018 will revert back to single-figure growth, while a correction in the memory market will see sales decline in 2019.

Given the current economic climate and tight supply, Penn recommended that industry grasped opportunities now. “In the short term, growth and driving factors are very positive. But the industry also has a mind boggling range of new opportunities,” he concluded. “In some respects, the industry is showing signs of maturity; in others, it is still very young and full of growth.”

“We’ve set Jez up in a vacuum chamber to test our space debris harpoon. Should be straightforward.”

“Alright Jez, on my command.”

“He needs to put more weight on!”
For most of the 20th Century, batteries were an overlooked technology. And for good reason; the available batteries – predominantly lead-acid, although disposable zinc-carbon cells were also popular – were entirely suitable for the applications of the time. There was no particular reason to push the technology forwards.

But times changed. As the Century drew to a close, portable battery powered consumer electronics devices became widely used. Consumers not only wanted their products to last longer between either installing new batteries or recharging them, but a trend for smaller devices also appeared.

Now, electric and hybrid vehicles have added another twist. Together, these elements have kick started the recent interest in finding new battery technologies and chemistries.

Energy storage was one of the areas selected by ex industry minister David Willetts as one of the Eight Great Technologies. In a paper published in 2013, Willetts noted: “We need better ways to store electricity. This need arises at three distinct levels. First, there are the batteries in all our personal electronic devices. The second level is the development of better energy storage for vehicles. Thirdly, there is the challenge of storing more electricity for the Grid.”

Looking to take advantage of the opportunities, the Government is providing significant funding – as part of its Industrial Strategy – to help UK organisations to get the jump on other countries. Business and Energy Secretary Greg Clark announced in July 2017 the launch of the first phase of a £246million investment into battery technology designed to ensure the UK builds on its strengths and leads the world in the design, development and manufacture of electric batteries.

Known as the Faraday Challenge, the four year investment will feature a coordinated programme of competitions, delivered via Innovate UK, that aims to boost the research and development of battery technology.

Anna Wise, batteries innovation lead at Innovate UK, told New Electronics: “The Faraday Challenge will provide an exciting opportunity to rebuild technology that has been developed in the UK. From the start,” she continued, “we’ll be looking at how we can invest at seven stages of technology readiness; looking to accelerate work that is close to market, as well as longer term projects.”

Towards the end of 2017, a partnership between Warwick Manufacturing Group (WMG), Coventry and Warwickshire Local
our ambition, through the Industrial Strategy and the Faraday Challenge, to ensure that the UK leads the world and reaps the economic benefits in the global transition to a low carbon economy."

Dr Emma Kendrick, a materials chemist and energy storage technical specialist at WMG, provided attendees at last year’s Electronics Design Show Conference with an update on developments in the field. If you look at the rechargeable battery market, lead-acid is still the biggest technology, with NiCd and NiMH declining. But it’s a huge market, estimated to be worth $65 billion and growing.

When you consider the various market segments, it’s surprising to find the starter, lighter, ignition (SLI) sector in cars remains the largest of all markets and depends almost entirely on lead-acid batteries. “And lead-acid batteries will be around for a long time,” Dr Kendrick noted, “because it’s a massive market.”

It’s no surprise that demand for batteries in portable electronics product grew significantly since the 1990s, but more surprising perhaps is that demand has slowed somewhat. “The strongest growth in the rechargeable battery sector is now coming from the automotive and industrial sectors,” Dr Kendrick pointed out.

And it’s the electric vehicle (EV) market which the Faraday Challenge has at its heart. The Advanced Propulsion Centre, in association with the Automotive Council, has set some challenging targets for those developing batteries (see box).

“If I’m not sure how realistic these targets are,” Dr Kendrick admitted. “If we are to get costs down and create 1400Wh/litre batteries, we can’t stick with what we have. New chemistries will be needed.”

One company looking to hit these targets is Nexeon, which has pioneered the development of silicon based materials for next generation Li-ion batteries. It’s taking part in the £10m SUNRISE project (Synthomer, UCL and Nexeon’s Rapid Improvement in the Storage of Energy), which plans to develop better silicon based battery materials that can replace carbon in the cell anode, as well as optimising cell designs for automotive applications. According to the partners, their work will be ‘an essential step’ in the quest to provide EVs with a range of more than 400 miles. The work is also being seen as another way to enhance the UK’s position as a centre of excellence for battery development.

Nexeon will lead the silicon material development and scale-up stages of the project, while polymer specialist Synthomer will lead the development of a next generation polymer binder optimised to work with silicon. Meanwhile, Nexeon and University College London will work on material characterisation and cell performance.

Dr Bill Macklin is Nexeon’s chief engineer. He said SUNRISE will start as a TRL4 project – essentially lab based work. “But we’re aiming to be at TRL6 in three years.” To achieve that, the project partners will need to demonstrate prototype technology applied in the relevant sector.

Nexeon’s heritage is in the development of silicon anodes for use in Li-ion batteries. It did get to the point where it built a pilot production facility, but discovered the
he noted. “Our opportunities are far the requirements are less onerous,” for small batteries. “In this market, where there’s an appetite to address the portable device challenges alluded to in the Automotive Council’s targets. “A key feature when you’re making these things in commercial quantities will be cost,” said Dr Macklin. “Graphite costs around $12 per kg. If silicon anodes give four times the capacity of graphite, that material has to sell for about $50/kg – and that’s not a trivial target.”

While SUNRISE is focused on automotive applications, Dr Macklin believes a logical progression would be to address the portable device market, where there’s an appetite for small batteries. “In this market, the requirements are less onerous,” he noted. “Our opportunities are far broader than automotive, even though forecasts suggest this could be the dominant market in the future. We’re trying to ensure that our materials are applicable to all battery formats because nobody can predict a winner. But there’s still work to be done in order to get silicon – even at low levels – adopted in pouch batteries,” he admitted.

One of the attractions of developing batteries for portable electronics devices, according to Dr Kendrick, is the focus isn’t on cost. “Users are far more interested in charging once a day or less and for the battery to last for as long as possible. So developers are targeting energy density.” She noted this application is being served by layered oxide materials. “These have some of the highest voltages you can get, as well as highest specific capacity.” However, she warned that every market needs a different battery technology. “One technology doesn’t fit all. Today, we see technologies developed for consumer electronics, for example, being shoehorned into other markets. We need to know what we are developing batteries for so we can meet the various targets, such as life, cost and energy density.”

Looking to the future, Dr Kendrick believes lithium-sulphur batteries are ‘quite interesting’. “They are being developed in the UK by Oxis,” she pointed out, “but still need more work. One issue is that soluble products dissolve into the electrolyte, which means efficiencies are relatively low. While Oxis has produced a demonstrator system, which is light and has a good Wh/litre figure, the Wh/kg is not so good because sulphur isn’t particularly dense.”

Lithium-air was flagged by Dr Kendrick as another interesting technology. “It should have one of the highest energy densities as lithium is light, plus it draws oxygen from the air. In theory, it should have the best volumetric and energy densities, but it needs a catalyst layer and the volume of air needed is large, compared to the size of a standard Li-ion battery.”

There are also contamination problems caused by water vapour and CO₂ in the air used by the battery. “This reduces the effectiveness, so both need to be scrubbed from the air before it’s used.”

Lithium-air was the underlying concept in the Battery 500 project developed by IBM, but this has been shelved because commercialisation was seen to be too long.

Sodium-ion batteries may also come to market. “UK company Faradion has developed a ‘drop in’ technology which used the same production techniques as Li-ion,” she said. “Material costs should be lower as sodium is the fourth most abundant element. But while the materials discovery phase is often shortest, it’s the scale up aspects that take time and resources.”

**Automotive Council targets for 2035**

- reduce battery cell cost from £100/kWh to £38/kWh
- double energy density to 500Wh/kg
- increase battery cell operating temperature range to -40 to 80°C
- improve a battery pack’s recyclability from 10 to 50% today to 95%
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Voice dominates

At this year’s CES in Las Vegas, voice took centre stage, with ‘big technology’ companies appearing to view it as the next major evolution in computing. By Neil Tyler.

CES 2018 saw more than 20,000 new products unveiled, ranging from drones and emotion sensing robots to smart devices of all kinds.

Artificial intelligence (AI) and 5G featured in many of the announcements and at a pre-show CES keynote presentation, Intel’s CEO, Brian Krzanich described data as being the ‘unseen driving force behind the next great wave of tech innovation’.

“There was a tremendous amount of innovation, both in new technology and in applications that integrate those technologies,” said Robert LeFort, president of Infineon Technologies Americas.

“The use of AI across a wide range of products, combined with advanced sensing technologies, will have a far reaching impact on people’s lives.”

LG and Samsung were among companies that focused on AI and the development of connected products.

Half of Samsung’s press conference was dedicated to AI and although it said that connectivity would be the underlying driver for everything it would be doing over the coming years, the company suggested that it wouldn’t be until the 2020s that devices would start talking to one another. Samsung appeared keener to raise awareness than unveil new products.

“The overall trends are clearly toward smart, efficient and life improving innovations,” said LeFort.

One such device was Oticon’s HearingFitness app, which the company said was the first hearing health fitness tracker that looks to explore the full potential of advanced analytics.

The HearingFitness app has been designed to help people with hearing loss to understand how their behaviour and hearing health habits can influence how effective their treatment is and the impact it has on their overall health and well-being.

Extensive range of products

The range of products on show at CES was, as always, extensive.

Intel used its opening keynote address to demonstrate its 18 rotor, two person Volocopter taxi drone on stage and then used a swarm of 250 of its Shooting Star drones to light up the Bellagio fountains on the Las Vegas strip.

And while there were dozens of companies demonstrating the latest in drone technology, there were plenty of others that were exhibiting anti-drone solutions, with radar tracking and signal jamming solutions on display.

A host of robots was also in attendance and LG used its conference address to unveil Cloi, its home-helping robot which has been designed to provide an interface between the user and their consumer devices.

A live demo hosted by LG’s vice president of marketing David VanderWaal, however, didn’t quite live up to expectations and a large audience witnessed a one-way conversation with a largely unresponsive robot.

Certainly embarrassing, but as commentators suggested, this failed demo provided a metaphor for much for the technology that was on display at CES this year. Many of the devices weren’t quite ready.

In terms of its footprint, CES is now the fifth largest automotive show held in the US and, in many respects, has stolen a march on the Detroit Auto Show that follows it.

According to LeFort, autonomous and efficient mobility were the centre of attention this year.
“This year, the focus was on integration of sensors and AI for autonomous vehicles.

“What was interesting was that, while electric vehicles and autonomous vehicles are independent technologies, it is now clear from a product roadmap perspective that these technologies will be fully combined.”

For the first time, the show had a section devoted to smart cities.

“The smart city and smart home remain an area of emphasis for many companies in the consumer electronics ecosystem,” said LeFort. “Infineon, for example, highlighted several technologies in security and user identity, as well as solutions for wireless charging and the smart city infrastructure.”

**Voice takes centre stage**

What really stood out at CES was the importance that ‘big technology’ companies appear to now attach to voice, with most seeing it as the next major evolution in computing.

Smart speakers appeared to be helping to reignite interest in the smart home market, with voice acting as a central hub or virtual ‘butler’ and, at CES, the smart home concept saw a broad array of solutions on display, from heated toilets to leak detection services.

The battle to control the smart home via a virtual assistant – which includes Amazon’s Alexa, Google’s Assistant, Siri and others – was certainly hotly contested and there were a huge range of voice based gadgets on show.

“Voice interfaces were certainly prominent across the show,” said LeFort. “A key to the success of voice will be the ability of smart devices to accurately sense the identity of speakers, which will require high-accuracy microphones.”

The rivalry between market leaders Amazon and Google was particularly noticeable, with voice assistants appearing in things as diverse as showers, mirrors, light switches and microwave ovens.

Beyond the smart home, Google’s Assistant is being added to more car entertainment systems and, for example, Android Auto is now able to offer a hands-free means of operating Google maps.

Google, like Amazon, has also started to open up its assistant voice system to third-parties and CES saw a growing number of manufacturers unveiling new smart speakers. LG, for example, launched smart displays with Google’s Assistant.

Qualcomm Technologies said that it was now supporting Android Things, the Google Assistant and other Google services on its Smart Audio Platform.

This platform allows OEMs to create differentiated smart speakers that can support Google’s Assistant across different products and categories.

This integrated platform is able to bring together processing capability, connectivity options, voice user interfaces and premium audio technologies to meet consumer demand for more intuitive smart speakers.

“The Smart Audio Platform helps allow traditional speaker OEMs to join and participate in the growing smart speaker segment more efficiently,” explained Anthony Murray, general manager, voice and music, Qualcomm Technologies International. “Demand for voice control and assistance in the home is rapidly gaining traction and this platform is designed to offer much greater flexibility for manufacturers who are looking to deliver more differentiated user experiences.”

Ben Wood, chief of research at CCS Insight said that Google, Amazon, Microsoft and others were fighting ‘not only to cement their voice technologies, but also to ensure their assistant platforms are deeply embedded across the full spectrum of consumer electronics to maintain and deepen consumer engagement’.

Market research suggests that voice commands will dominate searches in the next two years and, as consumers embrace the IoT, voice, video and audio will converge as consumers look for a far richer sensory experience.

In response, NXP Semiconductors launched the i.MX 8M family of applications processors.

“Interacting with machines will be as natural as using your human senses,” suggested Martyn Humphries, vice president of consumer and industrial i.MX applications processor. “For instance, you can give a voice command to stream a specific TV episode and then ask a contextual question about the actor, which initiates a search and displays results on the screen – all while your show is still streaming.”

Whatever the hype that surrounds many of the products at CES, with 4000 exhibitors and more than 180,000 visitors, it remains a showcase for innovation from the smallest to the biggest companies.
Trojans aren’t restricted to the software domain; in some instances, hardware Trojans could even open backdoors in custom silicon. By Chris Edwards.

Outsourcing has reshaped the way electronics products are made – and helped to cut manufacturing costs massively. But, as production margins have fallen, so too has trust in the organisations that make up the supply chain. Companies which rely on outsourced manufacturing are having to come up with ways of ensuring that the products shipped to them have not had secure keys leaked or stuffed with viruses and compromised software. Even custom silicon is not safe.

Almost a decade ago, researchers from Case Western Reserve University described to delegates at the IEEE High-Level Design Validation and Test Workshop the ways in which they could see hardware malware – or Trojans – being introduced to an IC-design project. The widespread use of foundry services, third-party intellectual property and standard-cell libraries – as well as designers bribed to make circuit-level changes – all provide ways in which Trojans could be sneaked into circuitry.

Once it receives a trigger signal, the Trojan could open a backdoor to the group that wanted it introduced. In some use-cases, the Trojan may be introduced simply to compromise the product; no matter how it is used.

However, the nature of IC design makes hardware Trojans difficult to deploy as they require skills and levels of access that are probably out of reach of most cybercriminals. But other, lower hanging, fruit remains available to them. State actors have the skills, access and motive that may make the surreptitious deployment of some kinds of silicon highly attractive to them. In practice, such organisations may not bother trying to introduce backdoors without the knowledge of the manufacturer or find other ways to make gain access to secrets.

In 2015, the BBC identified declassified documents that confirmed the government convinced Crypto AG in the mid-1950s to compromise the security of its C-52 electromechanical encryption machines. Rather than making physical changes to the hardware itself, the company told the US National Security Agency (NSA) and the UK’s GCHQ which models target governments had bought – a practice that would allow the agencies to target decryption resources more effectively.

In 2013, the NSA came under suspicion of encouraging the use of algorithms supplied by specialist RSA that had been subtly weakened to make decryption easier.

While some ICs behave as if they have Trojans installed, in reality the backdoors were placed intentionally into the silicon by authorised designers. Usually, they are debug aids that were meant to stay secret, but often did not. Five years ago, Sergei Skorobogatov of the University of Cambridge and Christopher Woods of Quo Vadis Labs used side-channel emissions from the devices to uncover the key that would open the backdoor in the JTAG circuitry of an FPGA and to provide access to the encryption keys stored inside.

Although side-channel emissions provide one way to determine whether an IC has been compromised with a backdoor, designers have other options available through the deployment of EDA techniques with Trojan detection in mind. As with anything in cybersecurity, a cat-and-mouse game has produced ever more subtle ways of introducing Trojans and more powerful ways of detecting them.

The hardware Trojan is the subject of regular hacking competitions between research teams. For example, the Cyber Security Awareness Week (CSAW) organised by New York
University has run several challenges around Trojans. In these challenges, red teams try to circumvent the detection mechanisms used by blue teams.

2013’s CSAW challenge focused on methods to beat FANCI, a largely effective detector developed at Columbia University and NYU. FANCI works on the basis that a Trojan would only have a loose connection to the design such that its logic would seem to be practically unreachable. Code-coverage analysis of the RTL can identify such unconnected lumps of circuitry and flag them up as possible Trojans.

A couple of years later, the DeTrust technique created by Jie Zhang and colleagues at the Chinese University of Hong Kong showed one method for fooling FANCI: spreading the suspicious logic across many otherwise independent gates.

Months later, Syed Haider and coworkers from the University of Connecticut developed the hardware Trojan catcher (HaTCH), designed to track down stealthier functions inserted at the logic level. Rather than isolate the Trojans before manufacture so they can be removed, HaTCH focuses on remediation. It adds tagging circuitry to legitimate cores that work to prevent any on chip Trojans from activating or succeeding in displaying malicious behaviour, such as opening a backdoor.

A more wide-ranging technique that could serve as a defence against Trojans is to insist that all IP be supplied with formal proofs that describe the operations it would be allowed to perform. Any changes would be flagged by formal-verification tools during design and prototyping. Such approaches could still be vulnerable to attacks that tweak designs below the abstraction of RTL.

As with the cases where the NSA is understood to have sought the help of manufacturers, weakened encryption is one of the most likely ways in which a practical hardware Trojan might work and evade detection by all but side-channel analysis. And it is possible using a tiny change at manufacture. At the 2013 International Workshop on Cryptographic Hardware and Embedded Systems, Georg Becker and colleagues from the University of Massachusetts at Amherst showed a proof of concept that simply switched dopants used for one of the transistors in an inverter would only have a loose connection to the design such that its logic would seem to be practically unreachable. Code-coverage analysis of the RTL can identify such unconnected lumps of circuitry and flag them up as possible Trojans.

Figure 1:
By switching dopants, a transistor could be created that doesn’t switch

A transistor that no longer switched might be caught by a scan test looking for stuck-at faults. But embedded in a pseudorandom number generator, the inverter’s problem could be very hard to track down. Once there, the Amherst team estimated the fault could massively reduce the entropy of the random numbers it produced, resulting in very weak cryptographic keys.

In 2014, Takeshi Sugawara of Mitsubishi Electric and a team from the company and Ritsumeikan University showed such a tiny change in manufacturing could be detected after the fact. A combination of focused ion beams and scanning electron microscopy can reveal the dopants diffused into the substrate. It is an expensive proposition, involving delayering of the design and extensive analysis against a layout that contains a map of the expected dopants. However, for the kinds of high-value cryptographic IC that might be the targets of well-financed attackers, it is arguably one more in a list of checks that are readily justified.

As with other areas of embedded cybersecurity, the most feasible approach to dealing with the risk of hardware Trojans is one of focusing effort. Architectures such as Trustzone pull functions that need high levels of protection into a small portion of the overall SoC. In principle, this subset is much easier to verify than a design that calls for the either chip to be flagged by formal-verification tools during design and prototyping. Such approaches could still be vulnerable to attacks that tweak designs below the abstraction of RTL.

If the secure core is guaranteed to not leak information or provide trapdoors, the value to an attacker of putting a Trojan in the more weakly protected part of the SoC diminishes greatly. For the user of SoCs and the buyer of IP to go into them, the question then becomes one of the level of expected risk and the degree of trust they can put in staff, suppliers and contractors.
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Pushing the envelope

The demands of the IoT are pushing wireless MCU developers to create devices with more processing power, a range of connectivity options and ultra low power consumption. By Graham Pitcher.

As the Internet of Things becomes more of a reality, products for a wide range of applications are appearing that offer the required connectivity. Many of these have been developed for the consumer market or for IoT edge applications.

For both sectors, cost and performance are driving factors, which means component count and product size also play a major role. So it’s no surprise to find that engineers are looking for low cost, high performance MCUs which offer a selection of connectivity options. Step forward the wireless MCU.

While the concept of a wireless MCU isn’t new – New Electronics has been reporting on them for close to a decade – recent developments have seen the devices offer a new level of performance.

Established in 2001 as a WiFi specialist, Redpine Signals was one of the first to unveil an 802.11n chipset. In 2013, it launched what it said was the first multiprotocol wireless chipset for IoT applications. But at the end of 2017, it introduced two concepts aimed at the embedded market – WiSeConnect and WiSeMCU, which features a range of connectivity options and an integrated MCU.

Dhiraj Sogani, vp of marketing, contends the market for its wireless MCU modules is huge. “All devices need connectivity,” he asserted, “and wireless is important, not only for local links, but also to connect to the cloud.”

But this huge market to which Sogani pointed is also difficult to address. Jack Ogawa, Cypress’ senior marketing director for MCUs, said: “The market is extremely fragmented; we have to cover a spectrum of applications – and that spectrum is broad. It also means the ‘state of the art’ hasn’t been set, so technology continues to develop rapidly.”

Consequence, Ogawa observed, is the balance between having a good processor and wireless performance is moving dynamically. “And it all depends on the application,” he added.

Redpine’s WiSeMCU – also called the RS14100 – is said by the company to be the lowest power multiprotocol wireless MCU currently available. Designed around the ARM Cortex-M4F, the part can run at up to 180MHz and features a choice of dual-band 802.11abgn Wi-Fi, Bluetooth 5 and 802.15.4; the latter being suited for Thread or ZigBee.

Sogani said: “We’ve put a lot of effort into developing the system architecture; it’s not just about taking advantage of the power savings from the latest process node. While these devices are fabbed on a 40nm line, we’ve had to develop new techniques that reduce power consumption even further.”

While the RS14100 is said to draw 12µA/MHz in its lowest power mode, standby consumption has been a design target. “Most IoT devices are sleeping most of the time,” Sogani pointed out. “They wake up to transfer data, then go back to sleep. Battery powered devices depend on stand by current if they are to have a long operating life. We’ve reduced this to less than 500nA in deep sleep and believe this is three to four times lower than the competition.” Meanwhile, data throughput is said to be greater than 900Mbit/s, with the Cortex-M4F core acting as a ‘gear shifter’, responding dynamically to data processing requirements.

Ogawa noted: “When my device is asleep, it should consume little current. But there’s also work efficiency; when the device is awake, how quickly can it perform tasks and then go back to sleep? A balance between good sleep consumption and work efficiency is important – and that’s what we’ve targeted with PSoC6. Low power, more processing

Powered by a PSoC 6, the Oura Ring captures the user’s biometric data, which can be transmitted using Bluetooth.
and an embedded secure element are vital for IoT apps.”

Interestingly, Redpine has also integrated a four threaded processor that handles networking and security tasks, along with a physically unclonable function.

Asked what customers are demanding, Brian Bedrosian, vp of marketing with Cypress’ IoT business unit, said: “In general, three things. Ultra low power, but high performance parts with Bluetooth LE (BLE) for mesh, beacon and sensor applications. They also ask for ‘better’ devices, with more processing power and a flash/RAM footprint to support more complex applications. In this category, we’re seeing requests for parts with BLE only, BLE and Bluetooth, and BLE plus WiFi. One way we can meet these requests is with a PSoC6 and a discrete wireless chip. Finally, there are those who want the ‘very best’: a high performance MCU running at more than 300MHz, large RAM provision, wireless such as 802.11ac and an analogue controller.”

Ogawa added: “Everything in the embedded sector boils down to performance and cost and this ‘good/better/best’ approach is good way to cover the market.”

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<thead>
<tr>
<th>Security</th>
<th>ThreadArch wireless processor</th>
<th>M4 peripherals</th>
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<tbody>
<tr>
<td>• PLT</td>
<td>• program memory</td>
<td>• ICACHE</td>
</tr>
<tr>
<td>• CRC/TRNG</td>
<td>• CPU, registers</td>
<td>• M4 core</td>
</tr>
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<td>• HMAC-SHA</td>
<td>• data memory</td>
<td>• MPU, FPU</td>
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<tr>
<td>• ECDH</td>
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<td>• program memory</td>
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<tr>
<td>• AES/3DES/</td>
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<td>• SRAM</td>
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<tr>
<th>Cortex-M4</th>
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<tr>
<td>• I2C/SPI</td>
<td>• ultra low power subsystem</td>
<td></td>
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<tr>
<td>• MPU, FPU</td>
<td>• SRAM</td>
<td></td>
</tr>
<tr>
<td>• SPS</td>
<td>• M4 core</td>
<td></td>
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<td>• MPU, FPU</td>
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Block diagram of Redpine’s RS14100 wireless MCU

The RS14100 is said to have the lowest deep sleep consumption of all wireless MCUs

Wireless MCU comes as a system in package

A wireless MCU solution introduced in 2017 by Microchip takes the form of a system in package (SiP) in which a SAM L21 MCU is integrated alongside an IEEE802.15.4 sub GHz radio. The SAM R30, said to deliver design flexibility and proven reliability, is targeted at connected home, smart city and industrial applications.

The SAM L21 MCU features a Cortex M0+ core running at up to 48MHz. Within the SiP, there is 256kbyte of flash and 40kbyte of SRAM, 8kbyte of which is battery backed. Power management technologies and ultra-low power peripherals are said to allow the SAM R30 to typically draw less than 500nA at 1.8V in sleep mode. Configurable peripherals include up to five I2C/SPI/UART interfaces, with one in the low power domain, eight 12bit A/D converter channels and 48 capacitive touch channels with proximity sensing.

Meanwhile, the radio operates at frequencies ranging from 769 to 935MHz range, allowing the R30 to cover applications in China (780MHz), Europe (868 MHz) and North America (915MHz).

According to Microchip, the radio supports BPSK and O-QPSK modulation, with a transmit power of up to 11dBm and a receive sensitivity of -110dBm. This power level allows nodes featuring the SiP to be up to 1km apart, with the range doubled in a star topology.

with an M4. But, as devices get smarter, there will always be the need for more processing capability.”

A modular approach may work in some applications, but wearables don’t always have that luxury. Cypress’ PSoC6 has been selected for use in the Oura Ring, processing data from biometric sensors and providing BLE connectivity.

Petteri Lahtela, Oura Health’s CEO, said: “The new Oura ring required long lasting battery life, increased processing capacity and the use of advanced sensors, all in a stylish and comfortable form factor. Cypress helped us to meet these requirements and redefine what is possible for wearable health products.”

“Integration is king,” Ogawa concluded. “If you can bring it all together, that’s attractive.”
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Test complexity grows

Considering Type-C validation simply as an ‘incremental’ change to your testing environment is wrong and dangerous. By Erik Babbé.

Technology is moving rapidly and the market rewards early entrants. But shortened product development cycles mean that all aspects of development, including test and validation, become increasingly important. While the pressure to get products to market is high, technologies such as USB Type-C only increase the complexity of testing.

Understanding the connector helps to identify those areas where additional tests, instruments and test fixtures are needed. Getting it wrong can easily extend your test time and cost. If your device fails at a USB-IF compliance workshop, the cost and time delay will be even higher.

Figure 1 shows the 24pin USB Type-C connector. The power pins – VBUS and GND – support up to 5A/20V (100W), while the four transmit/receive (TX/RX) pairs allow for one, two or all four channels to be used for data transmission at any time and support up to 20Gbit/s per lane.

The CC1 and CC2 lines manage the definition of the connector interface by providing three functions: orientation configuration management; supply power to cable; and communication channel for power delivery. The side band communication channels SBU1 and SBU2 provide additional connections and can be used for protocols other than USB.

A simultaneous link of USB 2 (D+, D-) can be used for standard USB 2 operations or as a supplemental link, providing information for power delivery. The D+ connections are tied together, as are the D- connections to maintain orientation independence.

**Power Delivery (PD) manages the power allocations dynamically, adjusting voltage and current and establishes provider/consumer roles for all connected devices. These devices can request the power they need and get more power when required for a specific application. PD is bi-directional, making it possible for a device being powered to also supply power to other devices. PD also enables USB Type-C to support other standards, such as DisplayPort (DP) or Thunderbolt (TBT) through Alt mode.**

**USB Type-C test challenges**

Design and test engineers face several challenges as they update their device interface from the 4pin USB standard A/B to the 24pin USB Type-C connector. USB Type-C includes design changes that address issues with A/B type connectors/cables and offer more features and capabilities for USB Type-C enabled products. Understanding test challenges and solutions can help ensure successful USB Type-C integration and test for devices.

- **Power delivery**
  PD’s dynamic ability and range of possible power configurations, combined with the added challenge of evolving specifications for USB 2.0, USB 3.1 Gen 1 and Gen 2, and PD compliance, make USB Type-C device test validation more challenging than traditional USB test. Power, PHY layer and protocol layer remain the key test categories for compliance test. Important test parameters design engineers must consider include different voltage levels, device charging, cable functionality and determination of provider versus consumer device status.

Figure 2 shows the host and device as dual role ports (DRP). This is aligned with the USB Type-C environment, where roles can be swapped. The state of a DRP – host or device – is managed by the CC line as a part of the PD infrastructure. Debug of the PD protocol is one of the biggest challenges since it requires access to the CC lines and the VBUS signal for proper characterisation. USB PD has specified voltage/current levels that devices can select for
operation, making the ability to test PD levels as devices initialise important.

An example configuration for physical layer device test includes an oscilloscope, probes, current probe, USB PD protocol software, coupons/fixtures and a PD controller. With 300kHz data transfer rates, an oscilloscope of 500MHz or better is recommended, along with long record length to capture the entire packet. Although predominantly DC signals, most have AC characteristics and this requires a scope with adequate bandwidth. A probe offset is recommended in order to see signal transients when analysing the 5V DC supply signal as a DC block filters out DC and low frequency content.

• Transmit/receive
USB Type-C specifications introduce new TX and RX test challenges. The ability to measure quickly and accurately key aspects of the transmitted eye, LFPS and LBPM timing, transmitted SSC profile, SCD signals will be critical, as will the ability to perform de-emphasis and pre-shoot. Flexible signal generation and bit error detection are also key for RX test validation.

TX and RX compliance testing requires running compliance test patterns. These signal patterns are generated during compliance tests, while measurements are made in SigTest. Each compliance test presents individual challenges. USB-IF compliance testing will require many loading and charging conditions which increases the number of tests engineers must configure and execute.

For TX compliance test of USB 3.1, DP 1.3, TBT 3 and MHL, the N7015A and N7016A Type-C test fixtures are recommended for use with Keysight Infiniium oscilloscopes. This offers the best signal integrity, with a 20GHz bandwidth at -3dB and de-embeddable up to 30GHz. A Type-C plug interface fixture handles connector ‘flip’ and provides test point and probing access for transmitter and power delivery measurements.

The 16Gbit/s M8020A J-BERT offers such features as de-emphasis, pattern capabilities, continuous-time linear equalisation, decision feedback equalisation, the capability to create the various pattern structures and resequencing. The Keysight USB 3.1 receiver test solution provides accurate and repeatable test results, enabled by the M8020A’s calibrated jitter sources, precise emulation of pre- and post-cursor de-emphasis and inter-symbol interference traces.

• Cable and connector
USB Type-C channel specifications, including symmetrical connectors, enable wide bandwidth at -3dB and de-embeddable up to 30GHz. Infiniium oscilloscopes. This offers the best signal integrity, with a 20GHz bandwidth at -3dB and de-embeddable up to 30GHz. A Type-C plug interface fixture handles connector ‘flip’ and provides test point and probing access for transmitter and power delivery measurements.

Keysight’s J-BERT M8020A enables receiver characterisation of single and multi lane devices.

Author profile:
Erik Babbé is market development manager EMEA with Keysight Technologies

The right solutions
Strong involvement in standards groups and related workshops, along with specification development, has allowed Keysight to bring the right solutions to the market when needed.

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While many recent devices don’t need a negative voltage, some do. What’s the best way to generate one for your system? By Thomas Schaeffner.

Modern active components, such as A/D and D/A converters and operational amplifiers, typically don’t require a negative supply voltage. Op amps in particular are available with rail-to-rail inputs and outputs, and in most cases, input and output voltage can swing to close enough to GND.

However, there are still some cases where a negative voltage is required, including:
- high performance/high speed A/D and D/A converters
- gallium nitride power transistor bias
- laser diode bias in optical modules
- LCD bias

Typically, these applications are powered by one or more positive supply rails with step-down converters and LDOs as point of load regulators. In most cases, the mains supply does not provide the negative voltage, which means it has to be generated from a positive rail.

There are a number of ways to generate a negative voltage, mainly dependent on the input voltage, output voltage and output current required. Examples include: inverting charge pumps; inverting buck-boost converters; and CUK converters. Each has its advantages and disadvantages.

Inverting charge pumps
Inverting charge pumps, which can be regulated or unregulated, are typically used for output currents of about 100mA. They follow a simple two step conversion principle and only require three capacitors.
- charge a capacitor from a positive input voltage
- discharge the capacitor to an output capacitor while reversing the connection, so the positive terminal is connected to the negative and vice versa.

This approach generates a negative voltage equal to the input voltage – for example, -5V from a +5V supply. The TPS60400 family is an example of such a device. The absolute value of the output voltage can only be equal to or smaller than the input voltage.

Inverting buck-boost converters
For larger output currents, inductive solutions – such as the inverting buck-boost converter – are used. These generate a negative output voltage which can be greater or smaller than the input voltage and provide an advantage over charge pumps.

In the first step, when S1 is closed, an inductor is charged with current. In the second step, S1 is opened and S2 is closed. The current in the inductor continues to flow in the same direction and charges the output negative. Typically, S2 can be implemented as an active switch, but is a diode in most cases.

The output voltage depends on the duty cycle (D). With:

\[ D = \frac{T_{on}}{T} \text{ and } T_{on} \cdot V_{in} = T_{off} \cdot |V_{out}| \]

The output voltage is defined as:

\[ |V_{out}| = V_{in} \cdot \left| \frac{D}{1-D} \right| \]

In figure 1, input current only flows when S1 is closed and the output capacitor is only charged when S2 is closed. Therefore, the input and output currents are discontinuous and the peak inductor current is much larger than the average output current. The topology has a low loop bandwidth because a delay in the system’s response sets a limit for the control loop bandwidth. If the system demands higher current, the duty cycle has to be increased, which means a shorter \( T_{off} \). This decreases the amount of current transferred to the output in that switching cycle, so the output voltage drops even further. The control loop therefore needs time until the inductor current in the ton phase rises to the level where there is a higher current in the shorter toff phase delivered to the

So, if a lower absolute output voltage is required, an LDO can be added. The LM27761, which has an integrated LDO, is a suitable device whose output voltage can be adjusted from -1.5V to -5V from a 5.5V supply.

Figure 1: Schematic of an inverting buck-boost converter
output. This effect, referred to as right half plane zero, makes the response of the control loop somewhat slow. The loop bandwidth of an inverting buck-boost converter is typically in the order of 10kHz.

**CUK converter**

A CUK converter combines a boost converter with a step-down converter, with the two stages coupled by a capacitor. This topology requires two inductors or one coupled inductor, but supports continuous input and output current and therefore offers advantages for systems that demand low input and output voltage ripple. The control loop bandwidth, and therefore its speed, is lower than the inverting buck-boost converter.

For applications that require low 1/f noise in frequencies ranging to 100kHz, the CUK or the inverting buck-boost converter are not optimal solutions because their control loop bandwidth is much less than 100kHz. A solution to this issue is the inverting buck converter.

**Inverting buck converter**

Replacing the input inductor of the CUK converter with a high side switch leads to a new topology; the inverting buck converter. This consists of a charge pump inverter followed by a step-down converter and requires only one inductor. The control loop regulates the output voltage of the step-down converter and, because the charge pump stage is combined with the step-down converter’s power stage, it runs with the inverse of the step-down converter’s duty cycle.

In figure 2, the voltage at CP is switching between \( V_{IN} \) and GND while the voltage on SW is between \(-V_{IN}\) and GND. As the charge pump stage does not boost the input voltage, the voltage across the internal switches is only \( V_{IN} \), so lower than in the inverting buck-boost or CUK converter. This means more efficient low voltage switches can be used. The output LC of the buck-stage filters the output voltage so output voltage ripple becomes very small.

The TPS63710 offers several advantages over classical topologies, including:

- A control loop bandwidth of about 100kHz gives fast transient response
- Continuous output current for low output ripple voltage
- Low gain in the gain stage, so the noise level is not increased after the noise filter by a high gain of the gain stage
- A low 1/f noise reference system

The voltage of a bandgap (\( V_{BG} \)) is amplified and inverted to generate a negative reference voltage on \( V_{REF} \) using an external voltage divider formed by \( R_1 \) and \( R_2 \). This reference voltage is set to a voltage slightly less than (in absolute value) the output voltage. This voltage is filtered by an RC filter consisting of an internal 100kΩ resistor and an external capacitor (CCAP) for low 1/f noise up to 100kHz. The gain stage is formed by an inverter combined with a step-down converter with a voltage gain of 1/0.9.

In most converters, the voltage divider to set the output voltage is on the output side between \( V_{OUT} \) and GND, which sets a certain gain of the output stage of \( V_{OUT} / V_{REF} \). This increases 1/f noise on the reference voltage. In TPS63710, the gain is 1/0.9, which keeps 1/f noise at nearly the same level as the reference voltage on CCAP.

The TPS63710 accepts inputs ranging from 3.1 to 14V, with an output voltage ranging from -1V to -5.5V. As the TPS63710 uses a buck topology, the input voltage, in absolute value, needs to be larger than the output voltage by a factor of 1/0.7 at least.

Figure 3 shows the schematic of an inverting buck converter optimised for a typical 5V input voltage generating a -1.8V supply at up to 1A. Small size ceramic capacitors used on the input, the CP pin and the output have small electrical series resistance and therefore provide lowest output voltage ripple.
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When looking to secure that all important competitive edge, more companies are turning to ‘ready to go’ partner solutions, as Rok Stutnik explains.
ready-made solutions that allow and help our customers to accelerate the development of their GUI benefitting from much greater efficiencies.

This greater efficiency is achieved by pre-loading the latest Qt 5 software library on to a SBC that is already pre-configured, and which has been tried and tested to deliver optimum performance with the latest screen and display technologies.

The result is a ‘ready to go’ fully working Qt-based cross platform SBC eco-environment that enables engineers to start developing their products immediately.

This out-of-box solution features native compiling of Qt applications, allowing for quick and easy development from the board itself, without the need to install any extra software. In addition, the solutions we are able to offer are also configured to facilitate quick start-up of cross compiling on preconfigured ‘virtual machine’ images.

These options help to eliminate the process of initial Qt software set-up and configuration, testing and rework, as well as the abundance of potential set-up issues that so often will end up taking several months and a significant amount of specialist technical resource to address and then resolve.

This ‘ready to go’ Qt-based environments offers design engineers a plug-and-play solution, and our customers are also able to benefit from ongoing support, advice and working examples of how to maximise Qt development for more advanced topics and specific applications. In addition, our platforms also allow for engineers to explore and build their own bespoke Qt set-up if required.

The Qt-based framework provides a head start for engineers when developing their specific functionalities and user interface, while the support we are able to offer also includes cross-compiling, enabling development to be undertaken on laptop or desktop PC and transferred and debugged immediately over Ethernet onto the SBC giving a true out-of-box advantage. This allows for easy device interaction giving developers the fundamentals needed from day one, for quick, simple and fully flexible development capabilities to build a variety of user experiences - from the very simple open-source solutions to highly customised bespoke versions.

Furthermore, the Qt open source platform offers greater potential for continual product adaptability, ongoing future-proofing and product life extension.

While the opportunities for design engineers and software developers to start from scratch and create their own customised bespoke solutions are undoubtedly tempting, and indeed the talent and tools are there in abundance to do so, new product development constraints are very much dictated by a series of external demands.

These demands will include the needs of customers, the requirements of industry and of course, those all-important time and cost considerations.

As such taking a pre-loaded Qt platform that is development-ready and already configured for use with the latest display and screen technology can offer a considerable advantage in the race to market.

As the pace of change continues to gain momentum, time and cost considerations will ultimately dictate the new product lifecycle putting increasing pressures on the design and development teams to deliver within ever decreasing timescales. It’s in these situations that finding and then working with a trusted specialist partner, who can offer expert product and technical advice and ready-made plug and play solutions can really help you to propel your development project forward and give you a head start in the race to deliver a commercial, ready-to-go product.

Author profile:
Rok Stutnik is global product manager, Embedded at Densitron
Amphenol ICC USB 3.1 Type C connectors

Amphenol ICC USB 3.1 Type C connectors deliver 100W power in a reversible form factor – now available through TTI, Inc.

Data, power, audio and video in Gen 1 and Gen 2 versions with performance speeds up to 5Gb/s and 10Gb/s

Amphenol’s new ICC USB 3.1 Type C connectors are now in stock in Europe at TTI, Inc., a world-leading specialist distributor of electronic components. In a small space-saving form factor; these new ICC USB 3.1 Type C receptacle connectors are available in Gen 1 and Gen 2 versions and deliver up to 100W, supporting SuperSpeed communication of up to 5Gb/s for Gen 1 and 10Gb/s for Gen 2. Tailored for emerging product designs and particularly suited for very thin platforms, suitable applications include consumer laptops, tablets, portable power banks, portable HDVs, wearable devices, mobile phones, flash drives, and automotive infotainment.

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Mouser Signs Agreement with RushUp

Mouser Signs Agreement with RushUp to Distribute KiTRA and JAM Product Accelerator Boards for IoT

Mouser Electronics, Inc., the New Product Introduction (NPI) leader that empowers innovation, announces a distribution agreement with RushUp, creator of innovative product accelerator boards for makers, developers, and high-mix/low-volume companies that want to quickly incorporate Internet of Things (IoT) technologies into their products. Through the agreement, Mouser will distribute RushUp’s KiTRA and JAM board solutions.

The RushUp portfolio, now available from Mouser Electronics, is comprised of two product families: the KiTRA, based on Samsung ARM IoT modules, and the JAM, based on STMicro’s Open Development Environment (ODE) function packs from STMicroelectronics (ST). The KiTRA boards facilitate easy integration into small devices without the extra time and cost associated with R&D and engineering validation.

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New Gate Drivers

New Gate Drivers from Power Integrations Deliver Up To 5 A, Reducing System Complexity and Cost

Boosters available scalable drive up to 60 A peak gate current; full protection features included

Power Integrations (Nasdaq: POWD), the leader in IGBT and MOSFET driver technology for medium- and high-voltage inverter applications, today introduced the newest member of its SCALE-Driver™ IC family, 51012XQ, a single-channel, isolated, IGBT and MOSFET gate driver in a wide-body ESOP package. Featuring a peak drive current of up to 5 A, the new part is able to drive 300 A switches without boosters; external boosters can be used to cost-effectively scale gate current up to 60 A peak. This device provides N-channel drive for both the low and high side booster MOSFET switches which reduces system cost, minimizes switching losses and increases power capability.

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PicoCOM ASX

PicoCOM ASX

The latest member of the FKS form factor PicoCOM “family

All members of the PicoCOM™ product family are pin compatible and have a robust 80-pin plug connector. A size of 40x50mm only, PicoCOM™ ASX can offer the performance of Cortex®-A9 at a low price. The processor is an ARM®-MMX E504 ARM® Cortex®-A9 and -M4. Solid is the second processor in NXP’s portfolio which supports asymmetrical multiprocessing. Both cores (ARM® Cortex®-A9 and -M4) are connected to the internal bus fabric and have the possibility to access all peripherals. The advantages of the M4 cores are real-time processing and the interfaces are available immediately after power on.

The PicoCOM™ ASX offers up to 1.2GHz DDR3 RAM, 1GB SLC NAND Flash and 32GB eMMC, as well as an SD-Card slot interface. Other interfaces are 2x IEEE 1588 Ethernet, 1x USB Host/Device, 2x CAN, 1x 12C, 1x UART, Audio (Line-In-Out) and Digital I/O. A 32-bit RGB interface is available for connecting displays, a resistive touchscreen panel interface is available as well. A capacitive touch controller can be connected via the 12C interface.

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Fujitsu Chooses Wireless Connector Technology to Simplify USB Connections in Next-Generation Tablet PC

Fujitsu Chooses Lattice’s SiBEAM Snap Wireless Connector Technology to Simplify USB Connections in Next-Generation Tablet PC

Lattice’s SR2B22 and SR2B23 USB3 Devices Improve Ease of Use and Reliability of Connecting the Tablet to the Docking Cradle

SiBEAM Snap technology provides a short range 60 GHz wireless link that delivers up to 12 Gbps of data transfer

- Proven technology improves system robustness and industrial design by eliminating physical connectors

Lattice Semiconductor Corporation (NASDAQ: LSCC), the leading provider of customizable smart connectivity solutions, today announced that its SiBEAM® Snap™ technology will be integrated in Fujitsu’s next-generation Tablet PC, model S05B. The S05B will be the first tablet supporting USB 3.1 data transfers at 5 Gbps write/1 Gbps read and will be displayed during CES 2018. The product will be available in Japan starting in January 2018.

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New Keyed SMA fibre optic system

New Keyed SMA fibre optic system from OMC ensures consistent mated performance

Combines best features of multiple connector styles; eliminates rotational variation

OMC, the pioneer in optoelectronics design & manufacture, has launched a new, Keyed KSMA™ connector and diode receptacle system for its wide range of fibre optic transmitters and receivers which offers the rotational consistency of a keyed connector alongside the security and reliability for which the SMA connector is renowned.

The KSMA fibre optic connector system combines a new connector and diode housing design, which OMC describes as delivering the best of all worlds. Unlike the standard SMA connector, which can be inserted at any rotation about the ferrule axis, OMC’s KSMA system incorporates a mechanical keyway mechanism, thus eliminating rotational variation when a cable is mated to the transmitter or receiver.

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Nexperia expands logic portfolio

Nexperia expands logic portfolio with new voltage translator devices

Low-power translator solution now addresses standard logic shift register market

Nexperia, the former Standard Products division of NXP, today announced that it is expanding its logic portfolio – already the largest in the industry – with new devices that expand the company's translator solutions into the standard logic shift register arena.

The first translator solution in the expanded range, MLVCT535S is a world’s first: a cascadable 8-bit serial-in, parallel-out 1/0 expansion device that combines shift register function with voltage translation. This single-chip solution replaces two devices, delivering higher levels of integration and a smaller footprint. It operates in the 1.1 to 5.5 V range, enabling newer low-power controllers to interface with legacy solutions.

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PROVERTHA M12 Gender Changer Connector

PROVERTHA M12 Gender Changer Connector enables simple, reliable connection of homogenous M12 cables - now available at Aeroconnects female/female and male/male M12 cables; versions for industrial Ethernet, ProfiNet, DeviceNet/CanBus and Profibus; suits demanding rail applications

PROVERTHA M12 Gender Changer connector which enables cables with the same type of connector to be mated, is now available from Aerocon, the distributor and stockist of electrical and electronic components serving the railway, industrial, marine, defence and aerospace sectors.

Gender changers make it possible to connect cables with the same type of connectors (female/female or male/male). The new PROVERTHA M12 Gender Changer is available in versions for Industrial Ethernet, ProfiNet, DeviceNet/CAN bus and Profibus. It is available as 8, 0 and A-coded versions (5 and 8 poles).

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