New-Tech Europe May 2017

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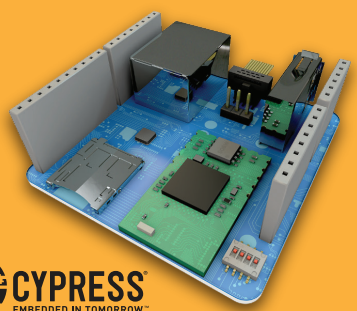

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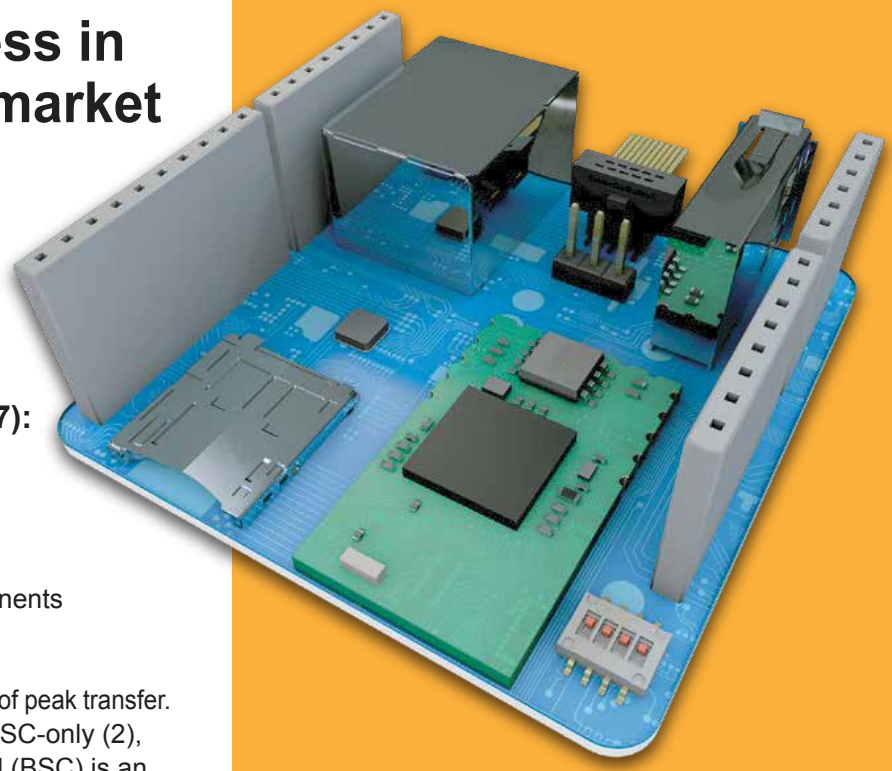

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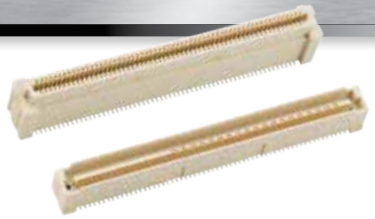

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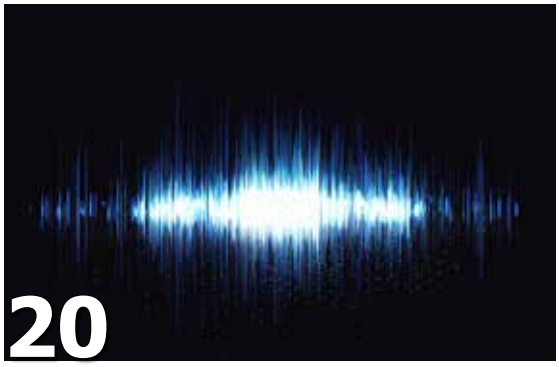


X-ray vision for crash tests

Stuttgart. Together with the Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institut, EMI from Freiburg, the Vehicle Safety unit at Daimler AG is trialling the application of x-r ay technology in crash tests for the first time at the i-protect Tech Center. Ultra-fast x-ray technology produces still images of defined areas in razor-sharp quality during a test crash. A new development here is that it is even possible in principle to look inside safety-relevant components in order to assess their behaviour. An additional bonus is that the data from the x-ray crash can be combined with computer-based simulation models. This synthesis can help to further improve the reliability of crash simulations in forecasting the effects of real-life crashes.

The interdisciplinary teams are also active within the i-protect Tech Center in the area of alternative restraint concepts – specifically with regard to the highly automated nature of driving in the future. The fields of science and practical application are jointly investigating which new approaches in the areas of interior monitoring and occupant classification are of relevance in helping to improve passive safety.

In the virtual world, muscle-controlled movements mark a major step towards active use of the digital human body model in place of the dummy in the development of new preventive protection concepts.

i-protect Tech Center – networking at international level

The next item on the agenda entails stepping up the research association's networking at international level. Since the i-p rotect Tech Center was established on 21 January 2016, Daimler AG has been pursuing work within this cooperation platform on sustainable solutions relating to integral safety for the mobility of the future. The partners are Robert Bosch GmbH, the University of Stuttgart, the Fraunhofer Institute for Mechanics of Materials (IWM) and the Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institut, EMI Freiburg, the Technical University of Dresden, the Technical University of Graz and the Klinikum Stuttgart.

Two's company when it comes to 3D mapping

EPFL researchers have developed the terrestrial and aerial components of a European spatial and urban mapping project.

Developing a good, high-resolution 3D map is a long, tedious and expensive process: a vehicle scans the surrounding environment from ground level up to the top of roofs or trees, while an aerial perspective is added using a drone. But a new approach, in which the terrestrial vehicle and drone are operated in tandem, has now been developed as part of a European project called mapKITE. EPFL researchers are involved in the consortium,* which is funded by the H2020 program, and have designed some of the key components of this breakthrough technology. These include technical features – such as the target – that allow the drone to 'latch' virtually onto the vehicle.

One look at the current approach to 3D mapping shows why combining terrestrial and aerial techniques makes sense. For example, to map out a long corridor like a road, river or railway, the drone has to work segment by segment, following markers on the ground. For control reasons, it has to remain within eyeshot of the drone operator, and to ensure its sensors are precisely aimed it has to be able to 'see' a certain number of ground control points. Another drawback is that with aerial mapping the direction of the drone's sensor must be repeatedly corrected in poorly textured environments (e.g. snow, sand or water). And at ground level, it takes just a tree, bridge or vehicle to block the image. Then there's the problem of ensuring the data collected from the air is compatible and consistent with that collected on the ground. MapKITE harnesses the advantages of the two techniques – and does away with their drawbacks – by combining them. The researchers equipped the drone with remote detection instruments and a navigation, steering and control system.

The terrestrial vehicle, which is manned, also has a real-time navigation system. A positioning system in the vehicle constantly calculates its route while at the same time generating a series of reference points for the drone by converting terrestrial navigation data (time, position, speed and attitude parameters) into aerial commands (altitude and route). This mechanism creates a 'virtual cord' that causes the drone to constantly follow the vehicle and operate at the same scale.

Davide Cucci and Jan Skaloud, from Geodetic Engineering Laboratory. © Alain Herzog/EPFL

The tandem concept goes beyond just having the drone tail the vehicle. The real value of the virtual cord derives from two features. The first is an optical target developed by EPFL's Geodetic Engineering Laboratory (TOPO). The target is a fractal design attached to the vehicle's roof that allows the drone to optically calculate its distance from the vehicle in real-time (and more accurately during post-processing). This means the drone knows its relative location at all times without using satellite navigation instruments and can conduct data fusion without relying on terrestrial targets. "Through this tandem approach, MapKite also complies with European regulations, since the drone can land autonomously on the vehicle if anything goes wrong or if its batteries need to be changed," said Jan Skaloud, a senior scientist at TOPO.

Galileo, the European global navigation system

The second key feature of the virtual cord is the use of signals from the European global navigation system Galileo – a first at this level of research. Galileo, which went live in December 2016, provides higher quality signals than the American GPS system and offers unique features that reduce errors in calculating terrestrial positions.

In mid-March, the tandem was tested at the BCN Drone Center, near Barcelona. The results were spectacular: the system generated 3D maps with a resolution of one centimeter, which is much more precise than systems like Google Street View. "With a target that's only 90 centimeters across, the images taken by the drone at a height of 100 meters provides the error in drone-to-target distance of less than 1%, while at a height of 50 meters the error is less than 0.25%," said Davide Cucci, a post-doc at TOPO.

Potential applications for this technology are numerous – especially in map-making, as this instrument can be used to create 3D models of long corridors. It could also be effective in inspecting and monitoring buildings and other structures in cities. Future developments are sure to emerge as well.

*MapKITE is a consortium of ten partners from six European countries and Brazil: GeoNumerics, TopScan, GRID-IT, ALTAIS, DEIMOS Engenharia, UAVision, CATUAV, EPFL, Engemap Engenharia and UNESP. EPFL is the only academic partner. The technology is patented.

BMW Group relying on innovation capabilities of German production locations for electro-mobility expansion

BMW Group Plant Dingolfing to produce BMW iNEXT from 2021+++ Plants will be able to build vehicles with combustion engine, plug-in hybrid or fully electric drive train in parallel+++ Munich/Dingolfing. The BMW Group today announced its plans to expand electro-mobility. At a meeting with Bavarian State Minister of Economic Affairs, Ilse Aigner, Oliver Zipse, member of the Board of Management of the BMW Group, responsible for Production said: "The BMW Group is a pioneer and an innovator in electro-mobility. We will begin producing the fully electric BMW iNEXT here at our Dingolfing plant in 2021. This decision will further strengthen our German production locations, which, with their innovation capabilities, play a leading role all across our production network. In the area of electro-mobility, in particular, our aim is to ensure end-to-end systems expertise within the company."

BMW Group plants worldwide will benefit from the German sites' production expertise and technology knowhow. At nine locations around the globe, the company already produces nine electrified models, including eight plug-in hybrids. The all-electric BMW i3, which is manufactured at BMW Group

Plant Leipzig, will be joined by the first fully electric MINI in 2019, a fully electric BMW X3 in 2020 and the BMW iNEXT from 2021. The Dingolfing plant does produce components such as high-voltage batteries and electric engines for these vehicles.

Press Event on 2 May 2017 and production of electric components at the BMW Group plant Dingolfing

Oliver Zipse: "Going forward, the BMW production system will create structures that enable our production facilities to build models with a combustion engine, plug-in hybrid or fully electric drive train at the same time. This will give us unique flexibility and put us in an optimal position on the cost side."

BMW Group Plant Dingolfing: Competence Centre for components for fully and partially electrified vehicles

With its long experience in the field of electro-mobility, state-of-the-art production equipment and specially trained staff, the Dingolfing location, together with the Landshut plant, forms the BMW Group's competence centre for the production of high-voltage batteries and electric engines. Dingolfing has been producing high-voltage batteries for BMW i models since 2013. In recent years, new production lines for high-voltage batteries and electric engines for BMW Group plug-in hybrids have also been installed. Dingolfing additionally builds the plug-in hybrid versions of the BMW 5 Series and the BMW 7 Series. From 2021, the plant will also produce a fully electric vehicle on site: the BMW iNEXT. Dingolfing will therefore become the second BMW Group location after Leipzig to build a fully electric BMW i vehicle.

The BMW Group has invested a total of more than 100 million euros in electro-mobility at the Dingolfing site to date, making the plant more competitive for the future and securing jobs. Several hundred Dingolfing employees already work in areas related to e-mobility. Further jobs will be created over the medium term as production ramps up.

The BMW Group is the world's third-largest manufacturer of electric vehicles and delivered over 62,000 electrified vehicles to customers last year, including more than 25,500 fully electric BMW i3s. With 2,864 new vehicle registrations in 2016 (+ 26%), the all-electric BMW i3 was the most successful electric vehicle in Germany.

In the first quarter of 2017, the company delivered almost 20,000 electrified models to customers around the world. The aim is to sell a total of 100,000 electrified vehicles worldwide this year.

By 2025, the BMW Group expects electrified vehicles to account for between 15-25% of sales. With its high level of flexibility, the BMW Group production system can respond quickly to changing market demands and will be able to integrate different drive forms directly into ongoing production as required.

BMW Group Plant Leipzig at the heart of the BMW i success story

Ten years ago, development of a fully electric BMW Group vehicle got underway with the launch of project i. BMW Group Plant Leipzig has made a decisive contribution to this undertaking: As the nucleus of electro-mobility at the company, the plant has produced the BMW i3 since 2013 and the BMW i8 since 2014. Project i laid the foundation for the new production technologies and processes that made this development possible. This technological knowhow is not only reflected in the qualities of BMW eDrive components, but also in flexible and quality-based production at Plant Dingolfing.

Google's Project Sunroof expands to 7 million homes in Germany

Google's Project Sunroof, which estimates whether homes get enough sunlight to switch over to solar power, is launching in Germany today. It's the first time Sunroof has expanded outside the US, where it finally reached all 50 states earlier this year after launching in 2015.

But as with its US coverage, Google's estimates don't reach all - or even most - homes in Germany. Its coverage is limited to densely populated areas, like Munich and Berlin. Google says that around 7 million Germany homes are covered, or about 40 percent of the country's homes.

Still, the tool serves as an extremely simple way to quickly look up whether your house - assuaming it's covered - could install solar panels to cut down on the energy bill. Right now, Sunroof's Germany coverage is only hosted on the website of the electricity provider E.on.

Because Google is partnering with an energy company for Sunroof's launch in Germany, the tool works a little bit differently than it does in the US. Rather than providing visitors with the contact information for a number of solar panel providers that could offer installation, German homeowners will be directed to go straight through E.on, instead of being presented with multiple options.

Google isn't selling something either way — for now, this really is just a reference tool. Sunroof is free even for the panel installers Google refers people to; a spokesperson clarified that Google doesn't make any money off of the product.

Biggest X-ray laser in the world generates its first laser light

With its first lasing, the European XFEL reaches the last big milestone before the official opening

In the metropolitan region of Hamburg, the European XFEL, the biggest X-ray laser in the world, has reached the last major milestone before the official opening in September. The 3.4 km long facility, most of which is located in underground tunnels, has generated its first X-ray laser light. The X-ray light has a wavelength of 0.8 nm—about 500 times shorter than that of visible light. At first lasing, the laser had a repetition rate of one pulse per second, which will later increase to 27 000 per second.

European XFEL Managing Director Prof. Robert Feidenhans'l said: "This is an important moment that our partners and we have worked towards for many years. The European XFEL has generated its first X-ray laser light. The facility, to which many countries around the world contributed know-how and components, has passed its first big test with flying colours. The colleagues involved at European XFEL, DESY, and our international partners have accomplished outstanding work. This is also a great success for scientific collaboration in Europe and across the world. We can now begin to direct the X-ray flashes with special mirrors through the last tunnel section into the experiment hall, and then step by step start the commissioning of the experiment stations. I very much look forward to the start of international user operation, which is planned for September."

Helmut Dosch, Chairman of the DESY Directorate, said: "The European X-ray laser has been brought to life! The first laser light produced today with the most advanced and most powerful linear accelerator in the world marks the beginning a new era of research in Europe. This worldwide unique high-tech facility was built in record time and within budget. This is an amazing success of science. I congratulate all those involved in the research, development, and construction of this facility with passion and commitment: the employees of DESY, European XFEL, and international partners. They have achieved outstanding results and demonstrated impressively what is possible in international cooperation. The European XFEL will provide us with the most detailed images of the molecular structure of new materials and drugs and novel live recordings of biochemical reactions."

The X-ray laser light of the European XFEL is extremely intense and a billion times brighter than that of conventional synchrotron light sources. The achievable laser light wavelength corresponds to the size of an atom, meaning that the X-rays can be used to make pictures and films of the nanocosmos at atomic resolution—such as of biomolecules, from which better understandings of the basis of illnesses or the development of new therapies could be developed. Other opportunities include research into chemical processes and catalytic techniques, with the goal of improving their efficiency or making

them more environmentally friendly; materials research; or the investigation of conditions similar to the interior of planets.

The X-ray laser light of the European XFEL was generated from an electron beam from a superconducting linear accelerator, the key component of the X-ray laser. The German research centre DESY, the largest shareholder of the European XFEL, put the accelerator into operation at the end of April.

In a 2.1 km long accelerator tunnel, the electron pulses were strongly accelerated and prepared for the later generation of X-ray laser light.

View into the 2.1-kilometre long accelerator tunnel of European XFEL with the yellow superconducting accelerator modules hanging from the ceiling (photo: DESY/D. Nölle)

At near-light speed and very high energies, the intense electron pulses entered a photon tunnel containing a 210 m long stretch of X-ray generating devices. Here, 17 290 permanent magnets with alternating poles interacted with the electron pulses from above and below. The magnetic structures, known as undulators, bring the electrons into a "slalom" course, and with every turn they release extremely short-wavelength X-ray radiation, which intensify across the length of the undulator stretch. For the first lasing, the X-ray light was absorbed and measured shortly before arriving in the underground experiment hall.

The 3.4 km long European XFEL is the largest and most powerful of the five X-ray lasers worldwide, with the ability to generate the short pulses of hard X-ray light. With more than 27 000 light flashes per second instead of the previous maximum of 120 per second, an extremely high luminosity, and the parallel operation of several experiment stations, it will be possible for scientists investigate more limited samples and perform their experiments more quickly. Therefore, the facility will increase the amount of "beamtime" available, as the capacity at other X-ray lasers worldwide has been eclipsed by demand, and facilities have been overall overbooked.

At the start of September, the X-ray laser should officially open. At that point, external users can perform experiments at the first two of the eventual six scientific instruments.

Remote sensing performed by flying robots

The press release is a joint effort of the National Land Survey of Finland, University of Jyväskylä, VTT Technical Research Centre of Finland and Natural Resource Institute Finland.

Drone project prepares ground for new business with Tekes funding

The DroneKnowledge project received significant Challenge Finland funding from Tekes, the Finnish Funding Agency for Innovation, with the help of which the research and business involving drones, or flying robots, are expected to take great steps in development.

Remote sensing performed by drones, that is unmanned flying devices, is a new revolutionary technology for precise and efficient production of spatial data. Targets of application in practice are, for example, targeted fertilisation or identification of vermin in agriculture, water quality measurements, forest inventory measurements and built environment measurements. Measurements can be performed with cameras, laser scanners or spectral cameras.

Automatic acquisition of data in real time

The DroneKnowledge project aims to improve the entire remote sensing process: equipment, applications and data processing. Researchers aim at an automatic process in real time, so that the results collected by drones could be accessible during the flight or after the drone has landed.

– The data from the drone could go automatically to the tractor – even a self-driving tractor without a driver, says the project leader, Research Manager Eija Honkavaara from the National Land Survey of Finland.

More affordable spectral camera being developed

– In the project, we are developing a spectral camera which would be closer to the prices of consumer products, says Researcher Heikki Saari from the VTT Technical Research Centre of Finland.

There are targets of application for small spectral cameras for instance within water quality control, identification of tree species and precision agriculture.

– With a spectral camera, we can, for instance, optimise

fertilisation or evaluate the best time for harvesting grass, states Researcher Jere Kaivosoja from the Natural Resources Institute Finland.

Research project with strong bonds to the corporate world

DroneKnowledge is a joint development project between the National Land Survey of Finland, University of Jyväskylä, Natural Resource Institute Finland and VTT Technical Research Centre of Finland. Well over a dozen enterprises that wish to utilise the research results in their business also participate in the project.

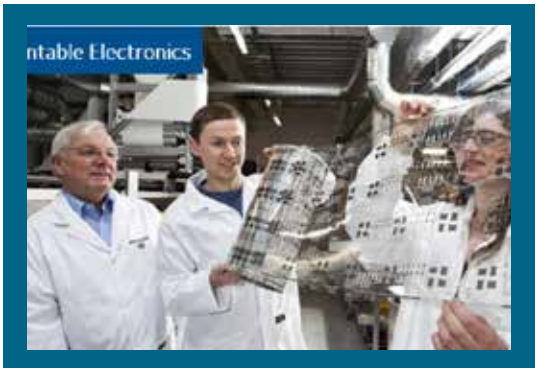
In future, drones will guide the work of tractors. Photo: Jere Kaivosoja.

The goal is to transfer the methods developed into practice through the enterprises and present the drone know-how of Finnish research institutes and businesses.

– In October, we will organise an international workshop in Jyväskylä, where researchers and businesses have the opportunity to show their know-how to the international top within the field, says Docent Ilkka Pölönen from the University of Jyväskylä.

Open Access Pilot Line for Hybrid Printed Electronics

Thin, Organic and Large Area Electronics or hybrid printed electronics is a continuously growing technology with estimation of €37B market reach in 2018. In order to secure European dominant position, all major RTD'S on hybrid Thin, Organic and Large Area Electronics are developing an open access pilot line that will impel the commercial adoption of this promising technology.



The project titled InSCOPE, has received funding from the European Union's Horizon 2020 research and innovation programme, and aims to create an open access pilot line service for Hybrid & Printed systems. The pilot line is modular ensuring a comprehensive toolbox of printing, assembly, production integration and process validation distributed over the InSCOPE partners. Building the revolutionary platform business model on the European ecosystem to allow faster transition of product concept from R&D to product and support the build of manufacturing capacity will also give a great chance for SMEs to enter the market with THIN, ORGANIC and LARGE AREA ELECTRONICS enabled products. The technology is well suited for applications that require flexibility combined with smart functionalities, especially in the health, smart packaging and smart building, and automotive sector. Lower manufacturing cost and fast access to prototypes are the main drivers of hybrid process integration for potential users.

InSCOPE, the Pilot line service is serviced by top European RTD's with leading technological positions and state of the art equipment in the domain of H-TOLAE.

The InSCOPE consortium brings together a multi-disciplinary group composed of 11 partners and 8 countries within the European Union forming an ideal and well-balanced team that includes Holst/TNO from Netherlands, Centre for Process Innovation (CPI) Limited from United Kingdom, Commissariat à l'énergie Atomique et aux énergies Alternatives (CEA) from France, Teknologian tutkimuskeskus VTT Oy from Finland, Interuniversitair Microelectronicacentrum IMEC VZW from Belgium, Philips Lighting B.V. from Netherlands; Robert Bosch GMBH from Germany, Walter Pak SL from Spain, Glaxosmithkline Research and Development LTD from United Kingdom, Kone Oyi from Finland and Amires from Czech Republic.

The main impact of the project will be acquired from pilot line service that will be tested on 15 SME development cases that are devoted to new functionalities enabled by H-TOLAE. Moreover, InSCOPE remains accessible to interested parties even after the duration of InSCOPE period. InSCOPE pilot line will mainly advance accuracy and reliability on print.

Corne Rentrop fom the Holst/ TNO Centre, who is coordinating the project adds: Maturing the hybrid printed electronics roadmap requires parties to supply large amounts of products at a high quality to allow industrial relevant tests, such as consumer satisfaction, clinical trials and large scaled demonstrators, therefore InSCOPE project is a great opportunity for supplying such service and at the same time strengthening the European role in Printed Electronics technology

Calculating the Ideal Power Inductance for Energy-Efficient Applications

› Alexander Gerfer, Ranjith Bramanpalli, Jochen Baier, WURTH

The energy-efficiency of devices with power supply units is essentially influenced by the inductor. To calculate the ideal power inductance, a solution has been found that reduces losses in core materials: a simple online tool that accurately determines AC losses.

Successful energy-efficient device-design depends largely on the power supply unit and therefore on the composition of its individual components. So, when selecting these components - such as inductors (coils or rather inductances), for temporary energy storage for example - it is important to understand their loss and heat behavior. By introducing new materials and calculating AC losses using various calculation models, the ideal power inductance for energy-efficient applications can be measured and ascertained.

Whilst linear regulators were the most widely used voltage regulators in the past, switch mode power supplies are now predominantly found in modern power electronics. The continuous reduction in processor voltages has played its part in this. Just a few years ago, switching frequencies of up to 300 kHz were widespread. Nowadays modern switching controllers usually have frequencies of 800 kHz or more. Switching losses, on one hand, but also power inductor losses, on the other, are important aspects in the design of switching power supply units. The latter can be influenced by the materials-mix. Conventional calculations of core losses using the Steinmetz-equations, quickly reach their limits. A new tool from Würth Elektronik eiSos based on a metrological approach, helps the developer determine the most accurate data to date for DC and AC current losses in power inductors within the application environment.

Reduction of core material losses

By introducing new iron alloy group material compositions, Würth Elektronik eiSos has further reduced core material losses for high current power inductors. Its component range WE-MAPI combines the optimal use of inductance and current carrying capacity with low internal losses thanks to clever material selection and manufacturing technology.

Conventional coils typically use enamelled copper wire wound around

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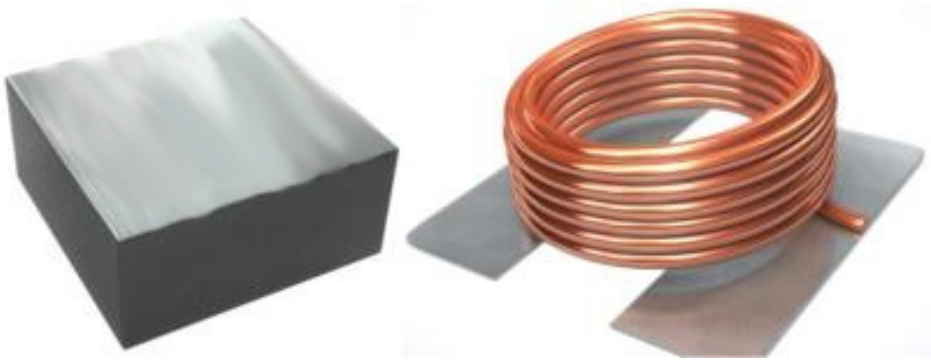

Figure 1: Outer package and core structure: core material losses are reduced with the WE-MAPI coil

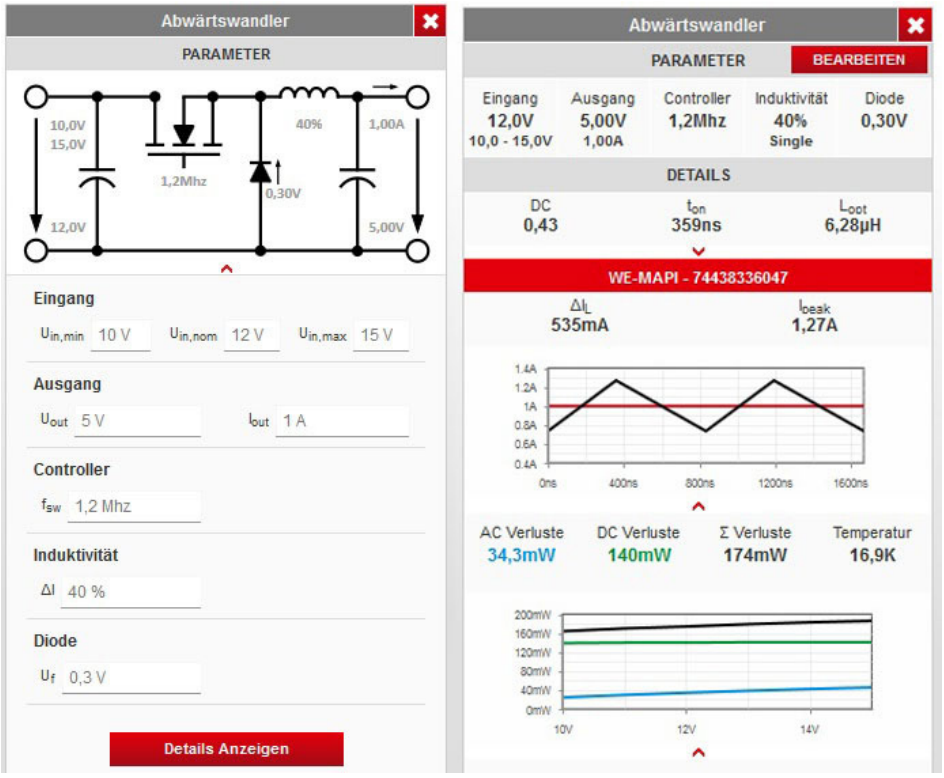

Figure 2: REDEXPERT User-Interface: the online tool calculates ideal power inductance and estimates temperature

the core and soldered or welded to the terminal with a clip. The outer shielding ring is then mounted and bonded with the inner core and the winding. WE-MAPI is different: the winding is contacted directly with the component's connection pad without soldering and welding. By no longer requiring the clip, the effective diameter was increased, thus requiring fewer windings for the same inductance values. This is directly expressed in a considerably reduced DC resistance (RDC) of the winding.

The core of WE-MAPI consists of an innovative metal alloy pressed around the winding. This gives the coil high inductance values with a small package size. At the same time, a self-shielding effect is achieved by the special construction of the core. The core material itself is temperature stable with little drift and soft saturation behavior. A protective layer is also applied around the core protecting the surface against environmental influences.

Losses in power inductors

The losses of power inductors are driven by a combination of core material losses and winding losses. The latter can be divided into DC current losses, principally influenced by the DC resistance of the winding (P=I2* RDC) and the AC losses (RAC) of the winding that result from skin and proximity effects.

In switching controllers, the coil is one of the most important components and therefore, accurate determination of losses and heating is a key step in the selection of the right component. To predict heating, the AC losses must be accurately determined first. Here, the Dowell-, Ferreira- or Nan/Sullivan methods are just some of the methods used today.

Historically, core losses were determined using the Steinmetz model, and later with a modified or generalized Steinmetz model. The main drawback of the Steinmetz equation is that it mainly applies for sinusoidal excitations and determination of the coefficients is usually only measured with small signals. However, for most applications in power electronics, the coil current is not sinusoidal. And the currents are large signals of several milliamps (mA) up to several hundred

amperes (A).
There are other models that attempt to tackle the problem of non-sinusoidal waveforms by separating hysteresis and eddy current losses. The empirical Steinmetz equation has proven to be a useful variant, but offers high accuracy only for sinusoidal currents. However, the various Steinmetz models only work optimally with a duty cycle of 50 percent and within a limited frequency range. Moreover, determining the magnetic path length is highly complex. Subsequently the determination of core losses with the help of existing models for iron powder and metal alloys is not only demanding, but the accuracy is also subject to significant fluctuations. For inductors that consist of several different core materials, an estimation of the losses is not possible, or at the very least highly complicated.

Empirical data-based AC-loss model

Würth Elektronik eiSos has developed a sophisticated model capable of accurately measuring the complete AC losses in inductors. It is based on empirical data generated by real-time application set-ups. Here the total losses of the inductor are divided into AC- and DC-losses.
Empirical data is captured with a DC/DC converter. A pulsed voltage is applied to the inductor, whereby the input power Pin and the output power Pout are measured. On this basis Ploss = Pin - Pout is determined and the AC losses of the coil PAC are separated. This procedure is used to measure and capture empirical data for various parameter settings such as fluctuations in the magnetic modulation, switching frequency, ripple current, etc. A model for the calculation of the AC losses is then created with the use of this empirical data.

Determining losses online

REDEXPERT is an online design tool from Würth Elektronik eiSos to select the most suitable power inductor for the respective application. It is an intuitive and effective tool that enables component comparison at the click of a button.
The calculation of AC losses in magnetic components is just as critical as it is complex - but not with REDEXPERT, as the AC loss model from Würth Elektronik is integrated into the tool. The calculation accuracy of the complete AC losses also makes the application suitable for temperature estimation.
Currently three topologies are supported in which the component can be selected for the application: buck, boost and SEPIC converters. The losses are displayed graphically over the complete input voltage range so that extreme scenarios can be taken into consideration. This allows the most energy-efficient power inductor to be selected for the respective application.
To determine the right inductor for a buck converter, the existing input voltage range and the output voltage and current are entered into the user-interface, as well as switching frequency, diode flow voltage and targeted ripple current of the inductor. A simple click on "Display Details" reveals the most suitable power inductor, including its anticipated ripple currents and the losses in the application.
A manual loss calculator is also available to determine the losses for power inductors independent of the topology. Only frequency, duty cycle and ripple current, or voltage drop, need to be entered and REDEXPERT takes care of the rest. A useful feature immediately displays the entries graphically below the data entry screen.
As REDEXPERT is a web-based tool, there is no need to download or worry about updating the tool. Registered users have access to further features, such as determination of inductance value or temperature increase of the inductor for every possible current value.

Advantages of the AC loss model:

- Empirical data is based on a DC/DC converter
- Accurate determination of losses for every given duty cycle
- Accurate across a wide frequency range (10 kHz to 10 MHz)
- Considers the smallest changes in the core material and the winding structure
- Applicable for components where more than one material is used
- Accurate determination of losses in components with iron powder and metal alloys
- Applicable for every possible core design and winding structure
- Includes AC winding losses

A Review of Wideband RF Receiver Architecture Options

› Peter Delos, Analog Devices

Abstract

The heterodyne receiver has been the standard receiver option of choice for decades. In recent years, the rapid advance of analog to digital (A/D) converter sampling rates, the inclusion of embedded digital processing, and the integration of matched channels now offers options for the receiver architect that were not practical only a few years ago.

This article compares the benefits and challenges of three common receiver architectures, a heterodyne receiver, a direct sampling receiver, and a direct conversion receiver. Additional consideration on spurious, system noise, and dynamic range is also discussed. The intention is not to promote one option over others, but rather describe the pros and cons of the options and encourage the designer to select through engineering discipline the architecture most appropriate for the application.

Architecture Comparison

Table 1 compares the heterodyne, direct-sampling, and direct-conversion architectures. The basic topology is shown along with some of the benefits and challenges of each architecture.

The heterodyne approach, is well proven and provides exceptional performance. The implementation is to mix to an intermediate frequency (IF). The IF frequency is chosen at a high enough frequency to allow practical filters in the operating band to provide good image rejection and LO isolation. It is also common to add an additional mixing stage to lower the frequency where very high dynamic range A/Ds are available. An additional feature is the receiver gain is distributed at different frequencies, thus risk of oscillation in high gain receivers is minimized. Through proper frequency planning the heterodyne receiver can be made with very good spurious and noise performance. Unfortunately, this architecture is the most complicated. It typically requires the most power and the largest physical footprint relative to the available bandwidth. In addition, frequency planning can be quite challenging at large fractional bandwidths. These challenges are significant with the modern quest towards low size, weight, and power (SWAP) combined with the desire for wide bandwidth and leads to designers considering of other architecture options when possible.

The direct sampling approach has long been sought after. The obstacles have been operating the converters at speeds commensurate with direct

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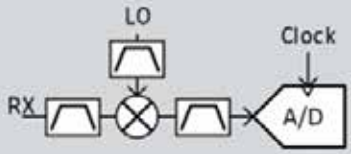
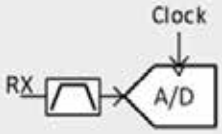
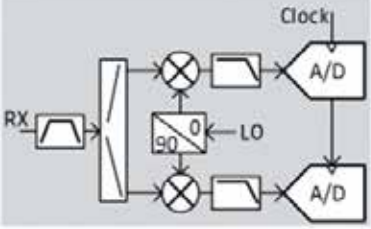
Type	Configuration	Benefits	Challenges
Heterodyne		• Proven/Trusted • High Performance • Optimum Spurious • High Dynamic Range • EMI Immunity	• SWAP • Many Filters
Direct Sampling		• No Mixing • Practical at L/S Band	• A/D Input BW • Gain not distributed across Frequency
Direct Conversion		• Maximum A/D BW • Simplest WB option	• Image Rejection -IQ Balance • In-band IF harmonics • LO Radiation • EMI Immunity (IP2) • DC and 1/f noise

Table 1: Receiver architecture comparison

RF-sampling and achieving large input bandwidth. This architecture all the receiver gain is at the operating band frequency, so careful layout is required if large receiver gain is desired. Today, converters are available for direct sampling in higher Nyquist bands at both L- and S-Band. Advances are continuing: C-Band sampling will soon be practical, with X-Band sampling to follow.

Direct conversion architectures provide the most efficient use of the data converter bandwidth. The data converters operate in the first Nyquist where performance is optimum and low pass filtering is easier. The two data converters work together sampling I/Q signals, thus increasing the user bandwidth without the challenges of interleaving. The dominant challenge that has plagued the direct conversion architecture for years has been to maintain I/Q balance for acceptable levels of image rejection, LO leakage and DC offsets. In recent years the advanced integration of the entire direct conversion signal chain, combined with digital calibrations, has overcome these challenges and the direct conversion architecture is well positioned to be a very practical approach in many systems.

Frequency Plan Perspective

Figure 1 illustrates block diagrams and frequency plan examples of the three architectures. Figure 1a is an example of a heterodyne receiver with a high side LO mixing the operating band to the 2nd Nyquist zone of the A/D converter. The signal is further aliased to the 1st Nyquist for processing. Figure 1b shows a direct sampling receiver example. The operating band is sampled in the 3rd Nyquist zone, aliases to the 1st Nyquist, then an NCO is placed in the center of the band digitally down-converting to baseband, followed by filtering and decimation reducing the data rate commensurate with the channel bandwidth. Figure 1c is a direct conversion architecture example. By mating the dual A/D with a quadrature demodulator channel 1 samples the I (in phase) signal and channel 2 samples the Q (quadrature) signal.

Many modern A/D converters support all three architectures. For example, the AD9680 is a dual 1.25 GSPS A/D with programmable digital down-conversion. A dual A/D of this type supports two channel heterodyne and direct sampling architectures, or the converters can work as a pair in a direct conversion architecture.

The image rejection challenges of the direct conversion architecture can be quite difficult to overcome in a discrete implementation. With further integration combined with digitally assisted processing, the I/Q channels can be well matched leading

to much improved image rejection. The receiver section of the recently released AD9371 is a direct conversion receiver and shown in Figure 2; note the similarity to Figure 1c.

Spurious

Any design with frequency translation requires much effort to minimize unwanted frequencies folding in-band. This is the art of frequency planning and involves a balance of available components and practical filter design. Some of the spur folding concerns are briefly discussed and the designer is referred to the references for further explanation.

Figure 3 shows the folding of the A/D input frequency and the first two harmonics as a function of input frequency relative to the Nyquist band frequencies. For channel bandwidths much less than the Nyquist bandwidth, a goal for the receiver designer is to select operating points that place the folded harmonics out of the channel bandwidth.

The receiver downconversion mixer has additional complications. Any mixer creates harmonics inside the device. These harmonics all mix together and create additional frequencies. This effect is illustrated in Figure 4.

Figure 3 and Figure 4 only plot spurs up to the third order. In practice these are spurs of additional higher order

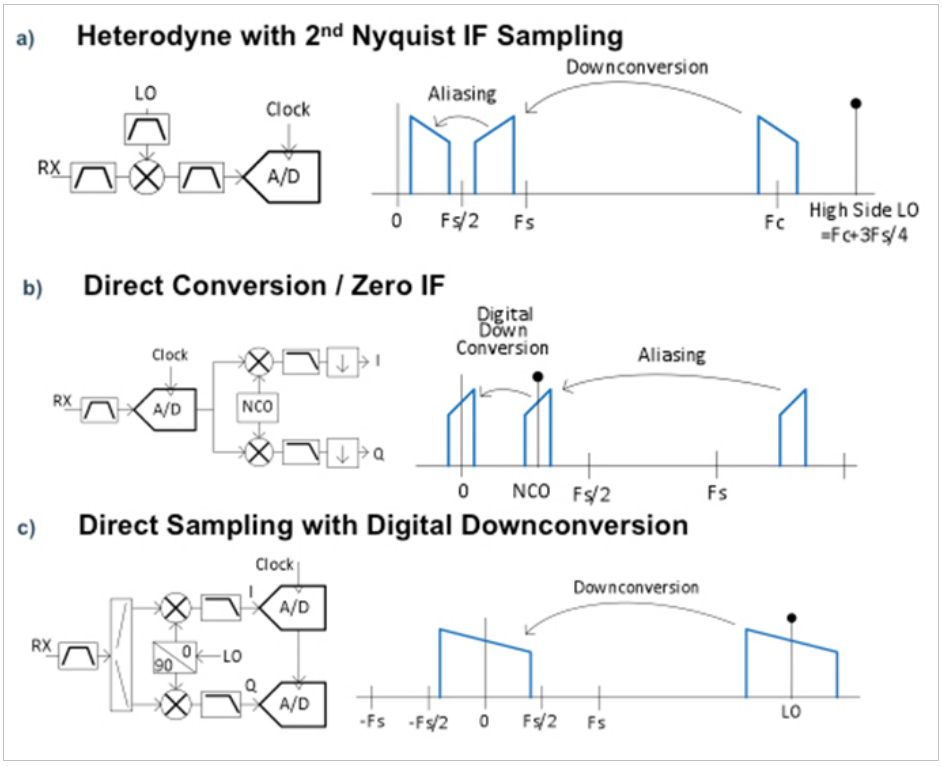


Figure 1: Frequency plan examples

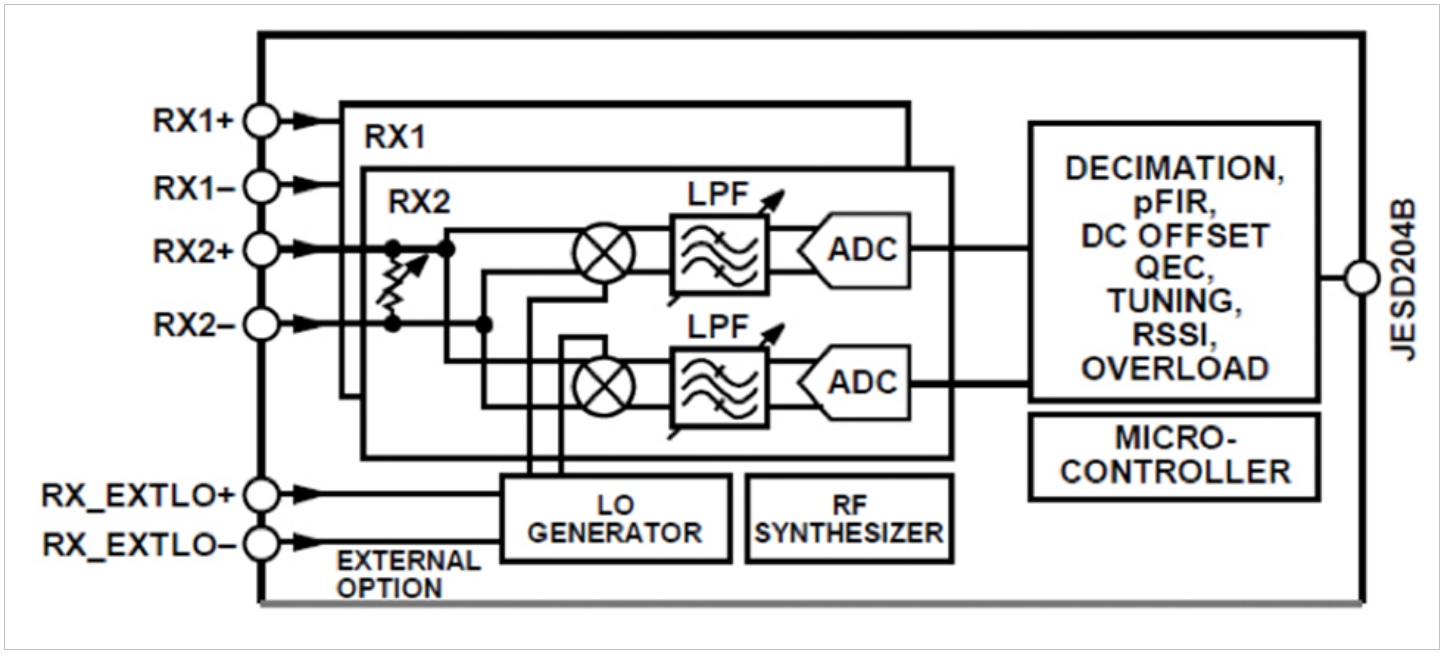


Figure 2: Receiver section of the AD9371: A monolithic direct conversion receiver

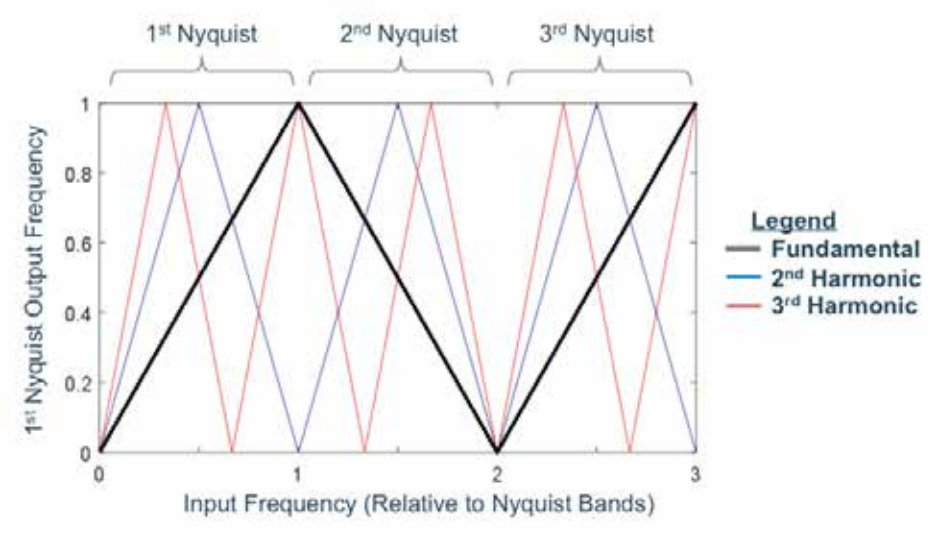


Figure 3: A/D Frequency folding

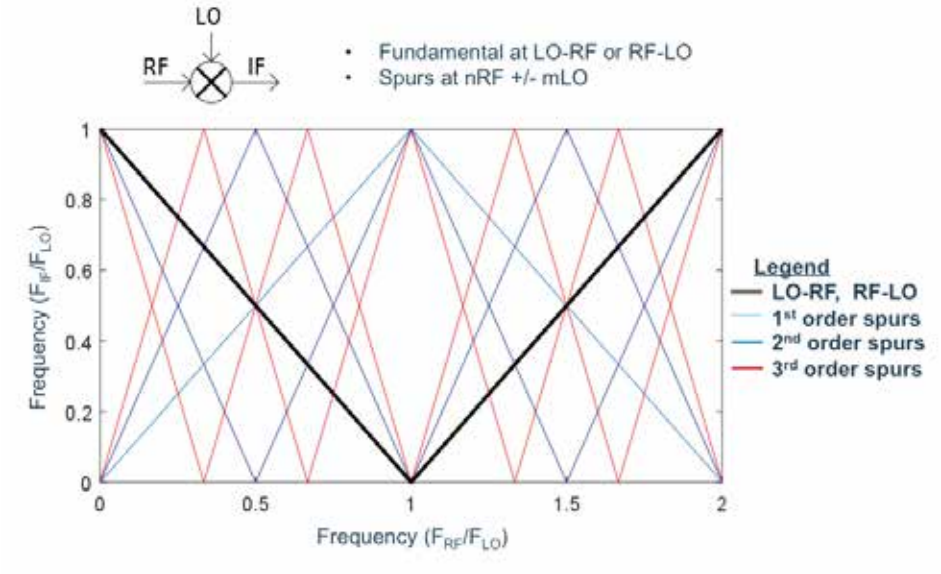


Figure 4: Downconversion mixer spurious

are considered which quickly creates a spur free dynamic range issue for the designer. For narrow fractional bandwidths, meticulous frequency planning can overcome the mixer spurious problems. As bandwidths increase, the mixer spurious problem becomes a dominant obstacle. As A/D sampling frequencies increase, it is sometimes more practical for a direct sampling architecture to have lower spurious performance.

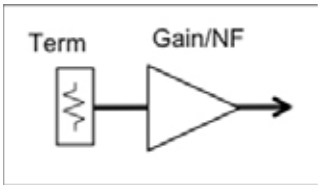
Receiver Noise

Much receiver design effort is placed on minimizing noise figure (NF). Noise figure is a measure of the degradation in signal to noise ratio.

$$F = \frac{(S/N)_{in}}{(S/N)_{out}} \quad \text{, standardized at 290K}(T_o)$$

$$NF = 10\log F$$

The impact of a component or subsystem noise figure is that the output noise power is increased above the level of thermal noise and gain by the noise figure.



Noise Power Out = -174dBm/Hz + Gain(dB) + NF(dB)
Cascaded Noise Figure is calculated

$$F_{Total} = F_1 + \frac{F_2 - 1}{Gain_1} + \frac{F_3 - 1}{Gain_1 * Gain_2}$$

$$+ \cdots + \frac{F_N - 1}{Gain_1 * Gain_2 * \ldots * Gain_{N-1}}$$

The selection of receiver gain prior to the A/D and determining the required A/D SNR is a balance of the overall receiver noise figure and instantaneous dynamic range. Figure 5 provides a representation of the parameters to be considered. For illustrative purposes, the receiver noise is shown to be shaped by the anti-aliasing filter prior to the A/D, the A/D noise is shown as flat white noise, and the signal of interest is shown as a CW tone at -1 dBFs.
First, common units of either dBm or dBFs is needed. Converting the A/D noise from dBFs to dBm is known from the converter full scale level and the converter noise density.

$$\text{A/D Noise}(dBm) = \text{A/D Full Scale}\,(dBm) + \text{A/D NoiseDensity}(dBFs/Hz)$$

The total noise is calculated as

$$\text{Total Noise}(dBm) = 10\log_{10}\left(10^{\frac{\text{Receiver Noise}(dBm)}{10}} + 10^{\frac{\text{A/D Noise}(dBm)}{10}}\right)$$

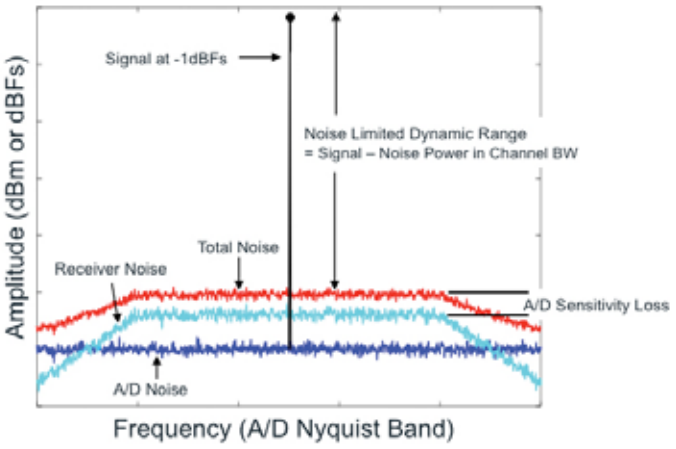


Figure 5: Receiver + A/D Noise

This leads to the concept of A/D sensitivity loss. A/D sensitivity loss is a measure of the receiver noise degradation due to the A/D. To minimize this degradation, the receiver noise is desired to be well above the A/D noise. The limitation comes in the form of dynamic range and larger receiver gain limits the maximum signal received without A/D saturation. Thus the receiver designer faces a constant challenge of balancing dynamic range vs. noise figure.

Conclusion

The heterodyne, direct sampling, and direct conversion receiver architectures have been reviewed with emphasis on benefits and challenges of each architecture. Recent trends and considerations in receiver design have also been presented. With the world wide desire for more bandwidth, combined with the advancement of GSPS data converters, it is anticipated that many varied receiver designs will proliferate well into the future.

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About the Author

Peter Delos is a Technical Lead at Analog Devices, Inc., in the Aerospace and Defense Group. He received his BSEE from Virginia Tech in 1990 and MSEE from NJIT in 2004.

He worked in the Naval Nuclear Power program from 1990 to 1997. This work included completion of the Naval Nuclear Power School Officer's Program, work as an instructor in a Naval Submarine facility, and Lead Electrical Field Engineer work on the Seawolf class Submarines in Groton, CT.

In 1997, Peter accepted a position with Lockheed Martin in Moorestown NJ and began a prolific career developing receivers/exciters and synthesizers for multiple Radar and EW programs. This experience encompassed architecture definition, detailed design, rapid prototypes, manufacturing coverage, field installations, and coordination among many engineering disciplines. This work led the migration of phased array receiver/exciter electronics from centralized architectures to on-array digital beamforming systems.

In 2016, Peter accepted a position with Analog Devices in Greensboro, NC. He has nearly 20 years of experience in RF systems designing at the architecture level, PWB level, and IC level.

High-Order Switch Matrices Facilitate Network Infrastructure Testing

› Chi Man Shum, Mini-Circuits

Testing cellular network infrastructure often requires measurement and data collection from dozens – even hundreds – of base stations (BTS) within a test environment. The volume and complexity of signal traffic in these multi-device, multi-user test systems necessitates commensurate capability for routing signals between base stations and test stations. By partnering with customers to lower costs and improve efficiency in high-volume test systems, Mini-Circuits has developed a line of high-order switch matrices supporting a wide variety of switching configurations and control methods. This article will present a case study of a 20 x 6 non-blocking, full access switch matrix used to facilitate signal routing in a cellular network test system with extensions for other applications.

Case Study: A High Order Switching System for Cellular Network Testing

A cellular network operator was building a test setup to validate new BTS equipment on their network. The test system needed to evaluate each channel of new BTS nodes to verify they were meeting specifications; it needed to confirm that new equipment worked alongside existing, heterogeneous equipment without adverse interactions; and it needed to allow validation of supported handsets with the new BTS equipment.

For this functionality, the customer required a signal routing system to connect 6 independent test stations to any or all of 20 base station (BTS) channels. The setup needed to allow multiple users to connect to the same BTS if necessary, but also required a control mechanism to limit which test stations could access which BTS. To satisfy these requirements, Mini-Circuits developed the ZT-20X6NB, a 20 x 6 non-blocking full access switch matrix. This bi-directional switch matrix covers the key worldwide telecommunications bands from 600 MHz to 6 GHz and can be programed to connect ports B1 – B6 (shown in Figure 1) to any combination of ports A1 – A20, such that multiple input ports may be routed to the same output port simultaneously. Because of its flexibility, this non-blocking configuration is ideal for multi-user, multi-device test systems of the kind

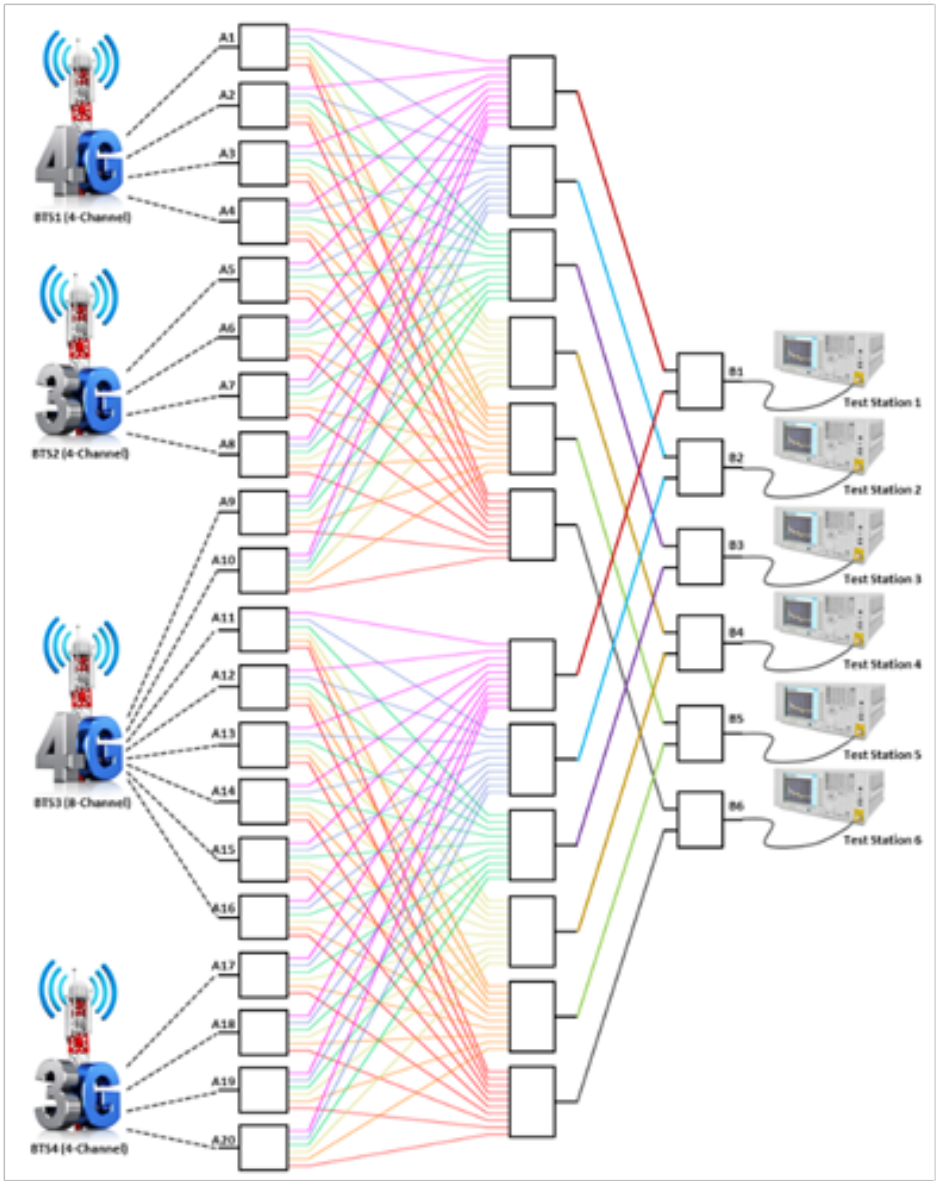

Figure 1: Functional schematic of multi-user base-station test system utilizing the ZT-20X6NB switch matrix. 6 independent test stations can interact with any of the 20 BTS channels.

this customer was building.

The system is designed into in a compact, 5U height, 10-inch rack-mountable chassis with all 26 RF connections (N-type) easily accessible on the front panel (figure 2). It includes both USB and Ethernet control interfaces along with a built-in touch screen giving users a versatile range of control options. Software support is provided through Mini-Circuits' user-friendly GUI application for remote control over a network or via USB connection. ActiveX and .NET API objects for Windows environments and HTTP / Telnet support ensure compatibility with most common programming environments.

User Permission Control

In order to allow multiple, independent tests to be conducted in parallel while preventing one user from inadvertently disrupting another's test, the GUI software features a user profile management interface through which an Admin can create and manage user profiles to control which users have access to which switch paths. Permission settings for different user access configurations can be saved as permission files and loaded to the GUI as needed in the future, minimizing setup time.

Cloud Sandbox Capability

In addition to USB, Ethernet and touch-screen control interfaces, the ZT-20X6NB system also incorporates "Cloud Sandbox" software that allows a customer to replicate a particular network or production environment. This virtual replica environment, called a sandbox, can be used for development, testing, demos, training and support. It allows the user to create a virtual, on-demand lab environment that is accessible from within a self-serviced cloud.

This cloud sandbox capability allows complex network infrastructure and automated test systems to be modelled and developed offline, in a virtual environment which consists of complex entities such as virtual, physical and network elements. Each of these environments is made up of various "shells," which are the building blocks that model infrastructure and applications. These shells are similar to device drivers that control a specific device.

Mini-Circuits has created a shell of the ZT-20X6NB for this purpose. Using this shell, the user can include the ZT-20X6NB into their virtual lab environment within the cloud sandbox.

Combined with a powerful orchestration script to author and direct a workflow, a complete environment replica with specific triggers can be created. Later, the sandbox environment can be deployed via portals and API's to be accessed by developers within and outside the company, thus enabling easier collaboration, shorter development times and lower overall costs.

The ZT-20X6NB is just one example of Mini-Circuits' capabilities to develop equipment to multiplex application-specific tests systems across multiple DUTs and multiple test stations in a wide variety of configurations. This system was developed for a unique set of requirements for the network test application described here, but the same capabilities can be readily extended to many other applications.

Figure 2: ZT-20X6NB in 6U height, 10-inch rack-mountable chassis.

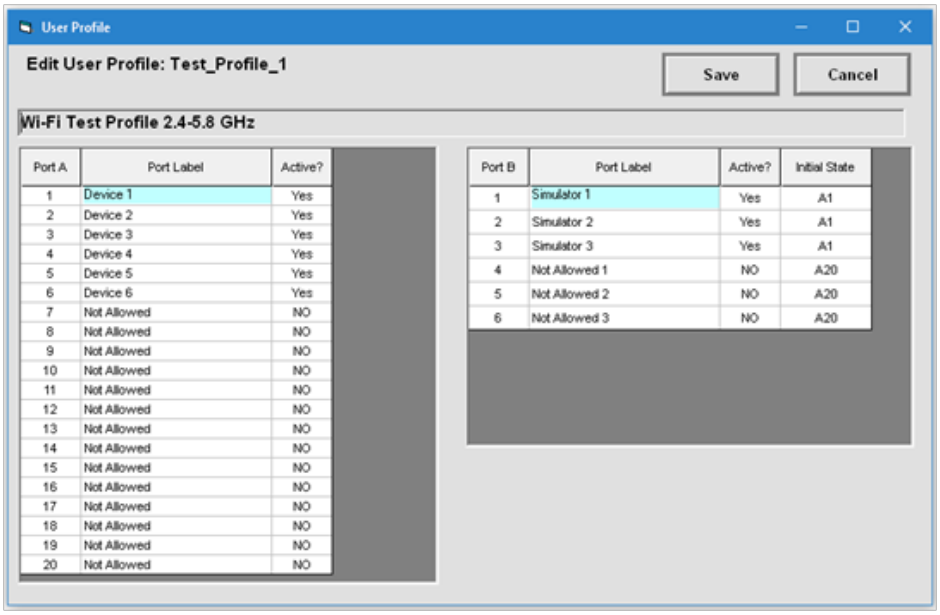

Figure 2: Receiver section of the AD9371: A monolithic direct conversion receiver

Extension 1: Cascadability

Depending on the number of test channels needed in a particular test setup, some users may require the flexibility to add multiple switch matrices into their system. To support this need, Mini-Circuits test systems have been developed with SPI interfaces, allowing a user to cascade multiple units in daisy chain configuration. All software commands are issued to the Master unit (the first unit in the chain), which controls all subsequent Slave units in the chain. The GUI software is extensible to support multiple cascaded units comprising hundreds of test channels, allowing the user to scale his or her setup while managing all switch paths of all units through a single, simple control interface.

Extension 2: High-Speed Solid State Switching

Consumer demand for ever higher data capacity is driving extensive efforts by network operators to accelerate research and development toward deployment of next generation wireless technologies like Massive MIMO and 5G. Because of the dense deployment model for these technologies, test systems need to collect very high volumes of data from many different base stations at once. Routing test signals in

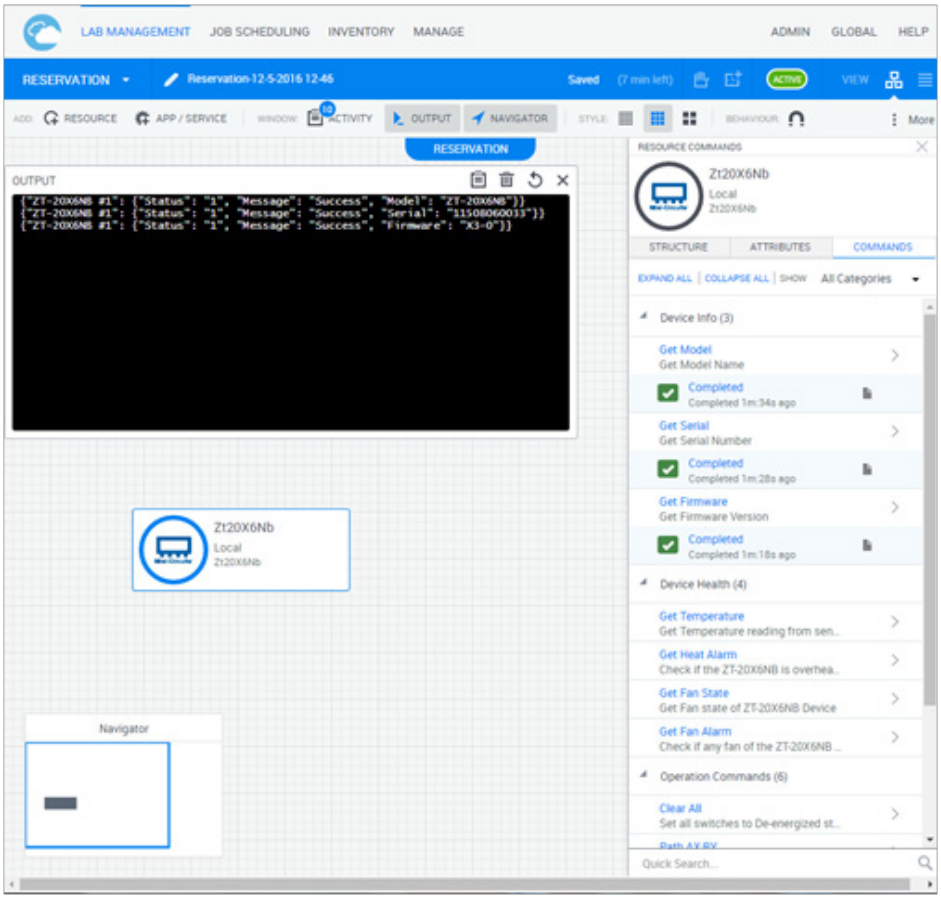

Figure 4: ZT-20X6NB shell in cloud sandbox environment

Figure 5: Three units daisy chained via SPI interfaces on rear panel.

these systems requires extremely fast switching.

To respond to the growing need for this capability, Mini-Circuits developed the ZTS-series of solid state switching systems. These systems incorporate solid state switches with very high isolation and switching speed in the order of 1 microsecond. These switches can be readily integrated into a system similar to the ZT-20X6NB, but with the advantages of solid state switch componentry for applications in which these features are needed.

Conclusion

The diversity of real-world test applications makes it virtually impossible to realize anything like a standardized solution, so Mini-Circuits has built our business in this area around principles of technical capability, flexibility, and speed. The specifications for many test solutions are often being defined concurrently with the design process, forcing us to be agile in the design and fabrication of a wide range of unique, user-defined solutions in a very short period of time. The turnaround time on these test systems directly affects customers' time to market, so they're depending on us to deliver a tailored solution, fast.

Mini-Circuits has developed a range of switch matrices, signal distribution and level control systems, some simple and others highly complex, that are used to interface between DUTs and a variety of signal generation and analysis equipment. We've capitalized on a building-block approach to developing custom equipment for each customer's unique needs. Our wealth and variety of components and subassemblies in stock allows us to create integrated assemblies for a wide range of custom specifications with exceptionally fast turnaround times.

The ZT-20X6NB is just one example of a solution we've developed for increasingly complex network infrastructure testing applications. As wireless standards and infrastructure continue to evolve, we expect the number and diversity of applications to expand as well, and we're looking forward to supporting our customers with more innovative solutions through this transition.

Design Environment V13 Enhances Design Automation and User Experience for RF/ Microwave Designers of High-Frequency ICs, RF PCBs and MCMs

› National-AWR

Introduction

Next-generation wireless devices, LTE-A/5G infrastructure, and aerospace/defense electronic systems are creating new challenges for the way engineers design and develop RF/microwave products. These challenges, stemming from high performance goals for bandwidth, linearity, and efficiency, are complicated by system and market requirements for smaller, lighter, and less costly devices. In addition to engineering challenges, business concerns include escalating development costs, limited engineering resources, and time-to-market pressures.

To fulfill product requirements, new semiconductor and printed circuit board (PCB) materials, as well as module technologies, are being developed to achieve unprecedented integration and functionality within an increasingly smaller form factor (Figure 1).

To successfully implement these technologies, engineers require highly automated simulation software that can accurately predict electrical performance as it relates to physical design that includes excitations and measurements associated with complex waveforms used in communication and radar systems as well as support for manufacturing processes.

V13, the latest release of NI AWR Design Environment, addresses these requirements with an integrated, open platform offering system, circuit, and EM co-simulation that captures the behavior of RF font-end components such as antennas, amplifiers, filters, mixers, and related signal-controlling passive and active devices. The latest enhancements improve engineering productivity with faster, more powerful circuit/system/electromagnetic (EM) technologies, robust model libraries, and greater design flow automation, supporting product development of microwave monolithic integrated circuits (MMICs), RFICs, RF PCBs, and multi-technology modules.

Design Environment and Automation

Design for Manufacturing

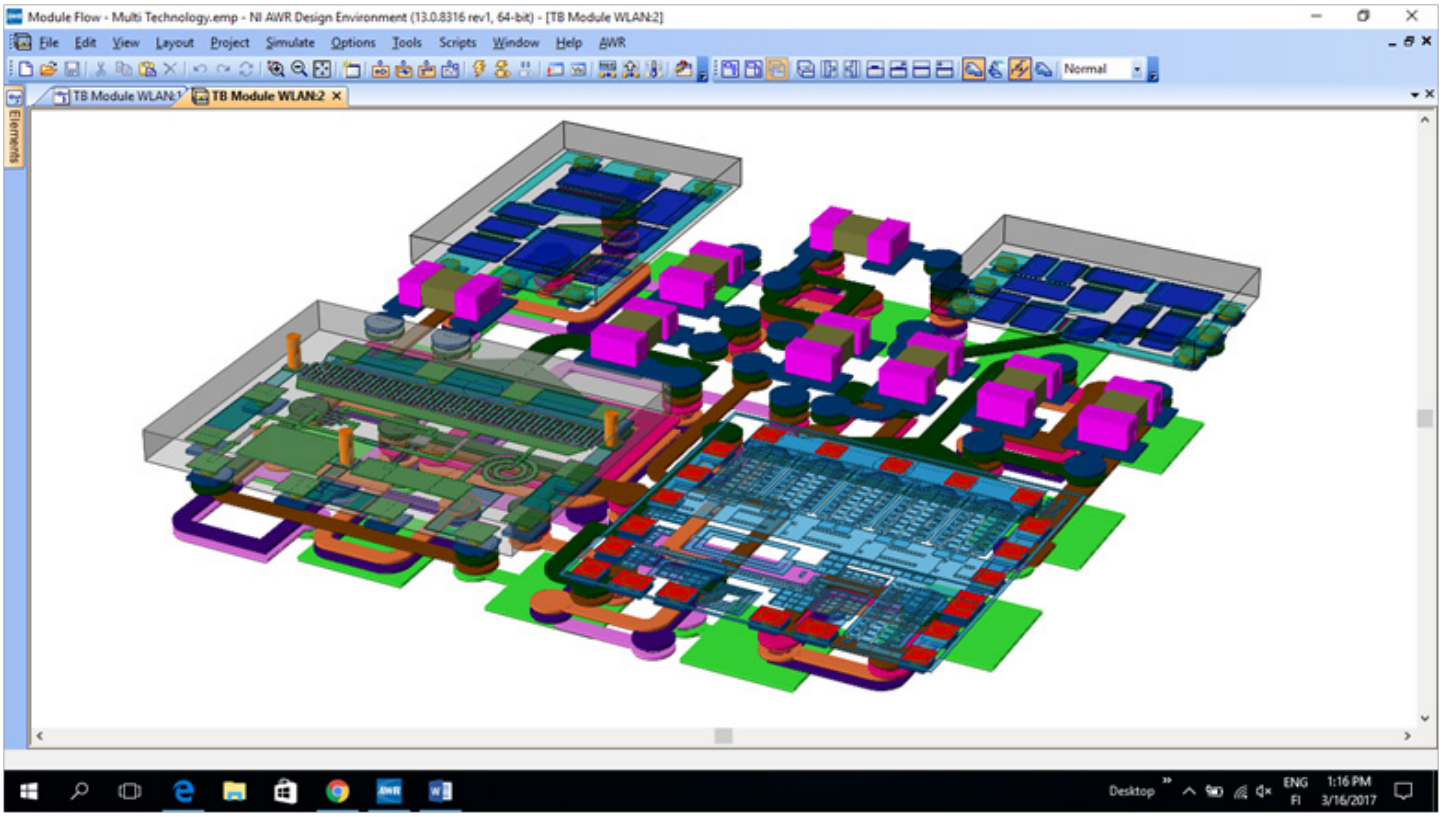

Figure 1. Module technologies are being developed to achieve unprecedented integration and functionality within a smaller form factor.

At RF and microwave frequencies, electrical performance is directly influenced by physical design. Therefore, great care must be taken to ensure that a component's physical attributes are fully incorporated into the simulation model and that the physical details used in simulation are fully and accurately replicated by the manufacturing process. V13 offers new and improved features that impact design layout and interoperability between NI AWR Design Environment and third-party IC and PCB electronic design automation (EDA) tools (Figure 2).

These enhancements deliver key capabilities for design entry (both schematic and layout), parameterized circuits, systems, and EM subcircuits, design synthesis, simulation and optimization controls, and measurement graphs. Overall the improvements serve to better facilitate designs based on specific manufacturing processes such as PCBs and multi-technology (mixed-technology) projects, commonly used to simulate multi-chip modules (MCM) that incorporate diverse MMIC and RFIC devices on a single laminate package/module.

A process design kit (PDK) helps manage design entry with information that contains files for the device library (symbols, device parameters, PCells), technology data (layer stack ups), simulation models, verification deck, and more. PDKs are used by circuit designers to construct a simulation version of their product from these components made available through the fabrication process. In V13, PDK-specific improvements make it easier to install new PDKs and work with multiple layout process files (LPFs) typical of MCMs. Custom toolbars can now also be distributed in PDKs to support highly customized design flows for leading front-end manufacturers.

Embedding RFIC design in MCM simulations

With MCMs, the off-chip design and simulation including embedded passives and laminate interconnects often require some representation of the RFIC device(s) for the overall module characterization. Module designers need a way to incorporate an accurate model for the RFIC (or critical portions of the RFIC design) within the circuit hierarchy that includes the laminate substrate. Advances in hierarchical design management, complemented with a new OpenAccess import/export wizard (supporting, for example, the import/export of RFIC schematics and project symbols from Cadence

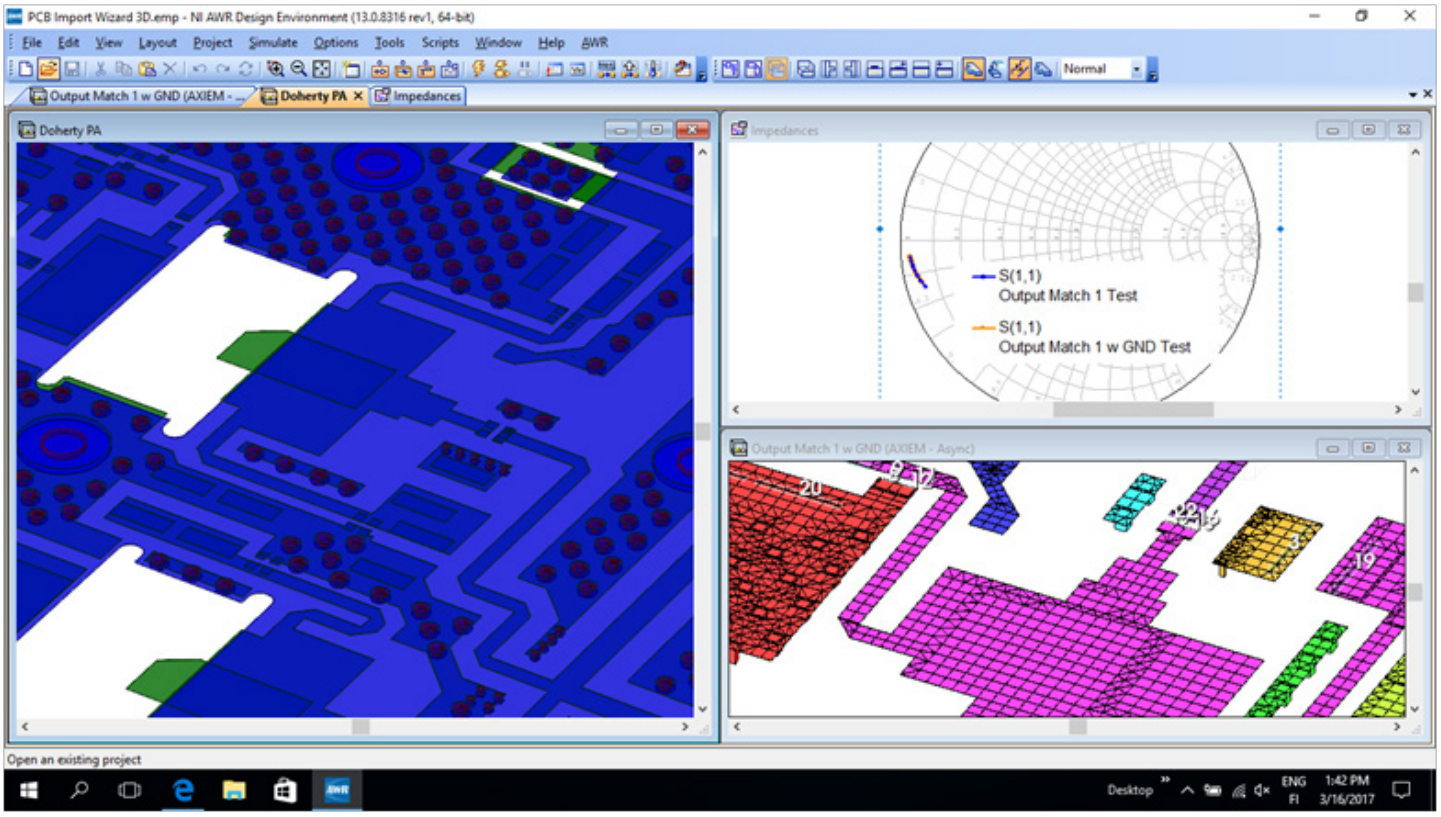

Figure 2. New PCB import wizard automates interoperability between NI AWR Design Environment and enterprise PCB layout tools.

Virtuoso) for Cadence Spectre netlist co-simulation, provide for the easy incorporation of small-scale RFICs developed in Cadence tools within an NI AWR Design Environment MCM analysis. With accurate RFIC blocks in the circuit hierarchy, MCM designers can focus on modeling and optimizing details of the laminate itself using 3D planar and/or full 3D EM simulation (AXIEM and Analyst™ respectively) or another third-party EM solver.

EM Simulation and Modeling Native 3D Planar and Full 3D EM Solvers

AXIEM and Analyst EM simulators within NI AWR Design Environment use Maxwell's equations to compute the electrical behavior of a structure from its physical geometry. AXIEM provides responses for 3D planar structures such as transmission lines, spiral inductors, antennas, antenna arrays (Figure 3), and metal-insulator-metal (MIM) capacitors, whereas Analyst addresses 3D objects such as wire bonds, ball grids, finite substrates, and 3D horn antennas. Improvements to AXIEM and Analyst in V13 focus on solver speed and accuracy, as well as features that support greater automation and design flow integration with Microwave Office.

AXIEM V13 simulations using the iterative matrix solver are now faster due to the simultaneous solution of multiple ports (right-hand sides), benefiting structures with large port counts the most. The AXIEM advanced frequency sweep (AFS) algorithm automatically selects a set of frequency points to simulate, then uses these simulated points to interpolate the S-parameter response for the entire band. In V13, AFS is now faster and more accurate, and generally converges on a solution with fewer frequency points.

Like AXIEM, Analyst V13 offers up to a 50 percent reduction in simulation run times. Major meshing upgrades improve robustness and speed and there is now even easier access to the "Ports Only" solve to access port fields, propagation constants, and port impedances. Analyst is now able to model the effects of surface roughness when a roughness parameter is specified, improving the accuracy of transmission line simulations where

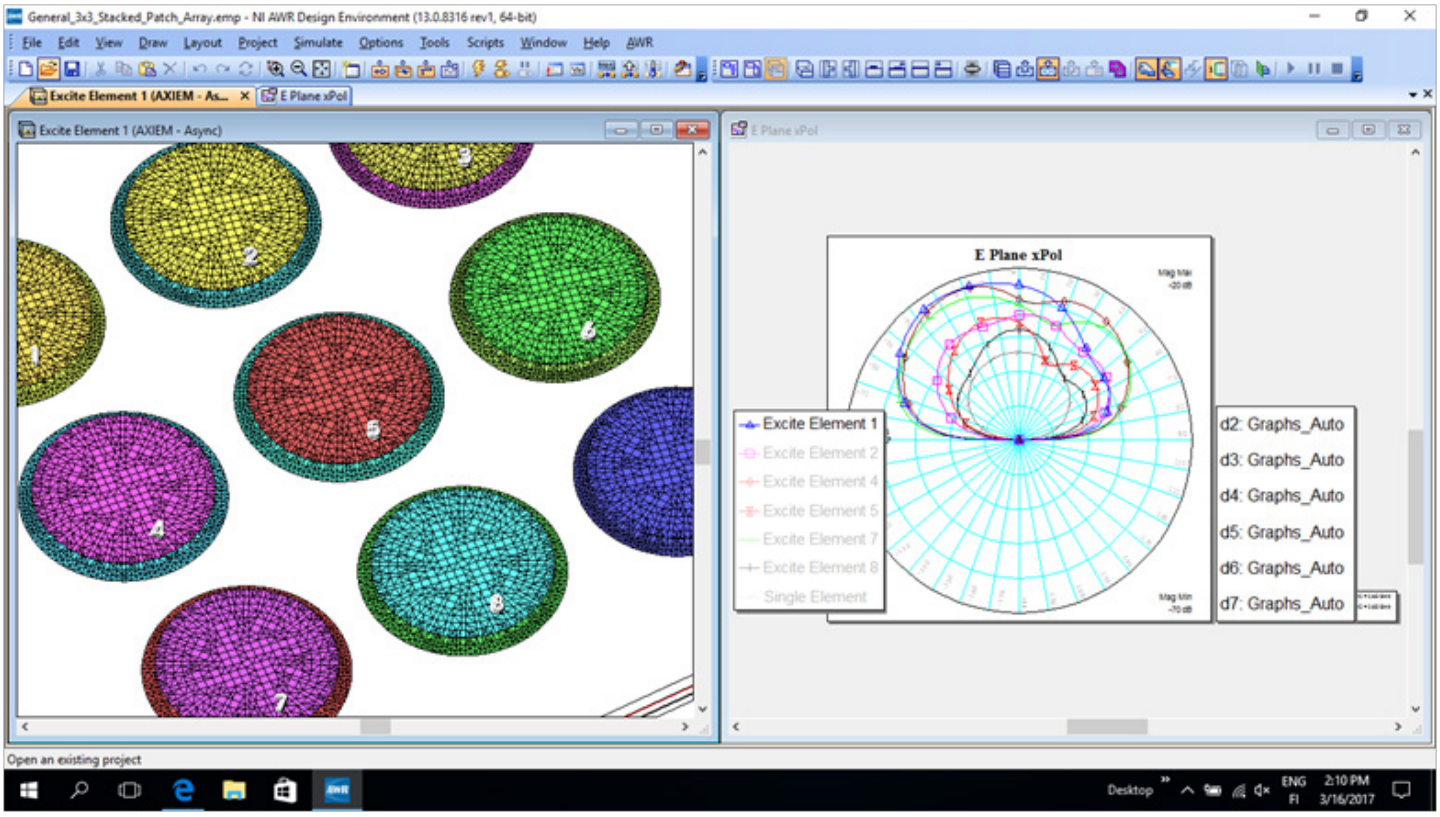

Figure 3. Mesh of 3D planar 3 x 3 patch antenna array and radiation patterns in AXIEM.

surface roughness impacts electrical behavior, such as insertion loss.

In addition, Analyst V13 also introduces new 3D editor functionality and improvements targeting drawing (sketcher) functions and solid object controls, materials and attributes organization in the browser tree, auto-complete for parameter and variable expression, and variable grouping and sorting, to highlight a select few.

Third-Party EM Technologies

The AWR Connected™ family of solutions that link NI AWR software to third-party solutions is now enhanced to further automate the flow of layout data from NI AWR Design Environment into partner EM products. In V13, AWR Connected for EM simulators, which includes ANSYS HFSS, CST, and Sonnet, is more robust and fully bi-directional. After the layout is created in the Microwave Office layout editor, third-party EM tools can readily be selected as the EM simulator of choice (Figure 4) and the resulting dataset is automatically imported back into Microwave Office to tune, optimize, perform yield analysis, and verify results.

Circuit/System Simulation and Models/ Libraries Harmonic Balance Technology

Harmonic balance simulation is an essential technology in analyzing RF/microwave nonlinear circuits with active devices (transistors). APLAC, the trade name of NI AWR Design Environment's high-frequency circuit simulation technology, is seamlessly integrated into both Microwave Office and Analog Office circuit design tools. It has been developed to minimize memory requirements and simulation run times while maintaining accuracy for RF/microwave designs. To address nonlinear devices for communication systems, APLAC now includes a time-variant HB (circuit envelope) simulator capable of addressing circuits excited by non-periodic signal sources such as modulated RF signals. The associated measurements provide the time-varying voltage or current of a particular carrier and the associated spectrum surrounding

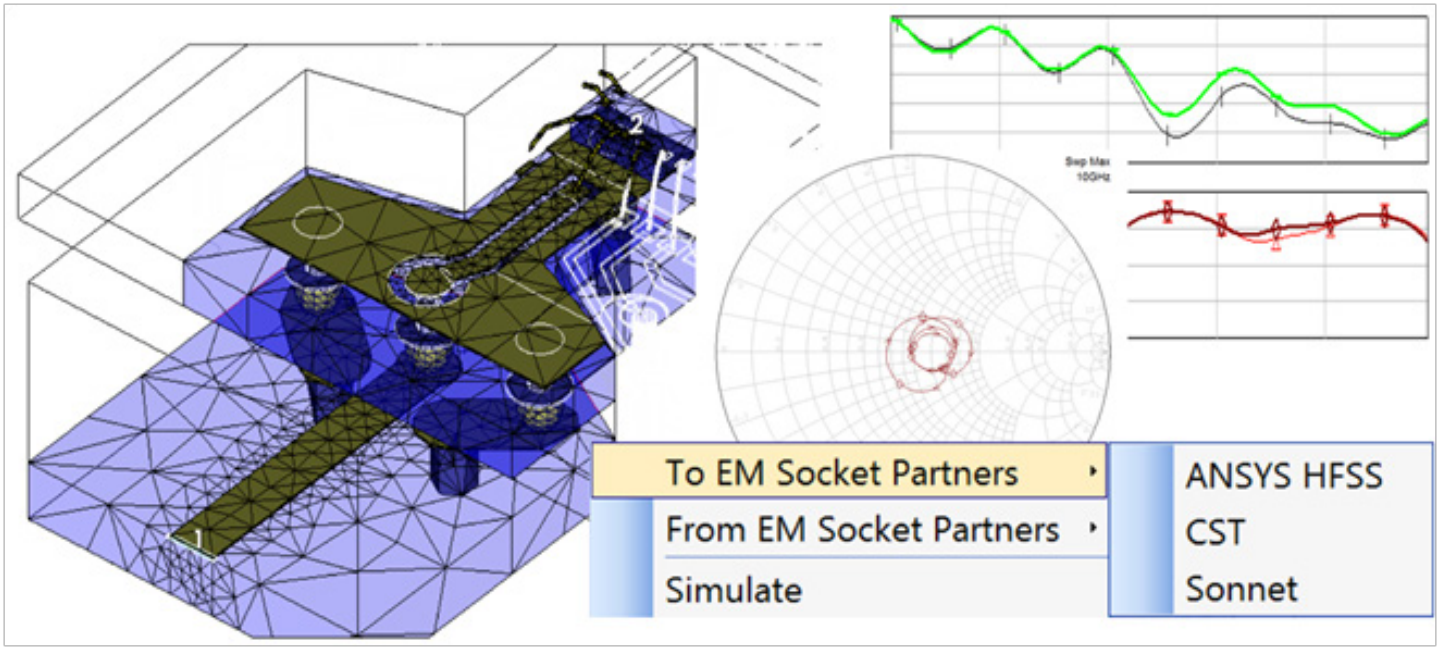

Figure 4. A third-party EM simulator can be selected as the EM simulator of choice by the user such that the resulting dataset is automatically imported back into Microwave Office to tune, optimize, perform yield analysis, and verify results.

that carrier. With the added capability of simulating modulated waveforms with circuit envelope, new sources have been added to describe modulated waveforms, such as the ability to specify the IQ data of a modulated signal.

Additionally, the speed and robustness of the APLAC transient (time-domain) simulation engine is enhanced with a new core algorithm and improved time-step algorithm. Other developments include new error control and a transient preset option that can be set to Accurate, Moderate, or Fast. The transient-assisted HB (TAHB) option, used for the digital divider circuits and accurate nonlinear phase-noise measurements of analog and RF applications, can be leveraged in V13 for oscillator analysis by setting the TAHB options to Disabled, Convergence Aid, or Initial Guess.

With time-domain simulations such as transient and circuit envelope, it is necessary to extract a time-domain model for passive devices, S-parameters, and transmission lines. Improvements to the time-domain model in V13 include a better speed-to-accuracy ratio in the extraction of S-parameter data, more robust handling of poor quality data, and more robust passivity enforcement.

For amplifier designs with an existing transistor model, V13 further supports nested source/load pull contours, enabling designers to directly observe changing source and load contours as a function of source and load impedance terminations. This unique capability allows designers to provide a new terminating impedance to either the source or load and directly observe the change to the contours at the other port without having to re-simulate the circuit, thereby eliminating the time-consuming iterative approach to source/load matching.

Design for Communication Systems

Achieving 5G performance is being addressed through developments in several primary areas. One is spectral usage, which includes variations on orthogonal frequency division multiplexing (OFDM) based waveforms that were introduced with LTE release 8 and inter- and intra-band carrier aggregation. Another is enhancing over-the-air (OTA) efficiency with the expansion of multiple-in-multiple-out (MIMO) and beam-steering technologies, and finally, moving to higher frequencies, particularly above 6 GHz and into the millimeter-wave frequency range. New capabilities in V13 better aide system and component designers who face further challenges related to implementing these technologies.

For PA designers, new waveforms and carrier integration will make it more challenging to address linearity and efficiency requirements and to achieve the bandwidth to cover the intra-carrier bandwidths. To help

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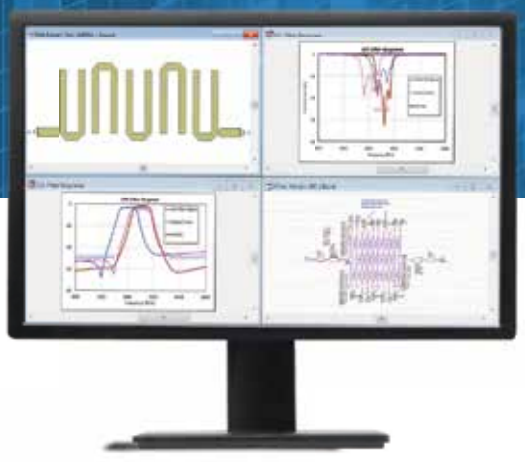

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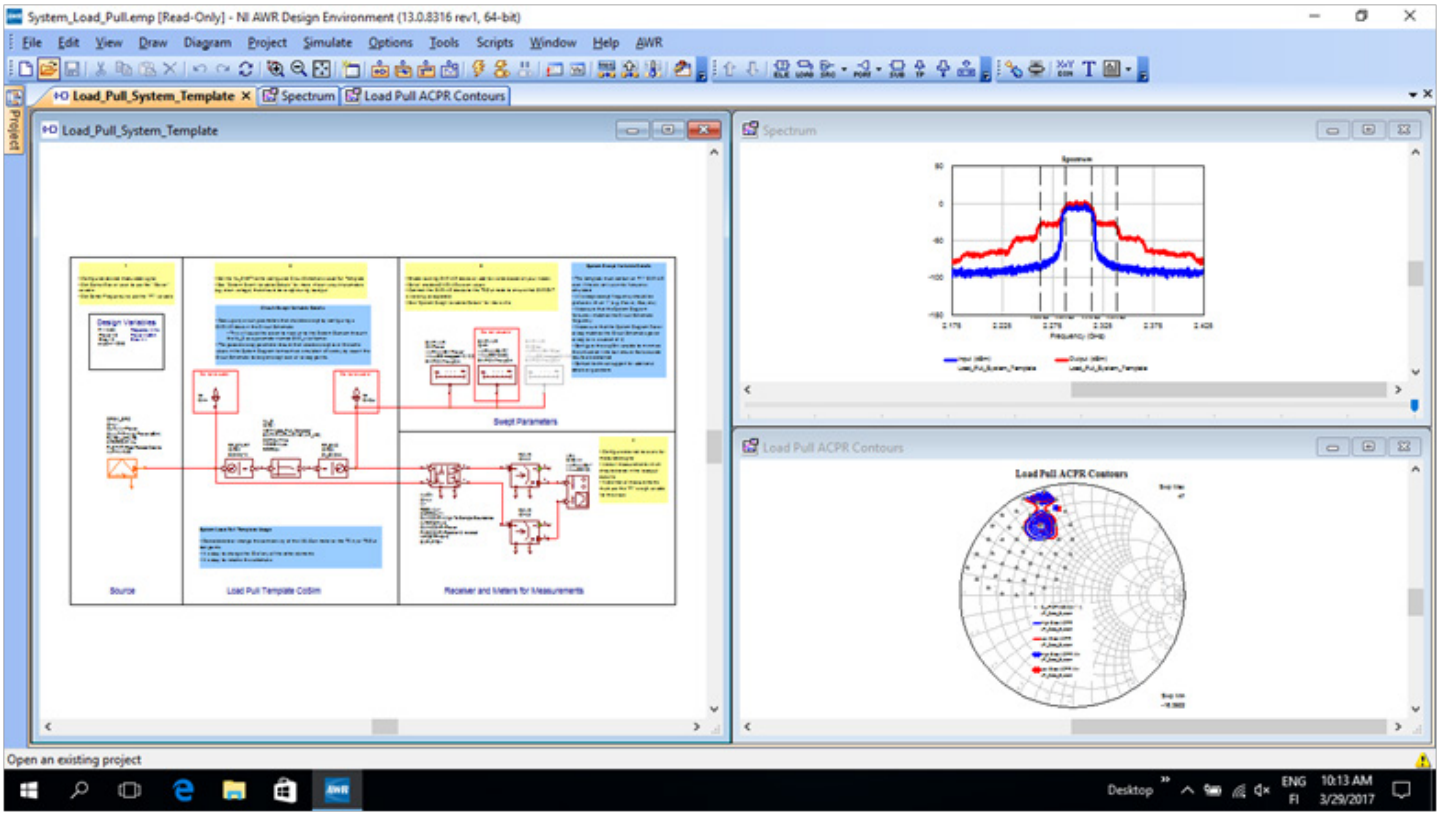

Figure 5. VSS supports load pull based on digitally-modulated active devices like power transistors to generate constant contours for communication performance metrics such as ACPR and EVM.

designers address these linearity and efficiency requirements, Visual System Simulator™ (VSS) system design software supports load pull based on digitally-modulated active devices like power transistors to generate constant contours for communication performance metrics such as adjacent channel power ratio (ACPR), error vector magnitude (EVM), and bit error rate (BER) using either measured load-pull data or a nonlinear behavioral model based on measured or simulated circuit/active device data (Figure 5).

Models and Libraries

System and PA simulation for communication applications specific to VSS is further enabled with new libraries and capabilities introduced in V13. The VSS software now provides LTE-Advanced (LTE-A) support for carrier aggregation of intra-band and inter-band component carriers and 5G candidate modulated waveforms (Figure 6) such as filter-bank multicarrier (FBMC), generalized frequency-division multiplexing (GFDM), and filtered orthogonal frequency-division multiplexing (OFDM).

These technologies take advantage of faster processing speeds to offer higher data rates and are therefore being considered to replace OFDM download (DL) and single-carrier frequency-division multiple access (SC-FDMA) upload (UL).

Measurements and Results

For sharing and re-using results in subsequent simulations, a new output file measurement feature in VSS writes a compatible nonlinear behavioral model text file that includes information on fundamental input, fundamental output, intermodulation (IM3) products (for two-tone simulations), harmonics (for one-tone simulations), S11, S22, characteristic input and output impedances, and noise figure. In addition, signal heritage information obtained from the RF Inspector (RFI) technology within VSS can be exported to an .xml file.

Even before a simulation is

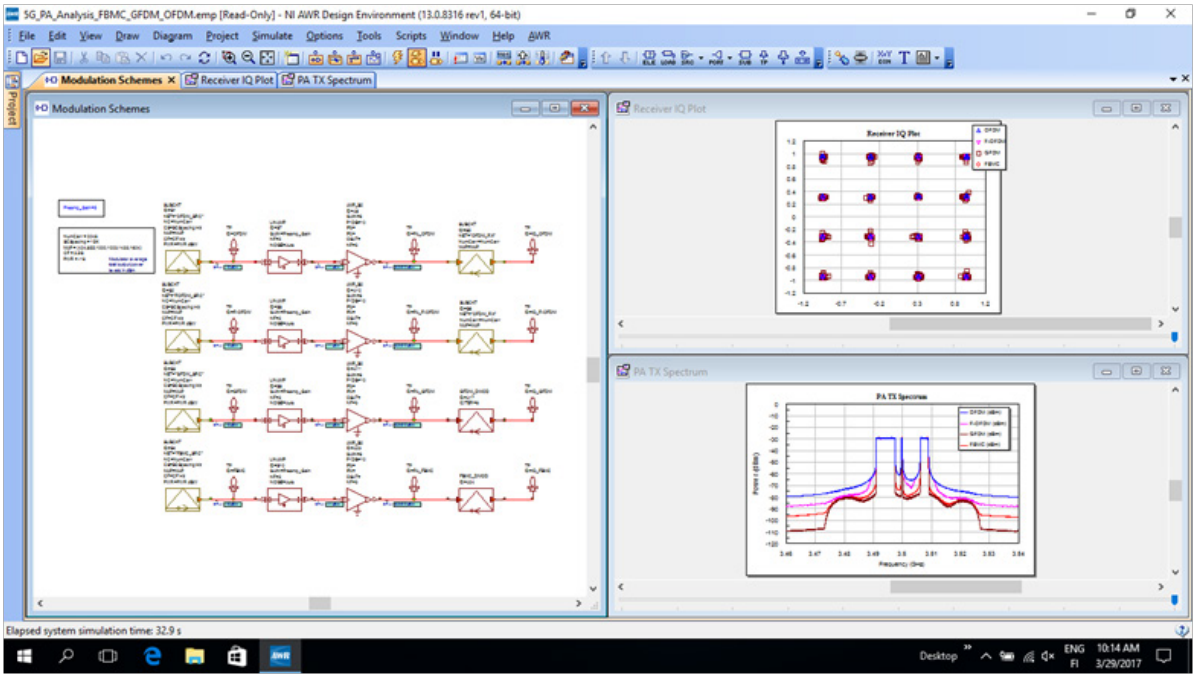

Figure 6. New 5G candidate waveforms and measurements support analysis of digitally-modulated nonlinear circuits and communications systems.

complete, the new marching waveforms feature in V13 begins plotting "real-time" measurement data on defined measurement graphs, giving designers an early preview of simulation results and the opportunity to adjust a design or simulation parameter if there are any issues with the design response or simulation setup.

To help users assess measurement data, two new marker types, auto-search markers and offset markers, are now available. Auto-search markers automatically search for a user-specified feature such as trace maximum and shift along the x-axis to stay aligned with the feature as the trace is updated due to tuning, optimization or other performance goal. Offset markers maintain a specified x or y offset from another marker on the trace. In addition, rich-text notes can now be attached to markers to help document graphs and share insights with fellow designers.

Optimization and Synthesis

Last but by no means least, V13 offers new functionality to accelerate design starts with the addition of synthesis wizards for designing transformers, power dividers, hybrids, mixers, and multipliers based on a given set of user input specifications. Design optimization has been improved with the introduction of genetic algorithm methods that use recombination and selection to rapidly and robustly explore a large number of points randomly distributed over the design space. This results in a more efficient and faster approach to investigating design possibilities and identifying optimum solutions.

Conclusion

NI AWR Design Environment V13 provides new and enhanced innovative solutions in design automation and simulation technology for the advancement of high-frequency electronic products serving the communication and aerospace/defense industries. As component requirements for these applications drive advances in semiconductor, PCB, and multi-chip module integration, NI AWR software offers powerful enhancements in design flow automation and greater speed and accuracy for its circuit/system/EM simulation technologies, enabling device manufacturers and system integrators to meet challenging performance metrics, size, cost, and time-to-market goals.

For more detail on NI AWR Design Environment V13 visit awrcorp.com/whats-new, which provides documentation covering the hundred plus enhancements/additions to this latest release.

Controlling graphics without a controller

MICROCHIP

A look at how a virtual controller can be set up to save cost and CPU time when rendering graphics

One of the popular ways of creating graphical embedded applications is to add an internal or external graphics controller. The problem is that this adds cost and can make designs unnecessarily complex, and in most cases for a simple graphical user interface such controllers are not needed.

An alternative is to use microcontroller peripherals to create a virtual graphics controller for graphics rendering without taking up large amounts of CPU time, in fact it can be less than five per cent.

In general, a controllerless graphics system needs to send a frame of pixel information to a display glass at a certain rate. This refresh rate is usually around 60Hz. To do this, the system must constantly send frame data to the LCD panel. At first, it seems like this task would take up most of the CPU time in an MCU. However, this is not the case for microcontrollers, such as Microchip's PIC32 MCUs, that contain a direct memory access (DMA) peripheral for data transfer. With a DMA transferring the pixel data, less than five per cent of CPU time can be used to achieve a virtual graphics controller.

The DMA peripheral can transfer data from one location to another without CPU intervention. In a controllerless graphics method, the DMA can be set up to transfer one line of frame data at a time through the parallel master port (PMP). Each line consists of many pixels. The DMA would send a portion of the frame buffer during one transfer. A PMP or timer interrupt request would then trigger the next DMA transfer until a line is transferred. In devices with non-persistent interrupts, a timer can be used as the DMA trigger source.

For devices with an external bus interface (EBI), this module can be used as a pixel clock source. Such a clock source can achieve faster pixel clock speeds than the PMP peripheral, yet the EBI shares the same pins as the PMP.

During data transfers, the PMP or EBI strobes a read or write signal after each pixel transfer. The read-write strobes act as the pixel clock

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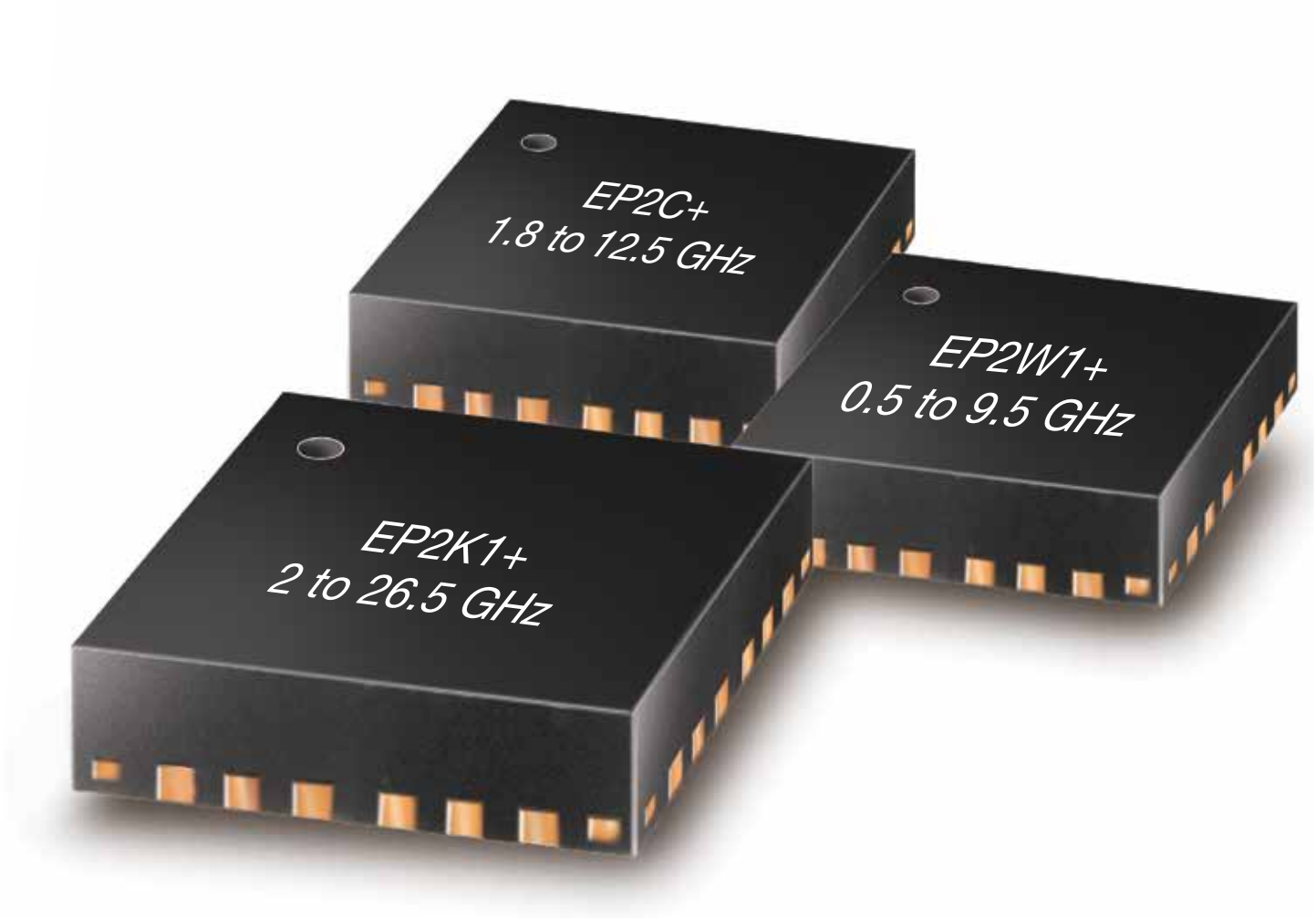

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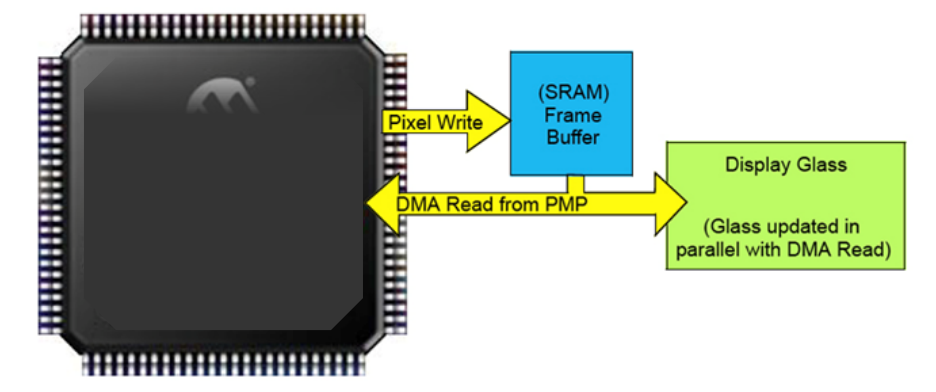

Fig. 1: External memory method

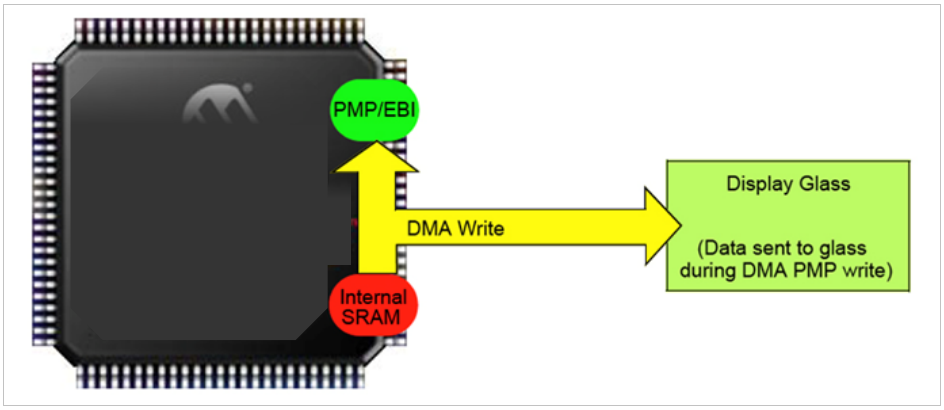

Fig. 2: Internal memory method

for the display glass. After each line of pixel data is transferred, the CPU is interrupted by the DMA and certain timing signals – such as HSYNC, VSYNC and data enable line (DEN) – needed for LCD panels are updated. This is repeated continuously until an entire frame has been drawn. The frame is stored in volatile memory so the image can be dynamic.

In this setup, SRAM is used and the configuration is the foundation for a controllerless graphics system. The system can be set up to use internal or external SRAM, as shown in Figs. 1 and 2.

TFT LCD panels

Though the controllerless graphics method was designed to work with TFT LCD panels, it can also work with CSTN or MSTN glass with minor modifications. The data lines consist of the pixel colour information. Most LCD panels can have eight to 24 colour data lines depending on the colour depth of the LCD panel. These data lines supply the LCD panel with the raw colour data of each pixel.

The HSYNC, VSYNC, DEN and PCLK clock signals synchronise the pixel data with the graphics frame and the LCD panel. The sync lines tell the LCD panel when the data are at the start or end of a line (HSYNC) or a frame (VSYNC). The DEN lets the LCD panel know when valid pixel data are being sent to the LCD panel and is required for some TFT LCD panels because of the time needed to set up the LCD panel for proper pixel locations.

Data are sent one line at a time until the entire frame is drawn. The PCLK signal is the clock source for the whole system. One clock pulse from the PCLK updates the LCD panel. All other clock lines must be synchronised to the pixel clock to achieve proper image output. LCD panels not containing HSYNC and VSYNC signals can still be used with the controllerless graphics setup.

Microchip's Low-Cost Controllerless Graphics PICtail Plus daughter board (LCC graphics board) was designed to demonstrate this technique and works with many existing PIC32 starter kits. The LCC software driver can help with synchronisation needing certain timing parameters, such as pulse width, front porch and back porch for horizontal and vertical pulses. After these values are compiled into the LCC graphics driver, the LCD panel displays the frame.

Fig. 3 shows what happens inside the PIC32 microcontroller when a graphics frame is being sent to the display. The DMA and PMP block indicates what the DMA and PMP peripherals that share the data bus with the CPU are performing. The CPU block indicates the tasks required for graphics rendering. The DMA interrupt service routine (ISR) is the only code that must be written besides setting up the DMA and PMP peripherals to send a graphics frame to the display.

Rendering new pixels

Rendering new pixels in the frame buffer is as important as refreshing the screen. This is performed by the CPU writing to the display buffer. If the frame is stored externally, the DMA transfer is suspended while

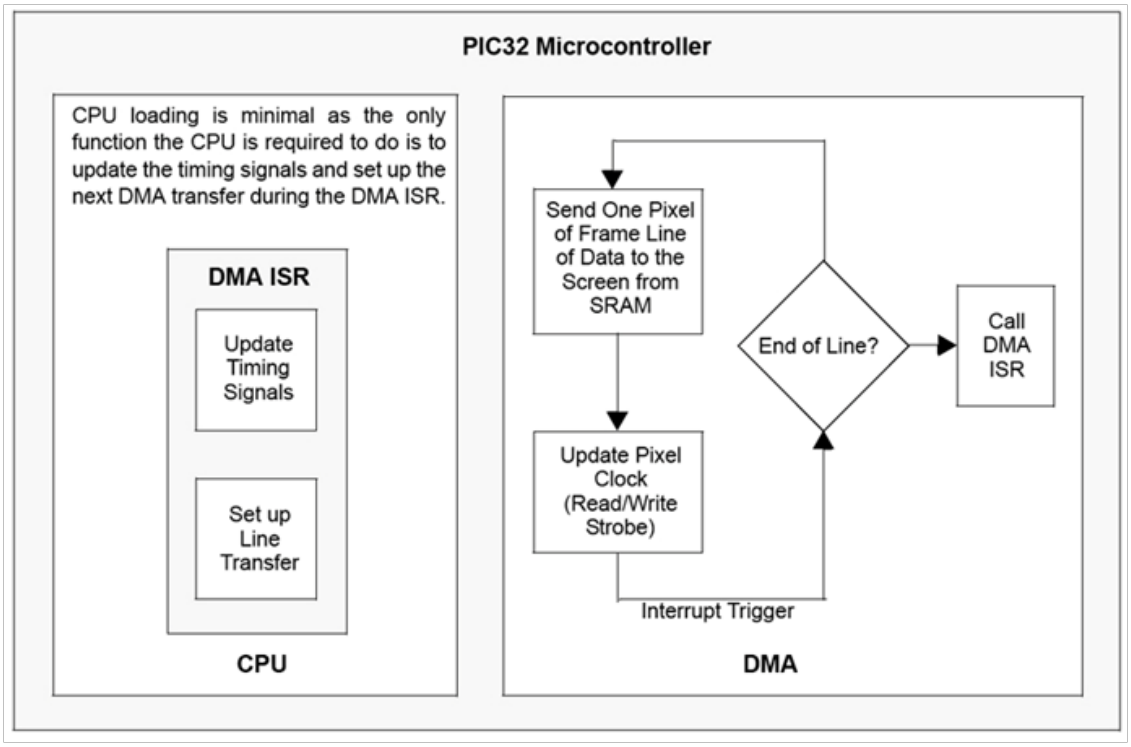

Fig. 3: PIC32 microcontroller LCC graphics flowchart

the frame is being updated. This is necessary because there is only one PMP peripheral and it is being shared by the virtual graphics controller or DMA transfer. This method does affect the refresh rate of the screen. The amount of pixel updates needs to be monitored to prevent too large a refresh rate change, otherwise the change will be perceptible by the human eye. This is done by using a pixel count variable within the virtual graphics controller that is updated on every pixel write and cleared during every DMA interrupt. With the introduction of the EBI peripheral, the suspension time needed for a frame update is dramatically reduced. When the EBI is used for writing, less data need to be stored and restored since the PMP registers are no longer being shared for reading and writing. Also, the EBI module is a more efficient peripheral when communicating to external SRAM.

Software

The internal SRAM method uses the write strobe of the PMP for the pixel clock. Jumper rows one and two on the LCC graphics board must be set for this configuration. In this setup, all colour is 8BPP and no external SRAM is used. SRAM from inside the MCU is continuously writing its pixel values to the PMP.

For 8BPP colour, a 332 RGB colour format is used, that is three colour values for red, three for green and two for blue. This is a common colour format, because red is an easier colour for the human eye to detect than blue.

The external SRAM method uses the read strobe of the PMP for the pixel clock. Jumper rows two and three on the LCC graphics board must be set for this configuration. In this setup, all colour is 16BPP and the external SRAM contains the graphics frame that is continuously being read. For 16BPP colour, a 565 RGB format is used with five colour values for red, six for green and five for blue.

In both methods, when connecting to an LCD panel with more than 16 colour lines, the unused colour lines are tied to the most significant bits of the last colour bit being used. This ensures that a full colour scale from white to black can be achieved.

Conclusion

This article has shown how a low-cost controllerless graphics system can be implemented with microcontroller peripherals to create a virtual graphics controller using only a small amount of CPU time.

Security and Reliability Design for SSD in IoT Era

› Precyan Lee Product Manager, Advantech

In this Everything is Connected IoT era, massive data generated from many kinds of internet connected devices. Which is also implying the security risk of IT system is much higher than before, even beyond our imagination. For example, in 2016, a team of hackers managed to take remote control of Tesla and manipulate the devices inside the car, even hit the brakes from 19 KM away. In 2017, a "white-hat hacker" sent out 150,000 print jobs in 24 hours which printed ASCII art. All these "innovative" internet attacks and the "creativities" from the hackers are really the warnings of our public safety, which could be exposed to risks because of the insufficient protection of IT devices. Although these cases are more about the safety of network connection and communication protocols, but storage medias in each layer of IoT structure which carry data and remain system operation, the reliability and security is even more critical. In this article, we will be discussing this topic from storage hardware reliability, data security, and application flexibility.

Great oaks from little acorns grow, reliable SSD is all about Flash

NAND Flash is widely adopted in IoT applications as storage device, which is the storage media that record the data with proper arrangement from storage controller IC. Hence, the selection of IC defined most of the reliability already. With the incremental usage of Flash IC in all kinds of the handheld devices and 3C products, the secondary market of this kind of the storage IC also emerged. All kinds of non-original package IC, even second hand IC are overwhelmed in the market already. However, no matter data collection or big data analysis in the cloud, the whole eco-system of IoT applications is about the value of data. If emphasizing too much on cost and apply Flash IC from secondary market, which risks the reliability of whole system and lowering the expected value of data.

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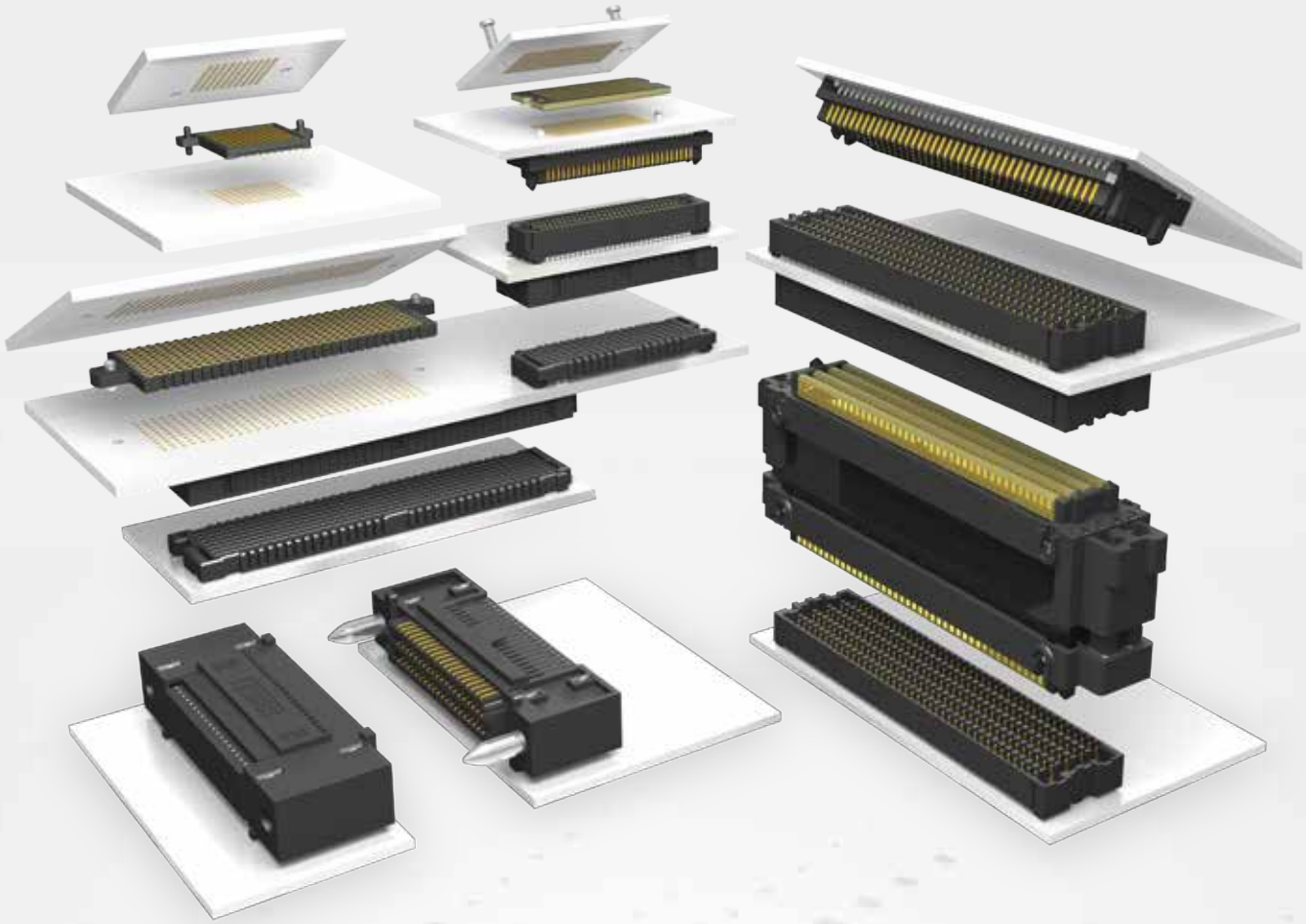

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quantity is much smaller, but higher chance to apply in mission critical applications, which means the quality control threshold should be different to maintain high quality standard and prevent disaster consequences from any quality issues. Hence, Advantech phased-in industrial leading QC standard to apply 100% product screening test instead of sampling QC. Every single piece of Advantech storage products shipped would be tested with 5 cycles of the read/write stress test, temperature test, thermal shock, and vibration test to ensure excellent yield rate of our product.

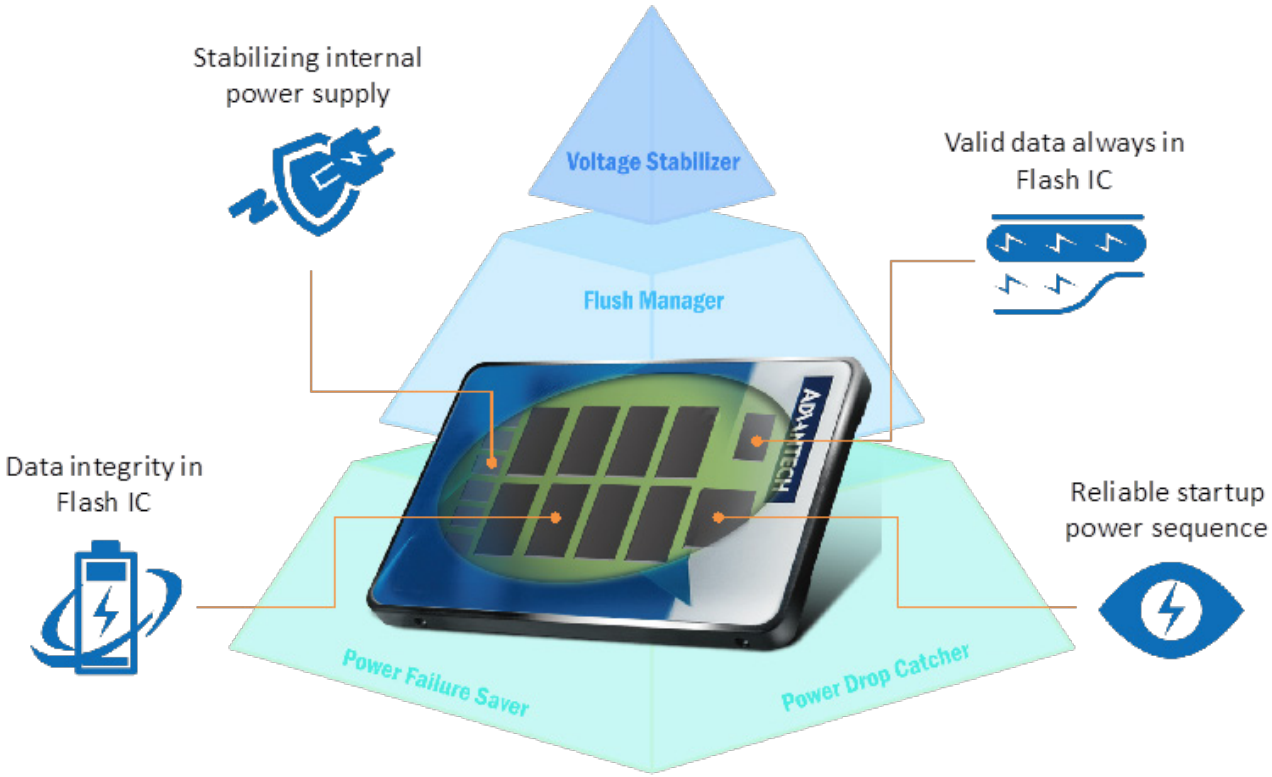
Security upgrade for SSD with SQFlash Utility

The cases mentioned in the beginning of the article about network communication security is indeed a very serious challenge, other than that, the people with bad intention has also lots of approaches to acquire data from the system in field side, or even on the storage device directly. As a carrier of data and applications, the variety of security features of storage devices could be very handy for the architects to design the system and raise the overall security level. Therefore, AES-256 internal encryption has become a mandatory feature for the modern SSD design. Besides, except for internal data encryption, with the implementation of unique device code verification or user authentication, a simple storage device can be empowered with software keys (SQFlash – Security ID) or data vault (SQFlash – Flash Vault) functions. Which realize peer-to-peer security protection.

Complete power failure protection of SQFlash

Fundamental to SSD reliability is how SSDs perform data management, especially in unstable power scenarios. SQFlash designed with the most advanced and complete multi-stage power

failure protection that ensures that no matter which kind of scenario, you will be fully covered by our advanced product functions. The multi-stage power failure protection of SQFlash is built into the SSD building blocks. From the core storage area of the



Flash IC, the Power Failure Saver feature ensures data integrity. SQFlash also features Power Drop Catcher to handle glitches from voltage drops, and Flush Manager to ensure all valid data is safely stored in the Flash IC. The SSD can be optionally built with a Voltage Stabilizer to provide a stable operating environment for SSD components in case of serious power fluctuations.

Flexible design of storage to cope with variety of IoT applications

Various application scenario is one of the characteristics of IoT application, which requests diversified product specification and design flexibility. On the other hand, storage product need to be adopted in extreme temperature and humidity environments, fluctuated power supply, indoor/outdoor, different operation system, or various read / write behaviors… etc. Storage devices need to be designed for accommodating in these scenarios and support flexible and fast adjustment. Durability and performance are both factors that are mostly concerned, but in different application, the setting and trade-off of both factors could be in total opposite. Which again reveals the importance of manageability and flexibility of the storage products. Also, proper simulation conditions from the architects that familiar with the context of application is always helpful to make efficient decisions on choosing suitable storage products.

Advantech industrial storage solution – SQFlash has built-in abundant management tool for applying to various of IoT and embedded applications. SQFlash with controller IC supports internal AES (Advanced Encryption Standard) enables high standard security that prevents hackers to read data even directly from Flash IC. Further, a complete package of SQFlash Utility AP and API provides advanced security features like Security ID, Write Protection, and Emergency Erase provides excellent conveniences for system integrators to design intelligent systems with complete security total solution. For special requirements, Advantech SQFlash DTOS (design-to-order-service) also supports hardware / firmware / software design to fit customer's unique applications.

Storage product is just like a human brain in a system, which stores all kinds of important data and the process / application that remains the system in normal application, the stability and security of storage is the key.

Autonomous Is the New Mobile: Linley on Cars

› Paul McLellan, Cadence

Cars are everywhere these days. It doesn't really matter what sort of event you attend in the semiconductor ecosystem, you will hear a lot about cars. In fact, even if you go to the movies. The best-picture-Oscar-for-two-minutes winner La La Land, is a love story but it famously opens with...cars. Pixar's next movie...Cars 3. I think it is the perfect theme for semiconductors in 2017. Wherever you turn, it will be cars.

I recently went to IRPS, the International Reliability and Physics Symposium. It has been going since 1962 when the sophisticated automotive electronics of the day was pretty much a coil, to generate a high enough voltage for a spark, and a mechanically driven distributor to sequence the cylinders. This year's conference covered a lot of topics but one of the tutorial tracks was automotive, and a several of the papers were concerned with automotive reliability. I left IRPS in Monterey early in the morning to drive up to Santa Clara for the Linley Autonomous Hardware Conference. This used to be focused on mobile, but from a merchant semiconductor point of view that is now boring: the big guys design their own chips, and Qualcomm and Mediatek mop up most of the rest. Now it is all about cars: LED-based lidar, networks-on-chip for automotive reliability, vision processing, deep learning.

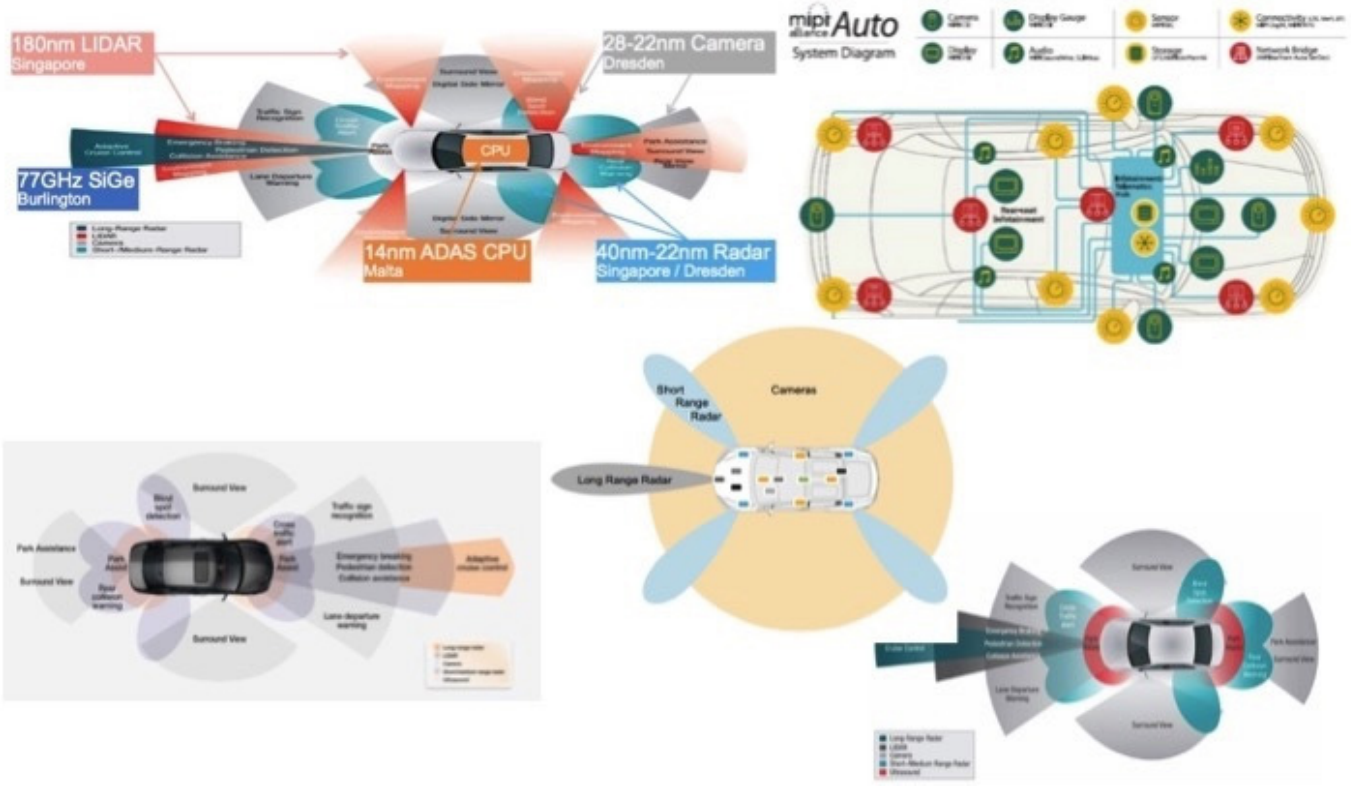
Automotive Semiconductors Are the Next Big Thing

One of the reasons for this is that it is the Next Big Thing in semiconductors. But it is also a segment of the industry in transition. Until recently, "interesting automotive semiconductor" was an oxymoron like "jumbo shrimp." It was a segment that consisted of low-complexity devices designed in extremely mature and well-characterized processes. Competition was mainly on price and reliability considerations. No chips were in leading-edge processes since there wasn't a decade of data to characterize them, and the performance wasn't required. Then along came advanced driver assistance systems (ADAS) and autonomous driving. Suddenly higher performance networks (Ethernet) and higher performance processors were required to process camera data.

It was a new class of requirements. The advanced semiconductor ecosystem didn't understand the reliability requirements in detail since they weren't required for mobile. The automotive semiconductor leaders didn't understand advanced processes or high-performance multicore processors, since they

New-Tech Europe

Read To Lead



had no experience with them. However, it wasn't just the case of taking existing vision algorithms and characterizing them for automotive reliability requirements. Another transformation was under way that added a new ingredient to the mix: vision processing, such as recognizing street signs or pedestrians, moved from algorithmic approaches to deep learning approaches in the space of a few years. If you have read the book Blue Ocean Strategy, this was a blue ocean that created itself. In some sense, there are no market leaders. The historic market leaders in automotive semiconductors have the relationships with the OEMs and Tier-1s. The foundries and IDMs have the advanced processes. Various small companies have bits and pieces of the sensor fusion and vision processing. Another wrinkle was that ISO 26262 appeared in 2011 and gradually worked its way into everyone's consciousness. But there were no incumbents to be displaced, it was the start of a new era. What would be important going forward was not the same as what had been important in the past.

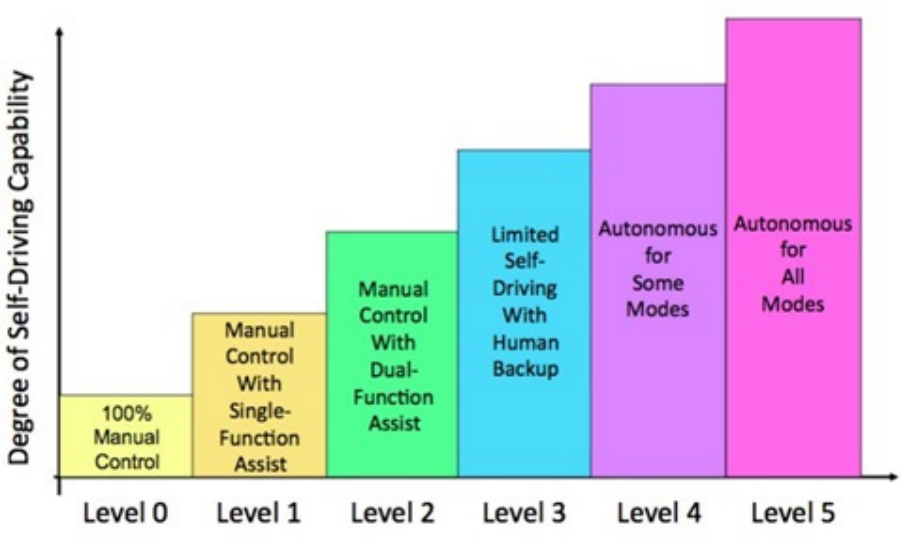
Qualcomm, NXP, Intel, Mobileye, NVIDIA

It is early but there is jockeying for position. Qualcomm is acquiring NXP, which was the market leader in automotive semiconductors and is itself fresh from digesting Freescale. On paper, that makes Qualcomm the market leader, but only in old-style automotive. Of course they have more experience with communication interfaces, especially 5G, than pretty much anyone. Intel is acquiring Mobileye for $15B. They are a manufacturing powerhouse at the leading edge, they have cellular modem technology, and now they will have the current leader in vision processing for automotive. Intel publicly admits that it "missed mobile" and it is clear that it doesn't want to make the same mistake in automotive. Another leader is NVIDIA with their DRIVE platform. When it was clear that they were not going to be among the winners in mobile—Qualcomm and Mediatek had all the prizes—NVIDIA redirected all those resources to automotive. Of course, they already have a lot of experience with deep learning since their GPUs power a lot of the training phase.

Being the early leader isn't always decisive, it's the second mouse that gets the cheese, but it is hard to enter a market once the players have been established. We seem to be at that phase right now and it may already be too late for a new semiconductor player to enter the market with any chance of success against Intel/Mobileye, Qualcomm/NXP/Freescale, NVIDIA, Renasas, and others who are already in the race.

Linley Autonomous Hardware Conference

To me, the story of Linley Autonomous Hardware Conference was not some



earth-shattering announcement, but instead that it was really a bit boring. It was boring because everyone said the same thing. That in itself is a story. The future is going to be cars with lots of sensors (lots of cameras, because they are cheap, some radar, some lidar) and high-performance chips that perform the sensor fusion, do the vision recognition, and handle the policy aspects of driving.

A decade ago, every presentation in EDA opened with a graph illustrating the design gap, before going on to show how whatever product was being presented would close it. Today, every automotive presentation opens with a picture showing the complexity of future automotive electronics. Here are a selection from the day:

Linley's opening keynote gave a good high-level overview of the space. He started off talking about how autonomous technology drives many markets such as planes and drones. But really it is all about cars (and trucks, but they are mostly just big cars). He covered a lot of the basics, such as SAE autonomous mode levels, that I have covered in numerous posts here already. Since Linley Group talks to a lot more people than I do, it is interesting to see what he considers the timescales for introduction:

Level 3 vehicles to debut this year in high-end ($50K+) vehicles and in trucks

Level 3 BOM cost will drop below $5K by 2022, and market may be lubricated by reduction in insurance cost

Level 4 vehicles in 2022 in high-end brands and commercial vehicles (taxis/uber)

True level 5 may take 10 years to develop

I think that everything may happen faster than this, since progress is being made so fast. It is not much more than a decade ago that autonomous vehicles couldn't go ten miles and required so much electronics that they required extra air conditioners on the roof. Deep learning has only become dominant in the last five years, perhaps fewer. Fully autonomous trucks have been in use in open cast mining for some years. Planes can land themselves, although the automotive people all claim that there are several orders of magnitude more code in a high-end car than a plane. That may be true, but there is also probably a reason we let 15 years olds behind the wheel of a car but not a 777.

Cadence presented a lot of information about the OpenVX standard, and how it has complete support on the Tensilica Vision P5 and P6 cores. See my earlier post See Further by Standing on the Shoulders of...OpenVX.

Linley also had some information on specific automotive processors:

Mobileye EyeQ3 dominates ADAS vision processors today. EyeQ4 rated at 2 trillion operations per second (TOPS) at just 3W. EyeQ5 expected to sample in 2018 with production in 2020, delivering 12 TOPS at 3W. One interesting wrinkle, that Linley didn't mention, is the EyeQx designs are MIPS-based (I don't think Intel was a MIPS licensee and the future of MIPS is unclear with Apple moving away from Imagination GPUs).

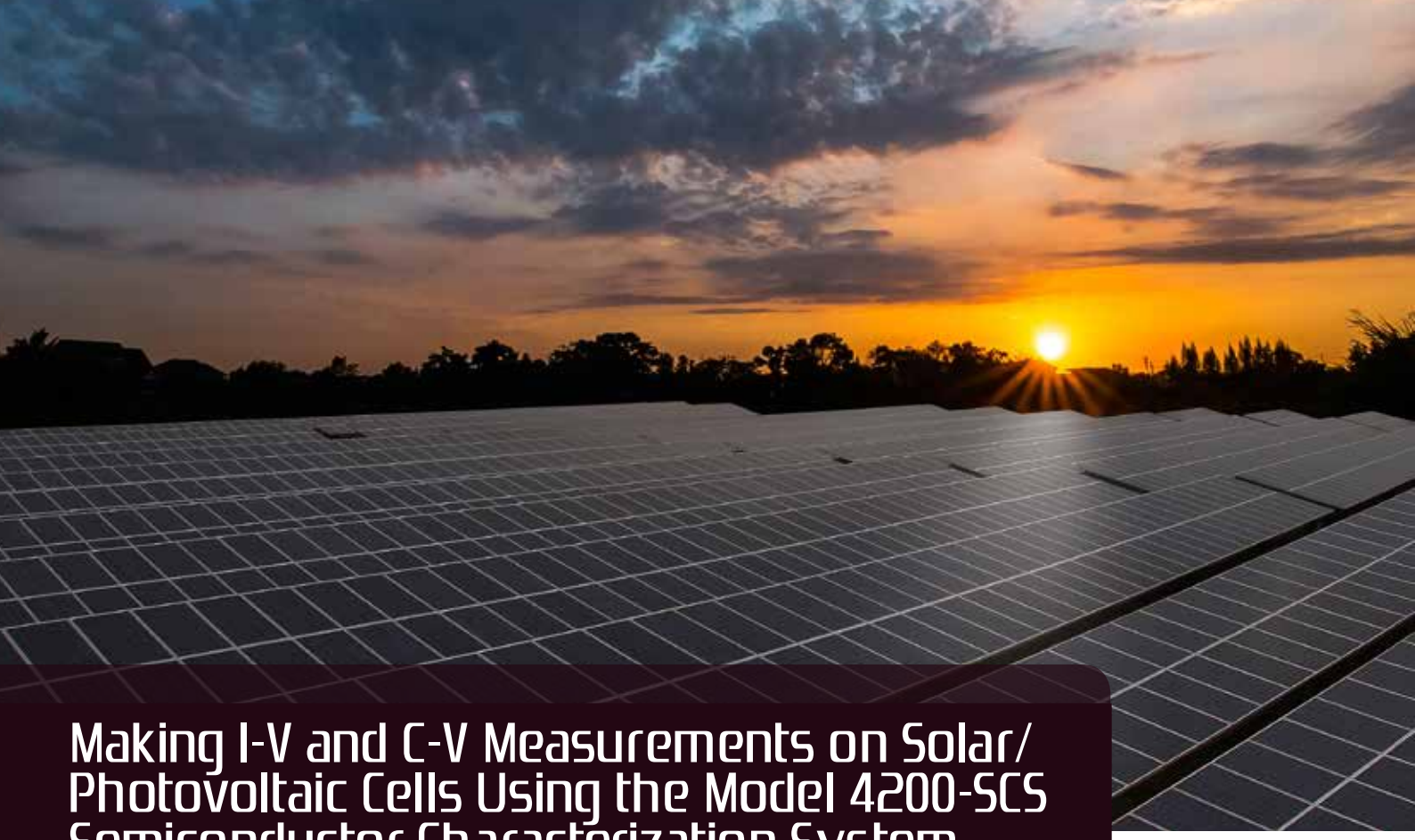
NVIDIA is developing a single-chip solution of their DRIVEPX2 called Xavier that combines 8 custom CPUs, 512-shader Volta GPU delivering >3TFLOPS, new integer only 30 TOPS vision processor, and a 30W power budget (sampling late this year and could be in 2020 cars).

NXP has a reference design called BlueBox with a vision-processing chip and an 8-core A-57 and a 40W power budget. Qualcomm is expected to boost R&D in this area. I covered BlueBox in passing in the DVCon Europe keynote.

Renasas has a new automotive platform called Autonomy, although Linley didn't mention it. That's because it was announced between the conference and me writing this post, that's how fast things are moving.

Lexus Lane Valet

It's way past April 1, so a bit late for a prank video, but Lexus came up with a new feature for advanced driver automation, with its lane valet:



Making I-V and C-V Measurements on Solar/ Photovoltaic Cells Using the Model 4200-SCS Semiconductor Characterization System

› Yossi Keren, Dan-el Technologies, Ltd.

Introduction

Because of the increasing demand for energy and the limited supply of fossil fuels, the search for alternative sources of power is imperative. Given that there is a vast amount of energy avail-able from the sun, devices that convert light energy into elec-trical energy are becoming increasingly important. Solar or photovoltaic (PV) cells convert light energy into useful electrical power. These cells are produced from light-absorbing materials. When the cell is illuminated, optically generated carriers produce an electric current when the cell is connected to a load. A variety of measurements are made to determine the elec-trical characteristics of PV cells. Characterizing the cells often involves measuring the current and capacitance as a func-tion of an applied DC voltage. The measurements are usually done at different light intensities and temperature conditions. Important device parameters can be extracted from the current-voltage (I-V) and capacitance-voltage (C-V) measurements, such as the conversion efficiency and the maximum power output. Electrical characterization is also important to determine losses in the PV cell. Essentially, electrical characterization is needed to determine ways to make the cells as efficient as possible with minimal losses.

To make these important electrical measurements, using a tool such as the Model 4200-SCS Semiconductor Characterization System can simplify testing and analysis. The 4200-SCS is a meas-urement system that includes instruments for both I-V and C-V measurements, as well as software, graphics, and mathematical analysis capability. The software includes tests for making I-V and C-V measurements specifically on solar cells and deriving common PV cell parameters from the test data. This application note describes how to use the Model 4200-SCS to make electrical measurements on PV Cells. Topics include the basic principles of PV cells, connections of the cell in

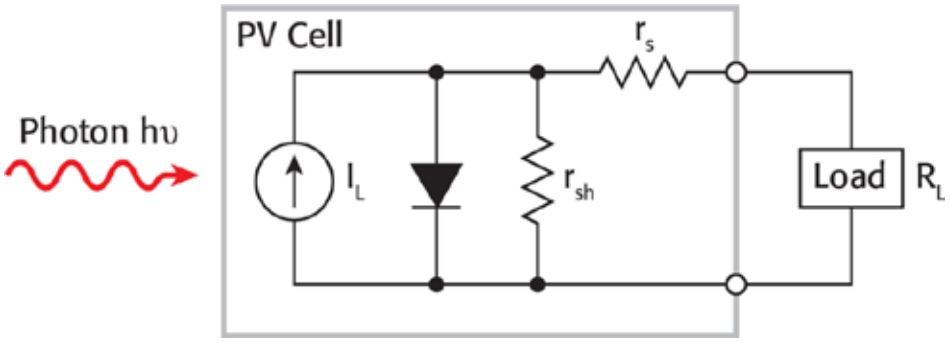


Figure 1. Idealized equivalent circuit of a photovoltaic cell

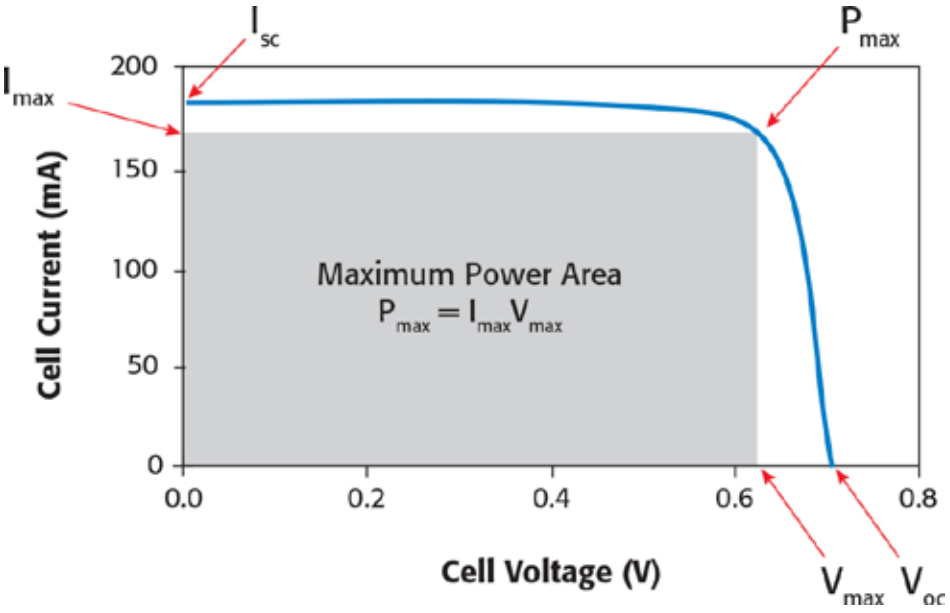


Figure 2. Typical forward bias I-V characteristics of a PV cell

the measurement circuits, forward and reverse I-V measurements, C-V measurements, meas-urement considerations, and sources of error.

Basic Photovoltaic Cell Circuit and Device Parameters

A photovoltaic cell may be represented by the equivalent cir-cuit model shown in Figure 1. This model consists of current due to optical generation (I_L), a diode that generates a current [$I_s(e^{qV/kT})$], a series resistance (r_s), and shunt resistance (r_{sh}). The series resistance is due to the resistance of the metal contacts, ohmic losses in the front surface of the cell, impurity concentra-tions, and junction depth. The series resistance is an important

parameter because it reduces both the short-circuit current and the maximum power output of the cell. Ideally, the series resis-tance should be 0Ω ($r_s = 0$). The shunt resistance represents the loss due to surface leakage along the edge of the cell or due to crystal defects. Ideally, the shunt resistance should be infinite ($r_{sh} = \infty$).

If a load resistor (RL) is connected to an illuminated PV cell, then the total current becomes:

$$I = I_S(e^{qV/kT} - 1) - I_L$$

where: I_S = current due to diode saturation I_L = current due to optical generation

Several factors determine the efficiency of the solar cell, including the maximum power point (P_{max}), the energy conver-sion efficiency (η), and the fill factor (FF). These points are illus-trated in Figure 2, which shows a typical forward bias I-V curve of an illuminated PV cell. The maximum power point (P_{max}) is the product of the maximum cell current (I_{max}) and voltage (V_{max}) where the power output of the cell is greatest. This point is located at the "knee" of the curve.

The fill factor is a measure of how far the I-V characteristics of an actual PV cell differ from those of an ideal cell. The fill factor is defined as:

$$FF = \frac{I_{max}V_{max}}{I_{sc}V_{oc}}$$

where: I_{max} = the current at the maximum power output

V_{max} = the voltage at the maximum power output

I_{sc} = the short-circuit current

V_{oc} = the open-circuit voltage

Another important parameter is the conversion efficiency (η), which is defined as the ratio of the maximum power output to the power input to the cell:

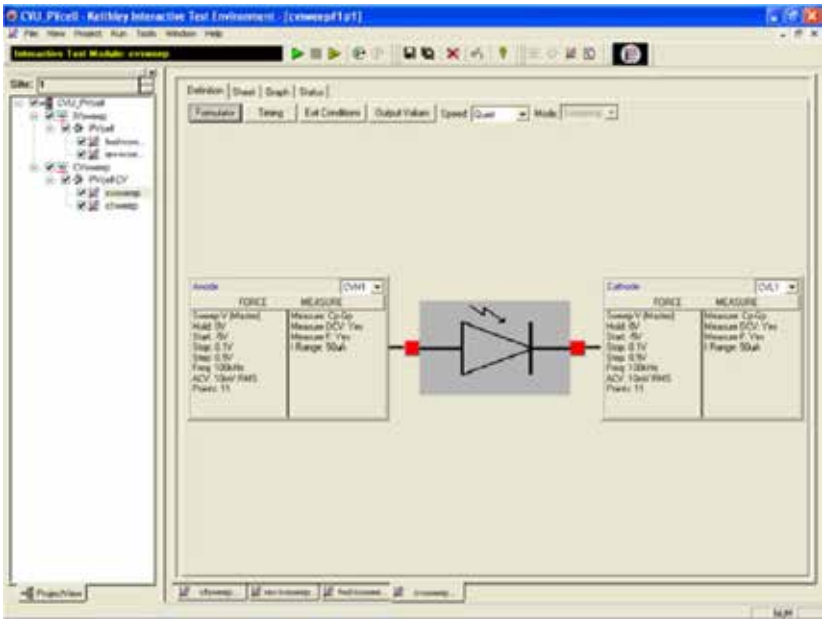


Figure 3. Screen Shot of PV Cell Project for the 4200

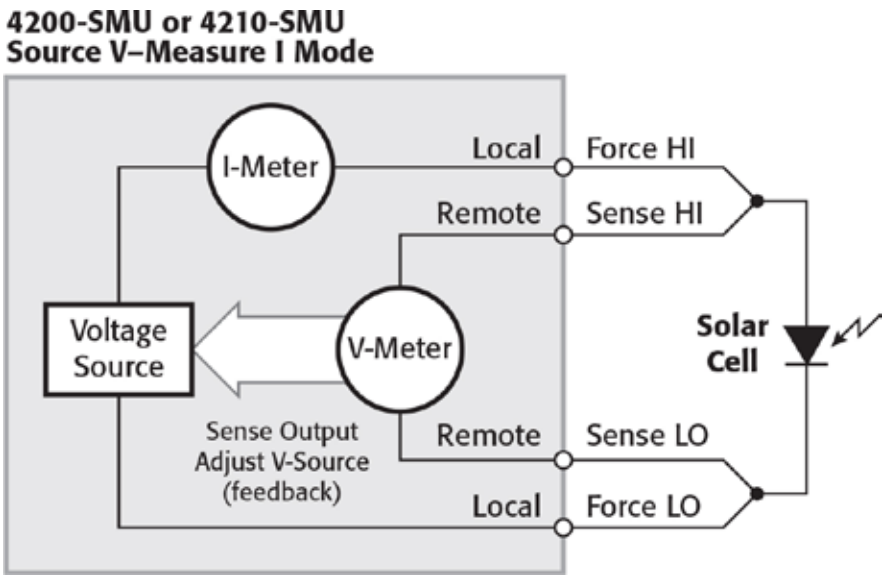


Figure 4. Connections of 4200-SCS's SMU to Solar Cell

$$\eta = \frac{P_{max}}{P_{in}}$$

where: P_{max} = the maximum power output

P_{in} = the power input to the cell defined as the total radiant energy incident on the surface of the cell

These described parameters of the solar cell can be deter-mined through electrical characterization of the device.

Using the 4200-SCS to Make I-V and C-V Measurements on the Solar Cell

To simplify testing, a project has been created for the 4200-SCS that makes both I-V and C-V measurements on a solar cell and also extracts common measurement parameters such as maxi-mum power, short-circuit current, open-circuit voltage, etc. The project is called "CVU_Pvcell" and is included with all 4200-SCS systems running KITE version 7.0 or later. A screen shot of the project is shown in Figure 3. This project has five tests, called ITMs (Interactive Test Modules), that perform a forward bias I-V sweep (fwd-ivsweep), reverse bias I-V sweep (rev-ivsweep), C-V sweep (cvsweep), 1/C2 vs. V plot (C-2vsV) and C-f sweep (cfsweep).

I-V Measurements Using the 4200-SMU

As described previously, many important device parameters can be determined from current-voltage (I-V) measurements of the solar cell. The I-V characteristics are measured using one of the Model 4200-SCS's Source Measure Units (SMUs), which can source and measure both current and voltage. Two types of SMUs are available for the 4200-SCS: the Model 4200-SMU, which can source/sink up to 100mA, and the 4210-SMU, which can source/sink up to 1A. If the output current of the cell exceeds these current levels, then the output current may have to be

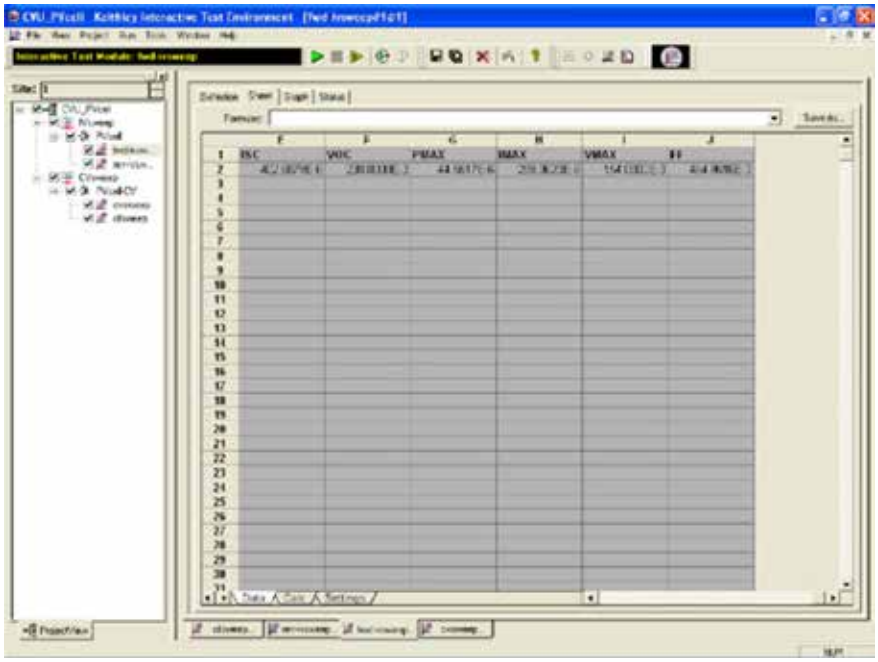


Figure 5. Results of Calculated Parameters Shown in Sheet Tab

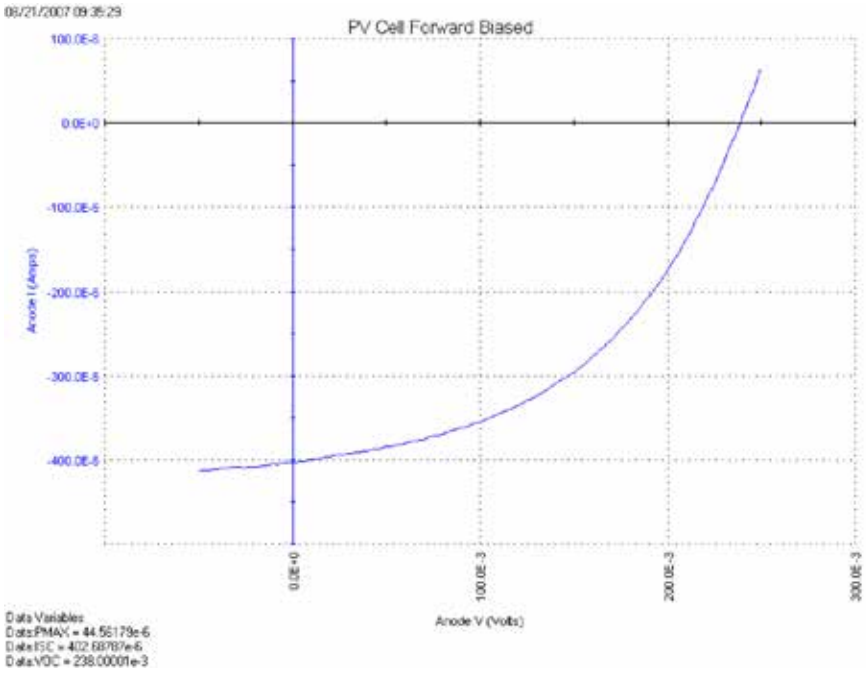


Figure 6. I-V Sweep of Silicon PV Cell Generated with the 4200-SMU

reduced. One way of reducing the output is to reduce the area of the cell. If this is not possible, then the Keithley Series 2400 SourceMeter® instruments, which are capable of sourcing/sinking higher currents, may be used.

Making connections to the PV Cell

A solar cell connected to the 4200-SCS's SMU for I-V measurements is shown in Figure 4. A four-wire connection is made to eliminate the lead resistance that could otherwise affect the measurement accuracy. With the four-wire method, a voltage is sourced across the PV cell using one pair of leads (Force HI and Force LO), and the voltage drop across the cell is measured across a second set of leads (Sense HI and Sense LO). The sense leads ensure that the voltage developed across the cell is the pro-grammed output value and compensates for the lead resistance.

Forward Bias I-V Measurements

Forward bias I-V measurements of the PV cell are generated under controlled illumination. The SMU is set up to source a voltage sweep and measure the resulting current. This forward bias sweep can be accomplished using the "fwd-ivsweep" ITM.

The user can adjust the sweep voltage to the desired values. As illustrated in Figure 2, the voltage source is swept from $V_1 = 0$ to $V_2 = V_{OC}$. When the voltage source is 0 ($V_1 = 0$), the current is equal to the short-circuit current (ISC). When the voltage source is an open circuit ($V_2 = V_{OC}$), then the current is equal to zero ($I_2 = 0$). The parameters VOC and ISC can easily be derived from the sweep data using the Model 4200-SCS's built-in mathematical analysis tool, the Formulator. For convenience, the "CVU_

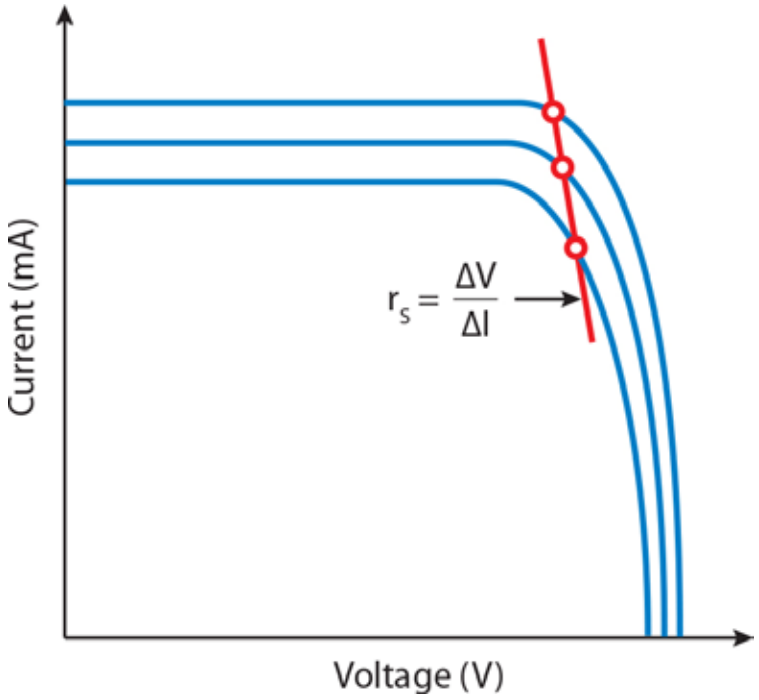


Figure 7. Slope Method Used to Calculate the Series Resistance

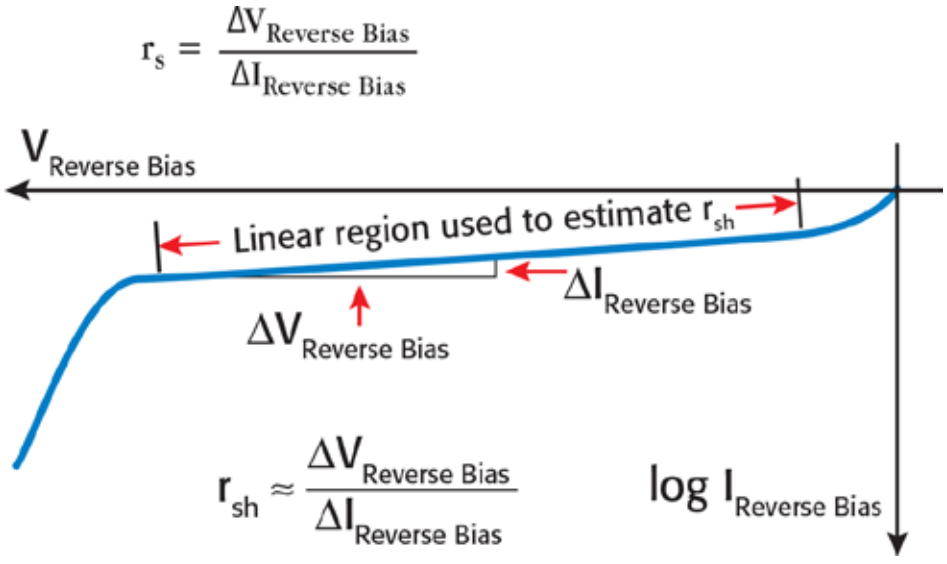


Figure 8. Typical Reverse-Bias Characteristics of a PV Cell

Pvcell" project has the common parameters already calculated and the values automatically appear in the Sheet tab every time the test is executed. Figure 5 shows some of the derived parameters in the Sheet tab. These parameters include the short-circuit current (I_{SC}), the open circuit voltage (V_{OC}), the maximum power point (P_{max}), the maximum cell current (I_{max}), the maximum cell volt-age (V_{max}), and the fill factor (FF).

Using the Formulator, the conversion efficiency (η) can also be calculated if the power input to the cell is known. The current density (J) can also be derived using the area of the cell.

Figure 6 shows an actual I-V sweep of an illuminated silicon PV cell generated by the 4200-SCS using the "fwd-ivsweep" ITM. Because the system's SMUs can sink current, the curve can pass through the fourth quadrant and allow power to be extracted from the device (I–, V+). Sometimes it may be desirable to plot log I vs. V. The Graph tab options support an easy transition between graphically displaying data on either a linear or a log scale.

The series resistance, (rs), can be determined from the for-ward I-V sweep at two or more light intensities. First, make I-V curves at two different intensities. Knowing the magnitudes of the intensities is not important. Measure the slope of this curve from the far forward characteristics where the curve becomes linear. The inverse of this slope yields the series resistance:

$$r_s = \frac{\Delta V}{I\Delta}$$

Using additional light intensities, this technique can be extended using multiple points located near the knee of the curves. As illustrated in Figure 7, a line is generated from which the series resistance can be calculated from the slope.

An important measurement feature

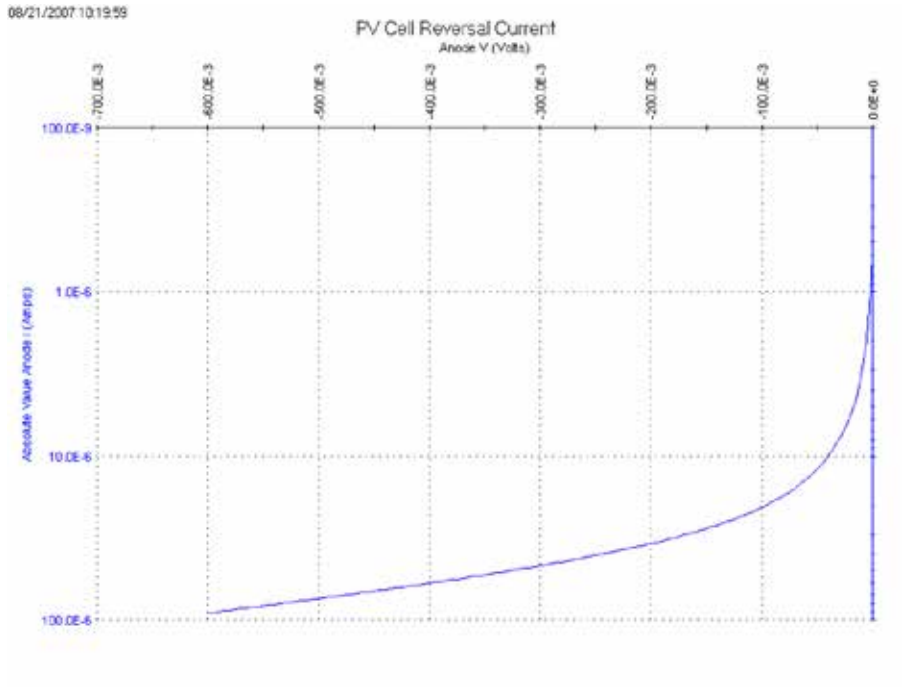


Figure 9. Actual Reverse Bias Measurement of Silicon PV Cell Using 4200-SMU

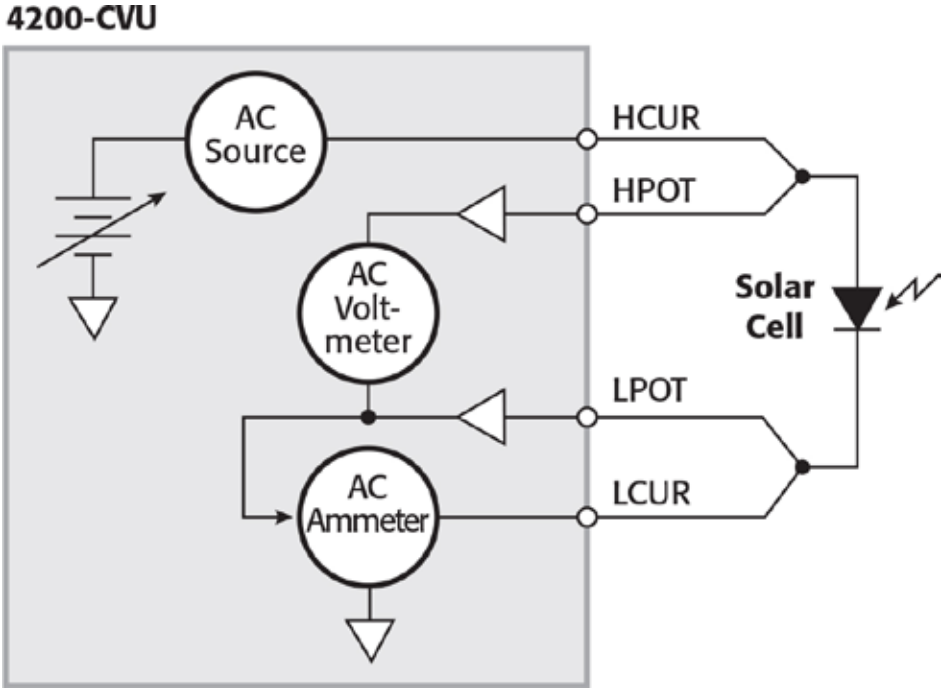


Figure 10. Connecting the 4200-CVU to a Solar Cell

of the system's SMU as an ammeter is that it has very low voltage burden. The voltage burden is the voltage drop across the ammeter during the meas-urement. Most conventional digital multimeters (DMMs) will have a voltage burden of at least 200mV at full scale. Given that only millivolts may be sourced to the sample, this can cause large errors. The 4200-SCS's SMU never produces more than a few hundred microvolts of voltage burden, or voltage drop, in the measurement circuit.

Reverse Bias I-V Measurements

The leakage current and shunt resistance (rsh) can be derived from the reverse bias I-V data. Typically, the test is performed in the dark. The voltage is sourced from 0V to a voltage level where the device begins to break down. The resulting current is measured and plotted as a function of the voltage. Depending on the size of the cell, the leakage current can be as small as in the picoamp region. The Model 4200-SCS has a preamp option that allows making accurate measurements well below a picoamp. When making very sensitive low current measurements (nano-amps and smaller), use low noise cables and place the device in a shielded enclosure to shield the device electrostatically. This conductive shield is connected to the Force LO terminal of the 4200-SCS. The Force LO terminal connection can be made from the outside shell of the triax connectors, the black binding post on the ground unit (GNDU), or from the Force LO triax connec-tor on the GNDU.

One method for determining the shunt resistance of the PV cell is from the slope of the reverse bias I-V curve, as shown in Figure 8. From the linear region of this curve, the shunt resist-ance can be calculated as:

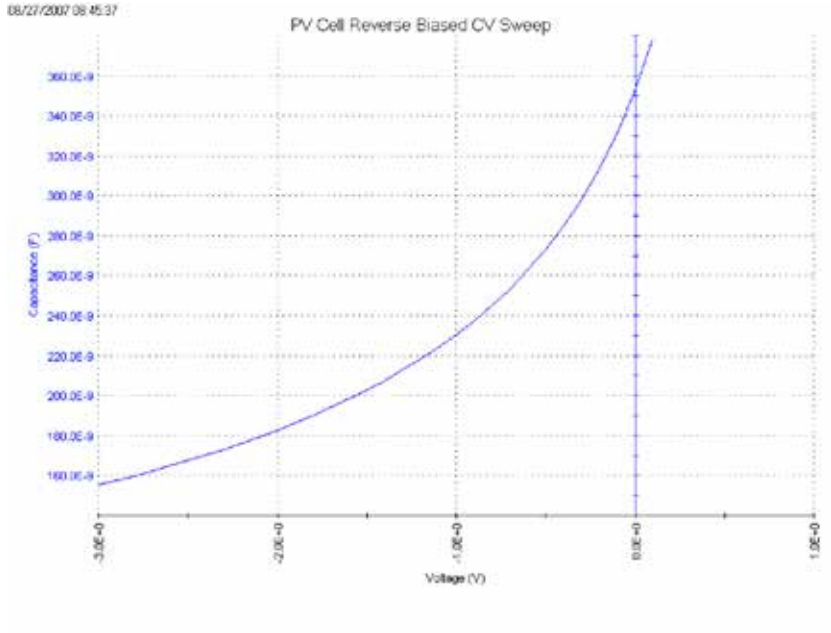


Figure 11. C-V Sweep of Silicon Solar Cell

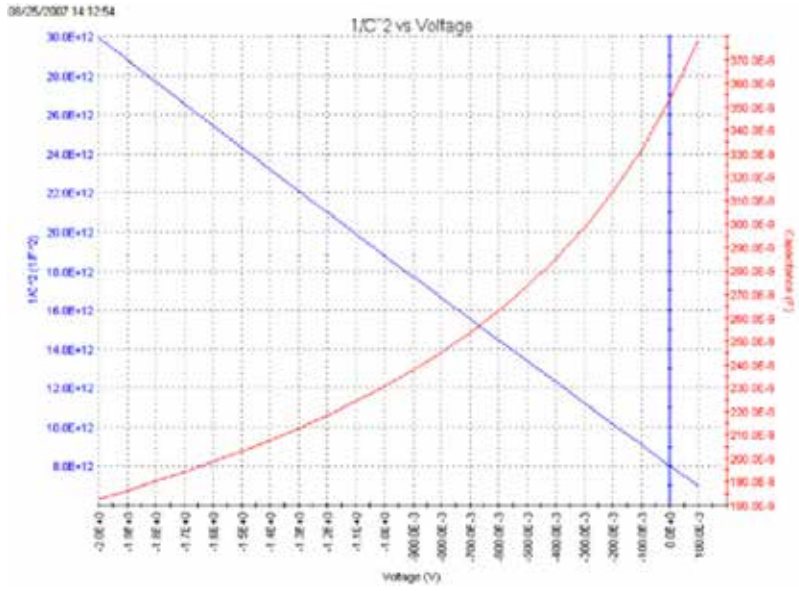


Figure 12. 1/C2 vs. Voltage of a Silicon Solar Cell

$$r_s = \frac{\Delta V_{\text{Reverse Bias}}}{I\Delta_{\text{Reverse Bias}}}$$

An actual curve of a reverse-biased PV cell is shown in Figure 9. This curve was generated using the ITM "rev-ivsweep". In this semi-log graph, the absolute value of the current is plotted as a function of the reverse bias voltage that is on an inverted x-axis.

Capacitance Measurements Using the 4200-CVU

In addition to determining the I-V characteristics of a PV cell, capacitance-voltage measurements are also useful in deriv-ing particular parameters about the device. Depending on the type of PV cell, the AC capacitance can be used to derive such parameters as doping concentration and the built-in voltage of the junction. A capacitance-frequency sweep can be used to pro-vide information about the existence of traps in the depletion region. The Model 4200-CVU, the Model 4200-SCS's optional Capacitance-Voltage Unit, can measure the capacitance as a func-tion of an applied DC voltage (C-V), a function of frequency (C-f), or a function of time (C-t).

To make a C-V measurement, a solar cell is connected to the 4200-CVU as shown in Figure 10. Like I-V measurements made with the SMU, the C-V measurement also involves a four-wire connection to compensate for lead resistance. The HPOT/HCUR terminals are connected to the anode and the LPOT/LCUR ter-minals are connected to the cathode. This connects the high DC voltage source terminal of the CVU to the anode.

Not shown in the simplified diagram are the shields of the coax cables. The shields from the coax cables need to be con-nected together as close as possible to the solar cell. Connecting the shields together is necessary for obtaining the highest accuracy because it reduces the effects of the inductance in the measurement circuit. This is especially important for capacitance

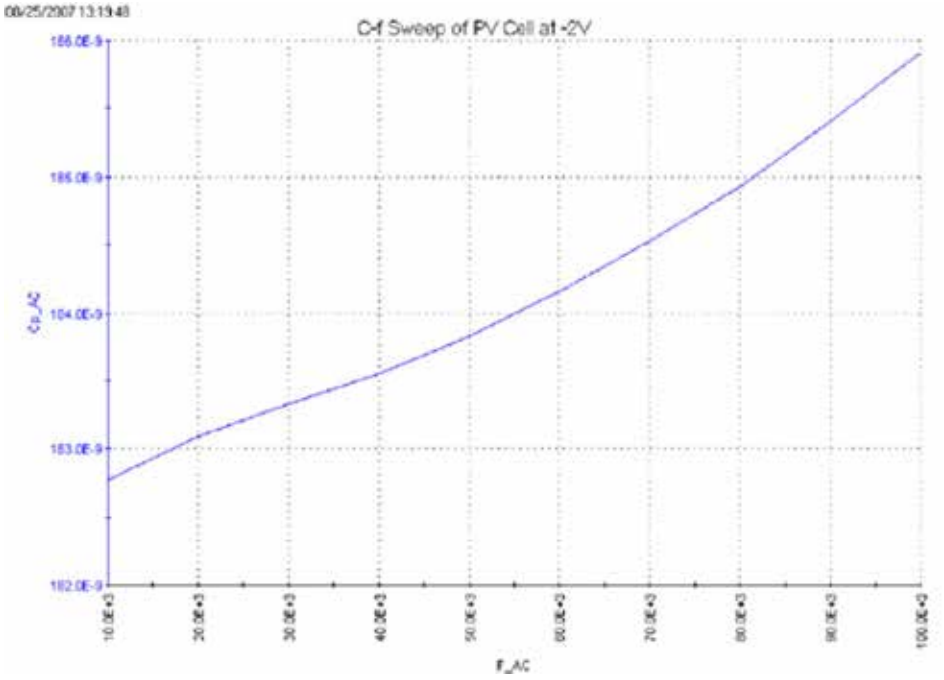


Figure 13. C-f Sweep of Solar Cell

measurements made at the higher test frequencies.

To reduce the effects of cable capacitance, it is also important to perform a SHORT cal, OPEN cal, and Cable Correction. These simple procedures are discussed in Section 15 of the 4200-SCS Complete Reference Manual.

Given that the capacitance of the cell is directly related to the area of the device, it may be necessary to reduce the area, if possible, to avoid capacitances that may be too high to measure. Also, setting the 4200-CVU to measure capacitance at a lower test frequency (10kHz) and/or lower AC drive voltage will allow mak-ing higher capacitance measurements.

C-V Sweep

C-V measurements can be made either forward-biased or reverse-biased. However, when the cell is forward-biased, the applied DC voltage must be limited; otherwise, the conductance may get too high. The maximum DC current cannot be greater than 10mA; otherwise, the DC voltage output will not be at the desired level.

Figure 11 illustrates a C-V curve of a silicon solar cell gener-ated by the 4200-CVU using the "cvsweep" ITM. This test was performed in the dark while the cell was reverse-biased.

Instead of plotting dC/dV, it is sometimes desirable to view the data as $1/C^2$ vs. V. The doping density (N) can be derived from the slope of this curve because N is related to the capaci-tance by:

$$N(a) = \frac{2}{qE_S A^2 [d(1/C^2)/dV]}$$

where: N(a) = the doping density (1/cm3)

q = the electron charge (1.60219×10^{-19}C)

E_s = semiconductor permittivity (1.034×10^{-12}F/cm for silicon)

A = area (cm^2)

C = measured capacitance (F)

V = applied DC voltage (V)

The built-in voltage of the cell junction can be derived from the intersection of the 1/C2 curve and the horizontal axis. This plot should be a fairly straight line. An actual curve taken with the 4200-CVU is shown in Figure 12. This graph was generated using the "C-2vsV" ITM. The "Linear Line Fits" graph option can be used to derive both the doping density (N) and the built-in voltage on the x-axis. The doping density is calculated as a func-tion of voltage in the Formulator and appears in the Sheet tab in the ITM. The user must input the Area of the device in the Constants area of the Formulator.

C-f Sweep

The 4200-CVU can also measure capacitance as a function of frequency. The curve in Figure 13 was generated by using the "cfsweep" ITM. The user can adjust the range of sweep frequency as well as the bias voltage.

Conclusion

Measuring the electrical characteristics of a solar cell is critical for determining the device's output performance and efficiency. The Model 4200-SCS simplifies cell testing by automating the I-V and C-V measurements and provides graphics and analysis capability.

This article is submitted under the sponsorship of Keithley and Dan-el Technologies, Ltd. the Keithely Representative.

DEVICE MANAGEMENT IN THE INTERNET OF THINGS - Why It Matters and How to Achieve It

› Keith Shea, Wind River

EXECUTIVE SUMMARY

For most enterprises, the compelling case for the Internet of Things (IoT) is the ability to access the valuable data being generated by hundreds or even thousands of field devices. That can happen only if the devices delivering that data and the gateways that direct data to enterprise systems are continually performing as expected. Device manufacturers and IoT system developers need to think upfront about how to manage those devices. This paper outlines the business case for efficient device management and introduces a solution for managing edge devices remotely, reliably, and cost-effectively.

LIFE ON THE EDGE

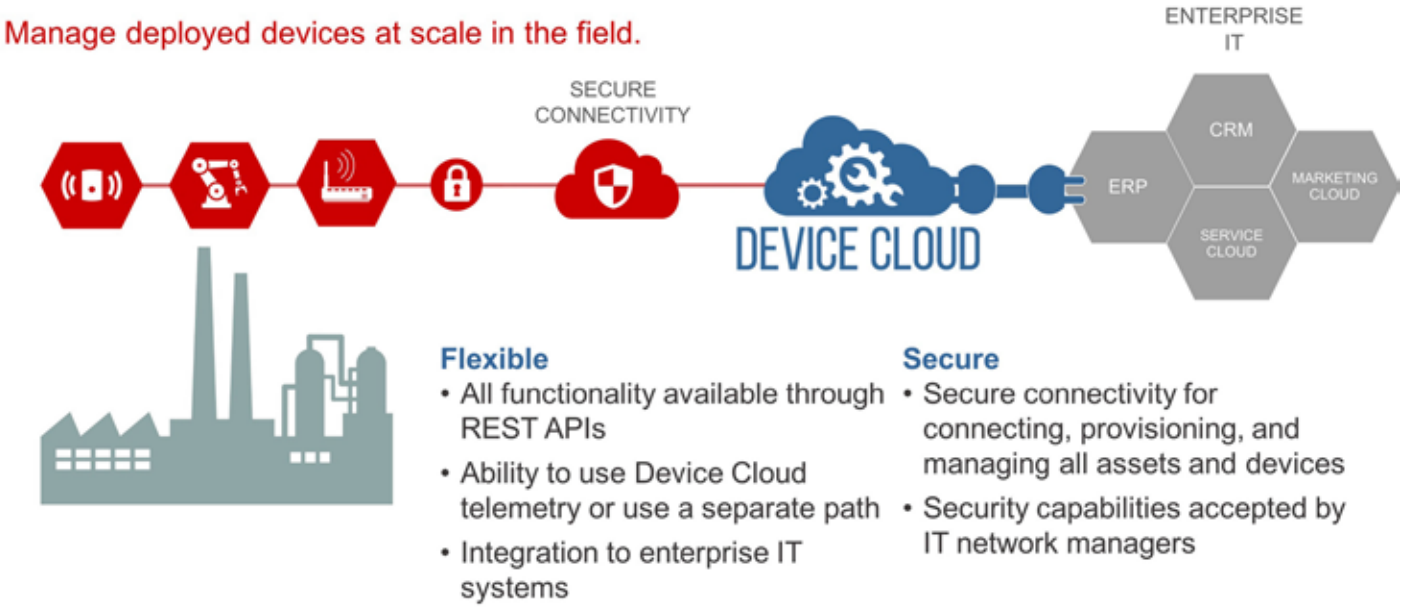
Data may be the hero of the IoT story, but the real workhorses are devices at the edge of the IoT system—the things in the Internet of Things. They're out in the field either generating and transmitting data to a centralized platform or performing automated tasks that generate data. A mundane job, perhaps, yet the overall performance of a system often hinges on the health of field devices. If a device, sensor, embedded agent, or gateway begins faltering, the consequences can be dire.

The challenge of maintaining devices may sound basic compared with aggregating and analyzing data, but it's essential to a successful IoT strategy. At a minimum, device manufacturers and system operators need a way to monitor the health of devices in the field to prevent system disruption and downtime. More importantly, they need to have an action plan: how to remedy those problems that will eventually occur.

With IoT, change is constant. Business priorities will shift as companies gain insights about their operations from the data. So system operators need an efficient, scalable way to provide updates across a large fleet of devices. Security, too, is a major concern. If a vulnerability is discovered in device software, patches must be deployed quickly—before intruders can exploit the gaps.

REMOTE CONTROL FOR THE DEVICE LIFECYCLE

Device manufacturers and system developers need to plan for these contingencies at the design stage.



With potentially thousands of field devices in play, it's not feasible or cost-effective to rely on truck rolls for fixes and updates. Instead, what's needed is a way to perform these tasks remotely, at scale, and over the Internet.

But IoT data collection typically runs just one-way—from device to cloud. Even when operators detect device anomalies, they typically don't have the tools to push commands back to the device and fix the issue. So the initial design of an IoT system must consider the entire operating lifecycle, from deployment to decommissioning.

Several distinct but interrelated issues must be addressed:

1. Commissioning and provisioning: Once devices are deployed and connected, operators need a way to activate and provision them efficiently. Today, that often means physically going from device to device and loading applications or performing upgrades manually. IoT system operators need to be able to configure, provision, and manage field devices remotely.

2. Security: Device security is critical to an IoT system. Hackers often target endpoint devices as a means of gaining entry. And security breaches at the device level can have severe consequences: financial losses, damage to credibility, even endangerment of human life. But securing devices is challenging since they're vulnerable to both physical tampering and network-borne threats.

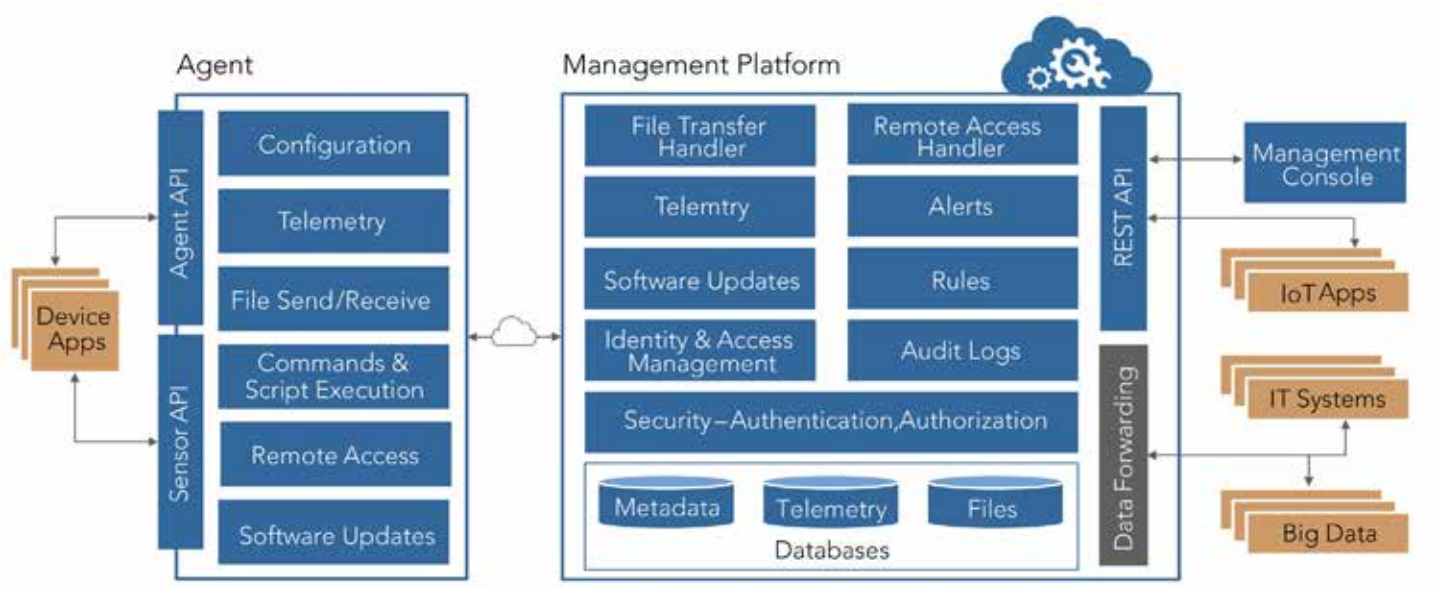
3. Monitoring and management: System operators need the right tools to monitor remote device performance and check for security vulnerabilities. They also need to be able to send instructions to those devices to correct a problem or change a function. This requires full two-way communication, where responses to devices can be completely automated.

4. Integration: Historically, information technology and operational technology systems have been kept separate. But IoT systems need to be integrated, with a centralized place to aggregate, analyze, and store data.

5. Updates and upgrades: While the devices in enterprise applications can perform for years, the software running on them will require regular updates and upgrades: from bug fixes to security patches to overall software improvements. And once an upgrade or a new application is ready, operators need to be able to deploy it quickly and cost-effectively to many devices at once.

6. Decommissioning: Developers must plan for end-of-device life at the design stage so operators can easily and remotely remove a device from service.

The challenge facing every IoT system developer and operator is how to gain consistently reliable and



secure remote control over devices typically far away and connected via the public Internet.

THE ANSWER IN THE CLOUD

Device management should be part of an IoT strategy from inception. But trying to build device management and two-way communication capabilities into a system from scratch can take time, devour resources, increase costs, and delay deployment.

A more practical solution is to leverage technology designed specifically for IoT device deployment and management. Wind River® Helix™ Device Cloud is the ready-built platform that makes it possible. The solution also provides RESTful APIs, enabling IT and OT professionals to quickly build vertical-specific IoT solutions and integrate disparate enterprise IT systems.

With Device Cloud, industrial companies can easily build device management capabilities into their infrastructures and greatly reduce the complexities of rolling out large-scale device deployments. Device Cloud gives customers the ability to:

Deploy: Connect devices to the cloud

Devices can be provisioned via a startup.bin file, authenticated via certificate exchange, and configured via network settings in the OS.

Monitor: Record device-related information

Data is collected on device health (CPU, memory, etc.), operations (pressure, speed, etc.), connection status, and device alerts, for example.

Service: Diagnose and repair devices remotely

Device application log files and historical trend data are analyzed, a tunnel is established to allow secure, remote device access, and repair procedures (change settings, push updates, etc.) are conducted, when necessary.

Manage: Track device properties and changes

The agent reports device properties and other "inventory" information that may be useful for understanding what is running in the field.

Update: Deliver content and software updates

Updates can be made to files, application software, the agent, and even the OS kernel.

Decommission: Remove devices from the system

Devices are stopped but agent files remain (deactivate), device is returned to factory default state, or devices may be deleted from the cloud, and all device data is erased (decommission).

UPDATES WHEN AND WHERE THEY ARE NEEDED

Device Cloud automatically collects and integrates data from disparate devices, machines, and systems, enabling operators to track device status, share data, and proactively determine when updates are needed. Using an embedded software agent, device properties and operating

data can be transmitted securely to the cloud. Operators can easily view device information through a web-based management console, perform diagnostics, and take prompt corrective action.

The cloud-based platform is also designed to integrate with enterprise systems that utilize or analyze data from IoT networks. Device Cloud data and event forwarding ensures that device health issues will signal other systems of potential problems, allowing them to respond accordingly and prevent ingestion of potentially bad data.

SECURE DEVICE MANAGEMENT AND MONITORING

Recent security breaches with connected field devices have brought the urgent imperative to protect connected systems to the forefront of the IoT conversation. Security is imperative for IoT applications, for the protection of the machines they control, and for the people who depend on their reliable performance. Further, an Industrial company's success hinges on securing their connected devices and their data. Effective security requires an end-to-end strategy that spans the entire application lifecycle.

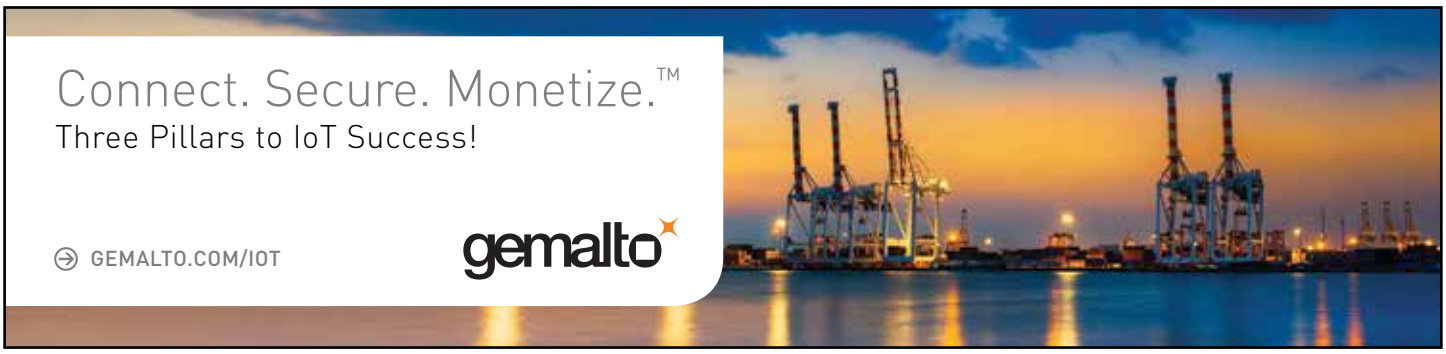
Security adds a additional layer of complexity. Without proper planning, building in security functionality can slow down development, drive up costs and, in some cases, impair the performance of a deployed application. With Device Cloud, users can build IoT applications on a platform using pre-configured, integrated software components in which many security issues have already been addressed. This takes the onus off developers to identify, source, and patch together different security technologies as development progresses, resulting in a much more efficient development process, much less system complexity, and a reduced risk of security gaps due to misconfiguration. Device Cloud includes a wide range of pre-configured features that enable developers to implement security measures across the device lifecycle at the design stage, including:

- Secure boot
- Device software update mechanism
- SPM
- Application whitelisting
- Network, data, and device encryption
- Embedded credentials and certificates
- Trusted Platform Modules
- Access permissioning
- Software isolation
- Integrity measurement

By providing pre-integrated security components, Device Cloud helps developers mitigate the risk of misconfiguration and implement security without delaying development or compromising system performance.

CONCLUSION

With IoT adoption becoming widespread, a growing number of enterprises are unlocking the valuable data generated by their everyday operations: gaining business insights, optimizing operations, improving profitability, and uncovering new business opportunities. But IoT can only be effective if connected devices are actively monitored and managed. Fortunately, technology exists that makes it easier to build that capability into IoT devices and systems. Utilizing Device Cloud, device manufacturers and IoT system developers can accelerate device deployment and close a critical gap in IoT operations, ensuring that the devices enterprises depend on for crucial business data are secure, responsive, and performing at the highest possible level.



Innovation in cellular communications: making smart meters even smarter

› Diego Grassi, u-blox

Smart metering aims to reduce energy consumption and costs, and it brings together a range of disciplines and expertise. It is a global trend where governments, regional regulatory bodies, those in the energy/utilities sectors, system integrators, design houses and original equipment manufacturers (OEMs) are involved in worldwide deployments of telemetry infrastructure. This is used by utilities in residential, commercial and industrial scenarios.

Rapid growth of smart metering

The smart metering trend started in the electricity industry, initially with traditional walk-by Automated Meter Reading (AMR). This has evolved into the rapidly expanding wider practice of Advanced Metering Infrastructure (AMI), which can enable features such as dynamic, time-of-use price plans.

Smart metering now extends to gas and water, distribution automation and new areas of telemetry, such as remote sub-monitoring of Home Area Network (HAN) devices, including Programmable Control Thermostats (PCTs).

The overall smart metering trend is primarily made possible by innovation in communication technology.

The benefits of smart metering for both consumers and utilities companies are many: automated billing, profiling of end-user usage data, revenue protection and a reduction in meter-tampering-related fraud. Innovation is also enabling new, industry-specific features that are transforming the full metering market value chain.

The benefits of smart metering

For example, smart metering deployments are the building blocks used by the electricity industry to implement outage management or grid voltage optimisation. Water companies are using them to enhance network leakage control, while in the gas sector, they're enabling the introduction of new methods of distribution.

All these technology enhancements improve the allocation of energy, reduce resource wastage and enable more accurate control of network distribution. This enables utilities to reduce their operational costs; these savings can be passed on to

consumers.

According to ABI Research, the number of smart meters deployed worldwide by 2020 will reach 780 million for electricity, 150 million for gas and 90 million for water. It's an enormous market opportunity. Central to it is the choice of connectivity technology, and this must be pre-determined before implementation, typically respecting national energy regulators' requirements.

Cellular communication: continuous innovation turns smart metering into the industrial Internet of Things

While Power Line Communication (PLC) and various versions of radio frequency (RF) radio communication technologies have historically been used for large-scale metering infrastructures, cellular communication is now the preferred choice for the lion's share of new deployments.

This is the result of government mandates, which require the use of technology based on specifications from open standards. Utilities companies are also increasingly keen to use existing public cellular networks. Doing so reduces the capital and operational cost of large-scale roll-outs, because utilities do not need to allocate resources to design, install, operate and maintain a private network. Instead, they can focus on their core business.

The advantage of cellular open standards for utilities

Cellular open standards bring additional benefits in interoperability, coverage and capacity, as well as other critical aspects, which are especially pertinent for multiservice utilities.

A good example is when AMI platforms are used by utilities that operate multiple metering applications, such as electricity, gas and water. The benefits will also be felt in situations where smart metering is paired with other municipal automation and remote monitoring systems, such as waste collection, smart parking services and other forms of urban and environmental surveillance.

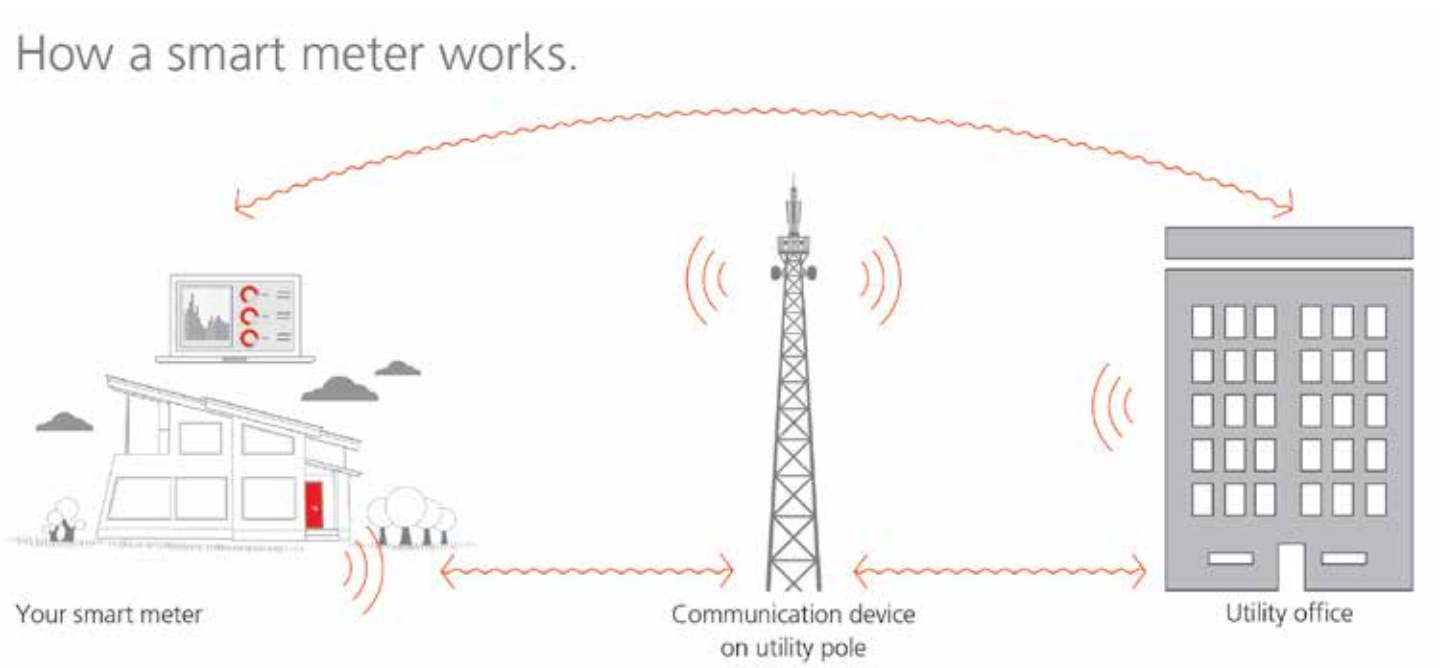
In these cases, using cellular communication makes engineers' jobs much easier than it would be if they were required to use a more niche or proprietary radio technology. Because cellular is based on open standards, it offers better interoperability between different smart metering devices and multiple OEM suppliers. Cellular technology can therefore help minimize network design complexity and secure quality of service by reducing radio signal collision and interference.

Smart metering security

Another important aspect of smart meter design is security. Security is a fast-evolving landscape and the complex IT networks that utilities companies deploy will need to operate for a very long time. Security will therefore require continued attention throughout a network's lifetime.

The 1983 WorldGames quote, "Hey, I don't believe that any system is totally secure," is not just a science fiction problem. It is not difficult to imagine a catastrophic scenario where smart meters get hacked, especially once millions are deployed and have been operating in the field for many years.

A malfunction or a malicious attack on smart meters' firmware could result in millions of devices turning off simultaneously, risking massive damage to a large region or to an entire country's grid. AMI must therefore safeguard security over



time, which is why a key requirement of smart meters is that their firmware (the embedded software that controls the smart meter) can be updated over the air (OTA).

Sending an engineer to do this would be both expensive and slow – prohibitively so in a situation where millions of meters need to be upgraded, as could be the case following a security breach. Doing the update wirelessly removes the need for a service engineer to be sent out.

An OTA firmware upgrade is typically hard to achieve in most sub-GHz low-power radio networks, which generally only support downlink rates of a few hundred bytes of information per day to each device.

Conversely, efficient wireless upgrades are possible with Firmware Over The Air (FOTA), a feature used extensively in mobile phones, and now supported in cellular machine-to-machine (M2M) technology. It enables users to update their module firmware over a carrier network.

The use of cellular technology in smart metering

Because of these inherent benefits, cellular technology is currently enjoying widespread use in smart metering deployments, providing end-to-end connectivity in metering infrastructure. A large share of residential and commercial networks are being deployed using 2G General Packet Radio Service (GPRS) solutions, while industrial smart meters are predominantly based on 3G technology.

Even when utilities deploy point-to-multipoint solutions based on short-range radio protocols (such as wireless M-Bus 169 MHz, or other proprietary Low-Power Wide-Area radio technology), cellular is still used to provide back-haul connectivity from local HAN data concentrators to the utilities' data management systems.

Cellular is also used in metering communication hubs, the so-called 'Smart Meter Gateways'. This is an AMI topology, successfully deployed or planned in many European countries and in Japan, where residential and commercial buildings use cellular to connect electricity meters or separate gateway devices to the utilities' back-haul meter data management systems. The gateway device is then used to provide connectivity through industrial, scientific and medical (ISM) wireless RF (Wireless M-Bus 868 in Europe, Wi-SUN 920MHz in Japan and ZigBee) to meters and other systems in the building.

The move to 4G LTE

Their cost-efficiency and sufficient data speeds mean 2G and 3G connectivity have been commonly used in smart meters globally. However, for future

deployments, the utility ecosystem is already transitioning to 4G LTE connectivity.

This shift is being driven by two factors. The first is the product and infrastructure longevity offered by LTE technology, and the second is the introduction of specific versions of the LTE specification, such as Category 1, Category M1 and Narrowband IoT (NB-IoT). These introduce bandwidth, latency and power consumption performance that are optimized for the use cases of AMI.

Looking ahead

The availability of proven cellular communications modules can speed time-to-market and enables the creation of innovative solutions in metering markets. Future developments, such as LTE Cat 1, Cat M1 and NB-IoT promise even more exciting advances and pave the way for the transition from basic smart metering to an era of efficient wireless connectivity between multiple new categories of smart IoT sensors. This will enable those in the utilities industry to rapidly experiment with new business models by making relatively minor investments, compared to the costs and timescales that would be involved traditionally.

u-blox has a full line-up of cellular communication modules that can enable smart metering systems globally. This includes the 2G SARA-G and 3G SARA-U product families used in gas, water and standalone electricity metering installations, alongside the LARA-R, TOBY-R, and SARA-R series, which support LTE Cat 1 and Cat M1 standards for smart gateways systems.

u-blox is committed to the smart metering market, with an ATEX-certified cellular portfolio and manufacturing based on ISO 16785 to fulfill industry-specific rugged specifications, such as for operation in environments with extreme temperatures, humidity and vibration. u-blox has also been a thought leader with the introduction of NB-IoT, a technology that improves coverage and signal penetration, while extending the battery life of deployed smart meters. It simplifies the design, operation and maintenance of smart metering networks and grids, thereby helping reduce the total cost of smart metering roll-outs.

Diego Grassi joined the Product Strategy team in the Product Center Cellular at u-blox AG in July 2014. He is responsible for the development of Industrial, Retail & Enterprise markets.

Prior to joining u-blox, he held positions in product marketing, business development and strategic marketing in Semiconductors companies such as Micron, Numonyx and STMicroelectronics. There, he managed multiple demand generation and ecosystem enabling programs at worldwide level in the segments of telecom, consumer and industrial electronics.

Diego Grassi has a technical background in industrial electronics and holds a university degree with a focus on economics of the information.

Moon rover Audi lunar quattro featured in "Alien: Covenant"

The moon rover Audi lunar quattro celebrates its film debut in Ridley Scott's sci-fi blockbuster "Alien: Covenant" which premieres worldwide this May. Audi experts have developed the Audi lunar quattro in cooperation with the German start-up "Part-Time Scientists". It will soon embark on an actual mission to space.

Director Ridley Scott has integrated the Audi lunar quattro into "Alien: Covenant," a new chapter in his groundbreaking "Alien" franchise. The crew of the colony ship Covenant, bound for a remote planet on the far side of the galaxy, discovers what they think is an uncharted paradise, but is actually a dark, dangerous world. When they uncover a threat beyond their imaginations, they must attempt a harrowing escape. In its film debut, the Audi lunar quattro is an integral part of the Covenant mission and is deployed to help Faris (Amy Seimetz) navigate and assess the challenging, unknown terrain of a new planet.

Incorporating the Audi lunar quattro into the film is part of the collaboration between Twentieth Century Fox and Audi. "The 'Alien' franchise is the best way for us to garner suitable attention for the moon rover developed by Audi, and to showcase Audi's intelligent technologies in a visionary environment," explains Giovanni Perosino, Vice President International Marketing Communication at Audi.

"Fox's partnership with Audi on 'Alien: Covenant' is an opportunity to bring to the forefront the innovative work Audi is doing in exploration," said Zachary Eller, Senior Vice President Marketing Partnerships at Twentieth Century Fox. "We're happy to continue

our long relationship with Audi that has allowed our filmmakers to incorporate authentic, leading-edge technology into their futuristic worlds."

As part of the collaboration, a short film created by Twentieth Century Fox, 3AM and Audi was captured on one of the movie's biggest sets. It shows the Audi lunar quattro patrolling the Terraforming Bay when it detects an unidentified lifeform and goes to investigate what lurks in the dark. Watch "Alien: Covenant x Audi lunar quattro" here: http://youtu.be/5fEmCnStgac

The Audi lunar quattro is preparing for an actual mission to the Moon. Since 2015, the premium manufacturer from Ingolstadt has worked with a team led by Robert Böhme, founder and CEO of "Part-Time Scientists", on developing the rover. Audi experts have supported the Berlin-based start-up, in particular with Audi's all-wheel drive expertise (quattro technology), expertise in lightweight construction, experience in developing vehicles with electric and plug-in hybrid motors (e-tron), and with design optimization.

By selecting the finest materials, the developers have managed to reduce the weight of the exploration vehicle to just 30 kilograms. The Audi lunar quattro is 85 percent aluminum, produced by the 3D metal printer at Audi's headquarters in Ingolstadt. A pivoting solar panel supplies the rover with energy. On top of that, you have intelligent quattro drive technology and the efficient e-tron motor. The car manufacturer's Mission to the Moon is nearing completion: In the very near future, we can expect to see the advanced Audi lunar quattro set its course for the Moon.

For more on the story of the Audi lunar quattro's origins and the cooperation with Twentieth Century Fox, visit on www.audi.com/mission.

Top Image: In its film debut, the Audi lunar quattro is an integral part of the Covenant mission and is deployed to help navigate and assess the challenging, unknown terrain of a remote planet.

New family of maXTouch® touchscreen controllers designed for large-screen automotive HMI designs

Microchip announces a new family of maXTouch® touchscreen controllers. The MXT1665T-A family of automotive-qualified touchscreen controllers is designed for large-screen automotive Human Machine Interface (HMI) designs. The technology brings multi-touch HMI, such as that experienced on a mobile phone, to car drivers and passengers on screen sizes from 8 to 15 inches.

The MXT1665T-A family features Microchip's adaptive touch technology that uses self-capacitive touch as well as mutual-capacitive touch scanning. This combination provides a multi-touch experience even through thick cover lenses, thick gloves or in the presence of moisture and water. The product family is fully AEC Q100-qualified to address the unique needs of automotive system designs.

The family complements the successful MXT641T-A family of products and shares many of the same features developed for the automotive industry. It also supports larger screen sizes above 10 inches in addition to smaller multi-finger pinch separation.

The wide range of screen size options within Microchip's touchscreen controller families enables greater scalability and helps to shorten design time as well as lower system and development costs.

The MXT1665T-A family consists of three controllers: the MXT1665T-A supports 1664 touch-node sensors; the MXT1189-A supports 1188 touch-node sensors; and the MXT799T-A with support for 798 touch-node sensors.

A designated evaluation kit is available for each of the parts in the MXT1665T-A family. Each kit includes a PCB with maXTouch controller; a touch sensor on a glass/plastic lens; the FPC to connect to the sensor display; a converter PCB to connect this kit to the PC via USB; and cables, software and documentation. The controllers are also compatible with maXTouch Studio, a full software development environment to support the evaluation of maXTouch.

All the devices in the MXT1665T-A family are available now for sampling and volume production in a LQFP176 package.

For more information, visit Microchip's Web site at: http://www.microchip.com/MXT1665T_Main7302

Renesas Electronics Unveils the Renesas Autonomy™, Open, Innovative and Trusted Platform to Further Extend its Commitment to ADAS and Automated Driving

Delivers Total End-to End Solution that Scales from Cloud to Sensing and Vehicle Control

– The First Rollout of Renesas Autonomy Product, the R-Car V3M System-On-Chip, Provides Cutting Edge Capabilities for Smart Cameras Targeting NCAP Regulations

Renesas Electronics Corporation (TSE: 6723), a premier supplier of advanced semiconductor solutions, today announced the launch of Renesas autonomy™, a new advanced driving assistance systems (ADAS) and automated driving platform. As the first rollout under its groundbreaking Renesas autonomy Platform, Renesas released the R-Car V3M high-performance image recognition system-on-chip (SoC) optimized primarily for use in smart camera applications, as well as surround view systems or even lidars. The new R-Car V3M SoC complies with the ISO26262 functional safety standard, delivers low-power hardware acceleration for vision processing, and is equipped with a built-in image signal processor (ISP), freeing up board space and reducing system manufacturers' system costs.

Renesas will exhibit its first Renesas autonomy demonstrator, developed based on the new R-Car V3M SoC, at DevCon Japan to be held in Tokyo Japan on April 11, 2017.

About the Renesas autonomy Platform

Vehicles in the autonomous driving era will be required to sense the environment, control the vehicle, and conduct synchronized communications with the cloud. A wide range

of technologies is necessary to realize these functions and each technology needs to maintain high reliability to synchronize without any flaws. At the same time, these technologies are continuously advancing, which is why there is a growing demand for a total end-to-end solution.
Renesas launched the new “Renesas autonomy” platform, leveraging its long-standing experience and expertise in the automotive market as the leading automotive semiconductor supplier. Renesas autonomy is an open, innovative and trusted platform for ADAS and automated driving, consisting of Renesas’ sustainable and scalable SoC and microcontroller (MCU) roadmaps. Renesas is the only automotive semiconductor supplier in the industry to cover end-to-end solutions from secure cloud connectivity and sensing to vehicle control. Renesas’ groundbreaking platform further extends its commitment to ADAS and automated driving. The platform also gives system manufacturers access to Renesas’ expanding ecosystem of partners for ADAS and automated driving technologies, thereby improving development efficiency and speeding their time to market.

NXP Accelerates Automotive Software Design with the New S32K Microcontroller Platform Launch

Today launched the S32K1 family combining a breakthrough suite of automotive grade tools and software in support of a scalable family of ARM Cortex-based MCUs with future-proof features. This combination drastically reduces development effort and time to market in a broad range of automotive applications. With 10 of the top 15 global car manufacturers already using S32K in next-generation vehicles, this platform sets the future direction of automotive ECU development.
The traditional approach for software development has been to rely on AUTOSAR for automotive-grade drivers, however, not all applications require it. The alternative route is self-development, which is labor-intensive, adds qualification requirements and diverts critical resources. As ECU complexity increases, maintaining high-quality software and meeting time-to-market requirements can only be achieved through use of mature, validated sub-system components.
Minimized software complexity
NXP is utilizing its 15+ years of experience in delivering professionally maintained automotive-grade software to minimize development complexity for a broad range of customers regardless of their development approach.
In applications where the use of AUTOSAR is not mandated, NXP is providing an alternative, turn-key option for self-development with a free-of-charge, pre-qualified, automotive-grade software development kit (SDK) that enables rapid prototyping with simple drag and drop functionality. It includes:

- MISRA and SPICE Level 3 compliant low-level drivers (LLDs) for all peripherals
- Optional application-specific middleware for LIN, NFC and touch sensing
- FreeRTOS® operating system
- Drivers for complementary NXP ICs for faster application bring-up and production readiness e.g. system basis chip (SBC) drivers
- Documented source code and out-of-the-box examples eliminating the need for device documentation during application bring-up

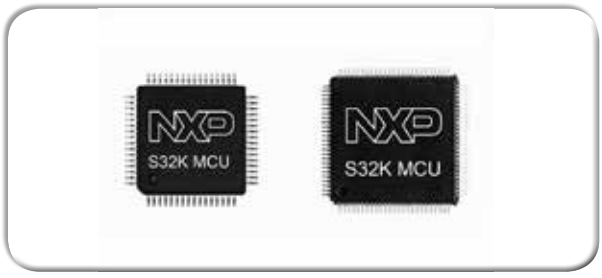
The SDK is pre-installed in NXP’s free S32 Design Studio (DS), an Eclipse-based integrated development environment (IDE) supporting multiple compiler and debugger options.
For AUTOSAR applications, NXP standard MCAL and OS support has been expanded with new Complex Device Drivers (CDD) and a new S32K starter kit from ARCCORE®, significantly lowering cost and complexity barriers to adoption. It is available free of charge for evaluation.
Future-proof hardware
Unlike existing solutions that require multiple MCU platforms to cover a similar range, the initial S32K1 family will span 128KB-2MB of flash memory based on high performance ARM Cortex-M cores. All family members include ISO CAN FD, CSEc hardware security, ASIL-B support and ultra-low-power performance. This scalable approach, combined with a common package strategy and production grade software, maximizes reuse allowing customers to react quickly to changing market requirements.
Quotes

"S32K marks an inflection point in NXP's automotive MCU strategy," said Manuel Alves, General Manager GPIS products in NXP's Automotive Microcontroller and Processors Business Line. "We are transitioning from multiple proprietary architectures to a continuous ARM Cortex MCU portfolio combining future-proof hardware with software differentiation."

"The S32K's software and tool support from NXP and multiple ARM ecosystem partners, enables fast time-to-market for developers of all experience levels," said Paul Lee, Global Distribution Marketing Manager for NXP's Automotive Microcontroller and Processors Business Line. "Furthermore, the significant investment in automotive-grade software sets a new standard for an MCU supplier."

Availability

S32K144 samples and a $49 development board are now available with production scheduled for the second quarter of 2017. S32K MCUs are included in NXP's Product Longevity Program which assures supply for a minimum of 15 years. For more information visit www.nxp.com/S32K.



ON Semiconductor Unveils Innovative Modular Automotive Imaging Platform

ON Semiconductor (NASDAQ: ON), driving energy efficient innovations, has introduced the Modular Automotive Reference System (MARS) that gives system and software developers a ready-to-use camera for research and development activities. The leading-edge MARS platform enables users to reconfigure cameras with different lenses, image sensors, image signal processors (ISPs) and communications options for rapid prototyping and experimentation. The system is so flexible that it can be used for the full spectrum of automotive camera applications including advanced driver assistance systems (ADAS), surround and rear viewing systems, in-cabin cameras (for gesture recognition, driver eye monitoring, or light level inspection purposes), and autonomous driving.

MARS enables shorter design cycles, reduced engineering costs, and assists automotive design teams in the implementation of imaging systems by providing them with a unique mix-and-match solution. Through it, various items of hardware can be combined in a robust and highly adaptable system with a compact form-factor. Due to the many different boards available, engineers have access to ON Semiconductor's broad portfolio of image sensors and co-processors, plus various automotive communications protocols from a select group of third party supply partners. This provides extensive scope in terms of finding the combination that best fits specific system requirements. The versatile platform can accommodate an almost limitless number of combinations due to consistent signal/power definitions for the interconnects utilized by these respective boards.

The ease of adapting this modular solution means that undertaking time-consuming activities such as creating custom boards (each capable of accommodating a different sensor option), testing out high-speed interface standards, or writing code for drivers, is no longer necessary. MARS is supported by a complete ecosystem, encompassing software development tools, schematics, gerbers, bill-of-materials (BOM) and much more. A comprehensive user guide is also included within the accompanying documentation.

"As image sensing proliferates in automotive applications, MARS will provide system and software developers tasked with turning concepts into reliable working applications with a valuable platform to simplify and speed proof of concept and development, and offer the scalability to get ideas from the lab to on-vehicle testing in real-world conditions," said Ross Jatou, General Manager and Vice President of Automotive Solutions Division of Image Sensor Group at ON Semiconductor. "The flexibility of MARS accelerates the component selection process by making the constituent sensors and co-processors totally interchangeable. The platform avoids the need to construct a multitude of custom boards to house different sensors for evaluation reducing engineering effort and shortening project times."

The support of commonly used communication standards (such as GMSL, FPD-Link, LVDS, MIPI, Ethernet) enables direct interfacing with existing vehicle electronic control units (ECUs). ON Semiconductor is working with an ecosystem of partners spanning lens developers, third

party ISP vendors, communications IC vendors, software developers and SoC vendors. MARS modules are already prequalified with a range of these third party products and the company will expand these offerings going forward.

Analog Devices' Wideband RF Synthesizers Feature System Size Reduction, Design Versatility, and Excellent Performance to 13.6 GHz

Analog Devices, Inc. announced the ADF5356, a 13.6 GHz next-generation wideband synthesizer with integrated voltage-controlled oscillator (VCO) which targets applications such as wireless infrastructure, microwave point-to-point links, electronic test and measurement, and satellite terminals. A complimentary synthesizer product, the ADF4356, operates to 6.8 GHz and is comparable in performance.

The ADF5356 generates RF outputs from 53.125 MHz to 13.6 GHz without any gaps in frequency coverage, which allows the device to be used as a multiband synthesizer, thus eliminating the need for multiple band-specific VCOs/synthesizers products and thereby reducing component count, board space, and power. The wideband range is achieved without compromising performance, since the ADF5356 offers superior PLL figures of merit (FOM), ultra-low VCO phase noise, very low integer-boundary and phase-detector spurs, and high phase-comparison frequency.

Developed on ADI's proprietary advanced SiGe BiCMOS process, the ADF5356 and ADF4356 feature industry leading VCO phase noise (-113 dBc/Hz @ 100 kHz offset at 5 GHz) with integrated rms jitter of just 97 fsec (1 kHz to 20 MHz) and integer-channel noise floor of -227 dBc/Hz. The phase detector spurious levels are below -85 dBc typical, and the phase detector comparison frequency can be as high as 125 MHz.

These RF synthesizers are easy to design-in, and fully supported by the ADIsimPLL, Analog Devices' comprehensive and easy to use PLL synthesizer design and simulation tool for assessing phase noise, lock time, jitter and other design considerations. To provide an upgrade path for designers, the synthesizers are pin-compatible with Analog Devices' existing ADF5355 and ADF4355 devices.

The ADF5356 and ADF4356 are specified over the -40°C to +85°C range. They operate from nominal 3.3-V analog and digital power supplies as well as 5-V charge-pump and VCO supplies, and feature 1.8-V logic-level compatibility.

Analog Devices' MEMS Accelerometers Provide Low Power Vibration Measurements, Enabling Wireless Condition Monitoring

Analog Devices, Inc. (ADI) today announced the addition of two devices to its popular series of low noise, low drift, low power, three-axis MEMS accelerometers. The low noise performance over high frequencies provided by the new ADXL356 and ADXL357 MEMS accelerometers delivers high resolution vibration measurements that enable the early detection of machine failure in condition monitoring applications. This performance comes with very low power consumption, making the ADXL356 and ADXL357 ideal for wireless sensor networks. These new MEMS accelerometers are also designed to provide accurate and reliable tilt measurements for environments high in shock and vibration without saturating the sensor, an important requirement for tilt measurement applications on heavy equipment or airborne platforms such as unmanned

aerial vehicles (UAVs). The ADXL356 and ADXL357 MEMS accelerometers are the latest examples of high performance sensor technology from Analog Devices that provides high-quality data for Internet of Things (IoT) applications and enables intelligent sensing from the edge of the network.

The analog output ADXL356 and the digital output ADXL357 three-axis accelerometers provide selectable measurement ranges of ±10 g, ±20 g and ±40 g for greater flexibility. The ADXL356 and ADXL357 also offer industry leading noise density of 80 µg/root Hz, with guaranteed maximum 0 g offset drift over temperature of 0.75 mg/C, enabling precision applications with minimal calibration. In addition, the hermetic package helps ensure that the end product conforms to its repeatability and stability specifications long after it leaves the factory. Highly integrated in a compact form factor, the low power ADXL357 requires only 200 uA, extending the life of battery powered applications including wireless networks for condition monitoring, airborne platforms such as UAVs or IoT applications.

For More Robust Mounting – ON Semiconductor's Python 2000 and 5000 Sensors, Now With LGA Packages

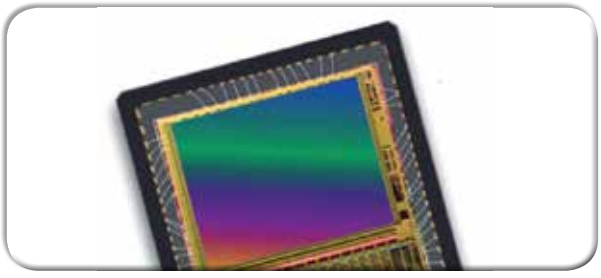
ON Semiconductor has brought out versions with 128-pin LGA packages for its popular CMOS sensors, the Python 2000 and Python 5000. This makes the sensors especially suitable for mounting in applications in rough surroundings subject to heavy movements. The new Python variants are available from FRAMOS, the image processing specialist.

The Python family from ON Semiconductor is particularly suitable for Machine Vision applications, Intelligent Traffic Systems (ITS) and inspection applications that require a high image quality and high speeds using a state-of-the-art CMOS global shutter. The new versions of the Python 2000 and 5000 (2 megapixels and 5 megapixels) are now also available with LGA packages as connecting and mounting variants. The LGA packages have very flat contact surfaces on the underside of the image sensor and, in combination with flexible bases, exert less mechanical stress on the PCBs during installation and removal of the sensor contacts. The LGAs can also be soldered directly in place for even more stable integration.

FRAMOS sensor expert Sibel Yorulmaz-Cokugur explains the advantages: "The new 128-pin LGA packages reduce sensor wear and prevents any damage. The improved heat dissipation compared to PIN packages keeps the sensor cooler and produces less thermal noise. This ensures a longer service life and lasting image quality, especially when using the sensors in rough conditions."

The highly compact and flat LGA packages also require less space in the PCB design. This allows for more compact vision systems, greater mounting density, or more integrated functionality on the PCB itself. The direct connection on the underside of the sensor means the LGAs also have a lower impedance and are therefore less prone to faults as well as providing better electrical performance.

The industry and product experts at FRAMOS use their specialist knowledge of sensors and systems to help customers integrate new sensors into their applications and projects with additional services such as development support, customer-specific adaptations and logistics services. For sensor fitting, FRAMOS provides advice on the most compatible base, e.g. from ANDON, and all other components.



High Gain Wideband RF Power Amplifier ICs

Solid State Supplies continues to strengthen its product portfolio relating to advanced analogue technology through its partnership with CML Microcircuits. Delivering heightened levels of operational performance, while still remaining very cost effective, the CMX901 is a 3-stage RF power amplifier that is optimised for VHF/UHF radio deployments. Requiring a single polarity 2.5V to 6V supply, this device is capable of covering a frequency range from 130MHz to 950MHz. It can attain 40dB gain, as well as power efficiency figures of up to 60%. At 160MHz, when 4V is applied, it provides a typical power output of 2.5W.

A working temperature range of -40°C +85°C enables this device to be deployed in demanding industrial environments, while its compact 5mm x 5mm form factor makes it highly appealing for applications where board space is limited. Among its key uses are in data logging equipment, marine VHF communications systems, automatic meter readers, industrial IoT equipment, mesh/MANET networking infrastructure, remote monitoring systems and RFID readers/writers. Input and output matched circuits are implemented through external components, in order to allow power and efficiency parameters to be adjusted to meet specific application requirements. Also available through Solid State Supplies to accompany the CMX901 power amplifier is the EV9011 evaluation board (which is offered in 3 different frequency band variants).

For more information please visit: www.sssltd.com/products/1350-cmx901-rf-power-amplifier.html

Littelfuse Introduces Three New Series of PolySwitch AEC-Q200 Qualified Resettable PPTC Devices for Automotive Applications

the global leader in circuit protection, today introduced three series of PolySwitch AEC-Q200 qualified resettable Polymeric Positive Temperature Coefficient (PPTC) devices. These surface mount devices are designed for robust overcurrent protection in extremely harsh automotive environments. Unlike fuses, resettable PPTCs do not require replacement after a fault event; they allow the circuit to return to the normal operating condition after the power has been removed and/or the overcurrent condition is eliminated.

The largest of the new devices, the 2920-size ASMDC Series, has a lower profile compared to existing 2920 size ASMD series surface mount PPTCs, and no heavy metal terminals. It also offers the highest holding current and voltage rating of the three. The two smallest of these new devices, the 0603-size femtoASMD Series and the 0805-size picoASMD Series, are ideal for applications in crowded automotive electronics boards.

Typical applications for the ASMDC, femtoASMD, and picoASMD Series Resettable PPTCs include automotive infotainment, communications (GPS navigation), network (CAN Bus, LIN bus), body electronics (door locks, lumbar pumps), security (keyless entry, rearview camera), ADAS (advanced driver assistance system) and climate control systems.

“The choice of compact footprint or low profile packaging combined with AEC-Q200 qualification make these SMD resettable PPTCs ideal for overcurrent and short-circuit protection under the hood,” said Yong Zhang, product manager, PPTC Devices at Littelfuse. “Together, they extend the wide range of form factors, operating currents, and voltage ranges Littelfuse offers, and give automotive electronics designers greater design flexibility.”

PolySwitch ASMDC, femtoASMD, and picoASMD Series Resettable PPTCs offer these key benefits:

Smaller-footprint picoASMD Series and femtoASMD Series devices provide a wider range of form factors to enhance design flexibility.

Low-profile ASMDC Series products help circuit designers meet the ever-increasing demand for compact and space-saving designs as the amount of electronics content in vehicles grows.

Resettable solutions designed to guard against overcurrents and short circuits in automotive circuitry restore systems to

operation after the fault condition is resolved, for greater safety, convenience and protection.

AEC-Q200 qualified, ISO/TS16949 certified devices meet the most stringent requirements to withstand harsh automotive environments.

Availability

Surface mount PolySwitch ASMDC, femtoASMD, and picoASMD Series Resettable PPTCs are available in tape and reel packaging in quantities of 4,000 or 3,000. Sample requests may be placed through authorized Littelfuse distributors worldwide. For a listing of Littelfuse distributors, please visit Littelfuse.com.

High Performance 5.1 Megapixel Imaging Solution for High-End Security Camera Applications

ON Semiconductor (Nasdaq: ON), driving energy efficient innovations, has unveiled AR0521 CMOS image sensor – the first imaging product based on a 2.2 micrometer (µm) Back Side Illuminated (BSI) pixel technology platform targeted specifically at security and surveillance applications.

The AR0521 is a small optical format 1/2.5-inch (7.13mm), 5 megapixel (MP) digital image sensor with an active pixel array of 2592 (H) x 1944 (V). It captures images in either linear or high dynamic range (HDR) modes with rolling-shutter readout, and includes sophisticated camera functions such as binning, windowing, and both video and single frame modes.

The advanced imaging solution offers 8, 10, or 12-bit outputs and boasts excellent video performance at 5MP 60 frames per second (fps) with a 1440p mode for 16:9 video. The superior low-light performance – often an important requirement in security camera applications – is largely due to the larger 2.2 µm BSI pixel that offers higher linear full well and lower noise than a smaller pixel.

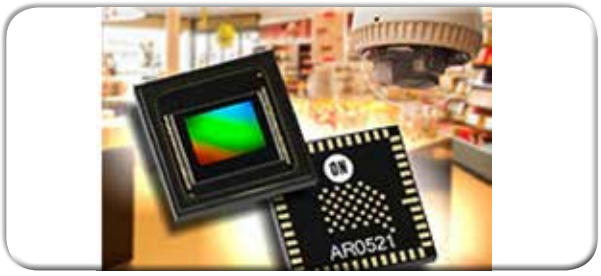
Incorporating both an electronic rolling shutter and global reset release, the AR0521 also offers advanced line synchronization controls for multi-camera (stereo) support. The ability of the AR0521 to produce extraordinarily clear and sharp images is enhanced by sophisticated digital processing functions, including integrated color and lens shading correction, digital gain and dynamic defect correction.

Primarily aimed at remote video surveillance applications, the AR0521 consumes very little power even when operating at full resolution of 60 fps at 10-bit output. The operating temperature range of -30°C to +85°C ambient allows the device to be used successfully outdoors in harsh environments.

“The ability to deliver high resolution, high quality video feeds in low-light conditions is becoming increasingly important in many applications,” said Gianluca Colli, Vice President and General Manager of Consumer Solutions Division, Image Sensor Group at ON Semiconductor. “This new device pushes the performance boundaries and will enable the development of enhanced indoor and outdoor security systems. Particularly key to its success will be the higher resolution that does not impact low light performance and the ability to generate high dynamic range output at frame rates of 30 fps.”

As a result of the programmable optical format (4:3, 16:9 & 1:1) the AR0521 is suitable for multiple use cases in mid- to high-end security applications including panoramic security cameras, birdseye security cameras, long range security cameras and speed dome security cameras.

The AR0521 is available today in mPLCC (12 x 12 mm) package. Visit AR0521 image sensor product page to learn more and order engineering samples or evaluation board.



New logic level MOSFETs in PQFN package deliver high power density

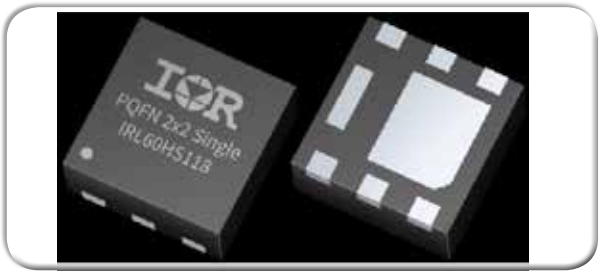
Infineon Technologies AG (FSE: IFX / OTCQX: IFNNY)

introduces a new logic level IR MOSFET™ family. It comprises three different voltage classes, 60 V, 80 V, and 100 V. The new devices are available in a 2 mm x 2 mm PQFN package which is perfect for form-factor critical wireless charging, adapter, and telecom applications. The small package size enables higher power density and improved efficiency. At the same time it is saving space, reducing parts count, and reducing overall system cost.

The new IR MOSFET devices in the PQFN package deliver between 11 and 40 percent lower R DS(on) than competitive products. The ultra-low gate charge (Q g) reduces switching losses without increasing conduction losses. In addition, the output capacitance (C OSS) and reverse recovery charge (Q rr) have been optimized, the FOM g (R DS(on) x Q g/gd) improved. This allows the IR MOSFET devices to operate at high switching frequencies of up to 6.78 MHz – as required in resonant wireless charging applications. The logic level gate drive provides a low gate threshold voltage (V GS(th)) which means that the MOSFETs can be driven at 5 V and directly from microcontrollers.

Availability

The IR MOSFET family is available now in 60 V and 80 V, with a 100 V device in development. Further information is available at www.infineon.com/IR-MOSFET-logiclevel.



Next-Generation Automotive Door-Zone Controllers from STMicroelectronics Bring Power Management and Failsafe Circuitry On-Chip

STMicroelectronics has advanced the state of the art in automotive door-zone controllers with a new family of monolithic devices that integrate power-management and failsafe circuitry previously implemented using external devices.

The new L99DZ100G/GP for front-door applications and L99DZ120 for rear-door controls enable designers to save space as well as boost reliability and energy efficiency. With the added advantage of software compatibility between the family members, they also help simplify development and accelerate time to market.

ST's advanced, proprietary BCD8S automotive technology provides the key to achieving this unique single-chip solution that meets power-management and failsafe demands in door-zone applications with features that include embedded Half-bridge and high-side drivers up to current ratings of 7.5A. There are also High-Speed CAN (HS-CAN) and LIN 2.2a (SAE J 2602) interfaces, control blocks, and protection circuitry. The L99DZ100GP adds support for ISO 11898-6 HS-CAN selective wake-up that maximizes energy savings by allowing infrequently-used Electronic Control Units (ECU) to remain powered down while connected to the CAN bus.

Both front-door controller variants integrate MOSFET Half-bridges for driving up to five DC motors and can also drive an external H-bridge. In addition, there are eight LED drivers and a further two drivers for bulbs, a gate driver for a mirror heater, and a control module for electro-chrome glass. Voltage regulators for external circuitry such as a microcontroller and sensors, as well as associated timers, watchdogs, reset generators, and protection are also provided. The L99DZ120 contains similar features, tailored to requirements for rear doors, including motor drivers for electric windows.

Further value-added features include automatic LED duty-cycle compensation to ensure consistent brightness as the vehicle supply-voltage (VS) fluctuates. In addition, innovative thermal clusters allow outputs to be disabled individually if an event such as a short-circuit occurs. This enables unaffected outputs to operate normally, ultimately delivering a superior end-user experience.

The L99DZ100G/GP and L99DZ120 are in production now, packaged as LQFP64 devices. Please contact your local ST sales office for pricing and more information.

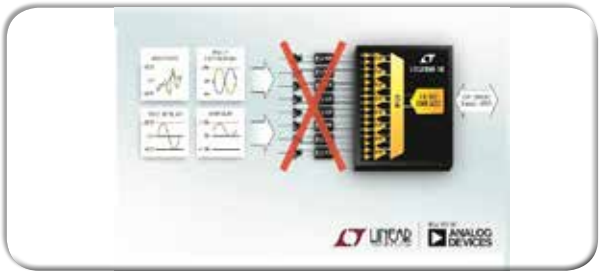
Buffered 18-Bit Octal ADC with Picoamp Inputs Shrinks Solution Size

Analog Devices, Inc., which recently acquired Linear Technology Corporation, announces the LTC2358-18, an 18-bit, 8-channel simultaneous sampling successive approximation register (SAR) ADC featuring integrated picoamp input buffers. With board real estate at a premium, the LTC2358-18 brings substantial space and cost savings by eliminating front end signal conditioning circuitry normally required to drive unbuffered switched-capacitor ADC inputs. The combined component savings of three amplifiers, six resistors and two capacitors for each channel, a total of 88 components over 8 channels, saves BOM cost and significant board space and provides over 40% savings in power consumption. Picoamp inputs and 128dB CMRR over a 30VP-P common mode range enable the LTC2358-18 to directly connect to a wide range of sensors without compromising measurement accuracy.

While converting eight channels at 200ksps per channel throughput, the LTC2358-18 provides added flexibility via independently configurable SoftSpan™ input ranges. Each channel can be programmed on a conversion-by-conversion basis to accept ±10.24V, 0V to 10.24V, ±5.12V, or 0V to 5.12V unipolar, true bipolar, fully differential or arbitrary input signals. The differential analog inputs operate over a wide 30V input common mode range, allowing the ADC to directly digitize a variety of signals while simplifying the signal chain design. The input signal flexibility, combined with unrivaled ±3.5LSB maximum INL, no missing codes at 18 bits, and 96.4dB SNR, makes the LTC2358-18 ideal for high performance industrial process control, test and measurement, power line monitoring and motor control applications.

The LTC2358-18 features a precision internal reference with 20ppm/°C maximum temperature coefficient and an integrated reference buffer capable of accurate one-shot measurements, providing space savings in densely packed circuit boards. Optionally, an external 5V reference can be used to expand the analog input range to ±12.5V. The device dissipates 219mW when converting eight channels simultaneously at 200ksps per channel, and features nap and power-down modes to reduce power dissipation at slower throughputs.

In addition to its unique analog characteristics, the LTC2358-18 offers unmatched digital flexibility, featuring pin-selectable SPI CMOS and LVDS serial interfaces. The wide digital output supply range allows the device to communicate with any CMOS logic between 1.8V and 5V. In CMOS mode, applications can employ between one and eight lanes of serial output data, enabling the user to optimize bus width and data throughput. LVDS mode offers low noise, high speed communications over greater distances using differential signaling. Together, these I/O interface options enable the LTC2358-18 to communicate equally well with legacy microcontrollers and modern FPGAs.



Teledyne e2v launches new OctoPlus line scan cameras for Optical Coherence Tomography

Teledyne e2v, the global innovator of imaging solutions, has developed a new range of line scan cameras for Optical Coherence Tomography (OCT) applications in healthcare and industrial markets. The new OctoPlus range will have an immediate impact in ophthalmic OCT by reducing patient examination times and increasing the field of view available to practitioners when carrying out non-invasive eye examinations.

OctoPlus was developed following discussions with doctors and medical industry professionals. It is based on new image sensor pixel architecture and is specifically tuned to provide users with the most accurate images of the retina and cornea; mapping tissue structure, measuring thickness and visualising

blood flow dynamics for diagnostics.

OctoPlus will benefit patients, doctors and OCT equipment manufacturers by increasing patient comfort during eye tests, reducing examination time and enabling doctors to make more timely decisions. For doctors, OctoPlus will more than double the eye surface captured in a single scan without sacrificing resolution, and will improve confidence in the diagnosis protocol. This will lead to more effective treatment decisions based on OCT angiography and will allow for earlier detection of peripheral pathologies like diabetic retinopathy.

Specific advantages of OctoPlus include a 250 percent larger field of view compared to the Food and Drug Administration (FDA) approved commercial Swept Source OCT (SS-OCT) and a +5dB signal-to-noise ratio (SNR) in comparison with equipment currently available in Spectral-Domain OCT (SD-OCT).

A further benefit of OctoPlus is that it saves 60 percent of the power used by previous designs. This reduces heat generation, improves the stability of OCT equipment and increases maintenance intervals.

François Thouret, President of Professional Imaging at Teledyne e2v, said, "OctoPlus is a very exciting technology development for OCT. Within the next year, doctors will have wider access to functional imaging, which will benefit both patients and healthcare systems. Thinking beyond existing OCT markets, our ambition is to collaborate with partners to develop further innovation in OCT for emerging applications like neurology and dermatology."

The launch of OctoPlus follows the introduction of Teledyne e2v's ADQ14OCT, the first 14bit digitizer for SS-OCT, enabling high speed and high depth imaging.

STMicroelectronics' Chips Stand Guard in Haltian's Trackerphone for Children and Seniors

Motion-sensing and data-processing chips from STMicroelectronics (NYSE: STM), a global semiconductor leader serving customers across the spectrum of electronics applications, help increase family safety in the Snowfox trackerphone, a two-way portable communication device with locating capabilities designed for children and seniors by Haltian, a Finnish design and engineering start-up.

The matchbox-sized, easy-to-carry trackerphone maps its wearer in real time in addition to letting you reach them by calling. A simple one-button control on the device prompts notifications and call requests to family members, who can monitor their loved ones through a free smartphone app that offers various map views, location history, and event timeline.

ST's MEMS accelerometer inside the trackerphone detects the user activity to start the location measurements while the ultra-low-power STM32 microcontroller makes sure everything works reliably on minimal energy use. The outstanding real-time performance and power efficiency of ST chips gives Snowfox users the perfect balance of functionality and battery life.

"You simply cannot make compromises when you design a personal safety device," said Pasi Leipälä, CEO and co-founder, Haltian. "Based on our extensive study of different manufacturers and their solutions, we chose an ultra-low-power STM32 microcontroller for its perfect combination of power conservation, rich set of peripherals, and optimum package size. Similarly, the ST accelerometer scored best for us in power consumption and performance."

"The Snowfox trackerphone enables children and seniors to remain active and stay connected, giving their family members peace of mind in keeping their loved ones safe," said Iain Currie, Vice President North Europe Sales, STMicroelectronics. "Haltian's decision to rely on ST's high-performance, ultra-low-power chips confirms our enabling role in the development of innovative applications that help people get more from life."

ST's state-of-the-art technologies have also contributed to the success of Haltian's hardware prototyping

platform, Thingsee One, for creating new IoT (Internet of Things) products and services.

Maxim's PMIC Reduces Solution Size By 50% for Wearable Medical and Fitness Applications

Designers of primary cell wearable medical and fitness applications can now significantly reduce solution size by 50% and extend battery life with the MAX20310 ultra-low quiescent current (IQ) power management integrated circuit (PMIC) from Maxim Integrated Products, Inc. (NASDAQ: MXIM). The wearable PMIC supports a low input voltage of just 0.7V for new high-energy density battery architectures such as Zinc Air and Silver Oxide, as well as the more common Alkaline battery architecture. With personal and remote monitoring gaining traction, reducing size and extending battery life are critical benefits. For example, a report by Allied Market Research projects that the global remote patient monitoring market is expected to grow at a compound annual growth rate (CAGR) of 17% to reach $2.13 billion by 2022.1

There are several factors to consider when designing for wearable medical and fitness applications, including ultra-small form factor and longer battery life. However, designers typically need discrete components to build a sophisticated power tree which can take up precious board space, consume high quiescent current, and burn through battery life when the device is in sleep mode. In clinical environments, there are additional challenges since rechargeable solutions involve contacts, clips, and charging ports where germs may linger.

Using a novel single-inductor multiple-output (SIMO) architecture, the MAX20310 integrates four power outputs from a single inductor each with ultra-low quiescent current performance. This high integration reduces solution size by half over comparable discrete solutions, consuming over 40% less quiescent current and improving battery life as a result. In clinical environments, primary cell architectures can create hermetically sealed units to safely disinfect between use or even dispose of completely to inhibit patient-to-patient infection. The MAX20310 is ideal for applications such as non-rechargeable medical patches, environmental and equipment monitoring, and discrete sensors for industrial internet of things (IIoT). Operating over the -40-degree Celsius to +85-degree Celsius temperature range, the MAX20310 is available in a small, 1.63mm x 1.63mm wafer-level package (WLP).

Key Advantages

Small Solution Size: Available in a SIMO dual buck-boost architecture with single external inductor; Reduces solution size by 50% compared to discrete solutions

Versatile Architecture: Supports Zinc Air, Silver Oxide, and Alkaline battery systems with low input voltage of 0.7V to 2V

Longer Battery Life: Consumes 40% lower quiescent current during sleep or standby mode compared to discrete solutions

Commentary

"This ultra-small wearable PMIC allows for patient comfort, particularly when it comes to devices which must be worn 24 hours a day, 7 days a week," said Frank Dowling, Director for Industrial & Healthcare at Maxim Integrated. "It also improves active runtime for longer battery life, another essential component for wearable applications."

"Maxim's new PMIC is a way to improve patient outcomes through continuous monitoring, a trend which is rapidly growing," said Susie Inouye, Research Director and Founder at Databeans.

Availability and Pricing

Pricing available upon request

An evaluation kit is available: MAX20310EVKIT#

More information about MAX20310: https://www.maximintegrated.com/products/MAX20310

65V, 8A (IOUT), Synchronous Step-Down Silent Switcher 2 Delivers 94% Efficiency at 2MHz & Ultralow EMI/EMC Emissions

Analog Devices, Inc., which recently acquired Linear Technology Corporation, announces the LT8645S, an 8A, 65V input capable synchronous step-down switching regulator.

Its unique Silent Switcher® 2 architecture uses two internal input capacitors as well as internal BST and INTVCC capacitors to minimize the area of the hot loops. Combined with very well controlled switching edges and internal construction with an integral ground plane and the use of copper pillars in lieu of bond wires, the LT8645S dramatically reduces EMI/EMC emissions. This improved EMI/EMC performance is not sensitive to board layout, simplifying design and reducing risk even when using two layer PC boards. The LT8645S can easily pass the automotive CISPR25, Class 5 peak EMI limits with a 2MHz switching frequency over its entire load range. Spread spectrum frequency modulation is also available to lower EMI/EMC levels further.

The LT8645S's synchronous rectification delivers efficiency as high as 94% with a switching frequency of 2MHz. Its 3.4V to 65V input voltage range is ideal for dual cell transportation, 48V automotive and industrial applications. The internal high efficiency switches can deliver up to 8A of continuous output current to voltages as low as 0.97V. The LT8645S's Burst Mode® operation offers only 2.5µA of quiescent current, well suited for applications such as automotive/transportation always-on systems, which need to extend operating battery life. The LT8645S's unique design maintains a minimum dropout voltage of only 60mV (at1A) under all conditions, enabling it to excel in scenarios such as automotive cold-crank. Furthermore, a fast minimum on-time of only 40ns enables 2MHz constant frequency switching from a 24V input to a 2.0V output, enabling designers to optimize efficiency while avoiding critical noise-sensitive frequency bands.

The LT8645S's 32-lead, 4mm x 6mm LQFN package and high switching frequency keeps external inductors and capacitors small, providing a compact, thermally efficient footprint.

The LT8645S utilizes internal top and bottom high efficiency power switches with the necessary boost diode, oscillator, control and logic circuitry integrated into a single die. Low ripple Burst Mode operation maintains high efficiency at low output currents while keeping output ripple below 10mVP-P. For applications requiring the lowest noise operation, the LT8645S can be programmed to run in pulse-skipping mode. Its switching frequency is programmable and synchronizable from 200kHz to 2.2MHz. Special design techniques and a new high speed process enable high efficiency over a wide input voltage range, and the LT8645's current mode topology enables fast transient response and excellent loop stability. Other features include internal compensation, a power good flag, output soft-start/tracking and thermal protection.

New Wireless Gecko SoCs Help Developers Tackle Multiprotocol IoT Design Challenges

Silicon Labs (NASDAQ: SLAB) announces a major expansion of its Wireless Gecko system-on-chip (SoC) portfolio, making it easier for developers of

all skill levels to add versatile multiprotocol switching capabilities to increasingly complex IoT applications. The new EFR32xG12 SoCs support a broader range of multiprotocol, multiband use cases for home automation, connected lighting, wearables and industrial IoT. These SoCs deliver superior RF performance, enhanced cryptography acceleration, larger memory options, on-chip capacitive touch control, and additional low-power peripherals and sensor interfaces.

“Multiprotocol connectivity provides advanced capabilities to help simplify our networked lighting control designs while also satisfying customer needs for easy installation and over-the-air upgrades that extend product life,” said Bruce Bharat, Director of Product Marketing – Networked Controls, Acuity Brands Lighting, a market leader in providing indoor and outdoor lighting, controls and energy management solutions. “Silicon Labs’ Wireless Gecko platform gives us the multiprotocol SoCs, modules, robust software stacks and powerful development tools we need to get our network-enabled LED fixtures and controls to market quickly.”

Wireless Gecko SoCs support zigbee® and Thread mesh networking, Bluetooth® 5 and proprietary wireless protocols. Silicon Labs has optimized its wireless protocol stack architecture to enable efficient switching between different network protocols. For example, device makers can now use a single chip to commission and configure devices over Bluetooth with a smartphone, and then join a zigbee or Thread mesh network to connect to dozens or even hundreds of end nodes.

“The EFR32 Wireless Gecko portfolio is the most versatile, feature-rich multiprotocol platform available today,” said Daniel Cooley, Senior Vice President and General Manager of Silicon Labs’ IoT products. “We continue to enhance the Wireless Gecko platform with new hardware and software capabilities that advance multiprotocol connectivity and address the real-world requirements of IoT products.”

Superior RF Performance and Security

The Wireless Gecko portfolio offers the highest output power (up to +19 dBm) in the multiprotocol SoC market, reducing system size, cost and complexity by eliminating the need for an external power amplifier. EFR32xG12 SoCs also offer exceptional sensitivity in the 2.4 GHz band (-102.7 dBm for zigbee and Thread and -95 dBm for Bluetooth low energy) as well as improved sub-GHz performance for applications using proprietary protocols. The combination of highest RF output power and best sensitivity enables excellent wireless range, greater reliability and improved battery life for IoT applications such as smart meters.

EFR32BG12 Blue Gecko SoCs feature a 2 Mbps Bluetooth PHY, providing ample throughput for applications running a Bluetooth 5-compliant stack. The Bluetooth 5 standard enables four times the range, twice the speed, 800 percent greater broadcasting capacity and improved co-existence with other wireless IoT protocols.

To help secure the IoT, the EFR32xG12 SoCs include a second on-chip security accelerator dedicated to the multiprotocol radio and a NIST-certified true random number generator (TRNG). This additional hardware cryptography block runs the latest security algorithms with higher performance and lower power than conventional software implementations.

More Memory and Peripherals

EFR32xG12 SoCs offer four times more flash memory (up to 1024 kB with a dual-bank architecture) and eight times more RAM (up to 256 kB) than previous-generation Wireless Gecko devices. This significant memory expansion makes it easier to develop complex, feature-rich IoT applications supporting multiple protocol stacks, real-time operating systems such as Micrium OS, backup images for devices and over-the-air (OTA) updates for field upgrades to extend the life of IoT products.

The SoCs’ expanded set of digital and analog peripherals gives developers greater design flexibility and the ability to connect additional components, such as sensors. An autonomous capacitive sensing controller provides direct support for cap-touch interfaces in IoT products, without the cost and complexity of adding external controllers.

Pricing and Availability

EFR32xG12 Wireless Gecko SoC samples and production quantities are available now in 7 mm x 7 mm QFN48 packages, as well as 65-GPIO 7 mm x 7 mm BGA options for feature-rich applications requiring a large number of I/Os. Pricing for EFR32xG12 SoCs in volume quantities begins below $3.00 USD. For Mighty Gecko, Blue Gecko and Flex Gecko SoC pricing information, contact your local Silicon Labs sales representative or authorized distributor. The full-featured SLWSTK6000B Mighty Gecko Mesh Development Kit, supporting all protocols, is priced at $499. Additional radio boards for Mighty Gecko,

Blue Gecko and Flex Gecko are available priced at $49. (All kits USD MSRP.) The Wireless Gecko portfolio is supported by Silicon Labs' full suite of Simplicity Studio development tools, available to developers free of charge. To order Wireless Gecko samples and development kits, visit www.silabs.com/wirelessgecko.

Silicon Labs

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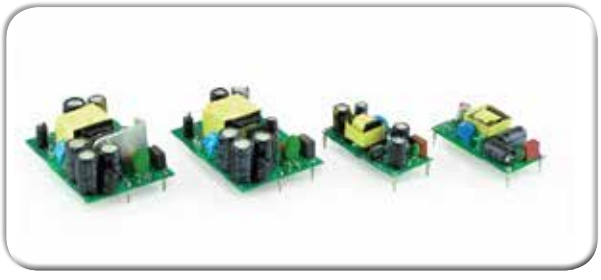
Low Power Open Frame Ac-Dc Power Supplies Housed in Compact, Board Mount Package

CUI's Power Group today announced the addition of four low power, open frame ac-dc power supply series to its VOF product family. The VOF-6B, VOF-10B, VOF-15B, and VOF-20B series are 6, 10, 15, and 20 W power additions to CUI's general purpose ac-dc power supply portfolio now ranging from 6 W to 300 W. Housed in compact, board mount packages measuring as small as 1.913 x 0.917 x 0.638 in (48.6 x 23.3 x 16.2 mm), the new models feature industry standard pin-outs, 4 kVac isolation and no-load power consumption less than 100 mW, making them ideal for space-constrained, low power ITE, industrial, consumer, and smart home applications.

The 6 W to 20 W modules feature a wide universal input voltage range of 85 to 264 Vac with single output voltages of 5, 9, 12, 15, 24, and 48 Vdc, depending upon the series. Operating temperatures at full load range from -25 up to +50°C, derating to 50% load at +70°C. All models carry UL/cUL and TUV 60950-1 safety certifications while meeting EN 55032 Class B and FCC Class B limits for radiated emissions. Protections for short circuit, over current, and over voltage come standard. The series also carry a minimum MTBF of 300,000 hours at 115 Vac at +25°C ambient, calculated per MIL-HDBK-217F.

The VOF-6B, VOF-10B, VOF-15B, and VOF-20B series are available immediately with prices starting at $7.57 per unit at 100 pieces through distribution. Please contact CUI for OEM pricing.



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