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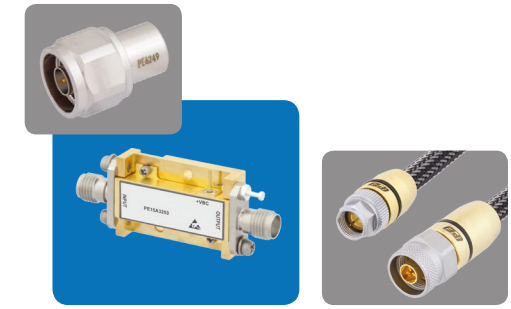

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Reality of 5G: RFS Interview

In this Q&A, Emmanuel Saint-Dizier, VP Strategy at RFS discusses the issues and challenges facing antenna technology in 5G networks.

1) Are existing operator infrastructure deployments suitable for new 5G networks?

"It's important to remember that while 5G is a technological evolution, it won't replace what's come before it. 4G and 5G will coexist. LTE-based systems will continue to evolve and 5G infrastructure will be built alongside. However, as 5G will be using new spectrum bands in sub-6GHz and mmWave, this will require new hardware as existing equipment simply won't be up to the task.

"Massive MIMO (mMIMO) has risen up as an enabler of both LTE-A and 5G. Yet there are still question marks over how this technology will become a reality on overcrowded cell sites and the cost attached with doing so – which has sparked an evolution in active antenna design."

2) What challenges will operators face with the roll out of 5G and how will antenna technology need to change?

"Operators face a series of technical and economic challenges in rolling out 5G which will have an impact on how they choose to deploy antenna systems in the future. There's no doubt active antennas will be needed to support new 5G networks, but current systems are contributing to the ongoing nightmare of cell site constraints in dense urban areas.

"Although macro site overcrowding is nothing new, it does present an issue. Operators need to find new ways of deploying 5G (or LTE-A and 5G-ready) active antennas at existing sites in the most efficient way possible. On a site where operators already have passive antennas supporting existing networks they have a few options.

"They could add new active antennas separately, which is largely impractical in most cities given the space issue. Another option is to combine existing passive arrays or "stack" them to create space for active antennas on the cell site, although this can have negative performance trade-offs depending on the installation.

"Instead, most operators have turned to hardware vendors to help address the space vs cost vs performance problem presented by 5G and are now looking to take an entirely new approach with Active Passive Antenna (APA) technology."

3) What role will this new antenna technology play in network densification and getting better performance from over-crowded cell sites?

"Cell site constraints are nothing new, particularly in dense urban locations where they're already overcrowded. It's become almost impossible for operators to acquire new sites as a result. As a typical site already supports many different antennas and bands for a variety of different purposes and operators, trying to add new ones creates a long, expensive, and complicated negotiation process with site owners.

"Active Passive Antenna systems combine a 5G active antenna with a passive base station antenna used for existing networks. For operators, it's effectively a two-in-one system housed in a form factor that's largely the same size as what they've deployed before. It's a simplified and streamlined way to get around cell site restraints, introducing a layer of active antennas to existing macro sites without increasing the overall antenna count per sector.

"This approach dramatically simplifies site negotiations and reduces the cost of ownership for active antenna deployments. After all, integrating mMIMO systems with passive multi-band antennas without dramatically affecting the form factor or performance can potentially solve the economic issues for operators, as well as minimizing visual impact."

4) What are the technical benefits of this approach over a standalone active antenna?

"Those in the industry also see APA technology as being able to address the technical challenges associated with designing mMIMO active antennas, for example power management. Heat dissipation is today a major hurdle for mass deployment of mMIMO antennas.

Currently, to maintain an acceptable temperature for the electronic components, manufacturers need to add massive, bulky, and heavy heatsinks.

"Within an APA, however, the passive antennas already have metallic structures with significant surface area and sufficient thermal mass. By structuring an APA system in a way that takes advantage of the design considerations and housing of the existing passive antenna to act as part of the heat exchange for the active antenna, innovative hardware vendors can not only reduce the weight of the overall system but provide a much more efficient, robust and reliable system overall."

5) How can operators prepare for new emerging technologies such as active antennas?

"Operators will have many different options when it comes to deploying 5G active antennas. However, for scenarios where maximizing cell site space, minimizing visual impact, and simplifying the roll out of mMIMO systems are key concerns, APA technology is arguably the most efficient approach.

"There's no question that 5G is coming. Operators need to be ready, and at the same time improve their 4G and LTE-A networks to support increasing demand for capacity. When it comes to the infrastructure to support this, the next steps are clear – operators need systems, such as APA, to drive down the cost/bit/sec/Hz of their network. This will ensure MNOs are not only able to improve their existing networks but also move from "5G hype" to making 5G a reality."

www.rfsworld.com

Samsung SmartThings, Harman look to fast-track IoT

Harman International (Stamford, CT), a subsidiary of Samsung Electronics (Suwon, South Korea), has announced a strategic collaboration with Samsung SmartThings – Samsung's smart home IoT platform division.

The collaboration is between the Samsung SmartThings R&D team and Harman Connected Services. The aim is "to accelerate the transformation to the connected world through cloud, mobility, and analytics solutions."

Harman says it will work with Samsung SmartThings to design and develop the SmartThings app, integrate third-party sensors into the SmartThings ecosystem, work on feature development for SmartThings Cloud, and drive initiatives for the IoT platform hub. The new association, say the companies, exemplifies the continuation of a successful relationship "to revolutionize the IoT and cloud space – not only for the consumer but also for the enterprise and the automotive OEM."

https://services.harman.com
www.smartthings.com/products

Europe ponders 3% tax grab on digital companies

The European Commission has proposed new rules on taxation in an attempt to increase the tax taken from digital businesses that it claims pay significantly less tax than traditional businesses.The EC estimates that digital companies currently have an average effective tax rate that is half that of the traditional businesses in the European Union.

As part of the process of reforming the tax rules the is proposing an interim tax of 3 percent of profits and this is likely to hit digital giants such as Google, Facebook, Amazon and E-bay. An interim tax at 3 percent would raise an additional €5 billion in annual tax revenue across the Europe Union, the European Commission estimates.

One of the primary issues is that it is hard to levy tax from companies that have little or no physical presence in a country even though they are making money from having users, subscribers or customers there. The European Commission is proposing that companies where value is created by the presence of users should be taxed in proportion to there user/subscriber base.

The proposed threshold is if the company has more than €7 million in annual revenues in a member state or more than 100,000 users in a member state in a year or has more than 3000 business contracts for digital services in a year.

The interim tax would applied on such activities as the sale of online advertising; social media activities and platforms for the sale of goods and services between users and the sale of data generated from user-provided information.

The interim tax would be collected where the users are located rather than where the company is located and would only apply to companies with annual worldwide sales of €750 million (about $920 million) or European Union revenues of €50 million (about $60 million).

GloFo shows silicon photonics roadmap

Foundry chipmaker Globalfoundries Inc., has said it has qualified a 90nm manufacturing process for silicon photonics on 300mm-diameter wafers and added an upcoming 45nm technology to the roadmap. The company's silicon photonics technologies enable the monolithic integration of optical components with electrical circuits.

The current generation of silicon photonic ICs is built using a 90nm RFSOI process that can provide 30 GHz of bandwidth to support data rates up to 800 Gbps and distance capabilities of up to 120km. The 90nm technology is supported by a physical design kit from Cadence Design Systems.

Globalfoundries' next-generation monolithic silicon photonics offering will be manufactured on a 45nm RF SOI process with production slated for 2019. The new process is expected to extend optical transceiver bandwidth to terabit applications.

www.globalfoundries.com

Ericsson takes network management to the cloud

Four regional operators in the United States are working with Ericsson to move network management to the cloud, allowing them to remain competitive while protecting and growing their profitability.

Through Network Management as a Service, Ericsson is supporting these operators in their journeys to virtualization, software-defined networking and, potentially, 5G network transformation. The aim is to help operators reduce the complexity of managing their networks while delivering a predictable total cost of ownership with efficient network evolution.

Steven K. Berry, President and CEO of Competitive Carriers Association (CCA), says: "Ericsson, a long-time CCA member, continues to demonstrate a deep understanding of the regional operator space, and solutions like this one will help carriers to stay competitive with larger operators."

The US operators to date that have chosen the Network Management as a Service are: Carolina West Wireless, Cellcom, Chariton Valley, and East Kentucky Networks.

Ericsson Network Management as a Service is offered from the Ericsson private telco cloud and manages performance, fault and configuration for physical and virtual functions across multiple radio technologies, core and IP. It exposes them in a unified manner to an operator's existing operational support ecosystems.

Operators that move network management to this service model realize the benefits of Ericsson's traditional Network Manager, such as high capacity, superior network performance, accelerated time to market and operations efficiency. In addition, they gain the benefits of cloud-based systems, including reduced complexity, lower cost of ownership, predictable spend, enhanced security, guaranteed availability and modern network systems.

www.ericsson.com

Printed memory pioneer to focus on NFC

Norwegian startup Thin Film Electronics ASA, a pioneer in the development of printed memory on thin flexible substrates, has sold its memory business unit to focus exclusively on fully printed Near Field Communication (NFC) labels and value-added marketing analytics.

According to sources, the memory activity has been passed on to Xerox' PARC (Palo Alto Research Center), a long-time partner who back in 2015, was licensing Thinfilm's proprietary technology and demonstrated its first Xerox Printed Memory product two years ago at printing equipment exhibition Drupa.

Manufactured via a printing process, the flexible non-volatile memory labels could store up to 36 bits of information (68 billion distinct data combinations), enough to record lot codes and serial numbers to expiration dates and geographic IDs. At the time of demonstration, Xerox was hinting such printable memory labels would address the needs of brand protection across a wide range of industries including pharmaceuticals, government, and other verticals. Thinfilm had completed the technology transfer to Xerox in the first quarter of 2016.

The startup anticipates it will reach cash break-even point early Q2 2019. Earlier in 2017, the company had launched its CNECT software portal, a multi-tenant cloud-based platform that integrates with its NFC SpeedTap and OpenSense tags. The turnkey solution is now a key differentiator for ThinFilm's NFC labels as it provides consumer brands with a secure way to store, manage and track the tags while performing data analytics on customer engagement and behaviour, with access to real-time NFC tapping activity.

http://thinfilm.no

Finnish MEMS resonator startup raises funds

Tikitin Ltd., (Espoo, Finland), a 2016 spin off from Finnish research institute VTT, has raised €3 million (about $3.7 million), to support the launch of its MEMS resonator technology.

Tikitin claims to be the first company to introduce MEMS resonantors that can be driven by the same circuits as quartz and thereby allowing pin-compatible replacement. The MEMS-based technology, which makes use of the piezoelectric properties of aluminum-nitride, offers thermal stability that is better than quartz down at ±10ppm across a broad temperature range. This means that for many applications it is unnecessary to provide temperature compensation, said Aarne Oja, CEO and co-founder of the company.

The technology has a frequency range from 16 MHz to 120 MHz and enables small die sizes. Phase noise performance is also similar to that of quartz-based oscillators. Compared with OCXO the OCMO offers small size, low power consumption, and operation in high ambient temperatures.

www.tikitin.com

Qualcomm, Tobii collaborate on eye tracking for mobile VR/AR

Qualcomm (San Diego, CA) has teamed up with Swedish eye-tracking technology developer Tobii Tech to reduce the power consumption of augmented reality (AR) and virtual reality (VR) displays. Qualcomm is the leading supplier of chips for mobile phones, so the deal with Tobii to add its eye tracking technology head-mounted displays (HMDs) is signficant.

Tobii, founded in 2001, is working with Qualcomm on a full reference design and development kit for the Snapdragon 845 Mobile VR Platform, which includes Tobii's EyeCore eye tracking algorithms and hardware design. Tobii will then license the eye tracking technologies and work with Qualcomm's HMD customers on the design of the optical system.

The heart of the technology is foveated rendering, where VR and AR devices become aware of where a user is looking and can direct high-definition graphics processing power to that exact spot in real time. This enables higher definition displays with lower poweer consumption and longer battery life. The devices automatically orient images to align with a users' pupils to adapt to the individual user, helping to increase the visual quality of virtual and augmented reality experiences, and allows HMDs to accurately track gaze in real time, enabling content creators to use eye contact.

"At its core, eye tracking fundamentally enables hardware manufacturers to build smarter and more capable devices with greater mobility, that in turn deliver truly immersive and natural experiences to delight users," said Oscar Werner, president of Tobii.

www.qualcomm.com
www.tobii.com

ADI targets radar with Symeo purchase

Analog Devices has announced that it has acquired Symeo GmbH that makes high-frequency radio sensor technology components for industrial applications.

Privately-held Symeo specializes in radar hardware and software for emerging autonomous automotive and industrial applications. According to Analog Devices, the company's innovative signal processing algorithms will enable ADI to offer customers a radar platform with significant improvements in angular accuracy and resolution.

Symeo's RF and sensor technology enables real-time position detection and distance measurement, enabling system integrators and original equipment manufacturers (OEMs) to offer high-precision radar solutions in rough industrial environments. The technology was originally developed within Siemens AG and later spun out as an independent entity by the Siemens Technology Accelerator GmbH.

www.analog.com
www.symeo.com/en

Computer the size of grain of salt embeds in everyday objects

IBM (Armonk, NY) says it has developed the world's smallest computer – one that is smaller than a grain of salt.

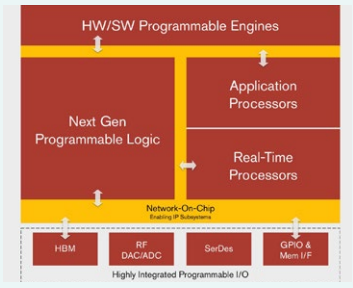
Announced at the company's Think 2018 technology event, the IBM-designed edge device architecture and computing platform is a system-on-chip (SoC) with a processor, SRAM, storage, a communication module, and a photovoltaic cell for power. The microcomputer's processor comprises several hundred thousand transistors and is said to have a performance on par with an x86 CPU from 1990.

According to IBM, the device will cost less than ten cents to manufacture and can monitor, analyze, communicate, and even act on data. Within the next five years, the company says, such micro-computers will be embedded in everyday objects and devices as "cryptographic anchors" that - in tandem with blockchain's distributed ledger technology – will be used to help track and verify the authenticity of goods.

http://www.research.ibm.com

Beyond FPGAs – Xilinx unveils adaptable computing platform

Xilinx has introduced a breakthrough product category called Adaptive Compute Acceleration Platform (ACAP) that goes far beyond the capabilities of an FPGA. An ACAP is a highly integrated multi-core heterogeneous compute platform that can be changed at the hardware level to adapt to the needs of a wide range of applications and workloads. Its adaptability, which can be done dynamically during operation, delivers levels of performance and performance per-watt that is unmatched by CPUs or GPUs.



An ACAP is ideally suited to accelerate a broad set of applications in the emerging era of big data and artificial intelligence. These include: video transcoding, database, data compression, search, AI inference, genomics, machine vision, computational storage and network acceleration. Software and hardware developers will be able to design ACAP-based products for end point, edge and cloud applications. The first ACAP product family, codenamed "Everest" will be developed in TSMC 7nm process technology and will tape out later this year.

Everest is expected to achieve 20x performance improvement on deep neural networks compared to today's latest 16nm Virtex VU9P FPGA. Everest-based 5G remote radio heads will have 4x the bandwidth versus the latest 16nm-based radios. A wide variety of applications across multiple markets like automotive; industrial, scientific and medical; aerospace and defense; test, measurement and emulation; audio/video and broadcast; and the consumer markets will see a significant performance increase and greater power efficiency.

www.xilinx.com

Cree buys Infineon RF power business assets

Cree, Inc., has acquired the RF Power assets of Infineon Technologies for approximately € 345 million – expanding wireless opportunities for Cree's Wolfspeed business unit and enhancing its leadership in RF GaN-on-SiC. The acquired Infineon RF Power team and capabilities will complement Wolfspeed's existing offerings and expertise with additional technology, design, packaging, manufacturing, and customer support. This business holds a leading market position offering transistors and MMICs for wireless infrastructure radio frequency power amplifiers based on both LDMOS and GaN-on-SiC technologies.

Further, Infineon will support the transaction with a long-term supply agreement for LDMOS wafers and related components out of its fab in Regensburg, Germany, and will also supply assembly and test services out of its facility in Melaka, Malaysia.

www.cree.com
www.infineon.com

Google aims to dominate with latest quantum processor

Google has unveiled its latest quantum processor, which it believes could ultimately achieve "quantum supremacy." Called "Bristlecone," the new gate-based superconducting system is designed to provide a testbed for research into system error rates and scalability of the company's qubit technology, as well as applications in quantum simulation, optimization, and machine learning. The ultimate goal, say Google researchers, is to build a quantum computer that can be used to solve real-world problems..

"Our strategy is to explore near-term applications using systems that are forward compatible to a large-scale universal error-corrected quantum computer," says Julian Kelly, Research Scientist, Quantum AI Lab. "In order for a quantum processor to be able to run algorithms beyond the scope of classical simulations, it requires not only a large number of qubits. Crucially, the processor must also have low error rates on readout and logical operations, such as single and two-qubit gates."

The device is based on the underlying physics of the company's previous 9-qubit linear array technology and uses the same scheme for coupling, control, and readout, but is scaled to a square array of 72 qubits. The researchers are looking to achieve similar performance to the best error rates of the 9-qubit device – which demonstrated low error rates for readout (1%), single-qubit gates (0.1%), and two-qubit gates (0.6%) as a best result – but across all 72 qubits of Bristlecone.

"We chose a device of this size to be able to demonstrate quantum supremacy in the future, investigate first- and second-order error-correction using the surface code, and to facilitate quantum algorithm development on actual hardware," says Kelly.

https://research.google.com/pubs/QuantumAI.html

A 4G phone without apps

Being funded at Indiegogo, the Light Phone 2 provides users with a simple 4G phone with e-ink, messaging and other essential tools all in a credit card size format.

The first Light Phone only worked as phone and had an illuminated 10-digit number pad. The idea is to provide users with a minimalistic phone that is used as little as possible, breaking free from the distraction of apps. Essentially, Light Phone is designed to be used as a second phone as a seamless extension of the smartphone. It is an unlocked 2G GSM phone that works independent of a current plan, but uses a unique software platform to enable it to keep the same phone number. The Light Phone is easily set up and controlled via an app on a computer.

The crowdfunded successor, Light Phone 2, adds more features, retaining the small size, simplicity of no apps, but is designed to be more of a standalone device. Light Phone 2 adds features such as messaging and an alarm clock, with the ability to store speed dials and contacts. It looks to build on the success of the first Light Phone, which sold over 10 000 units.

Still in the crowdfunding the stage, the specifications are still being defined – but essentially the Light Phone 2 will add a custom high resolution E-Ink screen, larger microphone and and speaker, USB-C, proximity sensor as well as up and down buttons. An aluminum casing for added durability and waterproofing are being explored.

Light Phone 2 uses Light OS and modified version of Android and is based on the Qualcomm MSM8909W. It will use a nanoSIM and offer 4G LTE Wi-Fi and GPS connectivity and bring back the headset jack.

www.thelightphone.com

CEVA, Nokia join forces on 4.9G and 5G SoCs

CEVA has enetered into an agreement with Nokia to support the development of the Nokia ReefShark baseband System-on-Chips (SoCs), set to be deployed for 4.9G and 5G wireless infrastructure. Under the agreement, CEVA has adapted its widely-deployed CEVA-XC architecture framework to address the massive increase in signal processing complexity in multi-RAT (Radio Access Technology) network architectures.

Nokia ReefShark is based on 3GPP 5G New Radio specifications. It reduces the size, cost and energy consumption at each cell site, while simultaneously boosting the intelligence and performance of massive MIMO antennas. ReefShark also boosts baseband compute capacity through plug-in units fitted into the commercially available Nokia AirScale baseband module. AirScale is software-upgradeable to full 5G functionality, and these plug-in units triple the throughput from Nokia's advanced 28 Gbps today, to up to 85 Gbps per module.

www.ceva-dsp.com

Boeing invests in IoT nanosatellite startup

Aerospace giant Boeing (Chicago, IL) has announced an investment in nanosatellite communications startup Myriota (Adelaide, Australia), which offers direct-to-orbit IoT connectivity for remote locations.

Myriota's technology enables two-way communications between ground-based micro-transmitters and low-Earth-orbit (LEO) nanosatellites to securely share data over narrow bandwidths. The company says it is seeking to "revolutionize" satellite communications by providing low-cost access to high-value data in remote locations.

Its direct-to-orbit platform enables applications across the logistics, defense, utilities, agricultural, environmental, and maritime industries, where IoT connectivity via traditional means is extremely challenging and expensive. Boeing is investing in Myriota via its venture capital arm, Boeing HorizonX , and the investment represents Boeing's first in a company outside of the U.S. and its 10th since Boeing HorizonX was launched in April 2017.

Myriota was founded in 2015 as a spin-out from the University of South Australia's Institute for Telecommunications Research. Its direct-to-orbit technology is designed to enable massive-scale, low-cost communications for IoT devices anywhere on Earth.

"We formed Myriota to solve a major connectivity problem: hundreds of millions of devices that need to communicate but don't have cost-effective, battery-friendly networks to do so," says Myriota CEO Alex Grant.

Boeing HorizonX Ventures participated in the $15 million Series A funding round, which was led by Australian firms Blue Sky Venture Capital and Main Sequence Ventures. Other investors include Right Click Capital and Singtel Innov8.

www.boeing.com
http://myriota.com

Wi-Fi market to see double digit growth

The latest report from MarketsandMarkets™ expects the Wi-Fi market to grow from USD 5.96 Billion in 2017 to USD 15.60 Billion by 2022, at a CAGR of 21.2 percent during the forecast period. The proliferation of mobile devices and rapidly growing adoption of BYOD and IoT within enterprises are some of the major factors expected to drive the growth of the Wi-Fi market.

The network planning and design segment is expected to hold the largest market size during the forecast period. Network planning and design services are executed to maximize the ROI and is an important part of the Wi-Fi value chain/ecosystem.

The sports and leisure vertical expected to grow at the highest CAGR during the forecast period. The digitalization of businesses has revolutionized the Wi-Fi market space for various verticals.

North America is expected to make up the largest region in market.

www.marketsandmarkets.com

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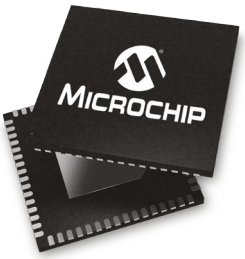

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The Evolution of Over-the-Air Testing to Meet the Needs of 5G

By Christoph Pointner, Rohde & Schwarz

With advancements toward 5G systems, there will be a significant increase in the number of wireless users. Users will expect a higher level of quality and accessibility from all of their mobile devices, which means there must be increasing reliability of the network and devices. Over-the-Air (OTA) testing is a critical task to evaluate and certify the reliability and performance characteristics of wireless devices such as mobile phones and tablets but also base stations in an environment that more closely resembles the one in which they are actually used. Testing the components that will support the 5G environment will be vastly different compared to testing in 4G/LTE. Although connecting mobile devices to test equipment through cables is the most convenient and cost-effective method, it does not mimic the actual behavior of these devices in the real world and it will become less and less feasible with ever higher integrated devices. This will present significant challenges as mobile operators move to higher frequencies in order to obtain larger bandwidths for support of 5G. In order to test mobile devices in situations similar to those that users actually experience, the tests must be executed wirelessly or over-the-air. This allows designers to see what truly happens as the radio waves propagate over the air from the user equipment to the base station and from the base station to the user equipment.

As mobile technology evolves toward 5G systems, there are two main drivers that will necessitate OTA testing. The level of integration of the device under test (DUT) will increase significantly, and it will be physically impossible to connect the DUTs to the test equipment by cables, thus requiring OTA testing. Secondly, at millimeter wave frequencies, signal absorption rates are much higher, requiring the need for beam focusing or forming to boost the gain. Test setups are needed for beam characterization and for checking beam acquisition and beam tracking performance. Only OTA test systems will provide this capability.

THE CURRENT STATE OF OTA TESTING

OTA testing of wireless devices is required by numerous regulatory agencies, standards organizations, industrial bodies and carriers. In order to have global access and interoperability of mobile systems, certification tests have been developed so that manufacturers around the world provide the same level of quality in all new mobile devices. CTIA (Cellular Telephone Industries Association) has set standards for OTA testing of 3G and 4G LTE devices, and has certification labs all around the world. Minimum performance requirements for OTA behavior have been defined in terms of radiated power levels during transmission and receiver sensitivity levels so that all calls are received under predefined circumstances. In the US especially, wireless carriers have also established industry performance requirements that must be met before a new device is permitted to run on its network.

OTA testing is typically used during the R&D phase for all equipment that radiates electromagnetic waves. In current mobile phones, for example, testing is designed to ensure that the signal is homogeneous, in that the same signal is transmitted or received from all directions. It is important that the antenna radiates in all directions, so that the mobile device user does not need to face in a particular direction to get a good signal, nor should a call be dropped as the user passes by a tall building. R&D-scale OTA test equipment is particularly useful in identifying issues early in the product development cycle.

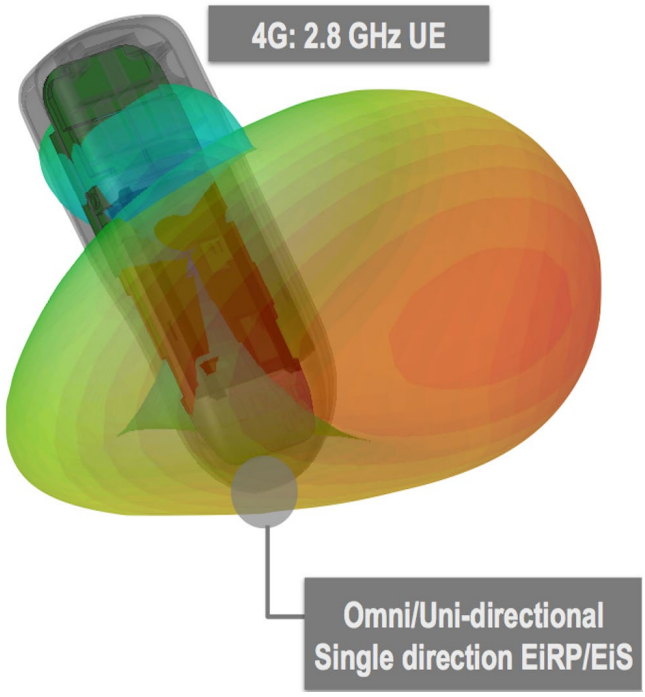

Figure 1 – Today's mobile phones are designed and tested for a uniform field.

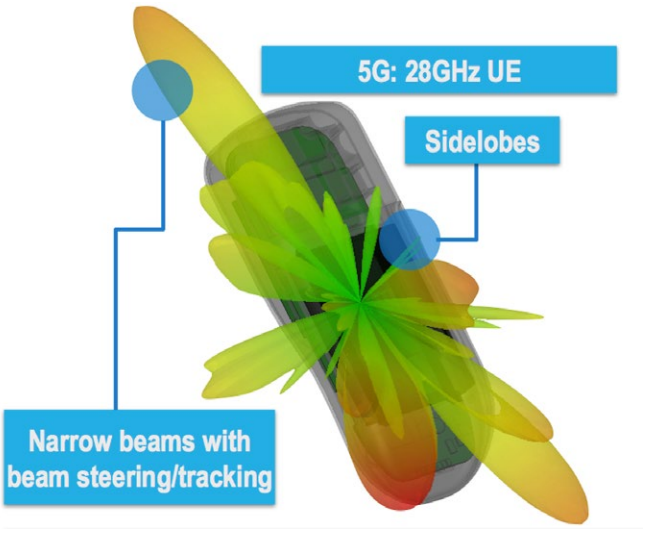

Figure 2 – Mobile devices will need to focus their transmitter beams to maximise transmit power at mmWave frequencies.

EFFECT OF 5G ON OTA TESTING

Using cm and mmWave

In order to attain space for these additional users and the wider bandwidth and higher data rates they require, mobile operators need to access higher frequencies in order to obtain larger bandwidths. In going to frequencies of 30, 40, 50, 60, and even 90 GHz, the devices enter the cm and mmWave ranges. As the wavelength becomes shorter at higher frequencies, the transmission distance for a given power level also becomes shorter. In order to accommodate losses such as free space path loss, atmospheric absorption, scattering due to rain and gases, and line-of-sight issues, advances in technology will need to be made. The new devices for these applications will become so highly integrated that using cable connections for testing will be very difficult, if not physically impossible – making OTA testing critically important for 5G.

Beam forming

Based on the above losses, the signal absorption becomes much higher at higher frequencies. To achieve the necessary communication distance, providers either need to increase the transmitter power or focus the radiated energy from the mobile device into a sharp, narrow beam. This will require new antenna structures and arrays to ensure that beams are properly focused. There will be a spatial or directional component to the focused beams, to ensure the beam is pointing in the right direction and to switch the beam if there is a blocked communication channel. This beam forming technique will extend the multiple antenna concept known as MIMO by sending data to different UEs simultaneously by exploiting their uncorrelated locations. Beam forming will also reduce energy consumption, as it will target individual user equipment and specifically leave out others with their assigned signal.

The usage of connectors for testing will not be possible due to their high costs, high losses and the degree of coupling. Also, in the case of massive MIMO systems, the radio transceivers are integrated directly with the antennas, resulting in a loss of RF test ports, meaning that the DUT radio and antenna performance can only be measured over-the-air.

OTA testing will be a game-changer for 5G – a prerequisite for the new designs and their certification. For 5G test systems, the basic components are expected to remain essentially the same, but they must be adapted for the higher frequencies.

OTA TEST SYSTEM COMPONENTS AND MEASUREMENTS

The key components of an OTA performance test system are the test chamber, the positioning equipment, test instruments for generating and analyzing signals, measurement antennas, and control and report software for automating the measurements. Communication is set up between the device under test and the measurement antennas to make sure the device transmits and receives signals properly. OTA testing is currently performed in a perfect (i.e., shielded and encapsulated) environment, inside an anechoic chamber which is designed to be non-reflective and echo-free. The size of the chamber varies with the object and frequency ranges being tested, and it is lined with foam pyramids that absorb reflected signals. The testing takes into account radiation characteristics on the equipment while eliminating interference from any other transmissions.

While diverse environments such as using a mobile device indoors or outdoors, in urban or rural settings, in open areas or forests, stationary or moving, or in the presence of other wireless devices are all real world conditions, they cannot be quantified for test purposes. These real-life scenarios are addressed through mobile network testing, which currently also undergoes a transformation process for 5G applications. Certification testing is done in specified test chambers that yield accurate, repeatable and reproducible measurements.

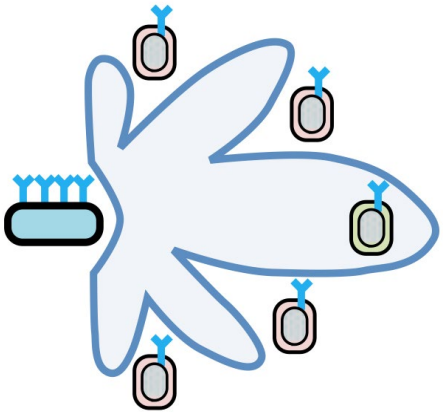

Figure 3 – Beam forming can direct power where it's needed while maximising interference to other devices.

OTA testing is used to measure performance factors such as signal path, antenna gain and pattern, radiated power and device sensitivity to both internal components and other devices, as well as reliability and safety issues. CTIA's "Test Plan for Wireless Device Over-the-Air Performance", May 2015, specifies test and setup procedures and measurement methods for power and performance only.

Some of today's key OTA test measurements include total radiated power (TRP) by the device, total isotropic sensitivity (TIS, per CTIA specifications), total radiated sensitivity (TRS, per 3GPP specs), equivalent isotropically radiated power (EIRP), and radiated sensitivity on intermediate channels (RSIC). TRP is an indicator of transmitter performance,

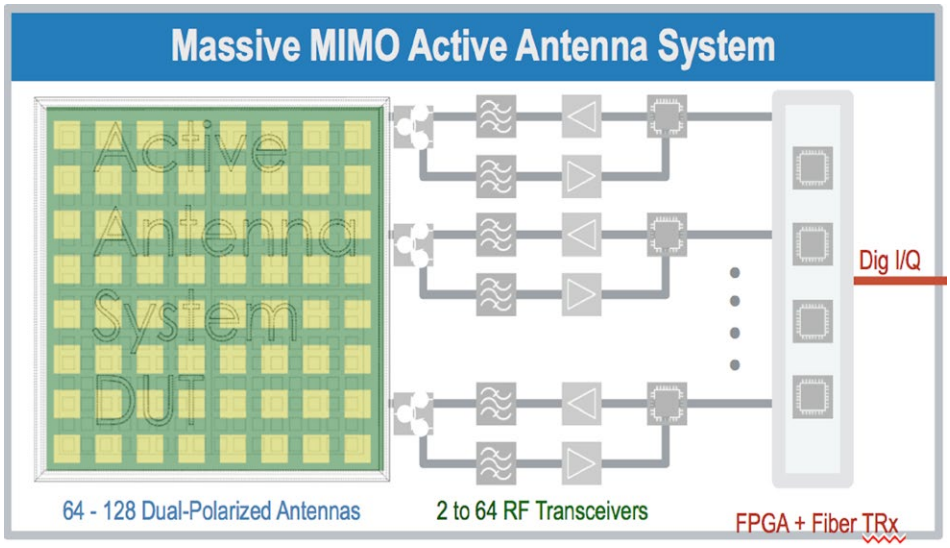

Figure 4 – a 5G capable device could consist of an array of polarised antennas, making wired test ports impractical or impossible.

while TIS/TRS are indicators of receiver performance. Additional measurements are made to characterize the antenna patterns and efficiency. Co-existence measurements are made to evaluate the degradation in sensitivity that occurs when multiple wireless technologies operate at the same time. OTA testing can be used to improve device performance in areas where problems are identified.

CHALLENGES IN 5G OTA MEASUREMENTS

There are several challenges related to OTA measurements and setting up an OTA test system. One set of challenges deals with the antenna system. As the technology advances toward 5G systems, finding the proper setup and positioning for the 3-D antennas to test the moving beams, while accounting for interference and scattering, will be difficult. A new measurement dimension – space, or power versus direction of departure – must be included. One particular factor that the devices must account for is the blocking effect of the human body on the radiation pattern, through using phantoms during OTA tests. OTA tests measuring the three-dimensional antenna pattern can be performed in either near field or far field. Measurements in near field allow smaller anechoic chambers for the measurement, but require setups capable of measuring both phase and amplitude with high location precision and additional post processing for the near-field to far-field transformation.

Another challenge is that each individual transceiver in the active antenna system needs to be characterized through an OTA interface, with measurements made for both the transmitter and the receiver. It is necessary that each transceiver turn on for individual verification or a set of transceivers turn on for joint assessment.

A third challenge relates specifically to beam forming, which will be used heavily in 5G. Due to the high path loss and limited range of a mmWave wireless system, precise beam generation and thus tracking and fast acquisition is required for mobile users. Whereas with antenna implementations for existing cellular technologies static pattern characterization was sufficient, mmWave systems will require dynamic beam measurement systems to accurately characterize beam tracking and beam steering algorithms.

A unique set of other challenges relates to testing the devices for RF conformance, which today relies on well characterized cabled test port connections to allow for repeatable measurements. Such a test setup and the necessary calibration needs to be defined in an OTA environment due to the lack of connectorized RF test ports in 5G devices.

A similar challenge arises during production. Radiated device tests must be performed for every wireless-enabled device. Given how rapidly devices are produced, OTA test systems will need to be flexible and quickly adapt to meet the testing needs of future and unforeseen devices, without sacrificing any quality or depth in the testing methods. Calibration of the antenna system to ensure that the misalignment between RF signal paths is below a specified limit, and functional tests of the completely assembled unit must all be performed.

SELECTING AN OTA TEST SYSTEM

In selecting an OTA performance test system, the most important items to consider are its flexibility and scalability. This is essential to test different frequency ranges, different device sizes, and different usage patterns.

An OTA test system can be purchased in either of two ways: as separate components that need to be assembled and integrated by the user, or as a complete turnkey system. Given the complexity of the systems and the need to integrate many disparate components, acquiring a complete turnkey system is the fastest way to ensure success. The OTA test system vendor

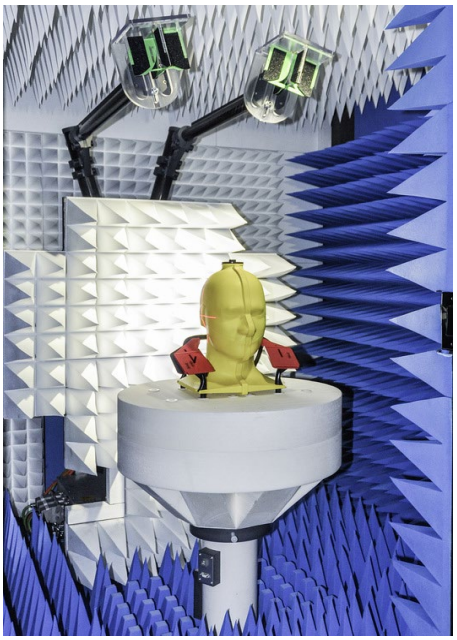

Figure 5 – OTA testing requires a chamber to block outside interference

can be a valuable resource and partner in educating customers on the features that are required, suggesting custom features to account for specific requirements, while supporting them throughout the installation and usage phases.

The advent of 5G presents new challenges for OTA testing, in that new testing methods and equipment will be needed for mobile device designs that have not yet been finalized. As OTA test vendors are essentially developing equipment for a moving target, they need to maintain close contact with their leading customers, and maintain an active presence in standardization

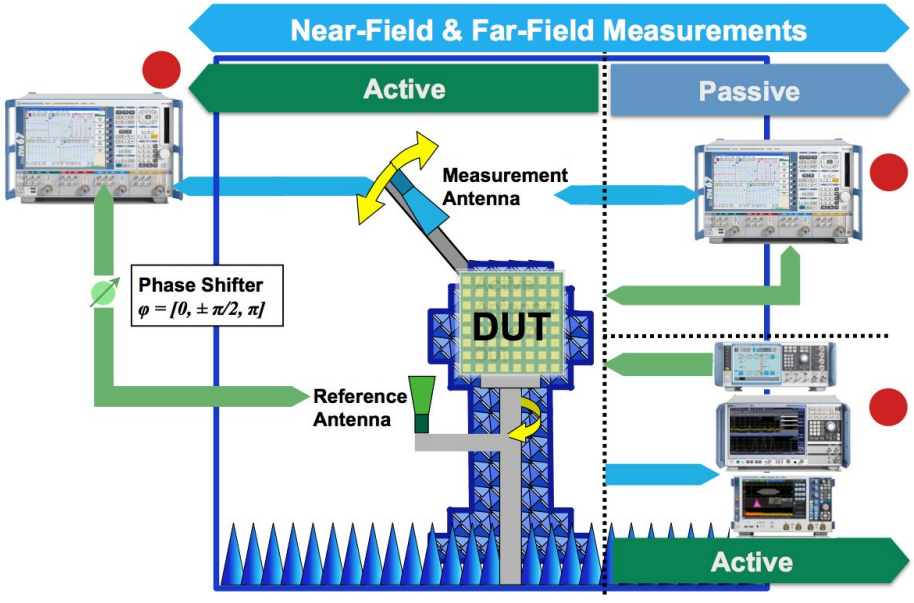

Figure 6 – Near-field and far-field OTA measurements require different test setups.

committees and workshops to keep up-to-date on the latest trends and overall market needs.

Today, Rohde & Schwarz offers its R&S®TS8991 OTA Performance Test System, a single-source turnkey system for wireless testing that meets the needs of industry and regulatory certification tests. The R&S®TS8991 includes the anechoic chamber, positioning equipment, test instruments and automated measurement software. It is compliant with CTIA, joint CTIA & Wi-FI Alliance® and 3GPP test plans. The test system is available in different sizes, and its modular system design allows for customer-specific configurations. Systems can be custom designed to meet specific requirements in terms of size, functionality, frequency range and applications. Addressing the needs of scalability and flexibility the first realizations of the R&S®TS8991 for 5G test applications are currently underway.

CONCLUSIONS

In the evolution towards 5G wireless devices, the role of OTA testing will become more critical. With higher levels of integration and millimeter wave frequencies, conducted measurements via test ports will not always be possible anymore. Device vendors will need to rely on OTA testing to validate device performance. In addition, as 5G device designs are finalized, OTA test system vendors will have to work quickly to utilize their experience and expertise to define new test methods and measurement systems.

Within the 5G device ecosystem, test and measurement will play a more strategic role relative to earlier generations, and OTA test vendors will need to work closely with their customers to meet their evolving needs and form strong partnerships along the way.

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Figure 7 – Addressing the needs of scalability and flexibility, the R&S®TS8991 comes in different sizes, and its modular system design allows for customer-specific configurations.

Noise Spectral Density: A New ADC Metric?

Ian Beavers Analog Devices, Inc.

Over the past decades, the high speed analog-to-digital converter (ADC) performance metric that mattered to most has changed, albeit slowly, as a result of signal acquisition systems' ever increasing and insatiable bandwidth requirements. The way in which ADC performance is measured also has changed.

In the 1980s, we judged an ADC largely on its dc specifications, such as differential and integral nonlinearity (DNL and INL). In the 1990s, we primarily judged an ADC on its signal-to-noise ratio (SNR). While spurious free dynamic range (SFDR) is also an important ADC parameter, noise spectral density (NSD) is yet another comprehensive specification that today's high speed and gigasample-per-second (GSPS) ADCs can use to define their performance.

Although NSD has been used for a long time to define a converter's noise, it may be new to many system designers as the headline specification of a new high speed ADC. NSD could also be a completely foreign concept to some engineers who have focused on other specifications when selecting a high speed ADC. Here are some answers to some typical questions from engineers that help demonstrate why they should learn more about this ADC performance metric:

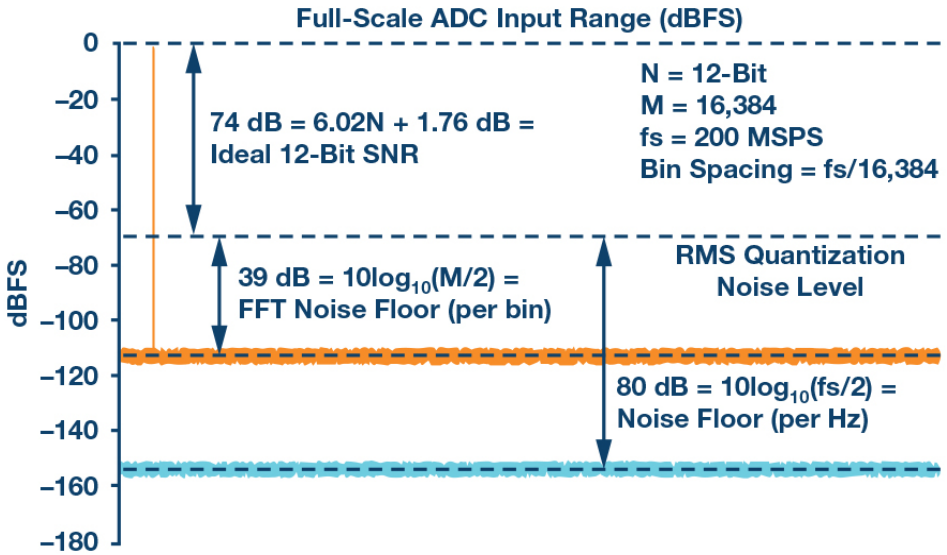

Figure 1 – A Nyquist ADCs quantization noise and FFT noise floor across a Nyquist zone are compared in magnitude to its NSD. The FFT noise per bin will be determined by the number of samples used in the FFT, while the NSD is defined with a unit bandwidth of 1 Hz.

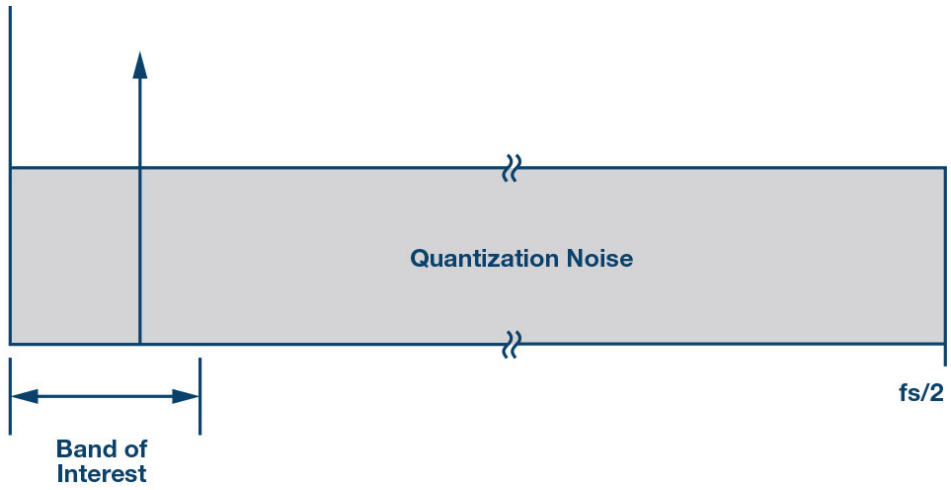

Figure 2 – The quantization noise of a Nyquist-rate ADC will be flat across its Nyquist band.

I HAVE SEEN THE NSD SPECIFICATION ON A NYQUIST-RATE ADC DATA SHEET BEFORE, BUT I NEVER REALLY UNDERSTOOD WHAT IT MEANT AND WHY IT IS IMPORTANT. WHAT IS NOISE SPECTRAL DENSITY?

NSD has been used for many years as a performance parameter on the front page of many ADC data sheets. You may have noticed that it is a relatively large negative number defined in either dBFS/Hz or dBm/Hz. A typical range that may be observed on a data sheet for an ADC's NSD could be anywhere from –140 dBFS/Hz to –165 dBFS/Hz. However, this is ultimately defined by the SNR performance of the ADC and the sample rate, as will be described later in this article.

The SNR from an ADC is defined as the log ratio of the signal power to the total nonsignal power that is seen at the input to the ADC. Relative to the ADC full-scale input, the signal-to-noise ratio is described as SNRFS. There are several components to the nonsignal power, such as quantization noise, thermal noise, and small errors within the ADC design itself. Since the ADC converts a continuous signal into discrete levels using a nonlinear process, quantization noise is inherently created. The quantization noise is the difference between the actual analog input that is typically represented by a sine wave, and the value of the smallest discrete step or least significant bit (LSB).

NSD defines the entire noise power, per unit of bandwidth, sampled at an ADC input. For a Nyquist-rate ADC, this noise is spread across the entire Nyquist band, which is equal to half of fs, the sample frequency, or fs/2.

WHAT DO THE UNITS FOR NSD INDICATE?

The term dBFS/Hz means that the noise is defined in units of power (dB) relative to the ADC full scale seen within a frequency bin width of 1 Hz. 1 Hz, you might ask? Why so small? 1 Hz is the baseline unit of noise bandwidth estab-

lished for how wide of an observation bin, in frequency, is used to define NSD.

For an absolute reference, the NSD may also be defined by the ADC input power in absolute terms of dBm/Hz. In this case, the absolute full-scale input power for the ADC must either be known or measured based on the input voltage and impedance.

HOW DOES THE NSD SPECIFICATION HELP ME DIFFERENTIATE ADCS FOR USE IN MY SYSTEM?

As the sampling frequency of Nyquist-rate ADCs doubles, the noise density decreases by 3 dB respectively, as it is spread across a wider Nyquist band. For a 2× sample rate, the same amount of input noise power would now be distributed across twice the bandwidth, which increases the SNR. This can be verified by doubling the value of the sample frequency (fs) in the following formula to realize a –3 dB reduction:

Noise power = $10log_{10}(fs/2)$

As sample rates for high speed ADCs continue to increase well into the GHz range, the benefit of increased SNR due to oversampling can be achieved. When comparing performance metrics for two ADCs, the potential to sample at a higher frequency can be considered with the benefit of a lower noise density.

HOW IS NSD DIFFERENT FROM THE NOISE FLOOR OF MY FAST FOURIER TRANSFORM (FFT)?

A typical FFT is taken using tens or hundreds of thousands of sample points — perhaps even a few million. For most ADC sample rates, this means that the bin frequency size represents a span of hundreds of Hz or a few kHz. An FFT bin size is defined as the Nyquist spectrum (fs/2) divided by the number of FFT samples with units of frequency. For example, a 131 MSPS ADC with a 2^{16} (65.5 MHz) sample FFT has a bin size of:

65.5 MHz/655000 samples = 1 kHz per bin

So, the noise of the ADC is spread across the Nyquist zone in relatively large bin widths that are 1000× as large compared to the bin width defined within NSD. This includes more noise energy in a single FFT bin.

For the example above, if a very large 65.5 MS FFT were now to be used for our 131 MSPS ADC, the bin width would be:

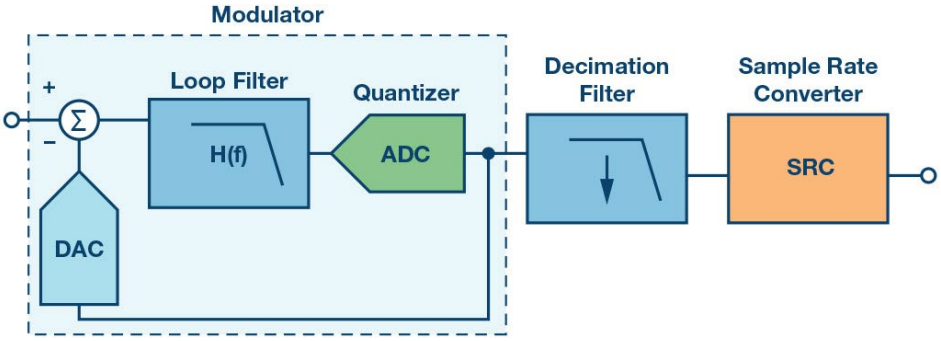

Figure 3 – The architecture of a CTSD ADC is based upon a loop filter and decimation filter that shapes the output noise.

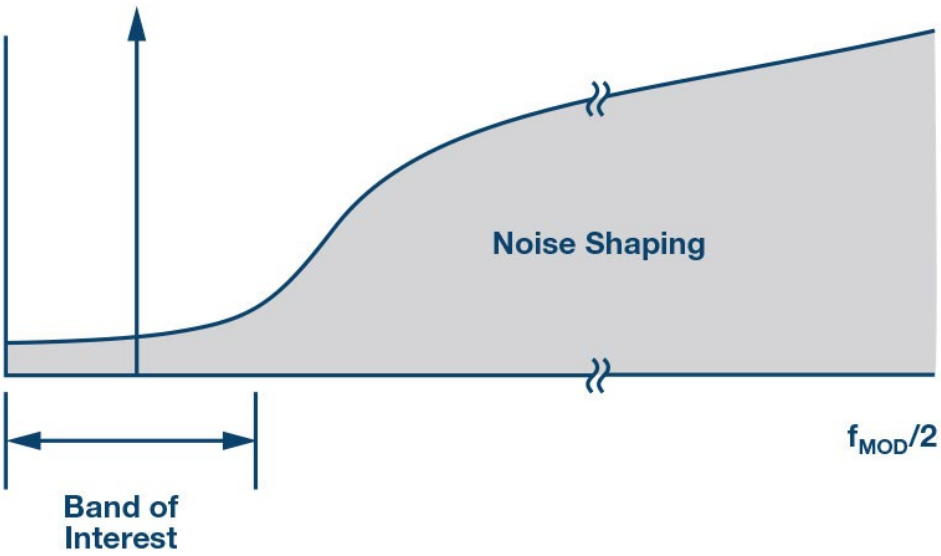

Figure 4 – The noise of a CTSD ADC architecture will not be flat. It will be shaped based upon the loop filter response within the modulator to push noise outside the band of interest.

65.5 MHz/65.5 million samples = 1 Hz

In this case, the noise floor of the FFT would be equal to the noise spectral density of the ADC, but, the total noise power still has never changed. The same noise power is only spread across finer frequency bin widths, as seen in Figure 1.

Contrast this with the NSD definition that has a noise unit of bandwidth or FFT bin frequency size of 1 Hz. You can now see why a typical FFT noise floor is almost always higher than that of the noise spectral density. Few engineers use a large enough FFT size in a system to achieve a bin width of only 1 Hz. This is why the noise appears to get lower when the number of samples in an FFT is increased.

However, the total noise is not changing. It is still being spread across the same Nyquist spectrum. Instead of using frequency bin increments that are defined by the sample size, the NSD definition uses smaller frequency bin increments of 1 Hz that capture less noise energy into a single bin.

HOW IS NSD MEASURED AND CALCULATED?

For an ideal ADC:

SNR = 6.02 × N + 1.76 dB

Where N is the resolution of the ADC, this will define the ADC's quantization noise level. A real ADC will not achieve these performance metrics, as non-linearities from its design will limit its practical SNR to be less than ideal. Seen another way, if we subtract the signal power from the ADC's full-scale input power, the rest is just the total noise power. If we summed up all of the 1 Hz bins of noise from our NSD number we would get a single power noise number.

To determine the NSD value for a Nyquist-rate ADC, the calculation of how

the noise is spread across a Nyquist zone must be computed and subtracted from the full-scale signal power. To start, we must know the sample rate. Let's take an ideal 12-bit, 200 MSPS ADC that has an ideal full-scale signal:

SNR = 6.02 × 12 + 1.76 = 74.04 dB

Its noise is spread across a 100 MHz Nyquist zone (fs/2). The noise per 1 Hz bin can be calculated using the log function:

Noise power per bin = $-10\log_{10}(fs/2)$
= -80 dBFS/Hz

For this 12-bit ideal converter, the NSD would be:

–74.04 – 80 = –154.04 dBFS/Hz

Since we live in a nonideal world with nonideal ADCs, we must find the ADC's actual SNRFS. This can either be measured directly or extracted from the manufacturer's data sheet.

The full-scale input signal power level of the ADC is computed using the known full-scale peak voltage or full-scale rms voltage and input resistance to the ADC. We can compute the full-scale power in dBm if the input voltage and input impedance are known, where:

$V_{rms} = V_p/\sqrt{2}$ *or* $V_p \times 0.707$

Signal power $= ((V_{rms}^2)/R_{in})$ *in W*

For full-scale signal power in units of dVm:

-

Signal power =
$10 \times \log((V_{rms}^2)/R_{in}) \times 1000$ *mW/W)*
$= 10 \times \log((V_{rms}^2)/R_{in}) + 30$ *dB*

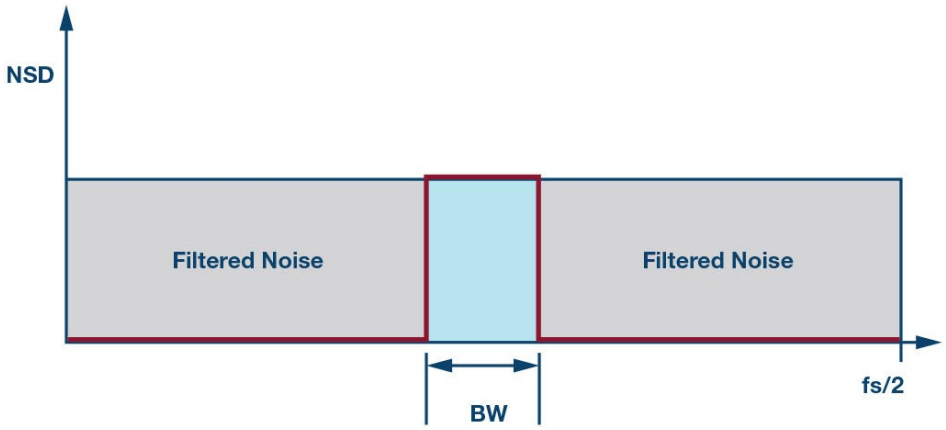

Figure 5 – By digitally filtering the output to observe only a smaller BW spectrum of interest, a processing gain improvement in SNR can be realized since the out of band noise is now filtered.

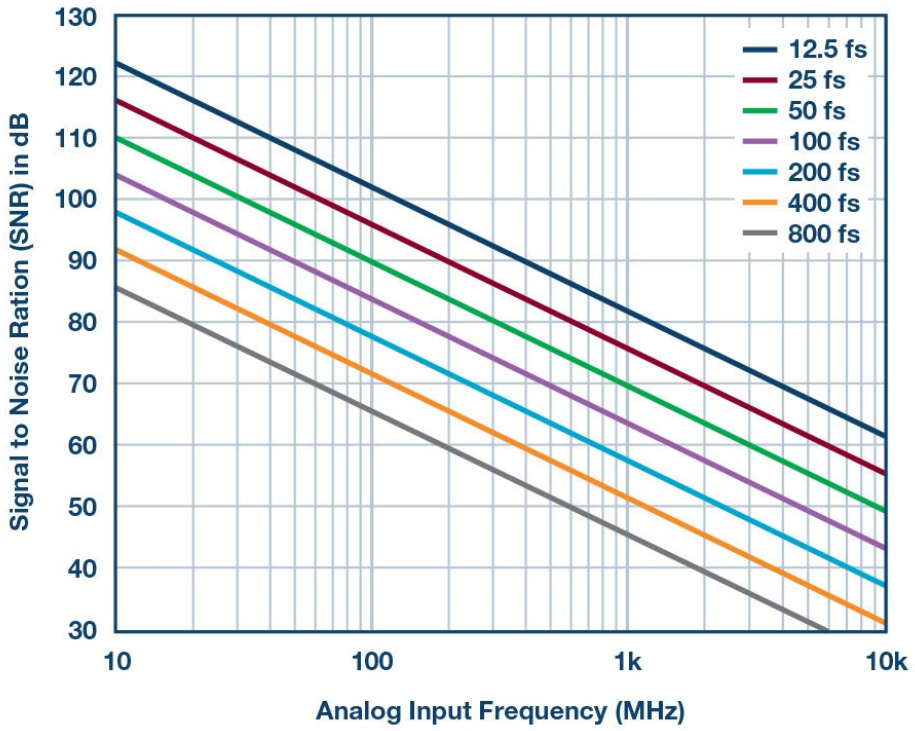

Figure 6 – Clock-jitter limited SNR can be plotted against the analog input frequency for various clock-jitter profiles.

WHAT IS THE SHAPE OF AN ADC'S QUANTIZATION NOISE SPECTRUM? IS IT ALWAYS FLAT?

Nyquist-rate ADCs operate at the minimum sampling frequency required to capture all of the information about the entire input bandwidth. Most Nyquist-rate ADCs that employ a pipeline, successive approximation register (SAR), or flash type of architecture will have quantization noise that is essentially flat from dc to the Nyquist frequency. As such, they will be equal opportunity noise receivers and receive finite power quantization noise equally across the entire fs/2 spectrum, as seen in Figure 2.

For applications where a full Nyquist bandwidth is not needed, alternate ADC architectures can be implemented. Band-pass, continuous-time, Σ-Δ (CTΣΔ or CTSD) ADCs use a noise shaping function that essentially pushes or filters the in-band quantization noise out of the frequency band of interest (Figure 3). This causes the noise transfer function to have a nonflat shape that is notched lower over a narrow band of interest, smaller than the Nyquist bandwidth. In this band, the CTSD ADC operates to its maximum performance where the SNRFS is the highest, which is show in Figure 4.

Since one of the main benefits of a CTSD architecture is its ability to detect signals within a narrow frequency band, the wideband NSD is not of particular interest. Instead, the dynamic range within the narrow pass-band will be highlighted as the performance metric for a CTSD ADC. The noise-shaping transfer function will be determined based on the loop filter order used within the design of the modulator.

HOW DOES THE PROCESSING GAIN OF AN ADC AFFECT THE NOISE DENSITY AND SNR?\

There are several applications where the primary signal of interest is located within only a small bandwidth, which is much less than the full Nyquist bandwidth. In

this case, digital filtering can be used to filter the noise outside of a smaller bandwidth. This processing can be done using a digital downconversion stage to decimate, tune, and filter the data before it is output from a Nyquist-rate ADC. Our SNR calculation must then include a correction factor for this filtering that accounts for the processing gain of the filtered noise, shown in Figure 5:

$$\textit{Ideal SNR (with processing gain)} = 6.02 \times N + 1.76\ dB + 10\log_{10}(fs/(2 \times BW))$$

Let's assume we're using a Nyquist-rate ADC with a sampling frequency of 100 MSPS, but, our system application does not need to observe the entire 50 MHz Nyquist bandwidth of the converter. Instead, we only want to observe a smaller, 1/8 of Nyquist in a bandwidth section of 6.25 MHz, between 20 MHz and 26.25 MHz. If we implement a digital filtering algorithm and tune the filter to this bandwidth of interest, a processing gain of 9 dB due to oversampling can be computed:

$$\textit{Processing gain} = 10\log_{10}(fs/(2 \times BW)) = 10\log_{10}(100 \times 10^6/(2 \times 6.25 \times 10^6)) = 10\log_{10}(8) = 9\ dB$$

For every power of two reduction in bandwidth, the processing gain due to the filtered noise will increase by 3 dB. This can be seen in the example above with a $1/2^3$ reduction in bandwidth yielding a processing gain of 3 dB × 3 dB.

WHAT OTHER COMPANION COMPONENTS CAN IMPACT THE NSD PERFORMANCE OF AN ADC?

Many external factors can degrade the best performance of a high speed ADC. This can result in a lower SNR and a higher effective noise density. Any complementary component that impacts the SNRFS or sample rate of the ADC can have the potential to impact its NSD in a system. Let's focus on clock jitter, which is one of the common SNR degradation culprits for high sample frequencies to an ADC.

High speed, high resolution ADCs are sensitive to the quality of the clock input. To achieve superior SNR in a high speed ADC, the root mean square (rms) clock jitter must be carefully considered, based on the requirements for the application's input frequency. The rms clock jitter can potentially limit the SNR of even the best performing ADC, exacerbated at higher input frequencies. While this will not change an ADC's NSD potential, it will limit its practical SNR performance in a system with a high jitter clock.

As the analog input frequency to the ADC triples using the same rms clock jitter, the best SNR performance is lowered by 10 dB. The degradation in SNR at a given input frequency (fA) due only to aperture jitter (tJ) can be calculated by:

$$SNR = 20 \times \log_{10}[1/(2 \times \pi \times fA \times t_J)]$$

Figure 6 shows the SNR limited performance of various input frequencies across different rms clock jitter profiles in units of femtoseconds. As the input frequency increases, a lower rms clock jitter will be needed to achieve the same SNR limit, as seen at lower input frequencies. For example, an rms clock jitter of 200 femtoseconds limits an ADC's SNR performance to no better than 70 dB at 250 MHz. However, a 1 GHz input signal would need an rms clock jitter of 50 femtoseconds or better to achieve the same SNR performance of 70 dB.

The noise spectral density of an ADC can be defined easily as the full-scale signal power of an ADC less the noise power, spread across 1 Hz bandwidth unit increments. A changing FFT sampling depth does not alter an ADC's spectral noise density. It only spreads the noise across different unit bandwidths of frequency.

The noise shape can vary depending upon the ADC architecture and whether or not digital filtering is used to filter out-of-band noise. Processing gain can enhance the dynamic range within the bandwidth of interest for Nyquist-rate ADCs that have a far wider bandwidth than a system requires.

ABOUT THE AUTHOR

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Teradata and Cisco join forces on IoT data/analytics

Teradata is working with Cisco on digital transformation with a focus on smart cities and communities. Combining the merits of the Cisco Kinetic for Cities IoT platform with the Teradata Analytics Platform will help cities become smarter and more connected by providing a powerful system for integrated data exchange.

The Cisco Kinetic for Cities platform excels at collecting, aggregating and normalizing real-time data securely across city networks. Teradata is among the first enterprise data analytics companies to integrate with this platform to provide smart data management, such as analytics, persistent data lifecycle management and data enrichment, that delivers business insights to cities and communities.

Data collection and management within a city is often decentralized and stored in departmental silos, where each city manager creates a "cockpit" of data and a set of tools for managing specific city facilities. This approach makes it difficult, if not impossible, to generate a city-wide view of the data. Disparate data silos must be integrated to reveal insights about the city as a whole. Only then can the data be used effectively to drive predictive and prescriptive decision-making for a variety of urban services, including lighting, parking, traffic and waste management, citizen engagement, safety and security.

Using Cisco Kinetic for Cities, cities can gather, aggregate and normalize information from disparate and siloed city applications, including but not limited to traffic, lighting and parking. Combining this real-time sensor data with other city information, such as data from payment systems, citizen sentiment and analytic applications, Teradata is able to deliver prescriptive and predictive analytics, as well as easy-to-comprehend visualizations, that help city leaders make smarter, more informed decisions. Such a combined solution could, for example, automatically detect security incidents and generate alerts, locate traffic bottlenecks and optimize signals to ease congestion or evaluate route options to shorten emergency vehicle response time.

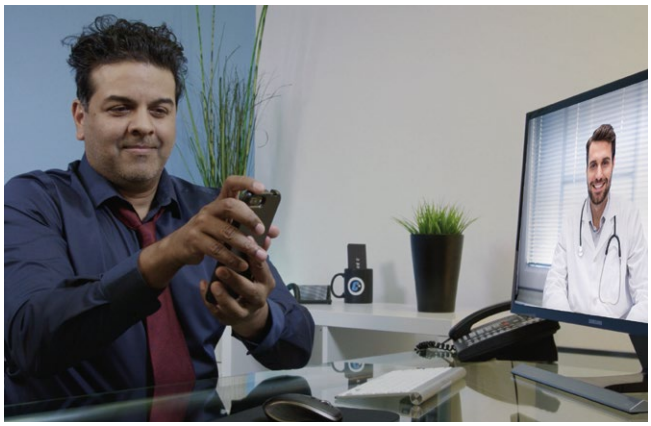
www.teradata.com
www.cisco.com

Medically accurate vital signs measurement using a smartphone

Leman Micro Devices (LMD), backed by major players within the mobile device industry, has announced that its V-Sensor and App integrated with next-generation smartphones will assist diagnosis by physicians and drive growth in remote medical consultation services by enabling patients to self-measure their own vital signs with medical accuracy for online appointments with doctors.

Remote medical consultation services are already showing significant growth around the globe – people in developed countries often cannot find the time to visit doctors during medical centre working hours and appreciate the convenience and reassurance of being able to speak to a doctor 24/7, while people in less developed nations can experience extreme difficulties in accessing face-to-face medical services due to distance, lack of transport infrastructure and other factors. With over 7 billion mobile devices in use worldwide, mobile phones are now bringing widespread access to remote healthcare services to people no matter where they live.

Doctors conducting appointments remotely have had, until now, to rely on patients' description of their symptoms, plus observation of what they can see using the phone's camera. Now the essential addition of hard diagnostic data can be provided by LMD's V-Sensor and App, which leads the field in smartphone medical devices. Integrated with



next-gen smartphones, the V-Sensor and App enables patients to measure their own blood pressure, heart rate, respiration rate, blood oxygen level (SpO2) and body temperature with medical accuracy and share the information from these five vital signs with their doctor during the remote consultation, facilitating diagnosis.

No external devices are needed; the smartphone provides the complete solution when equipped with a V-Sensor. V-Sensor uses the established Rivva-Rocci technique to measure blood pressure, but instead of having a cuff on their arm, the user simply presses their index finger against LMD's V-Sensor on the side of the smartphone. The V-Sensor app ensures the correct range of pressures is applied and gives an accurate reading in around 60 seconds, without needing any additional accessories or equipment. A thermopile is also built into the V-Sensor module for non-contact body temperature measurement and other built-in features allow all five vital signs to be measured by the patient in less than 60 seconds, without any extra accessories and all to medical accuracy.

"Smartphones with LMD's V-Sensor and App make valuable additional information which is medically accurate and available to doctors exactly when they need it." says Tom Foley, a leading expert in remote healthcare. "A smartphone with integrated V-Sensor and App also enables patients to check their vital signs regularly with results automatically collected and archived, and these too can be shared during online telehealth consultations, perfect for accurately monitoring ongoing health conditions and for chronic care."

www.leman-micro.com

Nvidia, ARM aim to bring AI to billions of IoT devices

Nvidia (Santa Clara, CA) and ARM (Cambridge, UK) have announced that they are integrating their respective deep learning accelerator IP and machine learning platform to ease the building of deep learning IoT chips.

Under the partnership, the companies will integrate the open-source NVIDIA Deep Learning Accelerator (NVDLA) architecture into ARM's Project Trillium platform for machine learning. The collaboration, say the companies, will make it simple for IoT chip companies to integrate AI into their designs and help put intelligent, affordable products into the hands of billions of consumers worldwide.

"Inferencing will become a core capability of every IoT device in the future," says Deepu Talla, vice president and general manager of Autonomous Machines at NVIDIA. "Our partnership with ARM will help drive this wave of adoption by making it easy for hundreds of chip companies to incorporate deep learning technology."

NVDLA is a free, open architecture designed to promote a standard way to design deep learning inference accelerators. Based on the Nvidia Xavier autonomous machine SoC, its modular architecture is scalable, highly configurable and designed to simplify integration and portability.

Rene Haas, executive vice president, and president of the IP Group, at ARM adds, "Accelerating AI at the edge is critical in enabling ARM's vision of connecting a trillion IoT devices. Today we are one step closer to that vision by incorporating NVDLA into the Arm Project Trillium platform, as our entire ecosystem will immediately benefit from the expertise and capabilities our two companies bring in AI and IoT."

NVDLA is supported by NVIDIA's suite of developer tools, including upcoming versions of TensorRT, a programmable deep learning accelerator. The open-source design, says the company, allows for cutting-edge features to be added regularly, including contributions from the research community.

www.nvidia.com
www.arm.com

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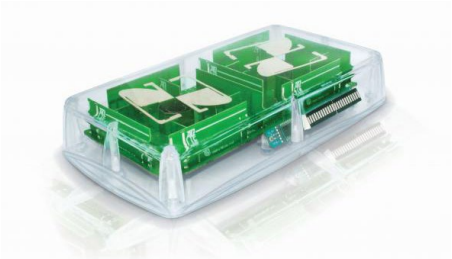
Software-defined antenna

to double throughput, coverage



In partnership with smart antenna technology provider Adant, Taoglas has developed a software-defined antenna system that changes the economics of next-generation wireless networks by extending coverage and increasing throughput by up to 100 percent. Dubbed Taoglas Shift, the antenna relies on Adant's advanced beam-steering technology to dynamically adapt its radiation pattern in real time to increase the link quality and deliver the best signal propagation and reception for mobile and stationary applications, both indoor and outdoor.

The Taoglas Shift antenna intelligently seeks out and finds the best signal on a regular basis, and then tunes the antenna in real time to achieve the highest throughput—reducing the need for redundant carriers to ensure strong coverage. The antenna and LTE module are combined in a single enclosure for fast solution deployment. The antenna can be deployed with today's wireless networks to solve coverage gaps and performance issues, and will also be a huge benefit to 5G networks as they emerge. Key features include directional beams that help mitigate interference from other co-located users. The antenna achieves a Total Radiated Power (TRP) and Total Isotropic Sensitivity (TIS) over 3 dB greater than a static omnidirectional antenna system of comparable size.

www.taoglas.com
www.adant.com

802.11ax Wi-Fi FEM

claims first with active steering

The EC714 5-GHz Wi-Fi front end module (FEM) from Ethertronics claims to be the first 802.11ax Wi-Fi FEM with integrated active antenna technology, providing robust Wi-Fi RF performance and linearity required to support 802.11 ax/ac applications.

Combined with Ethertronics' patented active steering antenna technology, this system delivers the 2x performance and coverage benefits in a flexible, cost-optimized solution.

The EC714 Wi-Fi active steering FEM is based on a breakthrough CMOS architecture, enabling the integration of an 802.11ax -class Wi-Fi FEM design with an advanced active steering engine into a single ASIC. The EC714 supports the complete set of RF-level performance requirements for 802.11ax/ac, including support for 160 MHz channel bandwidth at MCS11 in 5 GHz frequency bands. The FEM features a +18.5 dBm power output for high-performance 802.11ac applications (MCS9 – 80 MHz channel bandwidth) and MCS11 – 160 MHz channel bandwidth support for high-performance 802.11ax applications.

www.ethertronics.com

First signaling test system for Bluetooth® LE

Rohde & Schwarz has announced first system for Bluetooth LE signaling tests, facilitating device and component tests for manufacturers.

Bluetooth Low Energy (LE) has emerged as a major transmission technology for the Internet of Things (IoT). Bluetooth LE components are found in a variety of applications in the automotive industry, in sports and healthcare, in consumer electronics and smart homes, and in other areas. Many of these radio sensors are very small and integrated into equipment. When drafting the Bluetooth LE test specifications in 2010, Bluetooth SIG specified a direct test mode via a control line but did not specify an OTA signaling test mode. Many small Bluetooth LE devices offer no port or interface to connect a control line.

The test system uses OTA measurements on a CMW270 wireless connectivity tester to verify the RF properties and performance of Bluetooth LE devices in operating mode. The DUT's signal level, modulation and receiver sensitivity, among other parameters, can be determined in this way. The Bluetooth LE signaling functionality of the CMW270 provides the basis for the complex measurements and the wide variety of Bluetooth applications that have emerged as a result of the tremendous growth in the IoT sector. That makes the RCMW platform a safe investment also for coming generations of Bluetooth specifications.

The CMW270 delivers the full range of Bluetooth RF tests, including Bluetooth Classic, Bluetooth LE, and the latest standard, Bluetooth 5. Users can perform signaling tests and tests in direct test mode, as well as numerous audio tests on Bluetooth basic rate/enhanced data rate (BR/EDR) links. The CMW270 is especially suitable for tests during development and for preconformance tests in preparation for Bluetooth SIG qualification.

www.rohde-schwarz.com

Ultra-low-power precision real-time-clock

targets IoT applications

EM Microelectronic has released the EM3028 Extreme low power Real-Time Clock (RTC) module, setting a new industry benchmark for accuracy and power consumption.

EM3028 targets green IoT applications, with 50% extended battery life compared to its closest competitor, at double the accuracy. It extends the device life span at a reduced overall BOM cost.

EM RTCs provide an elegant solution for increasing the autonomy of connected devices, by providing accurate sleep and wake-up timing for their power-hungry elements. The frustrating need to frequently charge or replace the batteries of a wearable device becomes a thing of the past with the EM3028 used as an ideal companion for the company's energy harvesting systems – this unique combination requiring, in certain applications, no charging or battery replacement throughout the complete device life span.

The high accuracy and long-term stability of this RTC guarantee consistent performance throughout the device lifetime without the need to calibrate

during manufacturing. Its 1-ppm accuracy guarantees a 30 seconds precision over one year, twice as good as the best-in-class RTC previously on the market, while consuming the energy equivalent of 4 water drops per day.

The device features an integrated backup switch and, thanks to the extreme low power operation, allows waking up a sleeping device even years after it has been switched off for power saving purposes, all at extremely low BOM cost.

Other key features of EM3028 include a 32-bit UNIX timer, operating voltage range as low as 1.2-V, as well as a plug-and-play, factory pre-calibrated non-volatile configuration setting guaranteeing the configuration and user parameters are never lost, even in case of system power fail. The extremely small device size makes it ideal for integration in tiny wearable applications.

www.emmicroelectronic.com

Wireless sensor hub evaluation kit

real-time IoT

The SDAWIR0x wireless sensor hub evaluation kit allows product designers and engineers to validate the advantages of wirelessly connecting IDT's high-performance humidity, temperature and flow sensors in their latest industrial IoT, smart home, connected appliances, fluid metering and control and environmental monitoring applications.

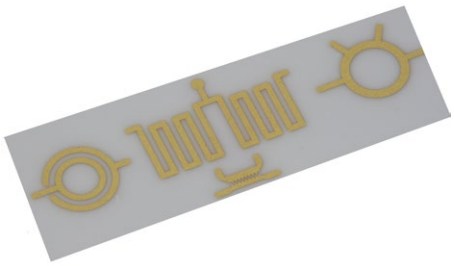
The development environment integrates IDT's HS3001 humidity and temperature sensor, FS2012 flow sensor and ZWIR4512 6LoWPAN module and network stack in a single sensor module. The ZWIR4512 connects the environmental sensors via Wi-Fi to output the sensor data in real-time to a private network where it can be viewed on iOS or Android devices. Up to one hundred sensor modules can be connected to a single Wi-Fi hub; or thousands in a full mesh network. Over-The-Air (OTA) firmware updates simplify development and system updates after deployment. This platform makes the SDAWIR0x ideal for a variety of connected devices requiring real-time temperature, humidity and flow data, such as smart thermostats, smart refrigerators, environmental weather stations, pumps and metering equipment and medical infusion pumps and CPAPs.

The SDAWIR0x security stack enables secure, end-to-end communication – even over unsecure network nodes – with its standard-compliant implementations of the Internet Protocol Security (IPSec) protocol suite and the Internet Key Exchange Protocol version 2 (IKEv2). x

www.idt.com/sensorhub

Etchable gold thick film process

Etchable gold thick film process



Remtec has commercialized an etchable gold thick film process for High Definition Thick Film (HDTF) circuitry as a low-cost alternative to thin films – representing a significant advancement in miniaturization, circuit density and performance.

The new etchable gold substrates allow the use of ultra-fine lines with a standard line/spacing resolution of 50/50 µm (0.002-inches) and premium circuit of 25/25 µm (0.001-inches). Circuit designers can also benefit from Remtec's capability for added value features available on the same substrate. In addition to an etchable gold circuit, the HDTF can incorporate conductor multilayers. It also integrates built-in components such as Lang couplers, inductors, filters and high precision resistors in a wide range from 50 mΩ to 1 MΩ laser trimmed to ±1% on the same ceramic base.

Remtec supports the new line of advanced HDTF substrates with new, state-of- the art processing equipment in a class 1000 clean room. Design engineers can also take advantage of the company's well-known core competency technologies such as AgENIG® (Electroless Nickel Immersion Gold on Silver) and PCTF® (Plated Copper on Thick Films) metallization in their ceramic package designs.

Typical applications for etchable gold HDTF ceramic metallization are for products requiring high circuit density and conductor proximity. HDTF substrates used for high performance products such as mm-wave microwave circuits and high pin count analog and digital designs. They are ideal for radar, missile and satellite communications systems in both defense and industrial applications.

www.remtec.com

Amplified power divider module

offers 8-ways

The APD-8-100M-28V from Planar Monolithics Industries is an 8-way, amplified power divider module that provides a 100 MHz signal to 8 outputs with less than 4 dB ±1.5 dB maximnum loss (measured loss is 3.1 dB).

This module balances a low noise figure with high output power. Other specifications include a VSWR of 2.0:1 maximum (measured 1.1:1 in and 1.25:1 out), Noise Figure of 9.0 dB maximum, 6.0 dB goal (measured 7.9 dB), Input Power P1dB of +13 dBm typical (measured +14.5 dBm).

Survival Input Power is +20 dBm maximum (measured +20 dBm) and Output Port to Port Isolation is 25 dB typical (measured 33 dB minimum). Power supply requirements are +28 V at 750 mA maximum (measured 172 mA).

The module has SMA connectors and has a weight of 140 grams with dimesions of 4.00- x 2.00- x 0.55-inches (10.16- x 5.08- x 1.40-cm).

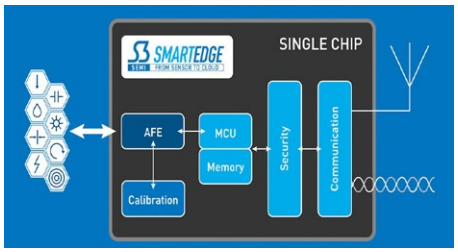
www.pmi-rf.com

S3 introduces 'platform' for wireless sensor nodes

As part of a plan to provide custom mixed-signal and RF integrated chips S3 Semiconductor has announced a platform approach to wireless sensor nodes.

S3 Semi, part of S3 Group Ltd., (Dublin, Ireland), has called its approach

SmartEdge and promises to reduce PCB area and power consumption by up to 75 percent and the bill of materials cost by 80 percent.



Seeing a need to put more computation at the edge of the network to reduce the power consumption, latency and expense while increasing security S3 Semi's SmartEdge platform includes a number of IP blocks useful for single-chip nodes.

These include a sensor analog front-end (AFE) suitable for conditioning many different types of sensor for temperature, pressure, humidty, flwo and so on; a microcontroller core, typically a Cortex-M class core, wired and wireless communications modem cores and security provision. The AFE can also be used to control actuators. S3 recently became an approved ARM partner for design.

S3 already supports wired communications popular in industry such as Fieldbus, HART, Profibus with Ethernet to follow. For Bluetooth and 802.11agn wireless standards S3 would license in a core, said Darren Hobbs, director of marketing and strategy at S3 Semi.

SmartEdge is a platform because it can also include software. S3 Semi has a legacy of supporting embedded software development through its internal teams and partner eco-system, covering development tools, debug tools and middleware components.

And because S3 has experience in managing the supply chain with access to foundries and test and packaging companies the company can also produce systems-in-package or multi-die components that could include sensors, and CMOS platform in a single component.

A typical manufacturing node for SmartEdge to target would be 0.18-micron where the costs are low and multiple extension modules are available for mixed-signal, power, non-volatile memory, Hobbs said. But for more complex ASICs the platform could go down to 40nm. "It will depend on the economics," Hobbs said.

S3 has a long-standing relationship with the foundry TSMC but Hobbs said the company has stepped outside that pairing from time to time. Hobbs said S3 has signed multiple customers to use SmartEdge and that one is in volume manufacturing with others set to start manufacturing during 2018.

www.s3semi.com

Solderless 2.9-mm RF connectors

enable faster assembly time

Intelliconnect (Europe) Ltd offers a range of cost effective 2.9-mm connectors that provide solderless attachment to 0.085-inch (RG405) and 0.14-inch cables.

System designers will find the main advantages of these connectors are faster assembly time, repeatability and performance and they also provide field replaceable connectivity.

The connectors feature a unique clamping technology that provides similar I/L and VSWR results to standard soldered connectors. No special tooling is required and cable retention force is similar to soldered versions.

These stainless steel 2.9-mm connectors have been designed for applications where reliability, durability, robustness and high frequency performance are very important. Typical applications include civil and military telecommunications, civil and military aeronautics, military equipment, space and measurement systems.

www.intelliconnect.co.uk

Certified Wi-Fi-and LTE modules

target European IoT market

Telit has released two modules, the WE866E4-P and the ME910C1-E2, designed to meet European specifications requirements for advanced IoT applications such as smart buildings, smart energy, industrial applications, medical devices and others.

The WE866E4-P is a fully integrated dual band, dual mode, combo Wi-Fi (802.11 a,b,g,n) and Bluetooth Low Energy (BLE) 5.0 module, with an extremely small footprint (285 mm^2) that provides an easy

and cost-effective way for manufacturers to add wireless connectivity to the products. The module comes with an integrated tri-core system-on-chip, with dedicated CPU's for IoT application, Wi-Fi and BLE. The module is self-contained with full Wi-Fi, BLE and TCP/IP networking stacks along with a complete suite of security features such as Secured Boot, Flash encryption, Copy Protection, HTTPS and WPA/WPA2 Personal and Enterprise security modes.

The ME910C1-E2 is a member of Telit's flagship xE910 module family delivering 4G radio access technology in the 28.2- x 28.2- x 2.2-mm family form factor. This module increases the addressable market for LTE technology to include a broad range of new applications and use cases best served with lower maximum data rate, ultra-low power, reduced complexity and cost and is capable of Cat M1, NB-IoT and 2G fallback. Some examples are smart meters, industrial sensors, health-care monitors, home automation, asset tracker and many more low data rate IoT devices.

www.telit.com

Radio analyzer

supports emerging LTE Cat-M1 and NB-IoT

Anritsu Corporation has introduced multiple software packages for its MT8821C radio communications analyzer that support emerging LTE Category M1 (LTE Cat-M1) and Narrowband IoT (NB-IoT) designs to create a highly efficient testing environment for LTE Cat-M1 and NB-IoT chipset and device verification.

The LTE Cat-M1 and NB-IoT support expands the test capability of the

MT8821C, and provides IoT-terminal and chipset manufacturers as well as communications operators with an all-in-one system that can speed development of IoT devices.

For LTE Cat-M1 testing, Anritsu has developed MX882116C Category M1 measurement software and MX882116C-006 LTE Cat-M1 IP data transfer measurement software. The MX882117C NB-IoT measurement software and MX882117C-006 NB-IoT IP data transfer software packages support NB-IoT verification. With the software installed, the MT8821C can conduct LTE Cat-M1 and NB-IoT 3GPP-defined RF measurement tests as well as IP data transferring functions to verify designs during the development and early deployment of IoT devices and services.

RF measurements defined in articles 6 and 7 of the 3GPP TS36.521-1 recommendations for LTE Cat-M1 and NB-IoT terminals can be made with the MT8821C with the software installed. Additionally, the eDRX and PSM low-power-consumption technologies are supported, along with IP data transferring functions necessary for comprehensive throughput measurement and function tests.

The new software options expand the measurement capability of the MT8821C all-in-one tester. With built-in RF TRx test functions and base station simulation functions for LTE-Advanced terminals, it supports tests of TRx characteristics while the terminal is communicating. With frequency coverage up to 6 GHz and 160 MHz wide frequency bandwidth for both Tx and Rx tests, the analyzer supports all cellular technologies compliant with 3GPP/3GPP2 UE RF TRX tests.

The system can control the mobile device by signalling and it supports measurements directly without changes due to the chipset for lower measurement environment setup costs. Through its unique Parallelphone Measurement (PPM) feature, a single MT8821C analyzer can perform simultaneous and independent testing of two UEs, reducing cost-of-test and improving throughput by 50 percent.

www.anritsu.com

Tiny industrial Bluetooth 5 module

targets IoT

Swiss company, u-blox has announced the ANNA-B1 Bluetooth 5 module for industrial applications, featuring an ultra-compact design and industrial operating temperature range that make it ideal for wide-ranging applications in size-constrained designs requiring high speed Bluetooth connectivity.

Essentially, the ANNA-B1 is a miniaturized variant of the meanwhile well-established u-blox NINA-B1 Bluetooth low energy module, packed as a System-in-Package (SiP) design into a tiny 6.5- by 6.5-mm footprint, just 1.2-mm thin.

The module includes an Arm® Cortex®-M4 microcontroller unit with a floating point unit, flash and RAM. The open CPU option provides full access to the module's microcontroller so that custom applications can be embedded into the module. Alternatively, product developers can speed up time to market by leveraging the full force of pre-flashed u-blox connectivity software. Fully tested and verified, and supporting many IoT applications, u-blox connectivity software includes a GATT client and server for connectivity attributes, Serial Port Service, simultaneous peripheral and central role, and NFC technology for easy pairing to other Bluetooth low energy devices.

ANNA-B1 has a built in antenna, but also allows for external antenna designs. Further, it comes certified for select markets off the shelf.

Typical applications for the ANNA-B1 Bluetooth module are small devices such as power tools, industrial and medical sensor products, wearables, and point of sale devices that require Bluetooth 5 connectivity, either individually or as part of a mesh network. Medical and sports wearables and telematics aftermarket products including insurance boxes will benefit from the the module's small footprint.

www.u-blox.com

Radio for short range wireless backhaul

in the 24 GHz band

Mimosa Networks thas launched the Mimosa B24 wireless backhaul radio, delivering affordable gigabit-speeds in the unlicensed 24 GHz band.

Coming in at a fraction of the weight, size and power consumption of competitive products, the Mimosa B24 delivers industry-leading price/performance, and perfectly fits the economics of broadband access in suburban and urban markets.

Designed from the ground-up using high-volume components to achieve maximum performance, the B24 delivers speeds of up to 1.5 Gbps IP throughput, automatically allocating traffic dynamically as needed. The radio is engineered for a number of key urban and suburban applications including MicroPoP backhaul, building top-to-building top connections for enterprise, campus and multi-dwelling units (MDUs), and video surveillance or smart city connectivity.

The B24 offers superior reliability for backhaul links of up to 3 km (2 miles), and leverages Mimosa's proprietary Spectrum Reuse Sync (SRS) technology, allowing up to eight collocated B24 radios to share the same channel, on the same tower or rooftop, each running at 1Gbps. For redundancy and flexibility, concurrent ethernet and fiber connections are supported, a feature previously unheard of in products with similar price points.

In dense urban and suburban areas where interference in unlicensed bands can be problematic, the B24 with SRS technology can overcome interference and improve overall link performance.

"The B24 delivers reliability at the distances we need in cities, at a fraction of the cost of our previous 24 GHz and 80 GHz alternatives," said Tyler Booth, CEO of Stephouse Networks. "With a compact design and low latency, guaranteed gigabit bandwidth can be delivered to most buildings instantaneously with none of the distance and siting challenges we often see in deploying 60 GHz."

In video surveillance applications, the B24 offers the highest quality video over a wireless backhaul. Its compact design means the B24 can be placed at surveillance locations without fiber, eliminating the cost and rights-of-way required for fiber. Likewise, the B24 is ideal for smart city applications where its high bandwidth and low cost make it the most economical way for municipalities and utilities to modernize their infrastructure without the disturbance and inconvenience of deploying a fiber network through the streets.

www.mimosa.co

Go/No-Go radio test system

targets the end-user

Aimed at the Land Mobile Radio market, the Mission Test System from Cobham, provides end users with a very quick automated test for their radio – ensuring that in critical situations – their radio will operate as expected.

The Mission Test System combines the 8800SX Digital Radio Test set with an RF shield case to ensure radio frequency interference is not an issue during the test. The system also comes loaded with the radio's specific Auto-Test application. The end user just needs to hook the radio up, close the case lid and push a button. Within 60 seconds, or less, the 8800SX will register a "Pass" or "Fail".

The Cobham 8800SX comes with the industry's largest touch-screen and our Auto-Test Applications are the gold standard with a proven track record for speed, accuracy and reliability. The Mission Test System allows AvComm to take their applications one step further, and provide the actual end users of the radio a very quick check that their radio is operational prior to their mission that day.

www.cobham.com

GaN MMIC LNAs

deliver output IP3 of +32 dBm

Custom MMIC continues to rapidly add to its extensive GaAs and GaN MMIC portfolio – adding three new unique GaN low noise amplifiers (LNAs) with easy to use evaluation boards.

The CMD276C4, CMD277C4 and CMD278C4 GaN MMIC LNAs deliver high linearity performance with output IP3 of +32 dBm while offering high input power handling of 5 W. The high input power handling feature enables system designers to avoid limiters and other protection networks, while still achieving extremely low noise figure over the operating bandwidth. These MMIC LNAs are housed in a leadless 4- x 4-mm QFN package. They are ideally suited for radar and electronic warfare (EW) applications where high performance and high input power survivability are required.

The CMD276C4 is a 2.6 to 4 GHz (S Band) LNA delivering greater than 14 dB of gain with a corresponding output 1 dB compression point of +25.5 dBm and a noise figure of 1.2 dB; while the CMD277C4 is a 5 to 7 GHz (C Band) LNA with 20 dB of gain, output 1 dB compression point of +26.5 dBm and a noise figure of 1.2 dB. The CMD278C4 is a broadband 8-12 GHz (X Band) LNA with 15 dB of gain,output 1 dB compression point of +28 dBm and a noise figure of 1.8 dB.

www.custommmic.com

3GPP-compliant reference test system

for sub-6 GHz 5G NR

NI has announced a sub-6 GHz 5G test reference system compliant with the 3GPP Release 15 specification for 5G New Radio (NR).

With commercial 5G NR deployments below 6 GHz on the horizon, engineers are actively developing sub-6 GHz 5G RF components and devices. The accelerated pace of 5G standardization is driving intense pressure to bring products to market quickly. The sub-6 GHz 5G NR reference system from NI is a cost-effective and high-performance option for test that helps engineers quickly characterize their designs and more easily transition from R&D to production test environments.

The new reference test system from NI is well-suited for testing new wideband RFICs, especially those operating in the 3.3 to 4.2 GHz and 4.4 to 5.0 GHz bands. Engineers can test devices operating with 400 MHz of continuous signal bandwidth and beyond with the PXIe-5840 Vector Signal Transceiver (VST), which includes 1 GHz of instantaneous signal generation and analysis bandwidth up to 6 GHz. With the NI VST, the system delivers residual EVM performance better than 0.32 percent (-50 dB) for 100 MHz NR signals along with faster measurement speed.

A critical component of this system is NI-RFmx NR measurement software, which has evolved in conjunction with the 3GPP specification. The latest version of NI-RFmx NR measurement software offers 5G NR waveforms and measurement capability compliant with the first official specification of 3GPP Release 15 for non-standalone NR, which empowers engineers to test both OFDMA and DFT-s-OFDM carrier aggregated waveforms with flexible subcarrier spacing from 15 kHz to 120 kHz.

www.ni.com/5g/nr

GaN FET drivers

for LiDAR, 5G envelope tracking

Texas Instruments has introduced two new high-speed GaN field-effect transistor (FET) drivers aimed at creating more efficient, higher-performing designs in speed-critical applications such as LIDAR and 5G RF envelope tracking.

The LMG1020 and LMG1210 offer switching frequencies of 50 MHz while improving efficiency and enabling five times smaller solution sizes previously not possible with silicon MOSFETs, the company says. The LMG1020 is a single, low-side GaN driver designed for driving GaN FETs and logic-level MOSFETs in high-speed applications, while the LMG1210 is a 200-V, half-bridge high-performance GaN FET driver designed for applications requiring high switching speed, minimized dead time, as well as high efficiency.

Featuring a claimed industry-best drive speed as well as a minimum pulse width of 1 ns, the 60-MHz LMG1020 enables high-accuracy lasers in industrial LIDAR applications. Its wafer-level chip-scale (WCSP) package measures only 0.8 x 1.2 mm, minimizing gate-loop parasitics and losses, further boosting efficiency.

Designed for GaN FETs up to 200 V, the 50-MHz LMG1210 features adjustable dead time control designed to improve efficiency by as much as 5% in high-speed DC/DC converters, motor drives, and Class-D audio amplifiers, as well as other power-conversion applications. It is offered as having the industry's highest common-mode transient immunity (CMTI) of more than 300 V/ns.

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