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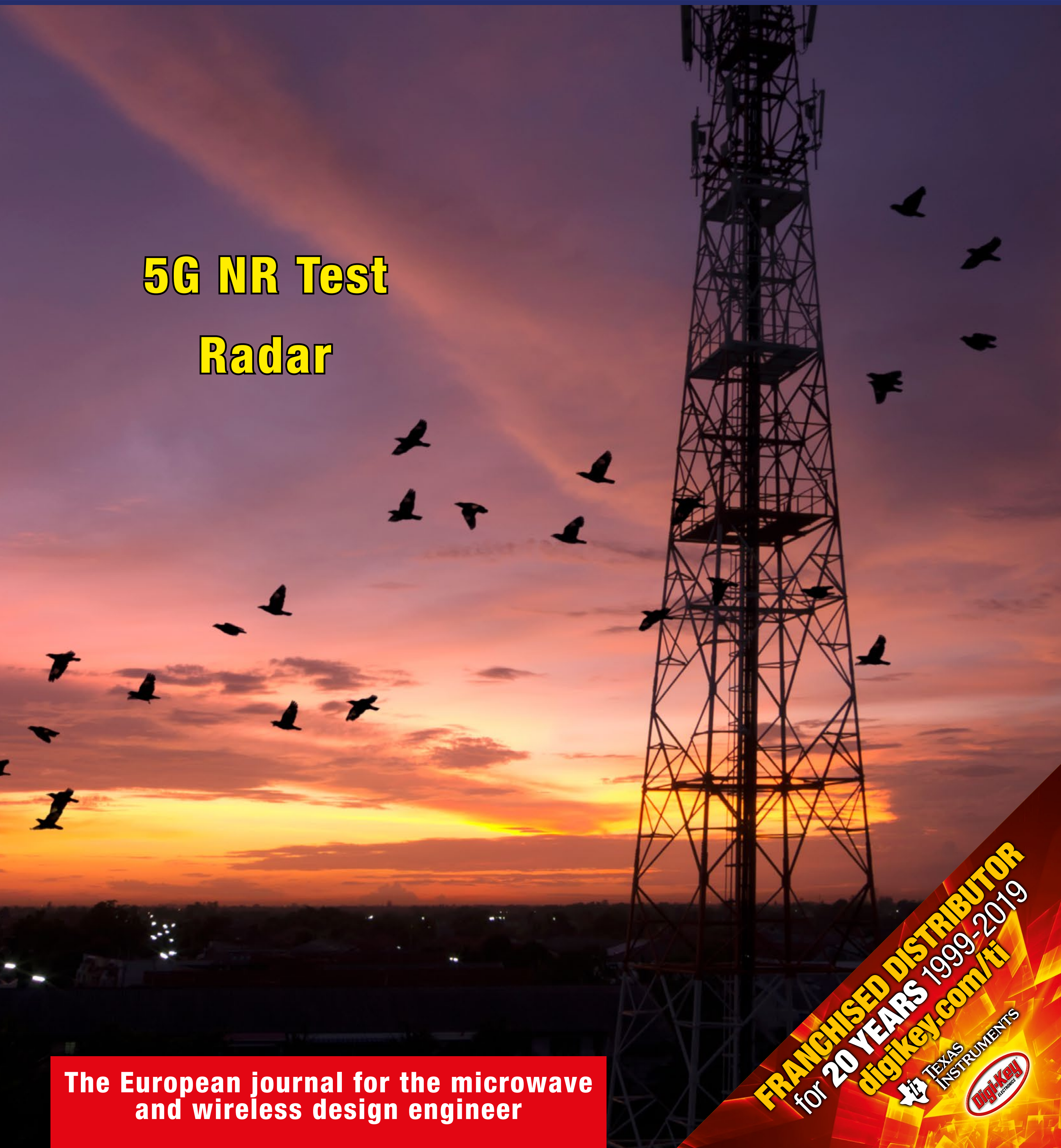

The European journal for the microwave and wireless design engineer

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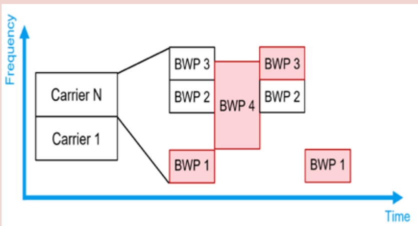

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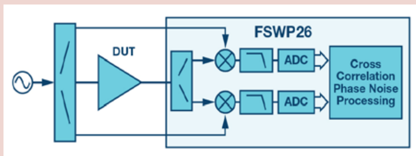

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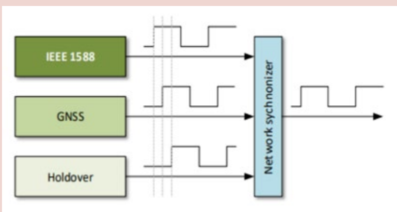

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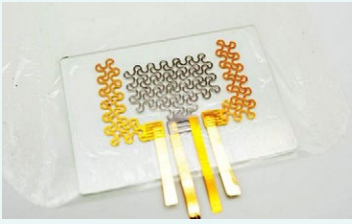
Smartphone and stretchable 'e-tattoo' enable heart monitoring

Engineers at The University of Texas at Austin have developed a graphene-based wearable device (e-tattoo) that can be placed on the skin to measure a variety of body responses, from electrical to biomechanical signals, that could make heart health monitoring easier.



The latest version of the team's electronic tattoo technology, the ultrathin lightweight and stretchable device can be placed over the heart for extended periods with little or no discomfort. Powered remotely by a smartphone, the e-tattoo measures cardiac health in two ways, taking electrocardiograph and seismocardiograph – a measurement technique using chest vibrations associated with heartbeats – readings simultaneously.

According to the researchers, their e-tattoo is the first ultrathin and stretchable technology to measure both ECG and SCG.

"We can get much greater insight into heart health by the synchronous collection of data from both sources," says Nanshu Lu, an associate professor in the departments of Aerospace Engineering and Engineering Mechanics and Biomedical Engineering.

Although soft e-tattoos for ECG sensing are not new, says Lu, other sensors, such as the SCG sensor, are still made from nonstretchable materials, making them bulky and uncomfortable to wear. The new e-tattoo is made of a piezoelectric polymer called polyvinylidene fluoride, capable of generating its own electric charge in response to mechanical stress. It also includes 3D digital image correlation technology that is used to map chest vibrations in order to identify the best placement location on the chest.

www.utexas.edu

LoRa gateway module market to hit US$3bn

A new report on LoRa Gateway Module Market by Persistence Market Research estimates the global LoRa gateway module market offers an incremental opportunity of more than US$ 3 billion up until 2028.

Increasing penetration of IoT has demonstrated the advantages to manufacturers and will positively impact the LoRa gateway module market. Expanding cellular IoT infrastructure and the introduction of 5G are also factors boosting the demand for LoRa gateway modules in industry, as well as an increasing amount of smart city projects and the increasing penetration of smart devices.

Continuous investments by countries industrial automation and the fulfilment of the current connectivity solutions for industries have encouraged vendors to offer cellular connectivity with new concepts that include LoRa. This demand has prompted a constant rise at a rapid pace for LoRa, particularly across the manufacturing industry sectors.

www.persistencemarketresearch.com

CEA-Leti and Radiall collaborate on RF components for 5G

Research institute, Leti, and Radiall have announced a five-year common lab to design innovative antennas, RF components to meet infrastructure requirements of 5G networks and photonics components for harsh environments.

5G networks require high-speed, point-to-point communication at millimeter-wave frequencies within a cost structure that operators are able deploy economically. The increase in ultra-dense 5G infrastructure systems required to accommodate high-speed mobile data traffic and IoT data is fueling a demand for low-cost, robust and reliable RF subsystems. This includes the use of compact and reconfigurable antennas that can be integrated on urban buildings and street furniture with minimal deployment cost.

However, at millimeter-wave frequencies between 30 and 300 GHz, severe path loss must be compensated through high-gain antennas enabled by transmit-array designs. Leveraging its expertise in antenna design, CEA-Leti previously collaborated with Radiall on transmit-array technology development. This collaboration resulted in a V-band (57-66 GHz) high-gain (32 dBi) antenna delivering up to 20 Gb/s that Radiall added to its product line.

Transmit-array architecture is a promising way to address this challenge because it minimizes the thickness of the antenna, while maintaining stability of the antenna gain over the entire bandwidth and controlling the sidelobe levels.

“Radiall and CEA-Leti launched a five-year common lab to create a sustained task force that will work on accelerating the development of high capacity and high coverage antennas for reliable and high-speed telecommunications, including 5G generations and beyond,” said Leti CEO Emmanuel Sabonnadière.

www.radiall.com
www.leti-cea.com

LG U+ selects iBwave tool for 5G stadium design

iBwave Solutions has announced that its software has been chosen by LG U+ to complete Asia's first 5G stadium design.

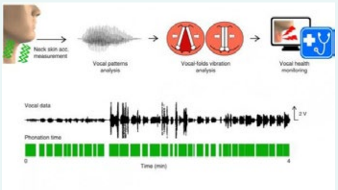
LG U+ and iBwave have been working closely together for the last year. With the support of iBwave's 5G Design Enterprise software design tool, LG U+ have dramatically improved their design quality, all while reducing the cost and time to complete in-building wireless designs. iBwave Design Enterprise is a powerful user-friendly software tool to design large and complex in-building wireless networks.

iBwave uses unique innovations such as 3D modeling, coverage, interference and throughput engines, as well as visualization of key performance indicators, to provide an accurate design for venues of all sizes. These features were essential to enhance the stadium with 5G. Technologies supported include Active/Passive DAS, Wi-Fi, small cells, public safety, LTE, LTE Advanced, LTE LAA, CBRS, IoT, and LoRa.

www.ibwave.com

Wearable skin sensor detects vibration for voice recognition

Researchers at the Pohang University of Science & Technology (Pohang, South Korea) have developed a flexible and wearable skin vibration responsive sensor that can be used for voice recognition in applications such as security authentication, remote control systems, and vocal healthcare.



When the sensor is attached to a neck, it can precisely recognize voice through vibration of the neck skin and - unlike a microphone on an external portable device - is not affected by ambient noise or the volume of sound. This addresses problems with conventional vibration sensors that recognize voice through air vibration, say the researchers, as the sensitivity of such sensors decreases due to mechanical resonance and damping effect, reducing their ability to measure voices quantitatively for purposes such as security authentication.

In their study, the researchers demonstrated that voice pressure is proportional to the acceleration of neck skin vibration at various sound pressure levels from 40 to 70 dB of sound pressure level (SPL). They then developed a vibration sensor consisting of an ultra-thin polymer film and a diaphragm with tiny holes that can sense voices quantitively by measuring the acceleration of skin vibration.

The researchers also successfully showed that their device can accurately recognize voice without vibrational distortion even in a noisy environment and at a very low voice volume with the user wearing a mouth mask. Their work, say the researchers, can be further extended to various voice-recognition applications such as electronic skin, human-machine interfaces, and wearable vocal healthcare monitoring devices.

www.nature.com/articles/s41467-019-10465-w

Rakuten Mobile and NEC to build first open vRAN in Japan

NEC Corporation has been selected to be the 5G network equipment provider for the world's first 5G open vRAN architecture being built in Japan by Rakuten Mobile. The partnership formed by the two companies will see Rakuten and NEC jointly develop a 3.7 GHz massive MIMO 5G antenna radio unit (RU) for the open vRAN architecture, which will be manufactured by NEC at its facilities in Japan. The RU is ideal for 5G conditions as it is compact, lightweight and consumes a low level of power, which reduces installation and operation costs.

Rakuten Mobile is currently building the world's first fully virtualized, end-to-end cloud-native mobile network. This innovative network is fully virtualized from radio access network to core and adopts 5G systems architecture from launch. Rakuten and NEC are already working together on an end-to-end BSS/OSS system to support the mobile network launch and subsequent operations.

www.nec.com

Major milestone for LoRa in space

Lacuna Space has announced the successful conclusion of the first phase of testing of a Space Gateway to provide complete global coverage for LoRa® devices and wireless radio frequency technology (LoRa Technology) to anywhere in the world, no matter how remote.

Over the course of the last two years, Lacuna has been collaborating with Semtech Corporation to extend LoRa Technology connectivity to the whole world. Lacuna Space has been developing satellite gateways and working with Semtech to evolve LoRa Technology to enable direct communication from LoRa-based devices to satellite gateways utilizing the LoRaWAN® protocol.

Lacuna's first satellite launch of the year was on 1st April 2019 from the Satish Dhawan Space Centre in India, where it shared a ride to Low Earth Orbit with EMISAT and 27 other satellites. Lacuna's LoRa-based Space Gateway was hosted on a 6U cubesat satellite provided by Nano Avionics, and Lacuna is pleased to announce that the satellite and the Space Gateway out-performed expectations during the initial commissioning phase.

Thomas Telkamp CTO, Lacuna Space, said that, "We have test systems deployed around the world in countries as diverse as South Africa, Netherlands, UK, USA, India, Japan, Slovenia and the Reunion Island, and we have shown that we are able to communicate effectively from anywhere in the world, no matter how remote, to our LoRa-based Space Gateway."

Lacuna is aiming to be ready to perform more extensive demonstrations with a select group of potential users towards the end of the year thanks to part funding and support from the European Space Agency and UK Space Agency.

www.lacuna.space
www.semtech.com
www.n-avionics.com

NXP, Microsoft focus on IoT edge security

In a major collaboration effort, chipmaker NXP and Microsoft will deliver a secure hardware platform for Industrial IoT edge applications. This includes new versions of NXPs i.MX 8 processor, enhanced by security IP from Microsoft. The ecosystem to be developed will be tightly entangled with Microsoft's cloud services. The move includes long-term security updates for installations in the field.

The collaboration aims to deliver a new Microsoft Azure Sphere certified crossover applications processor as an extension to NXP's i.MX 8 processor series. The goal is delivering a secure, smart embedded processor for IoT edge applications that seamlessly runs Azure Sphere's security platform. This processor will be based on the Arm Cortex-A35 architecture with one or two cores. It will also feature a powerful GPU and an HiFi4 DSP core for audio processing capabilities, all at very low power consumption. The processor will be available in limited samples in Q4, 2020.

www.nxp.com

Zigbee Alliance drives smart home, IoT product interoperability

The Zigbee Alliance has announced a major initiative to make smart home and IoT products easier to develop, deploy, and sell across ecosystems. The "All Hubs Initiative" is driven by a Zigbee Alliance workgroup comprised of leading IoT companies including Amazon, Comcast, Exegin, Kwikset, Landis+Gyr, Leedarson, Legrand, MMB Networks, NXP, Osram, Schneider Electric, Silicon Labs, Somfy, and many others with the goal of improving interoperability between IoT devices and consumer and commercial platforms.

This effort will result in a set of features at the application and network layers of Zigbee that will be incorporated into the upcoming 3.1 version of Zigbee. While Zigbee Alliance members are able to participate in this workgroup and contribute to and access these evolving specifications, the Alliance is publicly announcing this initiative as a number of smart home systems will add these features to their platform certification requirements ahead of the ratification of the full 3.1 feature set.

www.zigbee.org

Analog Devices invests in service and talent with bespoke UK HQ

On Friday 14th June in a strategic location next to Heathrow airport, Analog Devices opened the doors of its new UK headquarters office in Hayes, London, a location which will strengthen its ability to connect customers with the best engineering talent in the UK and overseas.

By locating its new office in London, close to a fast Elizabeth Line link to the city centre and a short distance from Brunel University, Analog Devices has made itself accessible to the capital's huge pool of talent – not only software and hardware engineers, but also a vibrant community of entrepreneurs and start-up workers, as well as skilled staff in non-engineering disciplines.

Close to Heathrow airport, the new HQ office is also a convenient hub for the company's domain specialists located in other Analog Devices locations such as Munich, Germany, Boston, US and Limerick, Ireland..

Roughly a quarter of Analog Devices' business comes form the EMEA region, with around 10 percent that generated in the UK. The UK is seen as strategically important not just in terms of business volume and growth but also due to a culture of innovation and engineering talent. For Analog Devices, the UK has a good mix of small, medium and large companies with no single large customer or region in the UK dominating in sales.

The site of the new office used to be a vinyl record factory owned by EMI at which discs from the likes of the Beatles and Rolling Stones were once pressed – a link to the UK's long audio engineering heritage which is mirrored in the decoration of the new office.

www.analog.com

MediaTek 5G ready with latest 7nm SoC

MediaTek has revealed that it is ready for 5G with the introduction of its groundbreaking chipset, a multi-mode, 7nm 5G system-on-chip (SoC) that supports LTE and 5G dual connectivity (EN-DC) with dynamic power sharing capability, plus multi-mode support for every cellular connectivity generation from 2G to 5G.

Announced at at COMPUTEX, the integrated 5G chipset, with the previously announced MediaTek Helio M70 5G modem built in, packs world-leading technology into its compact design. The SoC includes Arm's latest Cortex-A77 CPU, Mali-G77 GPU and MediaTek's most advanced AI processing unit (APU) to meet the power and performance demands of 5G to deliver super fast connectivity and extreme user experiences. The multi-mode 5G chipset is for 5G stand alone and non-stand alone (SA/NSA) sub-6GHz networks. It supports connectivity from 2G to 4G to bridge existing network access while 5G networks roll out globally.

www.mediatek.com

Startup developing mobile blockchain voting platform

Mobile election voting platform startup Voatz (Boston, MA) has announced that it has raised $7 million in Series A funding to further its goal of enabling citizens to vote in many types of elections and voting events via a secured smartphone or tablet. The Voatz platform uses biometrics, encryption, and blockchain technology to increase convenience, security, and auditability to election systems. The company says it plans to leverage the funds to enhance the accessibility and usability of its technology, and to grow its security footprint as it launches new pilot programs with states, cities, and select international jurisdictions.

Last year, the company conducted a successful pilot with 24 counties in West Virginia during the 2018 midterm elections where deployed military personnel and overseas US citizens leveraged the platform to cast their ballots. The pilot represented the first time that mobile voting secured by a blockchain-based infrastructure had ever been used in a US Federal Election.

More recently, in March the company announced a new pilot program with the City and County of Denver, CO to expand absentee voting for deployed military personnel and overseas US citizens during the city's 2019 municipal elections, which also concluded successfully. The company says it has also partnered with state political parties, universities, labor unions, church groups and nonprofits.

The funding round was led by Medici Ventures and Techstars, with participation from Urban Innovation Fund and Oakhouse Partners.

Voatz Co-Founder & CEO Nimit Sawhney comments, "We are committed to the steady progress of mobile voting backed by blockchain technology to improve our election infrastructure and make remote voting more accessible and safer."

https://voatz.com

Radar chip 'sees' both inside and outside the vehicle

Israeli startup Vayyar has launched a radar chip that enables in-cabin passenger location and classification, occupant size, vital sign and posture analysis, as well as 360° exterior mapping, including monitoring cars, objects and pedestrians around a vehicle.

The company's single-chip imaging radar constructs a real-time, high-resolution 4D visualization of both in-cabin and car exterior environments through the acquisition of dynamic point clouds. A single chip point cloud can display the dimension, shape, location and movement of people and objects, enabling the complete classification of the car's environment, regardless of bad lighting or harsh weather conditions.

In-cabin solutions include seat belt reminders, optimized airbag deployment, gesture control, driver drowsiness alerts, and infant detection alarms, even if the infant is covered by a blanket or hidden in a car seat or in the foot well. The company's exterior systems map and classify the car's surroundings to enable enhanced parking assistance, blind spot detection, lane switching assistance, automatic speed and distance control, and alerts for height obstacles, obstructions and more.

This latest advance in automotive radar capabilities is especially poignant in light of recent comments by Elon Musk on LIDAR and that Tesla has not plans to use the technology. One of the key issues facing LIDAR systems is cost and size. The advantage of LIDAR is its high accuracy. However, radar, when implemented on a chip, offers a more cost-effective approach and is capable of delivering a high degree of autonomous driving on its own. Radar is available now to develop autonomous systems, while the cost of LIDAR at the moment is holding back mass deployment.

"Today, existing radar systems do not deliver 4D point cloud capabilities. Vayyar is the first to close the gap between the robustness of radars and the resolution of LiDAR and optics. Our real-time, 4D point cloud system can work in any environmental condition and doesn't compromise one's privacy. We believe our sensors will create a shift in the way the automotive industry will use radar in the future," said Ian Podkamien, Director of Automotive Business Development for Vayyar Imaging.

Vayyar's Radar on a Chip (ROC) has 48 transceivers operating at 76-81 GHz which allows over 2000 virtual channels. The chip also consists of an internal DSP for real-time signal processing. This single chip system is easily integrated into existing automotive framework, reducing the overall cost and number of sensors needed for the vehicle.

www.vayyar.com

GPS/LoRa based personal tracker works without mobile network

How do you keep track of exactly where service and rescue personnel are at a large event? The Fraunhofer Institute FIT has developed such a system based on both GPS and LoRa. It even works when the mobile network fails, is overloaded or in places where such a network does not exist at all.

As part of the MONICA (Management of Networked IoT Wearables - Very Large Scale Demonstration of Cultural Societal Applications) research project, a consortium led by Fraunhofer FIT has developed a GPS/LoRa based tracker system that determines the exact location of people in a large crowd and displays it in an operations center. For example, the organizers of mega-events can see at any time where employees of the law enforcement forces, service staff, emergency doctors or firefighters are located. The location of these people is displayed in real time on a digital map of the location in an operations centre.

The system, which met all the above requirements, uses a GPS receiver to determine the location and the LoRa radio protocol to transmit the data to the control center. LoRa is a radio protocol designed for the "Internet of Things" and enables ranges of several kilometers. The system was tested at the major event "Rhein in Flammen", where tens of thousands of spectators watch a series of fireworks on the Rhine river every year. During the test, the entire event area was covered completely and redundantly with only two antennas. "The advantage of our system is that it functions independently of the mobile phone network and at the same time hardly needs to be set up its own infrastructure," explains Marco Jahn of the Fraunhofer Institute for Applied Information Technology FIT.

The trackers are about the size of a car key and can be attached to clothing or stored in the pockets of security personnel. Their basic function is to continuously report the exact position of the wearer to the control center. In addition, the trackers are equipped with a kind of "panic button". When activated, the position of the corresponding unit is highlighted on the digital location map and the responsible persons are provided with additional information.

In the course of the event, police, fire, rescue and law enforcement forces tested a total of 45 trackers. It is said that the system met all requirements.

The system, consisting of trackers, antennas and the digital location map, was developed by Fraunhofer FIT as part of the EU MONICA project and is suitable for large events of all kinds. MONICA fathoms out to what extent sensor technology and the Internet of Things can improve the security of visitors at major events. The project, funded by the European Union with 15 million euros, started in 2017.

www.fit.fraunhofer.de/en.html

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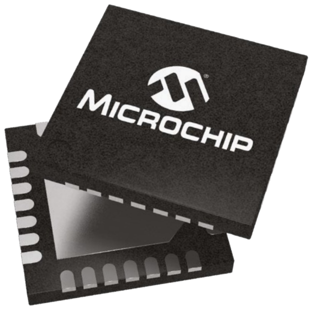

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MICROCHIP

5G NR network rollout is now – let's test!

By Arnd Sibila, Technology Marketing Manager, Rohde & Schwarz Mobile Network Testing

3GPP release 15 specifies the initial 5G standardization framework of the radio access network called 5G New Radio (5G NR). The standard contains a high degree of flexibility in radio parameters, which complicates network measurements. However, Rohde & Schwarz has already conducted measurements in pre-commercial 5G NR trial networks with its commercially available 5G NR network measurement solution. We gained interesting insights into the new technology's performance, capabilities and frequency bands.

The mobile communications industry undertook a paradigm shift in defining the next generation of mobile communications. Before discussing new technologies like in all previous generations, the industry researched and assessed the use cases and needs that 5G should fulfill. After a general agreement about the use cases, requirements were defined, including data rates, carrier bandwidths, latency values, number of devices, etc.

It was only after having reached a consensus on use cases and requirements that the 3GPP identified, discussed and evaluated candidate technologies. 3GPP release 15, issued in March, June and September 2018, specified the initial 5G standardization framework for the radio access network (RAN) called 5G NR.

5G NR is the global standard for providing a unified, more capable 5G wireless air interface. It will deliver significantly faster and more responsive mobile broadband experiences, and it will extend mobile technology to connect and redefine a multitude of new industries.

Parameter	Frequency range 1 (< 24 GHz, mostly < 6 GHz)	Frequency range 2 (> 24 GHz)
Carrier aggregation	Up to 16 carriers	
Bandwidth per carrier	5, 10, 15, 20, 25, 30, 40, 50, 60, 80, 100 MHz	50, 100, 200, 400 MHz
Subcarrier spacing	15, 30, 60 kHz	60, 120, 240 (not for data) kHz

Table 1: 5NR flexibility in frequency domain parameters.

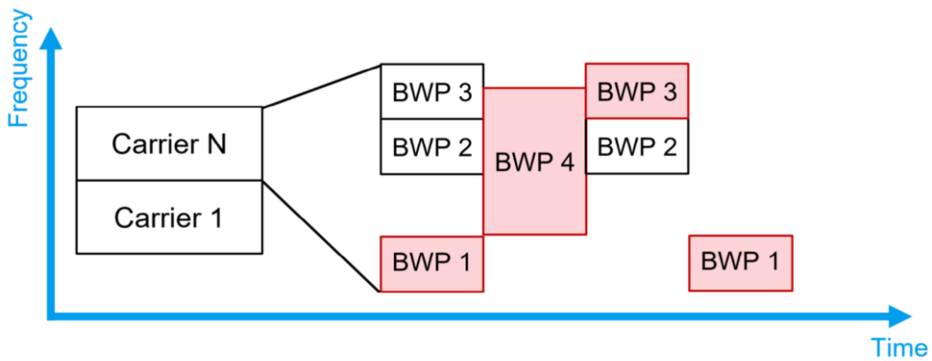


Figure 1: Bandwidth parts (BWP) in 5G NR – Source: Rohde & Schwarz.

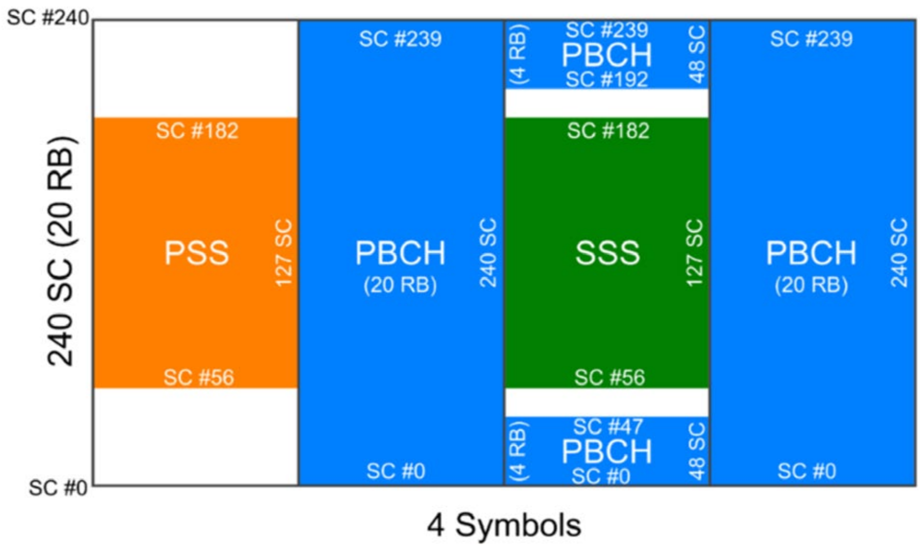


Figure 2: Details of the SS/PBCH block in 5G NR – Source: Rohde & Schwarz.

HOW DOES 5G NR DIFFER FROM LTE?

LTE radio access (or, in 3GPP terms, eUTRAN) is an OFMD based technology with a fixed subcarrier spacing of 15 kHz that supports carrier bandwidths from 1.4 MHz up to 20 MHz. LTE has a packet-switched architecture that supports a wide range of data applications. Voice is also supported as voice over LTE (VoLTE) or using fallback mechanisms to 3G and circuit-switched technologies.

The 5G NR specification embraces flexibility. It aims to include different use case families – from enhanced mobile broadband (eMBB) and massive machine type communications (MIoT) to ultra-reliable, low latency communications (URLLC) – that span across industries.

These different use cases require a wide variety of air interface characteristics in terms of frequency range, subcarrier spacing, carrier bandwidths, symbol durations, etc.; the network architecture needs to offer many options. Table 1 shows the flexibility of frequency-specific parameters.

To cope with the different 5G NR use cases and demands per service, 3GPP defines the concept of bandwidth parts (BWP). Each BWP has a fixed numerology (fixed subcarrier spacing, number and location of the resource block, symbol duration, etc.).

User equipment (UE) can be configured with up to four carrier bandwidth parts in downlink/uplink, but at any given time only a single downlink/uplink carrier bandwidth part can be active. The downlink control information (DCI), radio resource control (RRC) or a timer can trigger the switch of the active BWP (see Figure 1).

Another significant difference between LTE and 5G NR is the position of the synchronization signals, namely the primary (PSS) and secondary synchronization signals (SSS) within the carrier. Synchronization signals are very important. They are the first information that mobile devices need to identify in order to access the network.

In LTE, the sync signals are always located in the center of the carrier bandwidth; this makes them easy to find. In 5G NR, the sync signals are part of the SS/PBCH block (also called synchronization signal block, SSB) containing the physical broadcast channel (PBCH) information. These SS/PBCH blocks can be located at multiple positions all over the carrier bandwidth and are broadcast periodically as defined symbols in the radio frames and different beams versus time (see Figure 2).

BEAMFORMING OF SYNCHRONIZATION SIGNALS AND BROADCAST CHANNEL INFORMATION

Beamforming as a technology is not new, but with 5G, beamforming is not only applied to user-specific data streams but also to synchronization signals and broadcast channel information. Beamforming can be implemented with antenna arrays on the base station side, where different groups of antenna elements (dynamically allocated) form beams to different users depending on their phases and amplitudes related to each other.

Using beamforming also for synchronization signals and broadcast channel information provides better overall coverage thanks to the higher antenna gain. The synchronization signal block (SSB) in 5G NR can carry beam-specific information (SSB index). These SSB index “beams” are static and can be considered micro sectors, e.g. eight micro sectors in one macro sector for the 3.7 GHz case (see Figure 3).

5G NR SCANNER BASED NETWORK MEASUREMENTS IN THE FIELD

Understanding 5G NR coverage in real-life environments is just as important as it is for all other technologies. The introduction of new frequencies and features, such as 3.7 GHz and beamforming respectively, make testing particularly important and challenging, despite numerous simulations executed by industry players. Conducting measurements in pre-commercial network trials is the only way to gain new insights and to overcome doubts and uncertainties before the technology’s commercial launch.

With pre-commercial 5G NR network trials underway, Rohde & Schwarz mobile network testing (MNT) has already had the opportunity to execute 5G NR field measurements. In collaboration with a tier-1 mobile network operator, measurements in the 3.7 GHz frequency band were conducted in a European country as early as 2018.

COVERAGE IN 3.7 GHZ FREQUENCY RANGE

Bearing in mind the higher than normal frequency band, it was surprising how the 5G NR beamforming capabilities benefit the achievable coverage. In a suburban environment, the test engineers could measure a reference signal’s received power (RSRP) on the synchronization signals of –125 dBm at a distance of 6.5 km from the base station. They expected that 5G NR UEs could connect to base stations at signal levels down to –120 dBm (see Figure 4).

Figure 5 shows the SSB index “beams” or the “micro sectors” very

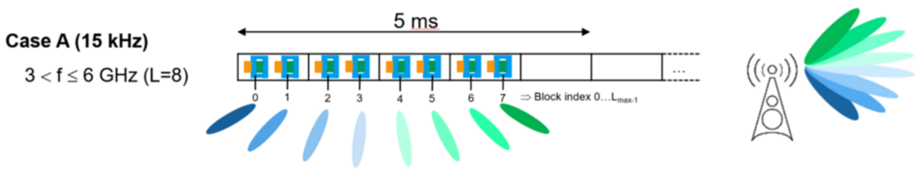


Figure 3: The SSB index beams are static and can be considered micro sectors – Source: Rohde & Schwarz.

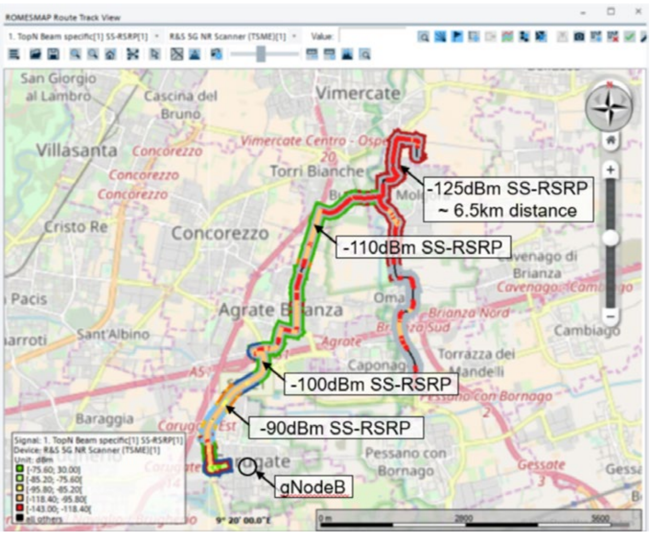


Figure 4: The 5G NR beamforming capabilities benefit the achievable coverage – Source: Rohde & Schwarz.

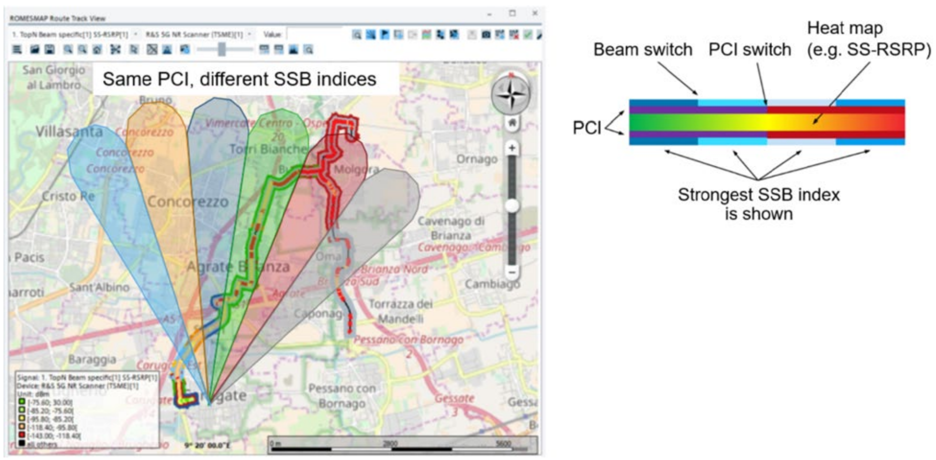


Figure 5: The SSB index “beams” of one PCI with color code added – Source: Rohde & Schwarz.

clearly. The outer color layer represents the SSB indices as explained in the color code. For a better overview, the colored micro sectors have been added to the screenshot.

For the trials, the tier-1 mobile network operator trusted the commercially available Rohde & Schwarz 5G NR network measurement solution. It comprises an R&S TSME6 or an R&S TSMA6 network scanner for data collection and the R&S ROMES4 drive test software suite for analysis and visualization. Equipped with an antenna, the 5G NR measurement solution fits into a backpack or shoulder bag for convenient and efficient drive and walk testing (see Figure 6 and Figure 7).

The described 5G NR network measurement solution can be expanded to a frequency range of up to 30 GHz (FR2) using the downconverter R&S TSME30DC. To avoid an impact of the body of the test engineer on the measurement results, Rohde & Schwarz offers a backpack that allows to mount the 5G NR mmwave receive antenna above the head level (see Figure 8).

5G NR UE BASED NETWORK MEASUREMENTS

Another important part of 5G NR network testing is using 5G NR devices such as evaluation boards, USB dongles, pre-commercial and commercial smartphones as they become available. This will provide insights into network quality regarding quality of experience (QoE) of applications, the interaction of devices with the real 5G NR networks and the device performance itself.

Such 5G NR UE based measurements include NR serving cell information such as NR DL ARFCN, PCI and SSB index, layer 1 RSRP / RSRQ, layer 2 PDSCH, PDCP, PUSCH information, LTE-NR EN-DC L3 signaling and application layer information (see Figure 9).

The R&S ROMES4 software suite for in-field real-time analysis supports the connection of the first-on-the-market Qualcomm X50 based UEs for 5G NR measurements. Rohde & Schwarz has demonstrated this capability of its network measurement solutions during the introduction of previous mobile communications technologies.

5G NR DATA ANALYTICS

Delivering excellent quality of experience to end users is a primary objective for mobile network operators in order to retain subscribers, attract new customers and competitively position themselves.

Network complexity will increase with the emergence of new cellular use cases and more demanding subscriber and machine QoE, enabled by the rollout of technologies such as 5G and internet of things (IoT). Therefore, it becomes more critical to understand the current network situation and pinpoint areas for development that will efficiently deliver the required performance. To measure and analyze pre-commercial 5G NR trials and very early deployments, a real-time analysis tool (such as R&S ROMES4) is sufficient. Network measurements in commercial 5G NR networks require a sophisticated post-processing tool for data analytics.

For accurate network engineering, benchmarking, monitoring and optimization, it is necessary to process a large quantity of complex data and produce clear, easy-to-understand intelligence in a network in order to make better decisions. Correct decisions can only be made when they are based on reliable and accurate data, processed quickly and appropriately. By processing data acquired from the end-user perspective, the Rohde & Schwarz data analytics tool SmartAnalytics provides a precise and clear assessment of an operator's own network quality (QoE from the end-user perspective) and its competitive position in the market.

SmartAnalytics provides visibility of the main factors influencing network performance and QoE status, its context, development trends, problems and possible degradation causes. Thanks to the network performance score integrated in SmartAnalytics, network operators can identify strategic areas for investment. As a result, mobile operators can efficiently deliver optimal end-user QoE and move ahead of the competition, which leads to a higher number of subscribers, a lower cost base and access to new revenue streams (see Figure 10).

SmartAnalytics is a flexible tool that encompasses different mobile network testing use cases, such as engineering, optimization, monitoring and benchmarking, using the same user interface and platform. It eliminates the need for separate test platforms, removes compatibility issues and provides a seamless interface across each stage of the network testing lifecycle. This provides OPEX and CAPEX efficiencies in test resources, equipment and execution.

CONCLUSION

With the 5G NR network rollout clearly on the horizon, network operators

Figure 6: The 5G NR network measurement solution comprising an R&S TSME6 scanner, antenna and the R&S ROMES software – Source: Rohde & Schwarz.

Figure 7: The 5G NR network measurement solution (here: R&S TSMA6 scanner and R&S ROMES) with its handy shoulder bag – Source: Rohde & Schwarz.

Figure 8: The 5G NR network measurement solution for mmwave frequencies (here: R&S TSMA6 scanner, R&S TSME30DC downconverter, antenna and R&S ROMES) in a convenient backpack – Source: Rohde & Schwarz

worldwide are planning pre-commercial network trials or even starting commercial network rollouts. The aim is to overcome the challenge of a more demanding and complex air interface and deliver the commercial and technical benefits offered by 5G.

A 5G NR measurement solution should provide accurate and reliable data collection with coverage measurements, application QoE measurements, and verification of the device interaction with a real 5G NR network.

The data analytics of this solution should comprise the entire network testing lifecycle, from network engineering and optimization to benchmarking and monitoring, and have the following objectives:

- To effectively store, process and visualize big data;
- To gain deep network insights;
- To ultimately build intelligence for investment prioritization based on the most critical factors influencing network performance and QoE.

Rohde & Schwarz fulfills all these requirements from a single source with its end-to-end 5G NR network measurement solution in line with the company's slogan "Be ahead in 5G. Turn visions into reality".

GLOSSARY

- **5G NR:** 5th Mobile Generation New Radio
- **BWP:** Bandwidth Part
- **DCI:** Downlink Control Information
- **eMBB:** Enhanced Mobile Broadband
- **EN-DC:** E-UTRA – NR Dual Connectivity
- **E-UTRA:** Enhanced UMTS Terrestrial Radio Access (3GPP naming for LTE)
- **LTE:** Long Term Evolution
- **mMTC:** Massive Machine Type Communications
- **NR DL ARFCN:** New Radio Downlink Absolute Radio Frequency Channel Number
- **OFMD:** Orthogonal Frequency-Division Multiplexing
- **PBCH:** Physical Broadcast Channel
- **PCI:** Physical Cell Identity
- **PDCP:** Packet Data Convergence Protocol
- **PDSCH:** Physical Downlink Shared Channel
- **PSS:** Primary Synchronization Signal
- **PUSCH:** Physical Uplink Shared Channel
- **QoE:** Quality of Experience
- **RAN:** Radio Access Network
- **RRC:** Radio Resource Control
- **RSRP:** Reference Signal Received Power
- **RSRQ:** Reference Signal Received Quality
- **SS:** Synchronization Signal
- **SSB Index:** Synchronization Signal Block Index
- **SSS:** Secondary Synchronization Signal
- **URLLC:** Ultra-Reliable Low Latency Communications
- **UE:** User Equipment
- **VoLTE:** Voice over LTE

Figure 9: 5G user equipment measurements with the R&S ROMES4 software suite – Source: Rohde & Schwarz.

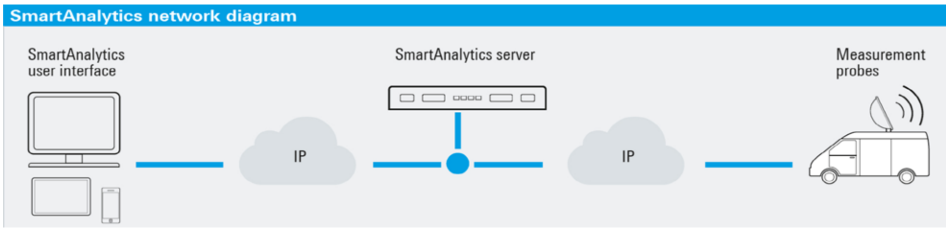


Figure 10: SmartAnalytics processes the data acquired for the end-user perspective e.g. by drive tests – Source: Rohde & Schwarz.

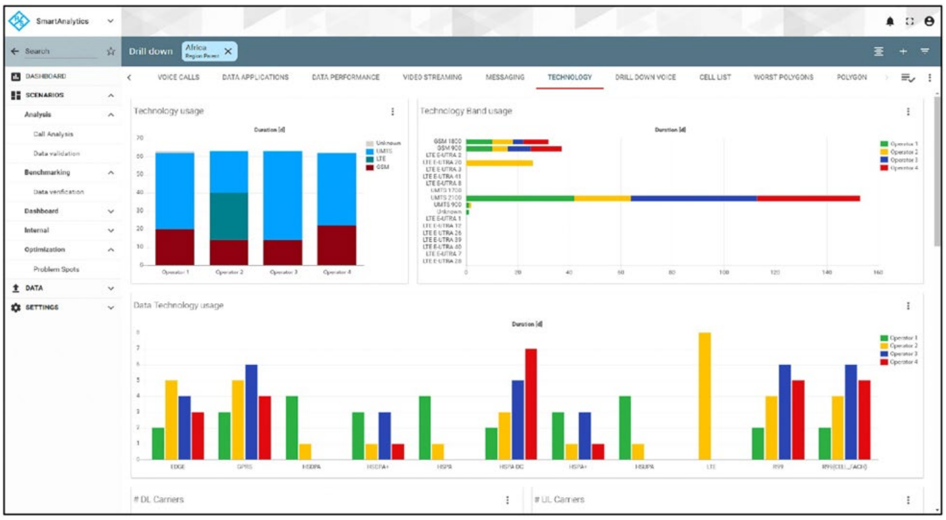


Figure 11: Network benchmarking (radio technologies) with R&S SmartAnalytics – Source: Rohde & Schwarz.

www.rohde-schwarz.com

LoRaWAN puts security first

By David Armour, Senior Product Manager, Semtech Corporation

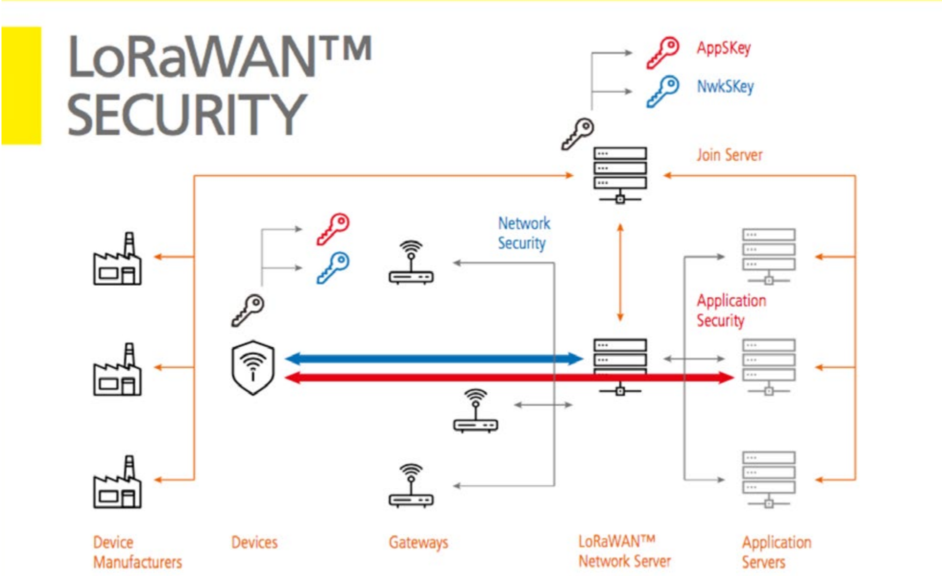
Traditionally, security has been an afterthought in computer network designs, which has helped make many of them vulnerable to hacking. But the LoRaWAN low-power wide area network (LPWAN) provides an example of a network technology that was designed from the outset to take security into account.

An LPWAN can provide an enticing target to hackers. It offers low-cost, reliable connectivity over distances of 10km and sometimes more. This makes the networks much easier to find than private short-range WiFi and Bluetooth networks and attacks can potentially be staged from many locations.

The devices that LPWANs connect are also of high interest to malicious users. For example, smart-city systems use LPWANs to automate the collection of meter data and perform control and monitoring functions of the urban infrastructure. Systems use this data to show parking availability and control when refuse is collected. Utilities are using LPWANs to collect data from remote substations. And farmers are making use of the technology to monitor livestock and crops all day, every day.

LoRaWAN itself has emerged as the dominant open specification for LPWANs. As of 2018, there are more than 500 vendors in the LoRaWAN ecosystem with some 60 service providers operating public networks around the world.

The types of systems for which LoRaWAN is designed place a number of constraints on designers that are not found in many traditional networking technologies. Low power and low cost are essential. Some devices that need to communicate over LoRaWAN may only keep running thanks to energy harvesting. This calls for a security infrastructure that can operate efficiently and rules out more heavyweight systems that were developed for desktops and servers that access the internet. But the protocol cannot skimp on protections and weak encryption schemes. Networks and devices need to be sure when they operate on a network they are talking to legitimate systems. And they need to use proven technologies.



In contrast to some cellular communications systems, LoRaWAN implements end-to-end encryption for the application data transferred between sensor nodes and application servers. Cellular networks may encrypt data packets for transfers over the wireless part of the network. But the packets are then decrypted to plaintext when they are transferred over the operator's core network. To provide end-to-end encryption, users need to select and manage additional security protocols such as TLS. These add an extra processing burden to the sensor node that will reduce battery life.

In creating the security mechanisms for LoRaWAN, the protocol designers decided to employ the AES cryptographic algorithms. These algorithms have been analysed by the cryptographic community for many years, are approved by NIST and have become widely adopted as reliable and effective for constrained nodes and networks.

To join a LoRaWAN network, each device must provide credentials that satisfy a network server that it is a legitimate user. Conversely, the device needs to be able to tell whether it is connected to systems for which it is designed. This ensures that only genuine and authorised devices will be connected to genuine and authentic networks.

To support these requirements, at manufacture, each LoRaWAN device is personalised with a unique 128bit AES key, known in the protocol as the AppKey. The device is also provided with a globally unique identifier, DevEUI, that is based on the IEEE EUI64 address space. Each network has its own identifier: based on a 24bit address range and managed by the LoRa Alliance.

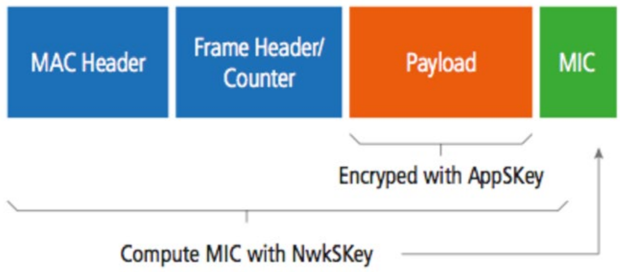
The AppKey is central to the over-the-air activation or join procedure in LoRaWAN. It ensures that both end device and the network infrastructure can agree that they are talking to legitimate systems and so continue to bring the device onboard. To initiate the join procedure, the device issues a request that is forwarded to a Join Server that performs the initial authentication routines, such as checking the device's AppKey. The method used to determine the validity of the AppKey is the AES cipher-based message-authentication code (CMAC) protocol.

Once the AES-CMAC has been computed and verified, the join server and device create a pair of session keys. One is the NwkSKey, which is used to protect LoRaWAN network commands; the other is the AppSKey, which encrypts the application data. The keys are distributed to the LoRaWAN network server and relevant application servers, respectively. This maintains a separation between application data and network management messages. This avoids the need to share keys with the network operator. Users can be sure packets containing application data simply pass through the LoRaWAN gateways and network routers without the risk of snooping or man-in-the-middle attacks.

All traffic sent and received by a sensor node is protected using the two session keys. The payload of each packet is encrypted using the AES counter mode (AES-CTR). This embeds a frame counter and message integrity code (MIC) computed using the NwkS-Key code in the payload. The combination of protections prevents packet-replay attacks, in which a hacker inserts data in a message and retransmits it into the data stream.

Although LoRaWAN enforces security as part of its core design, a number of aspects are outside the control of the protocol designers and need to be taken care of by the applications developer or integrator. The key elements that need attention are key management and provisioning.

An important aspect of LoRaWAN security is that it uses symmetric-key cryptography. Each root key that is dedicated to a sensor node needs to be made available to a corresponding server application for the required session keys to be generated. To manage the keys that will be used by server applications and programmed into devices, the user needs to employ a key management system (KMS) that is responsible for distributing keys to systems that need them. For example, a KMS can make root keys available to the Join Server so that it can perform the required AppKey check and handle the initial session-key generation routines.



Similarly, the KMS can be responsible for providing the AppKey to each device when it is ready to be programmed during manufacture, production test or installation. To ensure high security when requests are made to the KMS, two-factor authentication or similar techniques can be employed. In a typical scenario, an end-of-line tester requests a key for each device that it probes using previously created session keys to encrypt the transaction. A second factor, such as the correct response to a challenge issued by the KMS, ensures that only the authorised tester is provided with the requested AppKey. The LoRa-Alliance defines for network service providers a back-end specification for methods to allow a Join Server to make secure requests to a user's KMS.

Once delivered to the end device, the AppKey needs to be stored securely so that it cannot be read out and misused by a hacker who gains access to the hardware either physically or through network-based attacks. A microcontroller (MCU) with secure on-chip storage can satisfy this requirement. Alternatively, the MCU can be paired with a secure companion integrated circuit (IC) that is programmed with the AppKey and which takes care of the AES processing on behalf of the MCU. Cryptographic acceleration is also an effective hardware-based security feature to reduce transaction times significantly as well as power consumption.

With a sufficiently secure MCU, once it is programmed into on-chip flash there is no mechanism to read out the raw key. Physical protections can zero out on-chip keys if they detect an attack that shows a high risk of compromise. This ensures that the AppKey and other secure credentials cannot be stolen and misused.

Thanks to the decision to take security into account when designing the protocol, LoRaWAN's designers have succeeded in building an LPWAN that can cope with the challenges of today's IoT. Supported by an effective key-management infrastructure and choice of secure hardware for devices, integrators can achieve a high level of confidence that their systems are not vulnerable to hackers.

www.semtech.com

CEVA-powered Nurlink eNB-IoT SoC completes call on NB-IoT network

CEVA and Nurlink Technology have announced the successful completion of the first over-the-air (OTA) call on China Telecom's NB-IoT network using the Nurlink NK6010 NB-IoT System-on-Chip (SoC).

NK6010 is an ultra-low cost and power-efficient NB-IoT SoC designed specifically for narrowband connectivity in mass market IoT devices such as smart meters, wearables, asset trackers and industrial sensors. Based on the CEVA-Dragonfly NB2, the SoC incorporates RF front-end, RF transceiver, cellular baseband, power management unit and application processor, to minimize the chip size and cost of the solution. It supports full NB-IoT frequency bands with major global carriers, ensuring smooth and rapid certification of devices on any NB-IoT commercial network around the world. The SoC also includes an extremely low-power multi-GNSS subsystem, which supports GPS/Beidou/Galileo/GLONASS global navigation systems. This subsystem allows fast positioning while also supporting highly-accurate device tracking. NK6010 is currently undergoing testing with operators worldwide and expected to enter mass production later this year.

The CEVA-Dragonfly NB2 IP is a modular technology, composed of the CEVA-X1 IoT processor, an optimized RF transceiver, baseband, and a protocol stack to offer a complete Release 14 Cat-NB2 modem IP that significantly reduces time-to-market and lowers entry barriers.

Dragonfly NB2 IP is a fully software-configurable and can be extended with multi-constellation GNSS and sensor fusion functionality.

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Power Supply Modulation Ratio demystified: How does PSMR differ from PSRR?

ByPeter Delos Analog Devices, Inc.

ABSTRACT

Many radar systems require low phase noise to maximize clutter rejection. High performance radars demand careful attention to phase noise, leading to significant design investment in lowering phase noise of synthesizers and characterizing the phase noise of synthesizer components.

Low phase noise performance—in particular, ultralow phase noise performance—is known to require low noise power supplies to achieve the best performance. What is not well documented is a systematic approach to quantify the impact of power supply noise voltage levels on phase noise. This article aims to change that.

The theory of the power supply modulation ratio (PSMR)—a measure of how power supply imperfections are modulated onto the RF carrier—is presented. An RF amplifier is characterized by, and measured results demonstrate that, the power supply noise contribution to phase noise can be calculated and fairly accurately predicted. Based on the result, a systematic approach for power supply specification is also discussed.

INTRODUCTION AND DEFINITION

The power supply modulation ratio is analogous to the well-known term power supply rejection ratio (PSRR), but differs by a key point. PSRR is a measure of how much the power supply imperfections are directly coupled to a component's output. PSMR is a measure of how power supply imperfections of ripple and noise are modulated onto an RF carrier.

The Theory section below introduces H(s), a transfer function relating PSMR to power supply imperfections—how they are quantifiably modulated onto the carrier. H(s) has both amplitude and phase components, and can vary as a function of frequency and component operating conditions. Despite the number of variables, once characterized, the power supply modulation ratio can be used to accurately predict phase noise and spurious contributions from power supply based on supply data sheet specifications of ripple and noise.

THEORY

Consider ripple on the dc power supply for an RF component. Supply ripple is modeled as a sine wave signal with a peak-to-peak voltage centered about the dc output. The sine wave is modulated onto the RF carrier, creating spurious signals at frequency offsets equal to the sine wave frequency.

The level of the spurs is a function of both the sine wave amplitude and the sensitivity of the RF circuit. The spurious signal can be broken down further into both an amplitude modulated component and a phase modulated component. The total spurious power level equals the spur power from the amplitude modulated (AM) component plus the spur power from the phase modulated (PM) component.

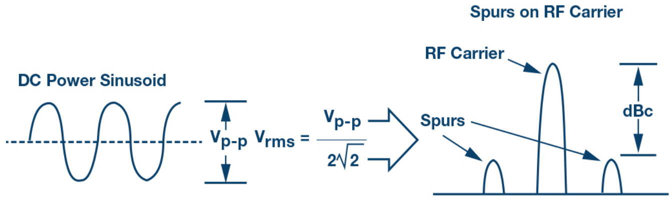

Figure 1: Sine wave ripple on a power supply modulates onto the RF carrier to create spurious signals.

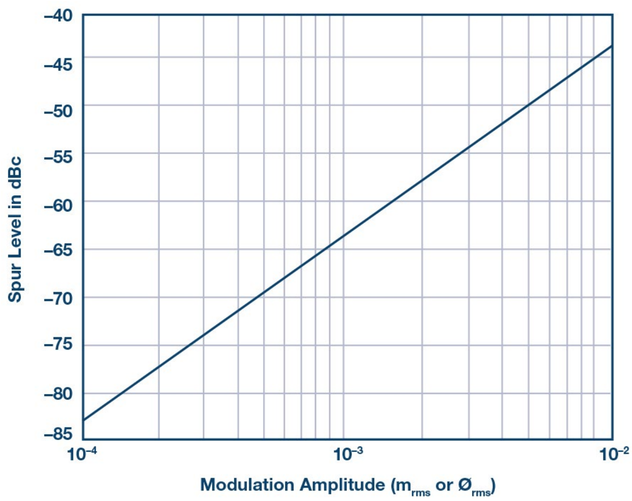

Figure 2: Spurious level versus m_{rms} and $Ø_{rms}$.

For the discussion here, H(s) is the transfer function from the power supply imperfections to an unwanted modulation term on the RF carrier. H(s) also has AM and PM components. The AM component of H(s) is H_m (s) and the PM component of H(s) is $H_Ø$ (s). The following equations make use of H(s) for practical RF measurements, with the assumption of low levels of modulation acceptable for power supply impact on an RF carrier.

Amplitude modulation of a signal can be written as

$$x(t) = (1 + m(t))\cos(2\pi f_c t) \quad (1)$$

The amplitude modulation component m(t) can be written as

$$m(t) = m_{rms}\sqrt{2}\cos(2\pi f_m t) \quad (2)$$

where f_m is the modulation frequency.

The AM modulation level of the RF carrier can be directly related to the power supply ripple by

$$m_{rms} = H_m(s) v_{rms} \quad (3)$$

where v_{rms} is the rms value of the ac component of the power supply voltage. Equation 3 is the critical equation that provides a mechanism to calculate the AM modulation of the RF carrier due to power supply ripple.

The spurious level can be calculated from the amplitude modulation by

$$spur_{AM} = 10\log_{10}\left(\frac{m_{rms}^2}{2}\right) \quad (4)$$

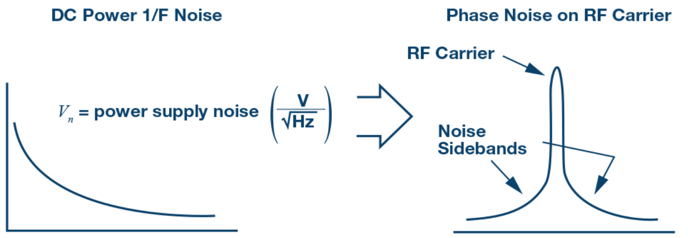

Figure 3: 1/f noise on a power supply modulates onto the RF carrier to create phase noise.

The power supply impact to phase modulation can be similarly written. A phase modulated signal is

$$x(t) = \cos(2\pi f_c t + \emptyset(t)) \qquad (5)$$

The phase modulated term is

$$\emptyset(t) = \emptyset_{rms}\sqrt{2}\cos(2\pi f_\emptyset t) \qquad (6)$$

Again, the phase modulation can be directly related to the power supply by

$$\emptyset_{rms} = H_\emptyset(s)\, v_{rms} \qquad (7)$$

Equation 7 provides a mechanism to calculate the PM modulation of the RF carrier due to power supply ripple. The spurious level due to phase modulation is

$$spur_{PM} = 10 log_{10}\left(\frac{\emptyset_{rms}^2}{2}\right) \qquad (8)$$

To help visualize the spurious impact of m_{rms} and $\emptyset_{rms}$, a plot of the spurious level versus m_{rms} and $\emptyset_{rms}$ is shown in Figure 2. To summarize this discussion, ripple on the power supply translates to modulation terms m_{rms} and $\emptyset_{rms}$ from a sine wave rms voltage on the power supply of v_{rms}. H_m (s) and $H_\emptyset$ (s) are the transfer functions from v_{rms} to m_{rms} and $\emptyset_{rms}$, respectively.

Now, consider phase noise. Just as a sine wave modulates onto the carrier to create spurious signals, a 1/f voltage noise density modulates onto the carrier to create phase noise (Figure 3).

Again, if we consider a signal x(t) with a phase modulation, then

$$x(t) = \cos(2\pi f_c t + \emptyset(t)) \qquad (9)$$

In this case $\emptyset$(t) is a noise term.

The power spectral density is defined as

$$S_\emptyset(f) = \left(\frac{\emptyset(t)_{rms}^2}{\mathrm{BW}}\right) \quad \text{with units of} \quad \frac{\mathrm{rad}^2}{\mathrm{Hz}} \qquad (10)$$

Phase noise is defined from the power spectral density as

$$L(f) = \left(\frac{S_\emptyset(f)}{2}\right) \qquad (11)$$

Next, the same $H_\emptyset$ (s) used for spurs produced from phase modulation created from power supply ripple is applied to phase noise. In this case $H_\emptyset$ (s) is used to calculate phase noise from 1/f noise on the power supply.

$$\emptyset_{rms} = H_\emptyset(s)\, v_{rms} \qquad (12)$$

$$L(f) = 10log_{10}\left(\frac{\phi_{rms}^2}{2}\right) \qquad (13)$$

A MEASURED EXAMPLE

To demonstrate these principles, the HMC589A RF amplifier was characterized for power supply sensitivity and phase noise by measuring these quantities using several power supplies. The HMC589A evaluation circuit used for the characterization is shown in Figure 4.

To characterize the power supply sensitivity, a sine wave was injected onto the 5 V supply. The sine wave created spurious on the RF and the spurious signals were measured in dBc. The spurious content was further decomposed into an AM component and a PM component. A Rohde & Schwarz FSWP26 phase noise analyzer and spectrum analyzer were used. The AM and PM spur levels were measured through AM and PM noise measurements, respectively, with the spurious measurement enabled. Results are tabulated in test conditions at 3.2 GHz with an RF input of 0 dBm (see Table 1).

The test data demonstrated that the RF amplifiers power supply sensitivity can be empirically measured with a sine wave modulation and the results can be applied to predict power supply noise contribution to phase noise. More generally, this can be extended to any RF component; here we demonstrate the principles with amplifier characterization and measurements.

First, a rather noisy power supply was used. The noise density was measured. The power supply contribution to phase noise was calculated based on the characterized $H_{\varnothing}$ (s) and compared to the phase noise measurement. The Rhode & Schwarz FSWP26 was used for the measurement. The noise voltages were measured with a baseband noise measurement. The amplifier residual phase noise was measured with an additive phase noise measurement using the internal oscillator of the test set. The test configuration is shown in Figure 5. In this configuration, the oscillator noise is cancelled in the mixer, and any noise that is not common is removed in the cross-correlation algorithm. This allows the user to achieve very low level residual noise measurements.

The power supply noise, measured phase noise, and predicted power supply noise contributions are shown in Figure 6. What becomes quickly apparent is the phase noise is dominated by the power supply between 100 Hz and 100 kHz offset, and the power supply contribution is accurately predicted.

The test was repeated with two additional power supplies. The results are shown in Figure 7. Again, the power supply contribution to phase noise is remarkably predictable.

A common challenge to low phase noise component characterization is ensuring the measurement is of the device and not the surrounding environment. To remove the power supply contribution from the measurement, an ADM7150 low noise regulator is used. The noise density quoted in the data sheet along

Input Sine Wave		Measured Spurs			Calculated H(s)		
Frequency	V (rms)	Spur (dBc)	Spur (dBc) AM	Spur (dBc) PM	H (s)	H (s) AM	H (s) PM
100	0.01	–52.2	–57.3	–53.7	0.35	0.19	0.29
1000	0.01	–52.4	–57.2	–54	0.34	0.20	0.28
10000	0.01	–53.5	–58.3	–55.3	0.30	0.17	0.24
50000	0.0066	–61	–65	–62.9	0.19	0.12	0.15

Table 1: HMC589A characterization of spurious versus power supply sine wave ripple at 3.2 GHz with a 0 dBm input power

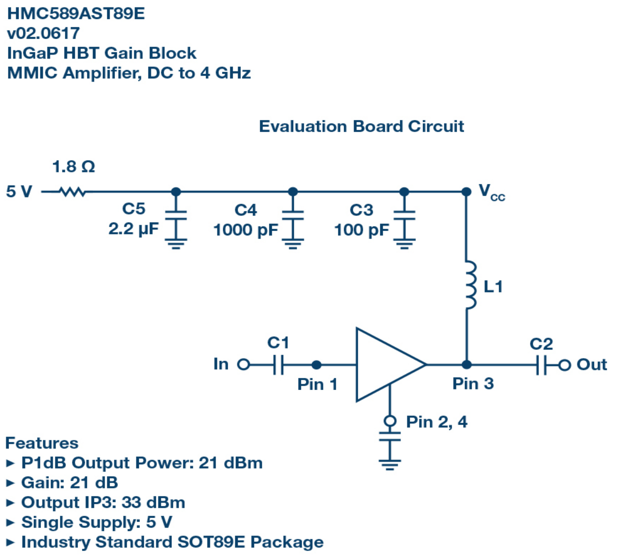

Figure 4: An HMC589A amplifier was used to demonstrate the PSMR principles.

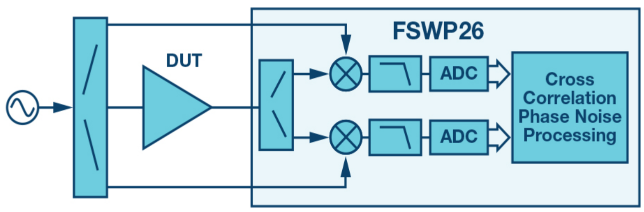

Figure 5: Amplifier residual phase noise test setup using the cross-correlation method.

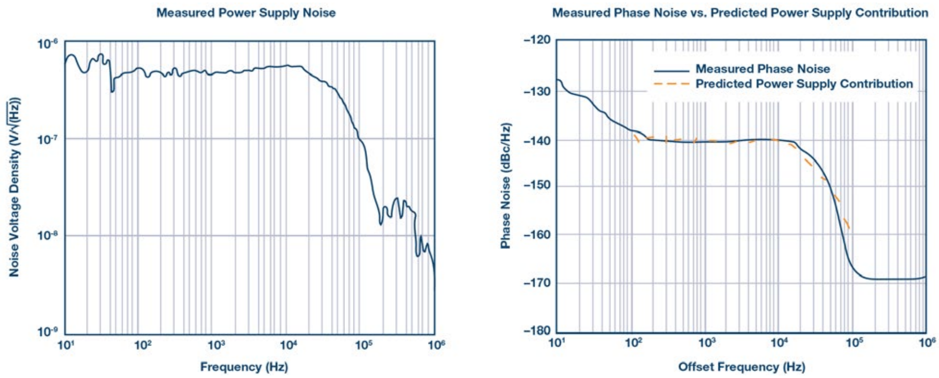

Figure 6: Validation of technique with a noisy power supply.

with noise voltage measurements of the device used for the phase noise testing is shown in Figure 8.

A family of low noise regulators is shown in Table 2 with key parameters listed. The devices shown here are all well suited for powering RF components in low phase noise RF designs; consult the data sheets for conditions and characterization curves. In the data sheet, the noise density and PSRR curves are included across a number of offset frequencies. In the table, noise density is shown for the 10 kHz offset, as this region is typically a limiter for many regulators. PSRR is shown for the 1 MHz offset, as many linear regulators lose rejection capability at these offsets, requiring additional filtering.

The results of the HMC589A residual phase noise test when powered from the ADM7150 are shown in Figure 9. This measurement shows the true performance of the amplifier where the noise floors are below –170 dBc/Hz and this performance holds all the way to a 10 kHz offset.

A SYSTEMATIC APPROACH TO POWER SUPPLY SPECIFICATION

Power supply design for low phase noise applications typically leads to cavalierly selecting the best regulation option available, disregarding actual minimal specifications, which leads to probable overdesign. For low volume designs this approach is likely worth continuing, but for high volume production, performance, costs, and complexity must be optimized—overdesign can be an unwelcome luxury.

Here is a method to quantitatively derive power supply specifications:

- Characterize H(s) with sine wave modulation on a power supply. H(s) will be a function of frequency, test every decade
- Allocate a power supply contribution to spurs and phase noise with some margin below the RF specification
- Calculate a power supply ripple specification,

$$v_{p\text{-}p} = 2 \times \sqrt{2} \times \frac{\sqrt{2 \times 10^{\frac{spur}{10}}}}{H(s)} \quad (14)$$

- Calculate a power supply noise specification,

$$v_n = \frac{\sqrt{2 \times 10^{\frac{L(f)}{10}}}}{H_\phi(s)} \quad (15)$$

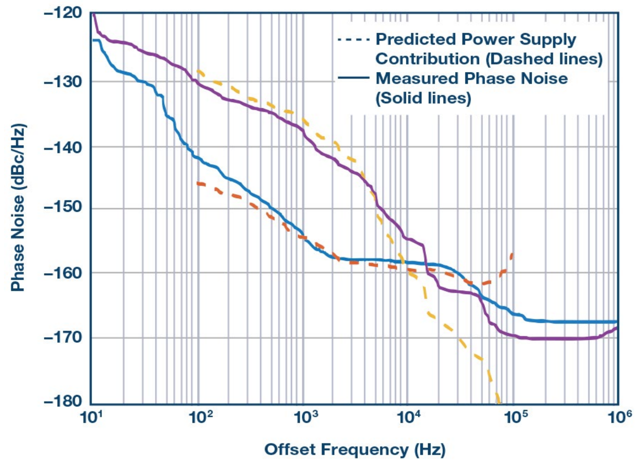

Figure 7: Validation of the technique with two additional power supplies.

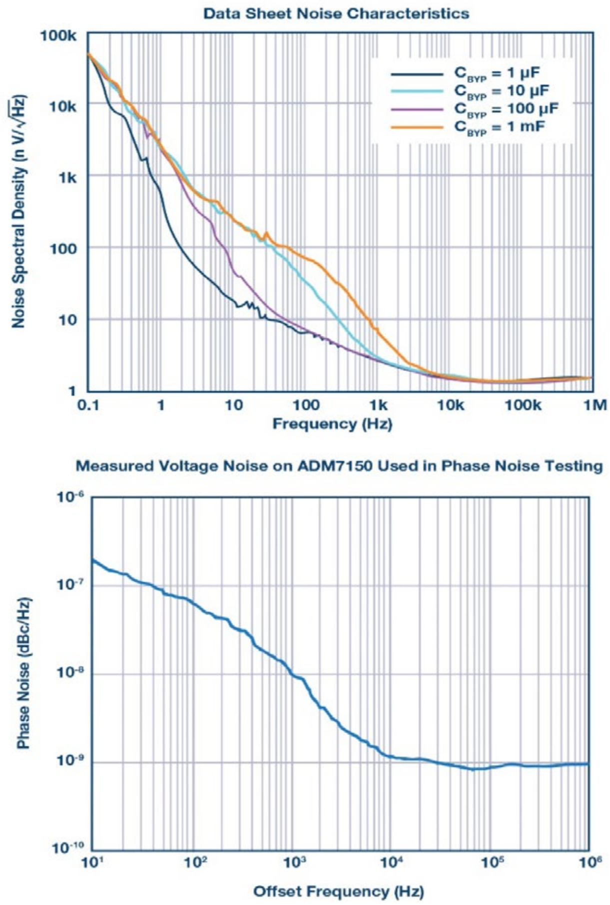

Figure 8: Low noise regulator ADM7150 noise voltage density.

Part Number	V_{IN} Range	V_{OUT} Range	I_{OUT}	Fixed/Adjustable	Noise Density @ 10 kHz	PSRR @ 1 MHz
LT3042	1.8 V to 20 V	0 V to 15 V	200 mA	Adjustable	2 nV/√Hz	79 dB
LT3045, LT3045-1	1.8 V to 20 V	0 V to 15 V	500 mA	Adjustable	2 nV/√Hz	76 dB
ADM7154	2.3 V to 5.5 V	1.2 V to 3.3 V	600 mA	Fixed	1.5 nV/√Hz	58 dB
ADM7155	2.3 V to 5.5 V	1.2 V to 3.4 V	600 mA	Adjustable	1.5 nV/√Hz	57 dB
ADM7150	4.5 V to 16 V	1.8 V to 5 V	800 mA	Fixed	1.7 nV/√Hz	>60 dB
ADP7156	2.3 V to 5.5 V	1.2 V to 3.3 V	1.2 A	Fixed	1.7 nV/√Hz	60 dB
ADP7157	2.3 V to 5.5 V	1.2 V to 3.3 V	1.2 A	Adjustable	1.7 nV/√Hz	55 dB
ADP7158	2.3 V to 5.5 V	1.2 V to 3.3 V	2 A	Fixed	1.7 nV/√Hz	50 dB
ADP7159	2.3 V to 5.5 V	1.2 V to 3.3 V	2 A	Adjustable	1.7 nV/√Hz	45 dB

Table 2: Family of low noise regulators optimally suited for low phase noise RF design.

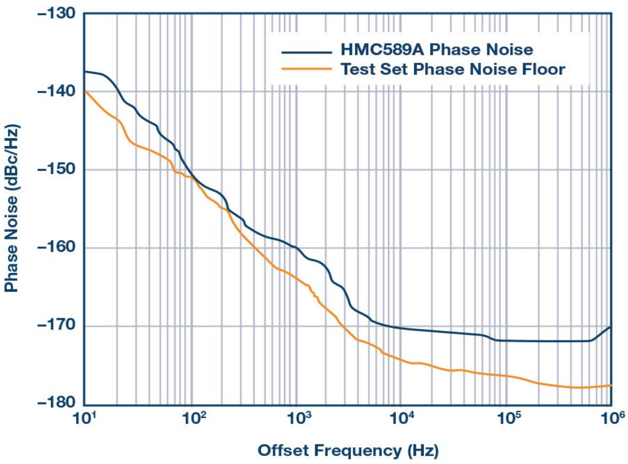

Figure 9: HMC589A residual phase noise at 3.2 GHz with a 0 dBm input RF power with dc power from the ADM7150 regulator.

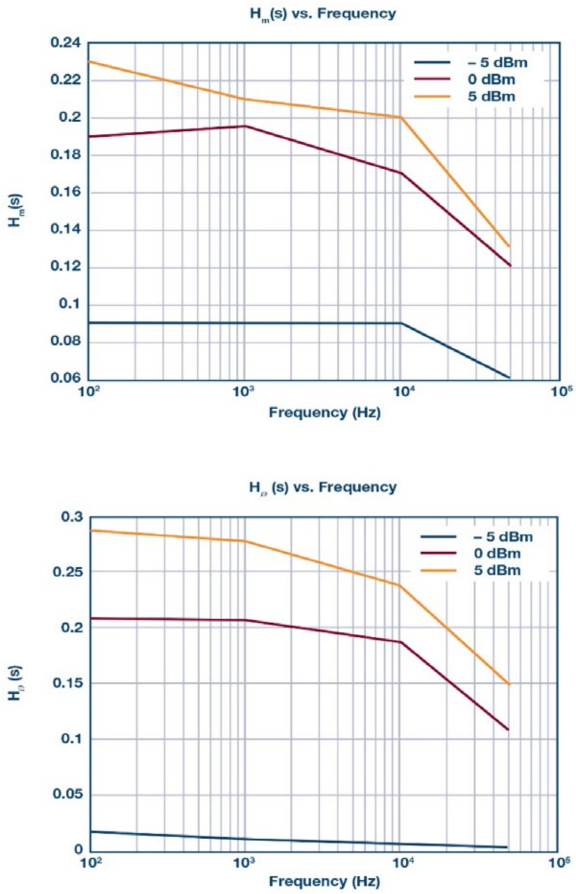

Figure 10: Variation of Hm (s) and $H_{\varnothing}$ (s) versus offset frequency and power levels in the HM-C589A evaluation circuit at 3.2 GHz.

An important consideration in Step 1 above is an understanding of how H_m (s) and $H_{\varnothing}$ (s) vary under the operating conditions expected in the design. In the HMC589A characterization this variation was measured at several power levels and shown in Figure 10.

SUMMARY

Although it is generally accepted that power supply ripple and noise should be limited in RF applications, the quantitative impact is rarely, if ever, well understood. The systematic approach shown here enables the working engineer to make informed power supply choices by bringing discipline to the process of quantifying the impact of the power supply on desired RF performance.

REFERENCES

- Bergeron, Jarrah. “Analyzing and Managing the Impact of Supply Noise and Clock Jitter on High Speed DAC Phase Noise.” Analog Dialogue, Vol. 51, 2017.
- Calosso, Calosso E., Yannick Gruson, and Enrico Rubiola. “Phase Noise and Amplitude Noise in DDS.” IFCS, 2012.
- Delos, Peter and Jarret Liner. “Improved DAC Phase Noise Measurements Enable Ultralow Phase Noise DDS Applications.” Analog Dialogue, Vol. 51, 2017.
- Jayamohan, Umesh. “Powering GSPS or RF Sampling ADCs: Switcher vs LDO.” Analog Dialogue, Vol. 50, 2016.
- “Phase Noise Characterization of Microwave Oscillators.” Agilent Technologies, Product Note, 11729B-1, 2007.
- Reeder, Rob. “Designing Power Supplies for High Speed ADC.” Analog Devices, Inc., 2012.
- Walls, Warren F. “Cross-Correlation Phase Noise Measurements.” IFCS, 1992.

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Daimler looks to 5G networked manufacturing

Not only the high data transfer rates, but above all short latency times and fast response behaviour make 5G mobile radio technology interesting for real-time applications such as robotics. Vehicle manufacturer Daimler is now taking advantage of these features: Together with Telefónica Germany, the company is building a 5G networked production facility.

Daimler plans to install a local 5G mobile radio network for data exchange between robots and control computers in a more than 20,000 m2 area of its "Factory 56" in Sindelfingen (Germany) and - after installation by Telefónica - operate it itself. According to Daimler, the use of 5G technology enables smart production by connecting all systems and machines. With this technology, which is being used for the first time globally in a real-world production environment, the company intends to set new standards in terms of flexibility and efficiency. The technology enables the operator, the Daimler subsidiary Mercedes-Benz Cars, to optimize existing production processes with new features. This includes the linking of data as well as the exact location of products and components on the assembly line.

It's about time for 5G – About giving radios precise local clock sources even in harsh environments

By Markus Lutz, CTO and Founder, SiTime Corporation

Redefining best practices for implementing 5G timing and synchronization solutions

Among the technological hurdles the industry faces while preparing for 5G, one of the most challenging is providing a network timing source that is accurate, stable and reliable enough to do more work, faster, over tighter channels than was possible with prior 4G networks that already had tight timing requirements. With 10 to 20 times more radios than 4G, the coming generation of 5G networks will have a much smaller latency budget between radios. Plus, the higher timing precision of 5G networks must be achieved even as this much larger number of radios, in less expensive housings and with less thermal and mechanical protection, must be pushed to locations with significantly lower environmental controls, including telephone poles and lampposts beside busy highways where they will be subjected to heat, vibration and rapid temperature shifts.

These and other 5G deployment challenges are being solved with the latest MEMS timing architectures that provide an alternative to earlier quartz crystal-based oven-controlled oscillator (OCXO) technology that had previously been used to deliver an accurate timing source. MEMS OCXOs overcome the limitations of quartz OCXOs while delivering new capabilities that will help usher in a new set of best practices for deploying 5G infrastructure in the harsh environments where this radio technology must operate.

TIGHTER TIMING IN HARSHER ENVIRONMENTS

As mobile operators move into 5G and edge computing, they require much tighter time synchronization in the radio equipment, which has necessitated the use of OCXOs. Prior to 5G, OCXOs were deployed in a well-controlled environment. Now, the computing, core network, and radio will be collapsed into a 5G system that may be deployed in an uncontrolled environment such as a tower, rooftop, and lamppost. The OCXOs will be exposed to vibration and temperature extremes in this environment, without the benefit of the thermal and mechanical protection that was provided with earlier 4G radio housings. This requires an evaluation of the benefits of MEMS and quartz timing technologies for implementing the critical functionality of a locally derived timing clock.

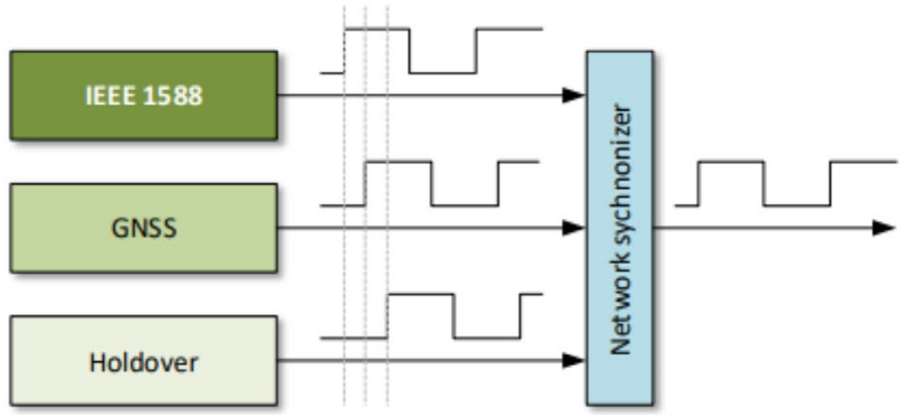


Figure 1: One of three timing sources is selected by the network synchronizer, with no phase jumps during switching.

The importance of this local timing source cannot be understated. It is one of three sources of timing in a 5G system that also include the network itself and the backup GNSS source that provides a pulse per second when the network goes down (see Figure 1). When this happens, the local timing source must act as a holdover clock and keep going until the primary source(s) of timing returns. It behaves like a flywheel that keeps spinning at a constant speed even when it's not being actively driven. There can be no drift or temperature induced frequency changes, and no "activity dips" or sudden frequency jumps. The holdover clock source must be extremely stable so that the network synchronizer that selects between the three sources can perform "hidden" switching with no disruption in the signal phase of the outgoing clock.

The problem with quartz-based OCXOs in this critical 5G holdover role is that they are extremely sensitive to environmental stressors including shock, vibration, heat and rapid temperature shifts. Each of these stressors can disrupt the ability of a quartz-based OCXO to deliver a stable timing source. The lack of a stable timing source degrades network performance, reduces uptime and impacts mission-critical services such as advanced driver assistance systems (ADAS).

Shock and vibration can be particularly problematic. Vibration can cause quartz oscillators to easily go out of specification, potentially for as long as the vibration continues. This span of time can be minutes for a passing freight train or even longer if, for instance, the oscillator is subjected to steady gusts on a windy day. Temperature also presents challenges. Depending on the season of the year and where the oscillator is deployed, it can be exposed to extremely hot or cold conditions that can last for prolonged periods of time.

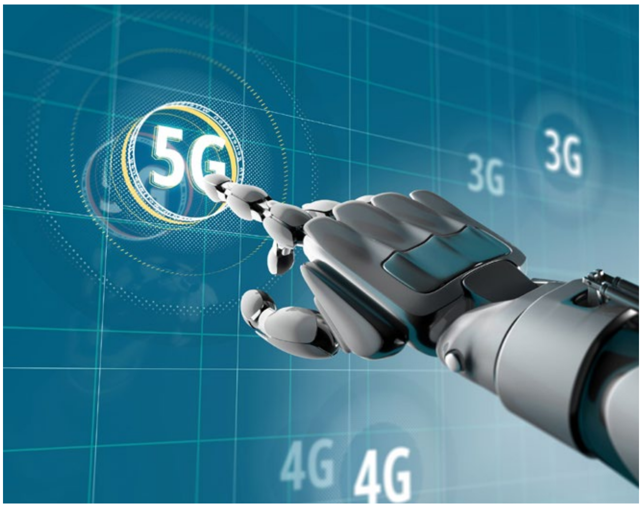
Also challenging are rapid temperature shifts, such as when a black box in the sun cools quickly as a rain cloud passes by, or in areas where colliding weather fronts and a moving jet stream bring together hot and cold air masses that can whipsaw ambient temperature from one extreme to another in a matter of minutes. Quartz oscillators have difficulty dealing with these effects, which can lead to frequency changes of hundreds of parts per billion (ppb). In many cases it may take several minutes for the quartz oscillators to return to the specified frequency due to the slow oven-control time constants.

None of this is satisfactory in the 5G environment, where the latency budget of the network behind the radios is now 5 to 10 ns, and the maximum time difference between radios is limited to 130 ns. To solve these problems, MEMS timing solutions use a combination of programmable analog, innovative packaging and high-performance temperature-compensation algorithms that deliver 20 times better timing precision than is possible with quartz-based alternatives. The ability of these MEMS OCXOs to maintain sub-ppb frequency stability under challenging environmental stressors will have a transformative impact on 5G system deployment. The technology also gives developers an opportunity to substantially re-think their design strategies so they can take full advantage of the new capabilities that MEMS OCXOs deliver.

NEW 5G BEST PRACTICES WITH WITH MEMS OSCILLATORS

MEMS oscillators create a new set of best practices for deploying accurate network timing sources. First, they eliminate the need for developers to restrict their OCXO printed circuit board (PCB) placement options. The sensitivity of quartz OCXOs to environmental stressors has required that they be separated from any sources of heat and airflow-induced thermal shock. These board placement constraints have complicated routing and created potential signal integrity problems. While developers have tried to solve this problem by using specialized plastic OCXO covers for thermal and airflow isolation, this introduces additional manufacturing steps and production complexity.

These concerns do not exist with MEMS OCXOs, which have 20 times the vibration immunity of quartz. MEMS OCXOs have much better dynamic stability with frequency slope vs. temperature (ΔF/ΔT) of ±50 ppt/°C typical (ppt = parts per trillion) and an Allan deviation (ADEV) of 2e-11 under airflow (see Figures 3A and 3B). MEMS OCXOs eliminate the need to worry about protective components or mechani-



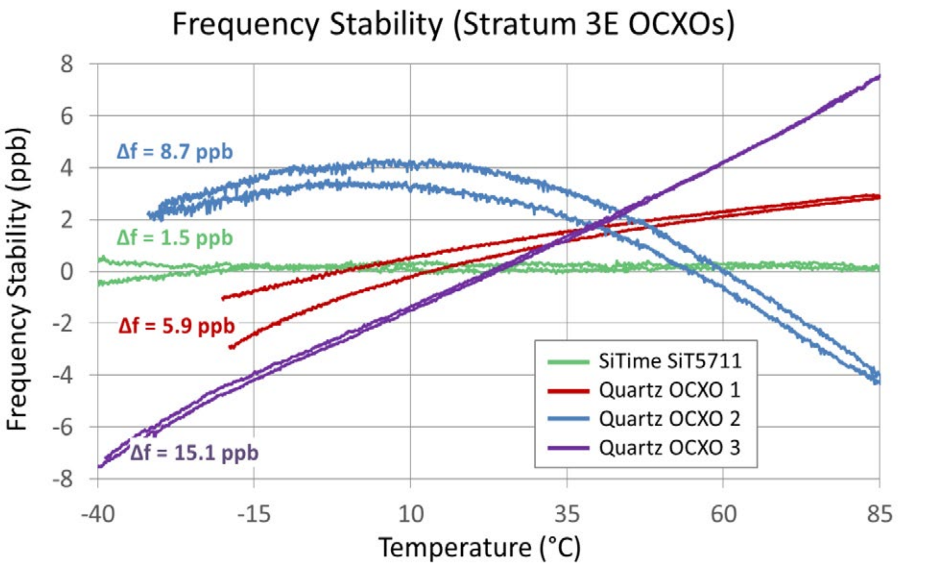


Figure 2: Comparison of measured frequency stability over temperature (hysteresis) of SiTime MEMS Stratum-3E OCXO and three quartz Stratum-3E OCXOs.

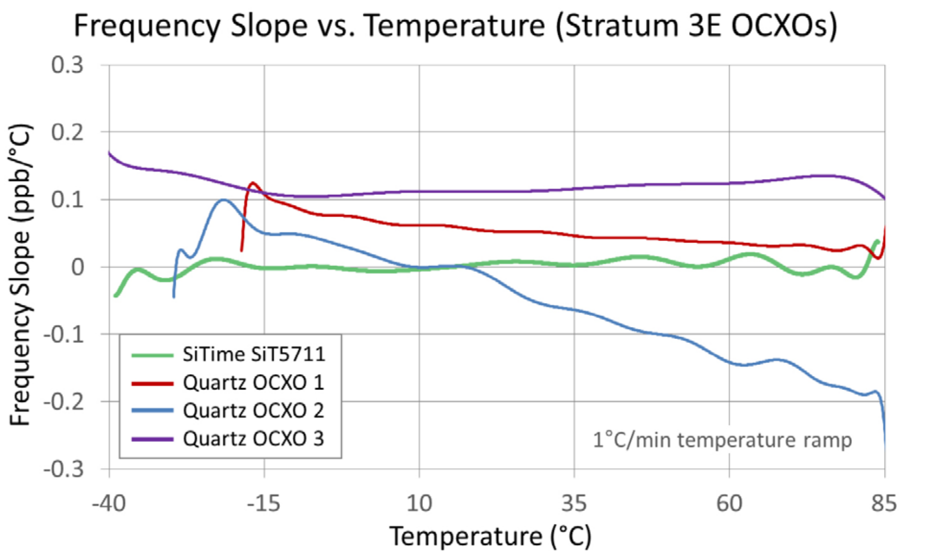


Figure 3A: Comparison of measured frequency slope versus temperature (ΔF/ΔT) of SiTime MEMS Stratum-3E OCXO and three quartz Stratum-3E OCXOs.

cal shielding during board design, and on-chip regulators mean there is no need for external LDOs or ferrite beads. Additionally, MEMS oscillators are resistant to microphonic and/or board bending effects, which is a key consideration for large telecom PCBs. Without these placement constraints, designers will have significantly greater freedom to place the components based on other criteria such as less cross coupling, reduced EMI, and higher density to save space.

Concerns about heat and rapid temperature shifts are also removed with MEMS oscillators. Developers using the higher-performance MEMS OCXOs should assume that their local timing source will operate cleanly up to 125°C with very tight stability. MEMS OCXOs will also maintain frequency within specifications even if ambient temperature changes by as much as 20°C within minutes. The timing source will not suffer any environmentally-induced fast frequency changes that can lead to dropped connections. It will be possible to give operators confidence that they can deploy 5G radios wherever they are needed.

The programmability of MEMS timing also redefines 5G design best practices. MEMS OCXOs expand the choices that developers have with regards to frequencies, output types, operating temperature, in-system control and other features. For example, developers can now choose the optimal frequency for the application, from 1 to 220 MHz and anywhere in between. They also can specify output types such as LVCMOS and clipped sine-wave to optimize board performance. Other options include extended temperature operation from -40 to +95°C and -40 to +105°C, I²C serial interface for in-system programmability and digital controlled oscillator mode instead of a traditional analog voltage-controlled oscillator (VCO).

These choices are not possible with quartz OCXOs, which are custom built from the ground up, have severe limitations on the capabilities that can be specified, and are difficult to procure and use. In contrast, MEMS OCXOs come in a variety of standard footprint choices and are available as drop-in replacements for legacy OCXOs while improving overall comparative system performance and robustness. Another advantage is faster startup time to the desired frequency – MEMS OCXOs get there in milliseconds while analog quartz-based OCXOs can take minutes.

Developers of 5G network equipment face difficult challenges. They must establish and ensure a stable timing source for 10 times the volume of installed radio equipment than was the case with 4G networks. The connection to the core network will be via lower-grade switched networks, further increasing the requirement for reliable clocks in the radios. Plus, the stability of the timing source must be guaranteed in significantly harsher environments than where 4G radio equipment has been deployed, without benefit of the earlier radios' more protective housings. MEMS oscillators offer an alternative to legacy quartz-based OCXOs, which simply cannot meet these challenges. MEMS solutions deliver the stability, performance and immunity to shock, vibration, heat and rapid temperature shifts that are necessary for ensuring that 5G radios can be installed wherever necessary, regardless of environmental conditions. At the same time, these MEMS OCXOs redefine best practices for creating 5G systems and give developers significantly more design options than they had with legacy quartz-based OCXOs.

www.sitime.com

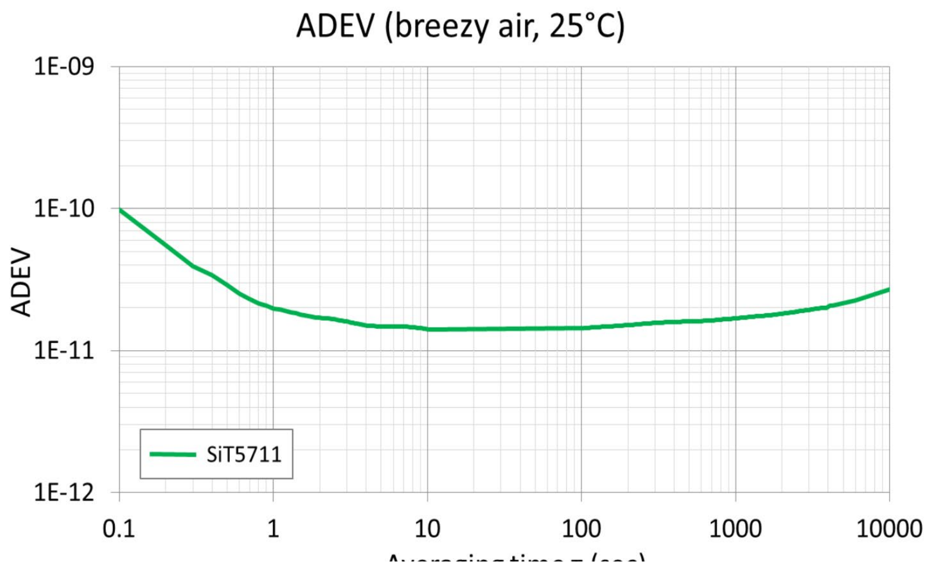
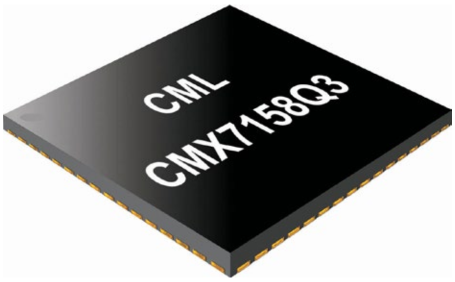


Figure 3B: MEMS Stratum-3E OCXO showing an Allan deviation (ADEV) of 2e-11 under airflow.

Scrambler IC

enables greater robustness against security breaches



Recognising the growing need to protect communication systems from the threat of being compromised by unauthorised parties, CML Microcircuits has introduced the CMX7158 scrambler IC.

Based on the company's proprietary FirmASIC® technology, so as to facilitate configuration, this compact user-programmable scrambler IC is optimised for inclusion in multi-function audio systems, as well as handheld wireless/cellular equipment.

Maintaining elevated levels of audio quality, it can rapidly switch between clear and scrambled voice modes via a programmable frequency inversion point, with minimal delay being experienced. Furthermore, its completely independent Tx and Rx signal paths mean that this IC is capable of full duplex operation.

Thanks to FirmASIC, a Function Image™ is generated in which the CMX7158's functional parameters are defined. This is loaded to the system upon power-up/device initialisation – either from the system's host microcontroller (across the C-BUS interface) or through an attached serial flash memory. DTMF encode/decode, Selcall signalling and VOX detection on both channels are among the other main features encompassed.

Key applications for the CMX7158 include cellular radio accessories. Bluetooth headsets, wired/wireless access control systems, plus private mobile radio (PMR) and land mobile radio (LMR) radio hardware, as well as legacy wireline telephony. Supplied in a space-saving 48-pin VQFN, it supports low power operation (drawing from a 3.0V-3.6V source, with power conserving modes available). The numerous analogue audio interfaces incorporated make integration into existing system designs very straightforward. CML also offers the PE0402 evaluation board to accompany the CMX7158.

www.cmlmicro.com

Telit's modules pave way for 5G massive IoT

The ME310G1 and ME910G1 modules from Telit are designed for mass-scale LTE-M and NB-IoT deployments that feature hundreds of thousands or millions of devices. Based on the latest Qualcomm® 9205 LTE modem and featuring optional 2G fallback, the modules also provide a future-proof foundation for IoT deployments that span legacy networks, 4G and 5G.

The ME310G1 and ME910G1 are the first 3GPP Release 14 additions to the Telit portfolio and the first members of its new series based on the Qualcomm 9205 LTE IoT modem, which was announced in late 2018. The highly compact chipset enables Telit to meet booming global demand for ultra-small modules for applications such as wearable medical devices, fitness trackers and industrial sensors.

The modules are ideal for battery-powered applications via improved features such as Power Saving Mode (PSM) and extended Discontinuous Reception (eDRX), which periodically wakes up the device to transmit only the smallest amounts of data necessary before returning to sleep mode. Both modules also ensure reliable indoor connections, with a maximum coupling loss of up to +15-dB/+20-dB for superior in-building penetration compared to earlier LTE standards.

The multi-band ME310G1 and ME910G1 are available in versions with 2G fallback for use in areas where LTE-M/NB-IoT service is yet to be deployed. These versions also support GSM voice and will support VoLTE for applications that require the ability to make phone calls.

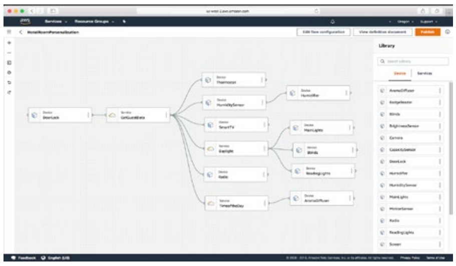
The ME910G1 is the latest member of Telit's best-selling xE910 and family. The ME910G1 is also a drop-in replacement in existing devices based on the family's modules for 2G, 3G and the various categories of LTE. With Telit's design-once-use-anywhere philosophy, developers can cut costs and development time by simply designing for the xE910 LGA common form factor, giving them the freedom to deploy technologies best suited for the application's environment.

The ME310G1 LTE-only variant is less than 200 mm^2 and variant with 2G fallback is less than 300mm^2 and they enable enterprises to deploy new small footprint designs across many application areas including asset tracking, health-care monitoring, smart metering, portable devices, industrial sensors, home automation, and others that benefit from low-power and low-data rate capabilities. The xE310 family's flexible perimeter footprint includes pin-to-pin compatible 2G and 4G modules, enabling integrators to design a single PCB layout and deploy a combination of technologies.

ME310G1 and ME910G1 samples are now available. Mass production begins in late 2019 and Q1 2020, depending on the product version.

www.telit.com

AWS tool builds IoT applications visually



Amazon Web Services (AWS) has announced the availability of a new service that allows developers to build new IoT applications by visually connecting devices and services and defining interactions, with little to no code.

AWS IoT Things Graph allows developers to build IoT applications by representing devices and cloud services as reusable models that can be combined through a visual drag-and-drop interface, instead of writing low-level code. The tool lets users represent their business logic in a flow composed of devices and services.

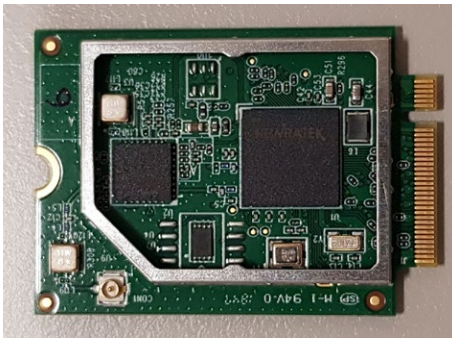
Each web service and each type of device (e.g., sensor, camera, display, etc.) is represented in Things Graph as a model. The models hide the implementation details that are peculiar to a particular brand or model of device, and allow users to build flows that can evolve along with their hardware.

Each model has a set of actions (inputs), events (outputs), and states (attributes). Things Graph includes a set of predefined models, and also allows users to define their own. Users can also use mappings as part of their flow to convert the output from one device into the form expected by other devices.

Once a user builds their flow, they can deploy it to the AWS Cloud or an AWS IoT Greengrass-enabled device for local execution. The flow, once deployed, orchestrates interactions between locally connected devices and web services.

https://aws.amazon.com

HaLow™ Wi-Fi built on Raspberry Pi 3HaLow™



NEWRACOM and Fortune Tech System have jointly announced a highly integrated and miniaturized HaLow™ Wi-Fi system, built on Raspberry Pi 3.

The product comprises a M.2 802.11ah communication module and the latest Raspberry Pi 3, claiming to be the the first to incorporate the HaLow module and Raspberry Pi 3. The module is equipped with the 802.11ah Wi-Fi SoC (NRC7292) from NEWRACOM.

The HaLow module, now featuring Cortex-MO and M3 dual processors, is designed for low-bandwidth, long-range, low-power and massive IoT applications that support 802.11ah communication standards. The data throughput reaches out to 1-Mbps within 1km coverage and on a 1-MHz channel bandwidth. In parallel, the newly released Raspberry Pi 3 is optimized for devices running on the Linux operating system and supports the integration of most functions on IoT devices.

Optimized for IoT devices, the NRC7292 from NEWRACOM is compliant with the IEEE 802.11ah standard. Operating in the sub 1-GHz license-exempt band, it offers a much greater range over 2.4 GHz and 5 GHz technologies. Further, 1-/2-/4-MHz channel widths with optional short guard interval (SGI) yield 150 Kbps to 15 Mbps PHY throughput, which can support low-rate sensor to high-rate surveillance camera applications. The protocol's power-saving mechanisms like a longer sleep time greatly reduces power consumption and hence increase battery life.

The self-contained IEEE 802.11ah Wi-Fi networking capabilities with fully integrated radio transceiver of the NRC7292 offers the ideal way to add Wi-Fi connectivity to IoT products. It minimizes the PCB size, requires minimal external circuitries, and enables fast time-to-market.

In response to growing market needs for IoT and advanced application, the launch of the Raspberry Pi 3 based HaLow Wi-Fi system system enables customers to accelerate designs for a wide array of IoT applications such as smart home/office/industry/city, healthcare, smart grid and security.

"HaLow promises delivery of up to 1-Mbits/s over a distance of one kilometer and support for thousands of nodes on an access point," said James Horng, general manager of Fortune Tech System.

www.newracom.com
www.fortune-co.com.tw

Power amplifiers

offer industry-leading saturated efficiency

Guerrilla RF, Inc., has introduced its first two InGaP HBT power amplifier products. Both devices deliver 60 percent saturated efficiency, with high gain and high output power – making them ideal choices for the final stage of applicable transmit chains.

GRF5504 is a high efficiency power amplifier that delivers up to 3.5 W at Psat, with Vcc set to 5.0 V and a low Iccq of 120 mA. PAE at Psat is roughly 64 percent and the device can be tuned over a range of frequencies from around 400 MHz to 500 MHz, with typical fractional bandwidths of 3 percent to 5 percent.

GRF5509 is another high efficiency power amplifier that delivers 4 W OP1dB, with Psat approaching 5 W with Vcc at 5.0 V and a low Iccq of 125 mA. PAE at Psat is 58 percent and this part can be tuned over a range of frequencies from around 700 MHz to 1000 MHz, with typical fractional bandwidths of 3 percent to 5 percent.

Both devices are supplied in the QFN-16 package (3-mm x 3-mm), with identical pinouts and flexible biasing for both voltage and current. Additionally, high linearity tunes for each part deliver OIP3 numbers greater than 45 dBm. These notes for optimal IP3/IMD/ACLR performance in linear applications can be found on the company's website, under the landing page of the individual part number.

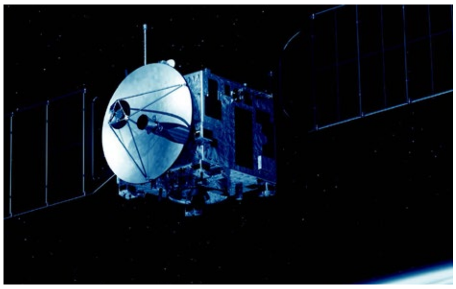
According to Research and Markets, the overall wireless network infrastructure market will witness tremendous growth over the coming years. At a compound annual growth rate of over 5 percent, the market will account for over $104 billion in annual spending by the end of 2020.

Samples and evaluation boards are available now for both devices, with production available in late Q3/early-Q4 2019.

https://guerrilla-rf.com

4-W Ka-band power amplifier

added to to SATCOM portfolio



A balanced 4-W power amplifier operating from 27.5 to 30 GHz, the MAAP-011250 is ideal for SATCOM and VSAT applications.

Ideally suited for next generation commercial VSAT outdoor units, the MAAP-011250 power amplifier utilizes a balanced design, giving system designers a consistent match regardless of their board impedance.

As the demand for high speed, broadband, data connectivity continues, MACOM is seeing changes in fixed wired networks, such as HFC and Fiber along with terrestrial wireless networks, and SATCOM, in order to meet this demand. As the requirements for increased data rates and bandwidth continue to drive higher power, higher frequency and higher linearity MMICs, MACOM is well positioned to provide both catalog and custom SATCOM systems.

With the addition of the 4-W amplifier, MACOM now offers 2, 2.3, 3, 4 and 7 W power output options spanning frequencies ranging from 27 to 31.5 GHz. These new GaAs-based Ka-Band PAs can provide strong linear gain, which is expected to enable customers to efficiently increase the power from the input to the output port with minimal tradeoffs.

The MAAP-011250 is a balanced 4-W, 4-stage power amplifier assembled in a lead-free 5-mm 32-lead AQFN plastic package. This power amplifier operates from 27.5 to 30 GHz and provides 24 dB of linear gain, 4-W saturated output power and output IP3 of 41 dBm while biased at 6-V. The MAAP-011250 can be used as a power amplifier stage or as a driver stage in higher power applications. The amplifier complements MACOM's portfolio of Ka-Band gain block amplifiers, drivers, mixers and PAs to deliver a complete chipset for high-performance wireless broadband data links.

www.macom.com

Handheld microwave analyzer

targets 5G, next generation

Keysight Technologies has announced the next generation of the its multi-purpose, handheld microwave analyzer, the FieldFox B-series, which delivers measurement precision and bandwidth up to 100 MHz for wide-band, real-time spectrum analysis to enable 5G testing in the field.

The FieldFox B-series microwave analyser joins a wide range of FieldFox handheld analysers that include a spectrum analyzer, VNA, CW signal generator, real-time spectrum analyser, and cable/antenna analyzer; amongst others.

Accurate microwave measurements are becoming increasingly necessary in harsh and hard-to-reach environments spanning a wide range of conditions, including day or night, rain or shine, hot or cold, aboard a ship, in an aircraft, or in a vehicle. In these situations, a handheld instrument must be capable of making the required measurements with performance and accuracy. Further, with the emergence of 5G networks and advances in satellite communications and radar, new applications are relying on ever more complex modulations, wider bandwidths, highly directional signals due to beam forming and phase array systems, as well as the increasing push to mmWave frequencies.

The latest FieldFox B-series analyzers offer wide-band, gap-free, real-time measurement capabilities that enable 5G network testing in the field. In addition, these new capabilities enable customers to locate and identify the shortest interfering threats to their satellite communication networks.

Designed to withstand the toughest working conditions, the rugged, durable and portable FieldFox B handheld analyzers provide the following benefits:

- 100 MHz bandwidth in real-time for accurate cellular base-station testing;
- PRF 28800F compliant to withstand explosive impact and wet weather conditions;
- 10 dB improvement in displayed average noise level (DANL) for measuring low noise signals and detecting weak interferers;
- Collect, play back, and analyze raw I/Q data for electronic warfare test;
- Save time and space in the field kit with a task-driven user interface for each operation mode;
- Handle routine maintenance and in-depth troubleshooting with precision, including multiple measurement applications to meet specific measurement needs;
- Easily transport measurements from the field to the lab for further analysis with the 89600 VSA software.

www.keysight.com

High-performance small cell products

Aimed at 5G networks, Qorvo® has announced new power-efficient, small cell front-end devices for the sub-6 GHz wireless infrastructure market.

The small cell products significantly boost efficiency, enabling base station manufacturers to enhance existing 4G LTE infrastructure with greater bandwidth, coverage, throughput and capacity – particularly in high-density, high-traffic areas.

The latest Qorvo products include the Band 3 QPA9903 power amplifier (PA), the Band 8 QPA9908 power amplifier, and the QPL9098 4-6 GHz bypass ultra-low noise amplifier. The PAs offer 34% power added efficiency, enabling Power over Ethernet (PoE) small cell architectures targeted for deployments in high-traffic areas, such as subways, train stations, and stadiums or for high quality of service (QoS) enterprise in-building applications.

The PAs are easy to linearize using DPD algorithms and their performance is optimized for wideband, multicarrier signals versus a single 20 MHz carrier. The highly rugged PAs can handle high levels of signal mismatch at output – up to 20:1 Voltage Standing Wave Radio (VSWR). Rugged packaging withstands the impact of a wide range of challenging environments.

www.qorvo.com

TI claims 12-bit ADC is fastest at 10.4 Gsps

Texas Instruments has launched a 12-bit ADC with a sampling rate of up to 10.4 Gsps and describes it as "the future of test and measurement."

The ADC12DJ5200RF is a dual-channel component with a bandwidth of 8 GHz suitable for 5G testing applications, high-speed oscilloscopes, and direct X-band sampling for radar applications. In dual-channel mode, the ADC12DJ5200RF samples at 5.2 Gsps and captures instantaneous bandwidth as high as 2.6 GHz at 12-bit resolution. In single-channel mode, the ADC samples at 10.4 Gsps and captures IBW up to 5.2 GHz.

The ADC supports the JESD204C standard interface, which can reduce the numer of serdes lanes needed to output data to an FPGA. Offset error is ±300 µV with zero temperature drift and the ADC12DJ5200RF consumes 4-W, 20 percent lower than competitive ADCs, TI claims.

www.ti.com

50-W fixed attenuators

broadband

Response Microwave has announced its latest DC to 18-GHz, 50-W fixed attenuators for use in laboratory, military and telecom applications. The family includes 1 through 50 dB attenuation values that operate between DC to 18 GHz. Electrical performance offers typical insertion loss of 0.5 dB and VSWR of 1.45:1 maximum. The attenuators have an impedance value of 50 Ω, while power handling is 50-W CW and package size is 0.64-mm OD by 0.110-mm length.

Connectors are passivated stainless steel SMA male to female and alternate interfaces are available upon request. Units accommodate environmental extremes from –55° to +125° C and are RoHS compliant.

www.responsemicrowave.com